THE PORT AUTHORITY OF NY & NJ

PROCUREMENT DEPARTMENT
ATTN: BID/PROPOSAL CUSTODIAN
4 WORLD TRADE CENTER
150 GREENWICH STREET, 21ST Floor
NEW YORK, NY 10007

REQUEST FOR PROPOSALS

ISSUE DATE: February 12, 2016

TITLE: DESIGN, FABRICATE AND DELIVER FOUR (4) SWITCHING LOCOMOTIVES FOR PATH

RFP NO.: 45178

SUBMIT PROPOSALS NO LATER THAN THE DUE DATE AND TIME TO THE ABOVE ADDRESS

QUESTIONS DUE BY: FEBRUARY 26, 2016 TIME: 3:00 P.M.

PROPOSAL DUE DATE: MARCH 8, 2016 TIME: 2:00 P.M.

CONTRACTS SPECIALIST: Richard A. Grehl

PHONE: (212) 435-4633

EMAIL: rgrehl@panynj.gov

TABLE OF CONTENTS

1. INFORMATION FOR PROPOSERS ON THIS REQUEST FOR PROPOSALS 3

- **A. General Information: The Port Authority of New York and New Jersey 3**
- **B. Brief Summary of Scope of Work 3**
- **C. Deadline for Receipt of Proposals 4**
- **D. Vendor Profile 4**
- **E. Submission of Proposals 5**
- **F. Communications Regarding this RFP 5**
- **G. Proposal Acceptance or Rejection 5**
- **H. Union Jurisdiction 6**
- **I. City Payroll Tax 6**
- **J. Additional Proposer Information 6**
- **K. Contractor Staff Background Screening 6**
- **L. Automated Clearing House Enrollment 6**

2. SCOPE OF SERVICES 7

3. PROPOSER PREREQUISITES 7

4. FINANCIAL INFORMATION 8

5. EVALUATION CRITERIA AND RANKING 9

6. DISADVANTAGE BUSINESS ENTERPRISE (DBES) 10

7. CERTIFICATION OF RECYCLED MATERIALS PROVISION 10

8. PROPOSAL SUBMISSION REQUIREMENTS 11

9. CONDITIONS FOR THE SUBMISSION OF A PROPOSAL 14

10. ATTACHMENTS 18

1. INFORMATION FOR PROPOSERS ON THIS REQUEST FOR PROPOSALS

A. General Information: The Port Authority of New York and New Jersey

The Port Authority of New York and New Jersey (the "Port Authority" or the "Authority") is an agency of the States of New York and New Jersey, created and existing by virtue of the Compact of April 30, 1921, made by and between the two States, and thereafter consented to by the Congress of the United States. It is charged with providing transportation, terminal and other facilities of trade and commerce within the Port District. The Port District comprises and area of about 1,500 square miles in both States, centering about New York Harbor. The Port District includes the Cities of New York and Yonkers in New York State, and the cities of Newark, Jersey City, Bayonne, Hoboken and Elizabeth in the State of New Jersey, and over 200 other municipalities, including all or part of seventeen counties, in the two States. The Port Authority manages and/or operates all of the region's major commercial airports (Newark Liberty International, John F. Kennedy International, Teterboro, LaGuardia and Stewart International Airports), marine terminals in both New Jersey and New York (Port Newark and Elizabeth, Howland Hook and Brooklyn Piers); and its interstate tunnels and bridges (the Lincoln and Holland Tunnels; the George Washington, Bayonne, and Goethals Bridges; and the Outerbridge Crossing), which are vital "Gateways to the Nation."

In addition, the Port Authority operates the Port Authority Bus Terminal in Manhattan, the largest facility of its kind in the world, and the George Washington Bridge and Journal Square Transportation Center bus stations. A key link in interstate commuter travel, the Port Authority also operates the Port Authority Trans-Hudson Corporation (PATH), a rapid rail transit system linking Newark, and the Jersey City and Hoboken waterfronts, with midtown and downtown Manhattan. A number of other key properties are managed by the agency including but not limited to a large satellite communications facility (the Teleport) in Staten Island, and a resource recovery co-generation plant in Newark. Prior to September 11, 2001, the Port Authority's headquarters were located in the World Trade Center, and that complex is still owned and being partially redeveloped by the Authority.

The Port Authority is hereby seeking proposals from qualified firms to Design, Manufacture and Deliver Four (4) Switching Locomotives ("Locomotives") as more fully described herein.

This Agreement may be funded in whole or in part by the Federal Transit Administration ("FTA"). Accordingly, the Proposer agrees to comply with the applicable FTA requirements contained herein and upon award of the Agreement, firms will be required to comply with the Federal Transit Administration Requirements in Exhibit A.

B. Brief Summary of Scope of Work

The Work consists of, but is not limited to, design, manufacture and delivery of four (4) switching locomotives ("Locomotives") and associated spare parts, as further explained in the Specifications.

It is intended that the Locomotives be manufactured and delivered with all appurtenances.
Any reference to a specific product in these Contract Documents is to indicate approved products or details. Other products or details will be considered suitable if they meet the intent of the performance characteristic cited or are comparable to the product or detail cited. PATH shall be the sole judge of as to whether a proposed substitution will be approved, and no substitution shall be ordered or utilized without PATH's prior written approval. PATH may require the Contractor to

furnish, at the Contractor's expense, a special performance guarantee or other assurance with respect to any approved substitution. Furthermore, the approval of any substitute proprietary item or make shall not in any way entitle the Contractor to additional compensation therefor. If the Contractor fails to deliver a suitable approved equal that is acceptable to PATH, then the Contractor shall supply item as specified herein, as more fully described in the Specifications.

C. Deadline for Receipt of Proposals

The due date specified on the cover page is the Proposal Due Date. Closing of due date is 2:00 P.M., Eastern Standard Time (EST)

PLEASE READ THE FOLLOWING DELIVERY REQUIREMENTS CAREFULLY. Proposers assume all responsibility for delays or problems in delivery of proposals.

Proposal submissions will be received at:

The Port Authority of NY & NJ
Attention: Proposal Custodian
Procurement Department
4 World Trade Center
150 Greenwich Street, 21st Floor
New York, NY 10007

Clearly mark the solicitation number on the outermost package.

At this address, proposals will be accepted via (1) regular mail, (2) express delivery service (e.g. UPS), or (3) hand delivery.

Express carrier deliveries by commercial vehicles can be made via vendors approved by Silverstein Properties, the 4 World Trade Center (4 WTC) Property Manager, through the Vehicle Security Center (VSC). Presently, UPS is the only delivery vendor with approved recurring delivery times.

There is extensive security at the World Trade Center Site. Individuals must present a valid government-issued photo ID to enter 4 WTC. Individuals without valid identification shall be turned away and their packages not accepted. Individuals without packages or carrying small packages or boxes that can be conveyed by hand or on a hand truck may enter through the lobby. All envelopes, packages and boxes may be subject to additional security screening.

There is no parking available at 4 WTC/150 Greenwich Street, and parking in the surrounding area is extremely limited.

The Port Authority assumes no responsibility for delays caused by any delivery service.

D. Vendor Profile

To ensure maximum opportunities, it is vitally important that Proposers keep their vendor profiles up to date with an appropriate e-mail address, as this will enable their firm to receive timely notice of advertisements, reminders, solicitations and addenda. Proposers may update their vendor profile or register as a Port Authority Vendor by accessing the online registration system at https://panynjprocure.com/VenLogon.asp.

E. Submission of Proposals

One reproducible original (containing original signatures and clearly designated as such) and ten (10) double-sided copies of the proposal must be submitted on or before the due date and time in accordance with the information on the cover page of this RFP and sent or delivered to the RFP Custodian at the address specified on the cover page. Each copy of the proposal as well as the parcel(s) used for shipping must be conspicuously marked with the Proposer's name and address as well as the Proposer's Vendor Number, if available. In addition, the outside of the package must clearly state the title of this RFP, the number of this RFP and the Proposal Due Date. Failure to properly label proposal submissions may cause a delay in identification, misdirection or disqualification of proposal submissions.

Consistent with environmentally preferable procurement practices, the Port Authority requests all documents submitted to be in a form that can be easily recycled (i.e., no plastic covers or binding) and to provide only supporting literature which directly relates to the proposal being submitted.

F. Communications Regarding this RFP

All communications concerning this RFP should be directed to the Contracts Specialist listed on the cover page. All questions regarding this RFP should be submitted in writing to the Contracts Specialist at the address or facsimile number listed on the cover page no later than 3:00 p.m. (EST) on February 26, 2016.

The Contracts Specialist is authorized only to direct the attention of prospective Proposers to various portions of this RFP so that they may read and interpret such portions themselves.

Neither the Contracts Specialist nor any other employee of the Port Authority is authorized to interpret the provisions of this RFP or give additional information as to its requirements. If interpretation or other information is required, it will be communicated to Proposers by written addenda and such writing shall form a part of this RFP.

G. Proposal Acceptance or Rejection

Acceptance shall be only by mailing to or delivering at the office designated by the Proposer in its proposal, a notice in writing signed by an authorized representative on behalf of the Port Authority specifically stating that the proposal is accepted or by execution of an agreement covering the subject matter of this RFP signed by authorized representatives of the Port Authority and the Proposer. No other act of the Port Authority, its Commissioners, officers, agents, representatives, or employees shall constitute acceptance of a proposal. Rejection of a proposal shall be only by either (a) a notice in writing specifically stating that the proposal is not accepted, signed by an authorized representative of the Port Authority and mailed to or delivered to the Proposer at the office designated in the Proposal, or (b) omission of the Port Authority to accept the proposal within 180 days after the Proposal Due Date. No other act of the Port Authority, its Commissioners, officers, agents, representatives or employees shall constitute rejection of a proposal.

H. Union Jurisdiction

Proposers are advised to ascertain whether any union now represented or not represented at the facility will claim jurisdiction over any aspect of the operations to be performed hereunder and their attention is directed to the Section of this RFP entitled "Harmony" included in the "Standard Contract Terms and Conditions" hereunder.

I. City Payroll Tax

Proposers should be aware of the payroll tax imposed by the:

a. City of Newark, New Jersey for services performed in Newark, New Jersey;
b. City of New York, New York for services performed in New York, New York; and
c. City of Yonkers, New York for services performed in Yonkers, New York.

These taxes, if applicable, are the sole responsibility of the Contractor. Proposers should consult their tax advisors as to the effect, if any, of these taxes. The Port authority provides this notice for informational purposes only and is not responsible for either the imposition or administration of such taxes. The Port Authority exemption set forth in the Paragraph entitled "Sales or Compensating Use Taxes", in the "Standard Contract Terms and Conditions" included herein, does not apply to these taxes.

J. Additional Proposer Information

Prospective Proposers are advised that additional vendor information, including, but not limited to forms, documents and other information, including DBE Participation Plan Submission Forms and protest procedures, may be found on the Port Authority website at:
http://www.panynj.gov/business-opportunities/become-vendor.html

K. Contractor Staff Background Screening

The Contractor awarded this contract will be required to have its staff, who are working at PATH and Port Authority facilities, and any subcontractor's staff working under this Contract, authorize the Authority or its designee to perform background checks. Such authorization shall be in a form acceptable to the Authority. The Contractor (and subcontractor) may also be required to use an organization designated by the Authority to perform the background checks. The cost for said background checks for staff that pass and are granted a credential shall be reimbursable to the Contractor (and its subcontractors) as an out-of-pocket expense as provided herein. Staff that are rejected for a credential for any reason are not reimbursable.

As of January 29, 2007, the Secure Worker Access Consortium (S.W.A.C.) is the only Port Authority approved provider to be used to conduct background screening, except as otherwise required by federal law and/or regulation. Information about S.W.A.C., instructions, corporate enrollment, online applications, and location of processing centers can be found at http://www.secureworker.com, or S.W.A.C. may be contacted directly at (877)522-7922.

L. Automated Clearing House Enrollment

The Port Authority of New York and New Jersey is transitioning to an all electronic method of paying its vendors and contractors via an Automated Clearing House (ACH) funds transfer.

The Contractor must complete the Port Authority's "Authorization Agreement For Direct Deposits And Direct Payments (ACH Credits)" form, which is available at http://www.panynj.gov/business-opportunities/pdf/ach-authorization-form.pdf, in order to receive payment. To avoid delays in payments for commodities and services provided, vendors and contractors must be enrolled in ACH**. Printed accounts payable checks will not be issued.** The Authorization Agreement shall remain in full force and effect until the Port Authority has received written notification from the Contractor of its termination in such time and in such manner as to afford the Port Authority and the depository financial institution(s) a reasonable opportunity to act on it. Any questions on this initiative may be directed to the ACH Enrollments contact line at 201 216-6002 or emailed to ACHENROLLMENT@PANYNJ.GOV.

2. SCOPE OF SERVICES

The attached Specifications set forth the requirements for the performance, design, manufacturing, assembly, testing, delivery, and acceptance of **four (4)** single cab, heavy rail diesel-electric Switching Locomotives and associated spare parts. In addition, these Specifications include requirements concerning program management, compliance demonstration, product support, and data submittal.

Locomotives shall be single cab Locomotives with AC or DC traction motors.

The Specifications are generally complete and comprehensive, but are not intended to describe all work details to be performed and therefore must be supplemented by the Contractor's experience in building heavy rail locomotives, on its examination of PATH System, and on its detailed design and testing capabilities.

The Contractor shall be solely responsible for the detailed design of the Locomotives and shall provide Locomotivesthat are, in all respects, compliant with these Specifications.

The full Specifications are set forth in detail in **Attachment C – Locomotive Specifications** and **Attachment D – Information Technology Provisions**.

3. PROPOSER PREREQUISITES

Only Proposers who can demonstrate that they comply with the following should submit proposals as only proposals from such Proposers will be considered:

a. The Proposer shall have had at least five (5) years of continuous experience immediately prior to the date of submission of its proposal in a a business that fabricates, designs and manufactures locomotives of a similar design as required herein and during that time have actually engaged in providing said or such locomotives to commercial or industrial accounts under contract. The Proposer may fulfill this prerequisite if the Proposer can demonstrate to the satisfaction of the Port Authority that the persons or entities owning and controlling the Proposer have had a total of at least five (5) years of experience immediately prior to the date of the submission of its proposal in a business that fabricates, designs and manufactures locomotives of a similar design required herein and were actually engaged in providing such equipment to commercial or industrial accounts under contract during that time, or have

owned and controlled other entities which have actually engaged in providing the above-described equipment during that time period.

b. During the time period as stated in (a) above, the Proposer, or persons or entities owning and controlling the Proposer, shall have performed or be performing under at least one (1) contract(s) requiring similar equipment and services to those required under this Contract.

c. In the event a proposal is submitted by a joint venture the foregoing prerequisites will be considered with respect to such proposal as follows: The prerequisite in subparagraph (a) and (b) above, will be considered satisfied if the joint venture itself, or any of its participants individually, can meet the requirements. If a joint venture which has not been established as a distinct legal entity submits a bid, it and all participants in the joint venture shall be bound jointly and severally and each such participant in the joint venture shall execute the bid and do each act and thing required by this RFP. On the original proposal and wherever else the Proposer's name would appear, the name of the joint venture Proposers should appear if the joint venture is a distinct legal entity. If the proposer is a common law joint venture, the names of all participants should be listed followed by the words "acting jointly and severally". All joint venture Proposers must provide documentation of their legal status.

All Proposers must include documentation that they meet the above prerequisites.
By furnishing this solicitation document to Proposers, the Port Authority has not made a determination that the Proposers have met the prerequisites or have otherwise been deemed qualified to perform the services. In addition, a determination that a Proposer has met the prerequisites is no assurance that they will be deemed qualified in connection with other proposal requirements included herein.

4. FINANCIAL INFORMATION

The Proposer will be required to demonstrate that it is financially capable of performing the Agreement resulting from this RFP. The determination of the Proposer's financial qualifications and ability to perform this Agreement will be in the sole discretion of the Port Authority. The Proposer shall submit, with its Proposal, the following:

A. (1) Certified financial statements, including applicable notes, reflecting the Proposer's assets, liabilities, net worth, revenues, expenses, profit or loss and cash flow for the most recent calendar year or the Proposer's most recent fiscal year.

(2) Where the certified financial statements in (1) above are not available, then reviewed statements from an independent Certified Public Accountant setting forth the aforementioned information shall be provided.

Where the statements submitted pursuant to subparagraphs (1) and (2) aforementioned do not cover a period which includes a date not more than forty-five (45) days prior to the Proposal Due Date, then the Proposer shall also submit a statement in writing, signed by an executive officer or his/her designee, that the present financial condition of the Proposer is at least as good as that shown on the statements submitted.

B. A statement of work which the Proposer has on hand, including any work on which a bid and/or Proposal has been submitted, containing a description of the work, the annual dollar

value, the location by City and State, the current percentage of completion, the expected date for completion, and the name of an individual most familiar with the Proposer's work on these jobs.

The Proposer's Federal Employer Identification Number (i.e., the number assigned to firms by the Federal Government for tax purposes), the Proposer's Dun and Bradstreet number, if any, the name of any credit service to which the Proposer furnished information and the number, if any, assigned by such service to the Proposer's account.

5. EVALUATION CRITERIA AND RANKING

Each Proposal will be evaluated by a Selection Committee composed of Port Authority personnel experienced in the disciplines necessary to make a value judgment and decision regarding the technical qualifications of a proposing Firm and its oral presentation, if necessary.

The Selection Committee members will base their evaluation on selection criteria, which are listed below in relative order of importance.

A. Experience of the firm and personnel

B. Management Approach

C. Technical Proposal

D. Cost Proposal

Award will be made to the responsible Firm whose Proposal is most advantageous to the Authority. In determining which Proposal is most advantageous, the Authority will evaluate Proposals to determine which Proposal offers the greatest business value to the Authority based upon an analysis of the qualitative technical factors and price/cost in order to derive which Proposal represents the "best value" to the Authority. In the event that two or more Proposals are considered by the Authority to be equal or similar in their technical merit, the evaluated cost or price becomes more important; in such a case, cost or price may ultimately be the deciding factor. Accordingly, the Authority reserves the right to negotiate with one or more firms to determine the best value. The Authority not necessarily make an award to the Proposer with the highest technical ranking nor award to the Proposer with the lowest price proposal, if doing so would not be in the overall best interest of the Authority.

6. DISADVANTAGE BUSINESS ENTERPRISE (DBEs)

This Solicitation is subject to the United States Department of Transportation regulations on Disadvantaged Business Enterprises (DBEs) contained in Part 26 of Title 49 of the Code of Federal Regulations. The requirements for the DBE Program are located in **Attachment E: Contract Specific Terms and Conditions** of this Solicitation.

For more information on the Port Authority certification process, please refer to the following website: http://www.panynj.gov/business-opportunities/sd-become-certified.html.

7. CERTIFICATION OF RECYCLED MATERIALS PROVISION

Proposers shall submit, with their proposal, a written certification entitled, "Certified Environmentally Preferable Products / Practices" attached hereto as "Attachment G" attesting that the products or items offered by the Proposer contain the minimum percentage of post-consumer recovered material in accordance with the most recent guidelines issued by the United States Environmental Protection Agency (EPA), or, for commodities not so covered, the minimum percentage of post-consumer recovered materials established by other applicable regulatory agencies. The data submitted by the Proposer in Attachment G is being solicited for informational purposes only.

Recycling Definitions:

For purposes of this solicitation, the following definitions shall apply:

a. "Recovered Material" shall be defined as any waste material or by-product that has been recovered or diverted from solid waste, excluding those materials and by-products generated from, and commonly reused within, an original manufacturing process.

b. "Post-consumer Material" shall be defined as any material or finished product that has served its intended use and has been discarded for disposal or recovery having completed its life as a consumer item. "Post-consumer material" is included in the broader category of "Recovered Material".

c. "Pre-consumer Material" shall be defined as any material or by-product generated after the manufacture of a product but before the product reaches the consumer, such as damaged or obsolete products. Pre-consumer Material does not include mill and manufacturing trim, scrap, or broken material that is generated at a manufacturing site and commonly reused on-site in the same or another manufacturing process.

d. "Recycled Product" shall be defined as a product that contains the highest amount of post-consumer material practicable, or when post-consumer material is impracticable for a specific type of product, contains substantial amounts of Pre-consumer Material.

e. "Recyclable Product" shall be defined as the ability of a product and its packaging to be reused, reconditioned for use, or recycled through existing recycling collection programs.

f. "Waste Reducing Product" shall be defined as any product that will result in less waste generated due to its use rather than another product designed to serve the same function with an greater waste generation rate. This shall include, but not be limited to, those products that can be reused, refilled or have a longer life expectancy and contain a lesser amount of toxic constituents.

8. PROPOSAL SUBMISSION REQUIREMENTS

In order to expedite the evaluation of proposals, the Proposer's response to this RFP shall follow the format and order of items, using the same paragraph identifiers, as set forth below.

A. Letter of Transmittal

The Proposer shall submit a letter on its letterhead, signed by an authorized representative, stating its experience and qualifications in meeting the requirements of this RFP. This letter shall include a statement on whether the Proposer is submitting a proposal as a single entity, a joint venture, or is partnering with another firm in a prime/subcontracting relationship. In all cases, information required for a single entity is required for each participant in a joint venture.

The Letter of Transmittal shall contain:

(1) Name and address of the Proposer and an original signature on the Letter of Transmittal by an authorized representative on behalf of the Proposer;

(2) Name(s), title(s) and telephone number(s) of the individual(s) who are authorize to negotiate and execute the Contract;

(3) Name, title and telephone number of a contact person to which the Port Authority can address questions or issues related to this RFP;

(4) Name and address of proposed subcontractors, if any;

(5) If a corporation: (a) a statement of the names and residences of its officers, and (b) a copy of its Certificate of Incorporation, with a written declaration signed by the secretary of the corporation, with the corporate seal affixed thereto, that the copy furnished is a true copy of the Certificate of Incorporation as of the date of the opening of the Proposals;

If a partnership: a statement of the names and residences of its principal officers, indicating which are general and which are special partners;

If an individual: a statement of residence;

If a joint venture: information on each of the parties consistent with the information requested above; if the Contract is awarded to a common law joint venture (a partnership of business entities) each member will be jointly and severally liable under the Contract.

B. Executive Summary

The Proposer shall submit a summary presenting the major features of its proposal including a concept of design for the Locomotives and how the proposal satisfies the requirements contained in this RFP, as well as the special competencies and expertise of the Proposer to meet the requirements of this RFP.

C. Agreement on Terms of Discussion

The Proposer shall submit a copy of the "Agreement on Terms of Discussion," signed by an authorized representative of the Proposer. The Agreement format is included as Attachment A and shall be submitted by the Proposer without any alterations or deviations. Any Proposer who fails to sign the Port Authority's "Agreement on Terms of Discussion" will not have its proposal reviewed. If the Proposer is a joint venture, an authorized representative of each party must sign the Agreement.

D. Certifications With Respect to the Contractor's Integrity Provisions

The Proposer, by signing the Letter of Transmittal, makes the certifications in the "Contractor's Integrity Provisions," included as Part III of Exhibit B of the Standard Contract Terms and Conditions of this RFP. If the Proposer cannot make any such certifications, it shall enclose an explanation of that inability.

E. Documentation of Proposer Prerequisites

The Proposer shall submit documentation to demonstrate that it meets all prerequisites, if any, included herein.

F. Proposal

1. All proposals must be submitted in a concise format and must address, including but not limited to the following.

A. Experience of the firm and personnel

The potential of the proposer to provide the types of locomotive equipment required by PATH based on (a) the proposer's past experience in successfully providing similar design, fabrication, and delivery for similar switching locomotives, (b) the proposer's past experience in maintaining comparable systems following delivery; (c) the experience of the Contractor's Lead Engineer who will manage the design services, including but not to mechanical design, commissioning, and final acceptance testing of similar locomotives; and (d) indication of its success on past projects.

B. Management Approach

(a) Submit a proposed staffing plan and organizational structure and management approach to be used for this project, (b) a tracking system for deliverables, controlling costs, and management of the fabrication, (c) Procedures for keeping the PATH team informed of issues and progress during project, (d) approach to quality control (e) the proposer's DBE plan and the extent to which it meets or exceeds PATH DBE requirements

C. Technical Proposal

The ability of the proposer to meet the functional requirements of this RFP based on, among other things:

(a) an analysis of the proposer's design solutions, as represented by drawings, illustrations, catalog cuts, and other submittals intended to demonstrate the proposer's understanding of PATH's design guidelines. The proposal shall include a Summary of Design Criteria (SDC) to be reviewed and evaluated. The SDC shall establish and list all Codes, Standards, Guidelines and Regulations, material type, design methods, special requirements and conditions, and procedures, etc. to whichthe design of the Locomotive shall conform. (b) an analysis of the features of the switching locomotives proposed for this project, and the extent to which each of these addresses the technical specifications and requirements of the RFP.
(c) the anticipated requirements for maintaining the installed system.
(d) the proposed schedule for undertaking and completing the work,
(e) ability to meet the FTA Buy America requirements.

2. Cost Proposal

The cost to PATH for this switching locomotives project, based on (a) the proposer's proposal for design, fabrication, delivery, commissioning and warranty of the switching locomotives, (b) the proposed cost of required spare parts and any other recommended spare parts.

The cost proposal must be submitted on the form provided titled, **Attachment B – Cost Proposal**.

3. Background Qualification Questionnaire (BQQ) (To be submitted directly to the Office of the Inspector General)

The Proposer shall submit a completed Background Qualification Questionnaire (BQQ), required for itself and all subcontractors and vendors known to the Bidder at the time of bid submission. This document and instructions for submitting the completed BQQ to the Authority's Office of Inspector General can be obtained at the Authority's website through the following link: http://www.panynj.gov/wtcprogress/pdf/PANYNJ_OIG_WTC_BQQP.zip

4. FTA Proposal Submission Requirements

The following items are additional proposal submittal requirements: :

a. Certification Regarding Lobbying Pursuant to 31 U.S.C. 1352
b. Standard Form LLL - Disclosure of Lobbying Activities
c. Certification Regarding Debarment, Suspension, Ineligibility And Voluntary Exclusion - Lower Tier Covered Transactions
d. Buy America – Certification Requirement For Procurement of Buses, other Rolling Stock And Associated Equipment (Rolling Stock)
e. Certificate of Cost and Pricing Data contained in Part IV Pricing Sheet(s)
f. Appendix A1 DBE Goals Statement in accordance with Part III clause entitled "DBE Program"
g. Appendix A2 DBE Participation Plan and Affirmation Statement
h. Appendix A3 Information on Solicited Firms
i. Financial Information in accordance with Part I, Section 13 "Financial Information."

G. Acknowledgment of Addenda

If any Addenda are posted or sent as part of this RFP, the Proposer shall complete, sign and include with its Proposal the addenda form(s). In the event any Proposer fails to conform to these instructions, its proposal will nevertheless be construed as though the Addenda had been acknowledged.

If the Proposer downloaded this RFP document, it is the responsibility of the Proposer to periodically check the Port Authority website at http://www.panynj.gov/business-opportunities/bid-proposal-advertisements.html and download any Addenda that might have been issued in connection with this solicitation.

H. Acceptance of Standard Contract Terms and Conditions

The Port Authority has attached to this RFP as Attachment E – Contract Specific Terms and Conditions, Exhibit A – FTA Federal Transit Administration Requirements, and Exhibit B – Standard Contract Terms and Conditions governing the Contract. The Proposer is expected to agree with these Standard Contract Terms and Conditions. However, if the Proposer has any specific exceptions to the Exhibit B –Standard Contract Terms and Conditions, such exceptions should be set forth in a separate letter included with its response to this RFP. After the proposal due date, the Proposer will be precluded from raising any exceptions unless such exceptions are justified by and directly related to substantive changes in the business or technical requirements and are agreed to by the Proposer and the Port Authority.

9. CONDITIONS FOR THE SUBMISSION OF A PROPOSAL

In addition to all other requirements of this RFP, the Proposer agrees to the following conditions for the submission of its proposal.

A. Changes to this RFP

At any time, in its sole discretion, the Port Authority may by written addenda, modify, correct, amend, cancel and/or reissue this RFP. If an addendum is issued prior to the date proposals are due, it will be provided to all parties in the medium in which the parties obtained the RFP. If an addendum is issued after proposals have been received, the addendum will be provided only to those whose proposals remain under consideration at such time.

B. Proposal Preparation Costs

The Port Authority shall not be liable for any costs incurred by the Proposer in the preparation, submittal, presentation, or revision of its proposal, or in any other aspect of the Proposer's pre-contract activity. No Proposer is entitled to any compensation except under an agreement for performance of services signed by an authorized representative of the Port Authority and the Proposer.

C. Disclosure of Proposal Contents / Use of Ideas and Materials

Proposal information is not generally considered confidential or proprietary. All information contained in the proposal is subject to the "Agreement on Terms of Discussion" attached hereto as Attachment A.

D. Ownership of Submitted Materials

All materials submitted in response to or in connection with this RFP shall become the property of the Port Authority. Selection or rejection of a Proposal shall not affect this right.

E. Subcontractors

If a Proposer intends to use subcontractor(s) the Proposer must identify in its proposal the names of the subcontractor(s) and the portions of the work the subcontractor(s) will perform.

F. Authorized Signature

Proposals must be signed by an authorized corporate officer (e.g., President or Vice President), General Partner, or such other individual authorized to bind the Proposer to the provisions of its proposal and this RFP.

G. References

The Port Authority may consult any reference familiar with the Proposer regarding its current or prior operations and projects, financial resources, reputation, performance, or other matters. Submission of a proposal shall constitute permission by the Proposer for the Port Authority to make such inquiries and authorization to third parties to respond thereto.

H. Evaluation Procedures and Negotiation

Only Proposers which meet the prerequisites, if any, may have their proposals evaluated based on the evaluation criteria set forth in this RFP. The Port Authority may use such procedures that it deems appropriate to evaluate such proposals. The Port Authority may elect to initiate contract negotiations with one or more Proposers including negotiation of costs/price(s) and any other term or condition, including modifying any requirement of this RFP. The option of whether or not to initiate contract negotiations rests solely with the Port Authority.

I. Taxes and Costs

Purchases of services and tangible personal property by the Port Authority in the States of New York and New Jersey are generally exempt from state and local sales and compensating use taxes, and from most federal excises (Taxes). All costs associated with the Contract must reflect this exemption and be stated in U.S currency.

J. Most Advantageous Proposal/No Obligation to Award

The Port Authority reserves the right to award the Contract to other than the Proposer proposing the lowest price. The Contract will be awarded to the Proposer whose proposal the Port Authority believes, in its sole discretion, will be the most advantageous to the Port Authority. Neither the release of this RFP nor the acceptance of any response thereto shall compel the Port Authority to accept any proposal. The Port Authority shall not be obligated in any manner whatsoever to any

Proposer until a proposal is accepted by the Port Authority in the manner provided in the Section of this RFP entitled "Proposal Acceptance or Rejection."

K. Rights of the Port Authority

(1) The Port Authority reserves all its rights at law and equity with respect to this RFP including, but not limited to, the unqualified right, at any time and in its sole discretion, to change or modify this RFP, to reject any and all proposals, to waive defects or irregularities in proposals received, to seek clarification of proposals, to request additional information, to request any or all Proposers to make a presentation, to undertake discussions and modifications with one or more Proposers, or to negotiate an agreement with any Proposer or third person who, at any time, subsequent to the deadline for submissions to this RFP, may express an interest in the subject matter hereof, to terminate further participation in the proposal process by a Proposer or to proceed with any proposal or modified proposal, which in its judgment will, under all circumstances, best serve the Port Authority's interest. The Port Authority may, but shall not be obliged to, consider incomplete proposals or to request or accept additional material or information. The holding of any discussions with any Proposer shall not constitute acceptance of a proposal, and a proposal may be accepted with or without discussions.

(2) No Proposer shall have any rights against the Port Authority arising from the contents of this RFP, the receipt of proposals, or the incorporation in or rejection of information contained in any proposal or in any other document. The Port Authority makes no representations, warranties, or guarantees that the information contained herein, or in any addenda hereto, is accurate, complete, or timely or that such information accurately represents the conditions that would be encountered during the performance of the contract. The furnishing of such information by the Port Authority shall not create or be deemed to create any obligation or liability upon it for any reason whatsoever and each Proposer, by submitting its proposal, expressly agrees that it has not relied upon the foregoing information, and that it shall not hold the Port Authority liable or responsible therefor in any manner whatsoever. Accordingly, nothing contained herein and no representation, statement or promise, of the Port Authority, its directors, officers, agents, representatives, or employees, oral or in writing, shall impair or limit the effect of the warranties of the Proposer required by this RFP or Contract and the Proposer agrees that it shall not hold the Port Authority liable or responsible therefor in any manner whatsoever.

(3) At any time and from time to time after the opening of the proposals, the Port Authority may give oral or written notice to one or more Proposers to furnish additional information relating to its proposal and/or qualifications to perform the services contained in this RFP, or to meet with designated representatives of the Port Authority. The giving of such notice shall not be construed as an acceptance of a proposal. Information shall be submitted within three (3) calendar days after the Port Authority's request unless a shorter or longer time is specified therein.

L. No Personal Liability

Neither the Commissioners of the Port Authority, nor any of them, nor any officer, agent or employee thereof shall be charged personally with any liability by a Proposer or another or held liable to a Proposer or another under any term or provision of this RFP or any statements made herein or because of the submission or attempted submission of a proposal or other response hereto or otherwise.

M. Conflict of Interest

Individual Conflict of Interest: If the Proposer or any employee, agent or subcontractor of the Proposer may have a possible conflict of interest, or may give the appearance of a possible conflict of interest, the Proposer shall include in its proposal a statement indicating the nature of the conflict and submit a mitigation plan addressing that conflict. The Port Authority reserves the right to disqualify the Proposer if, in its sole discretion, any interest disclosed from any source could create a conflict of interest or give the appearance of a conflict of interest. The Port Authority's determination regarding any questions of conflict of interest shall be final.
It is envisioned and recommended that the following items/concepts be addressed in a proposed mitigation plan where a conflict or the appearance of a conflict of interest may in the future, or does currently exist:

1) A proposed organizational chart/structure/firewall designed to keep staff and resources separate, as specific by project, and to allow for no overlap between team members and resources including, but not limited to: equipment, materials, staffing, laydown areas, and office facilities on said projects.

2) Specific plan(s) intended to maintain the separation and integrity, as specific by project, of the following to include, but not be limited to: confidential and/or privileged information, documents, plans, drawings, estimates and other financial data.

3) Specific plan to maintain proper and independent billing procedure(s) designed to address the avoidance of double and improper billings.

4) Specific plan to educate employees, on all levels, of the importance of said mitigation plan to promote the awareness and importance of mitigation and its roll in preventing fraud, waste, and abuse, and verification of such education/training and individual understanding.

5) Specific plan to internally oversee and/or audit the above-listed plans and procedures to ensure compliance.

6) Specific contingency plan, notification, and approval process for cases where there is a necessary, reasonable, and business related purpose for overlap in and/or sharing of staff members and/or resources.

7) Specific contingency plan addressing a direct or suspected violation of said mitigation plan. All violations must be reported to the Port Authority, including its Inspector General.

8) The Contractor shall ensure that any subconsultant/subcontractor must cooperate with the Port Authority's Inspector General and its Integrity Monitor, in auditing the mitigation plan for compliance. This cooperation must include access to all necessary documentation and interviews of employees.

The Authority reserves the right to disqualify the Proposer if, in its sole discretion, any interest disclosed from any source could create a conflict of interest or give the appearance of a conflict of interest. The Authority's determination regarding any questions of conflict of interest will be final.

As used herein, "Integrity Monitor" shall mean a private firm hired to assist the Office of Inspector General in preventing and detecting fraud. There are two applications for an Integrity Monitor. First, an Integrity Monitor is assigned to prevent or detect fraud on a specific project - for example

all Port Authority projects at the World Trade Center site have an integrity monitor. Second, the Port Authority has required contractors with integrity issues to retain at their own cost an Office of Inspector General-approved Integrity Monitor as a condition of being awarded contracts.

N. Organizational Conflict of Interest

(1) The resultant contract to this RFP may give rise to a potential for an organizational conflict of interest. An organizational conflict of interest exists when the nature of the work to be performed under the Agreement may, without some form of restriction on future activities, result in an unfair competitive advantage to the Proposer.

a. The Contractor shall have access to confidential and/or sensitive Authority information in the course of performing this Agreement. Additionally, the Contractor may be provided access to proprietary information obtained from other contracted entities during Agreement performance. The Contractor agrees to protect all such information from disclosure even after Contract expiration or termination unless so authorized, in writing, by the Authority and to refrain from using such information for any purpose other than that for which it was furnished.

b. To the extent that the Contractor either (i) uses confidential and/or sensitive Authority information or proprietary information obtained from other Authority contractors to develop any form of document, report, or plan that is determined by the Authority to be the basis, in whole or in part, of any subsequent solicitation issued by the Authority or (ii) develops written specifications that are used in any subsequent solicitation issued by the Authority, the Contractor agrees that it shall not be eligible to compete for such subsequent solicitation(s) as a prime or principal contractor or as part of any teaming arrangement unless the Authority provides, in writing, a specific waiver of this restriction. The duration of any restriction imposed under this subparagraph shall not exceed the length of the initial performance period of any subsequently awarded contract for which the Contractor was ineligible to complete.

(2) A Proposer, by submitting its proposal, agrees to the above stated conditions and terms and further agrees to perform all duties under the contract and, in doing so, agrees not to enter into contractual agreements with Authority prime contractors and first-tier subcontractors in such a way as to create an organizational conflict of interest.

(3) If the Authority determines that a Contractor has violated any term of this clause entitled "Organizational Conflict of Interest", the Authority may take any appropriate action available under the law or regulations to obtain redress including, but not be limited to, requiring the Proposer to terminate any affiliation or contractual arrangement with an Authority prime contractor or first-tier subcontractor at no cost to the Authority, determining the Proposer ineligible to compete for or be awarded any subsequent or "follow-on" contracts that may be based upon the Proposer's actions under the resultant Contract or violations of this numbered clause, or terminating such contract, in whole or in part.

10. ATTACHMENTS

Attachment A: Agreement on Terms of Discussion
Attachment B: Cost Proposal Form
Attachment C: Locomotive Specifications
Attachment D: Locomotive Information Technology Requirements
Attachment E: Contract Specific Terms and Conditions
Exhibit A: Federal Transit Requirements
Exhibit B: Standard Contract Terms and Conditions

Attachment F: DBE Program Attachments
Attachment G: Certified Environmentally Preferable Products/Practices

ATTACHMENT A

AGREEMENT ON TERMS OF DISCUSSION

The Port Authority's receipt or discussion of any information (including information contained in any proposal, vendor qualification(s), ideas, models, drawings, or other material communicated or exhibited by us or on our behalf) shall not impose any obligations whatsoever on the Port Authority or entitle us to any compensation therefor (except to the extent specifically provided in such written agreement, if any, as may be entered into between the Port Authority and us). Any such information given to the Port Authority before, with or after this Agreement on Terms of Discussion ("Agreement"), either orally or in writing, is not given in confidence. Such information may be used, or disclosed to others, for any purpose at any time without obligation or compensation and without liability of any kind whatsoever. Any statement which is inconsistent with this Agreement, whether made as part of or in connection with this Agreement, shall be void and of no effect. This Agreement is not intended, however, to grant to the Port Authority rights to any matter, which is the subject of valid existing or potential letters patent.

Any information (including information contained in any proposal, vendor qualification(s), ideas, models, drawings, or other material communicated or exhibited by us or on our behalf) provided in connection with this procurement is subject to the provisions of the Port Authority Freedom of Information Code and Procedure adopted by the Port Authority's Board of Commissioners on October 22, 2014, which may be found on the Port Authority website at: http://www.panynj.gov/corporate-information/pdf/foi-code.pdf. The foregoing applies to any information, whether or not given at the invitation of the Authority.

_____
(Company)

_____
(Signature)

_____
(Title)

_____
(Date)

ORIGINAL AND PHOTOCOPIES OF THIS PAGE ONLY.
DO NOT RETYPE.

ATTACHMENT B – COST PROPOSAL

NAME AND RESIDENCE OF PRINCIPALS SHEET AND PRICING SHEET(S), TABLE OF CONTENTS

1. PRICING SHEET(S) 2
   Entry of Prices 2
   Pricing Sheet 3

(Do not give business address)

1. PRICING SHEET(S)

Entry of Prices

a. The prices quoted shall be written in figures, in ink, preferably black ink, where required in the spaces provided on the Pricing Sheet(s) attached hereto and made a part hereof. Prices must be quoted in United States Dollars. All figures inserted will be interpreted as being quoted in United States Dollars.

b. All Respondents are asked to ensure that all charges quoted for similar items in the Contract are consistent.

c. Prices must be submitted for each Item required on the Pricing Sheet(s).

Pricing Sheet

Item No.	Description	Estimated Qty	Unit	Unit Price	Estimated Delivered Price
1	Locomotives	4	each	$_____	$_____
2	Spare Parts	4	lot	$_____	$_____
	ESTIMATED TOTAL DELIVERED CONTRACT PRICE:				$_____

LEAD TIME:

Indicate lead-time necessary for completion of fabrication, testing and delivery of equipment (see Part III, paragraph entitled "Delivery Requirements"):

_____ Weeks after return of approval drawings

Proposer shall certify in the form prescribed below that, to the best of its knowledge and belief, the cost or pricing data submitted was accurate, complete and current.

CERTIFICATE OF CURRENT COST OR PRICING DATA:

This is to certify that, to the best of my knowledge and belief, the cost or pricing data submitted, either actually or by specific identification in writing, to The Port Authority of NY & NJ or to The Port Authority of NY & NJ's representative in support of:

RFP No. 45178 are accurate, complete, and current as of [Insert Date].

This certification includes the cost or pricing data supporting any advance agreements and forward pricing rate agreements between the offeror and The Port Authority of NY & NJ that are part of the bid.

Firm: _____

Name: _____

Signature: _____

Title: _____

Date: _____

RFP # 45178

ATTACHMENT C

PATH LOCOMOTIVE SPECIFICATIONS

TABLE OF CONTENTS

Section	Title	Page
1	SCOPE OF SPECIFICATION	2
2	SYSTEM DESIGN	20
3	LOCOMOTIVE CONSTRUCTION AND ASSEMBLY	34
4	TRUCKS AND SUSPENSION	60
5	COUPLER EQUIPMENT	76
6	CAB AND CAB CONTROLS	78
7	TRAINLINE CONTROL	92
8	MONITORING AND DIAGNOSTIC SYSTEMS	94
9	AUXILIARY ELECTRICAL EQUIPMENT	100
10	PROPULSION EQUIPMENT	104
11	AIR BRAKE SYSTEM	118
12	HEATING, VENTILATION AND AIR CONDITIONING	126
13	COMMUNICATIONS	133
14	LIGHTING SYSTEMS	136
15	WORKMANSHIP, PROCESSES AND MATERIALS	139
16	SOFTWARE SYSTEMS	207
17	COMPLIANCE PROGRAM	216
18	SYSTEM ASSURANCE	254
19	CONTRACT MANAGEMENT	269
20	IN-SERVICE SUPPORT	289

APPENDIX A AND B – ATTACHMENTS FOR COMPUTER BASED TRAIN CONTROL

Attachment D – INFORMATION TECHNOLOGY PROVISIONS

Drawing No.	Drawing Title
L1-000	Drawing Index
P-0001	PATH PA4 CARBODY KINOMATIC ENVELOPE
P-0002	PATH – Dimension Diagram
P-0003	PATH –PA4 Clearance Limiting Outline – Undercar
P-0004	PATH – PA4-Static Envelope
P-0005	PATH – Tunnel and outside Area P-0006
	PATH – Elevation of Contact Rail and Protection Board Tunnel
P-0007	PATH – Assembly of Contact Rail and Protection Board Tunnel
P-0008	PATH- Location of Contact Rail in Highest Position
P-0009	PATH- Automatic Train Stop Tripper Arm – Sheet 1 of 2 (there is no sheet 2 of 2)
P-0010	PATH Coupler Arrangement
P-0011	PATH – Ohio Brass Coupler Coupler Head Assembly Form 8501
P-0012-A & B	PATH PA-4 “RT-2” Brake Equipment
P-0013	PATH- Flatcar Electrical Circuit

SECTION 1

1.0 SCOPE OF SPECIFICATION

1.1 General

These Specifications set forth the requirements for the performance of design, manufacturing, assembly, testing, delivery, and acceptance of four (4) single cab, heavy rail diesel-electric Switching Locomotives (hereafter Locomotives). In addition, these Specifications include requirements concerning program management, compliance demonstration, product support, and data submittal.

Locomotives shall be single cab Locomotives with AC or DC traction motors.

These Specifications are generally complete and comprehensive, but are not intended to describe all work details to be performed and therefore must be supplemented by the Contractor's experience in building heavy rail locomotive, on its examination of PATH System, and on its detailed design and testing capabilities.

References to commercial, industrial and PATH standards, specifications and recommendations, whether stated or not stated as the latest revision, pertain to the version in effect at the time of the proposal opening.

References to Specification sections within these Specifications are provided for convenience. If errors exist, or references are incomplete, the Contractor shall bring it to PATH’s attention, in writing, for clarification.

If at any time the Contractor finds that any requirement of these Specifications appears to be in error or in conflict with the general intent of these Specifications, then it shall immediately bring the apparent problem to PATHs attention, in writing. PATH will determine whether or not the Specification needs to be modified.

The Contractor shall be solely responsible for the detailed design of the Locomotive and shall provide a Locomotive, which is in all respects compliant with this Specification.

1.2 Work To Be Done

The Contractor shall design, furnish and deliver a diesel-electric Locomotive complete with all accessories and appurtenances as specified herein, and shall do all work including incidental and miscellaneous work set forth in the Contract Documents. The Locomotive shall be compliant with USA EPA Tier 4 Emissions. The Locomotive shall be designed to pull a 260-ton work car consist, which includes the weight of the Locomotive. Each Locomotive shall be a self-propelled single unit capable of operating in either direction. The Locomotive shall be designed for a minimum of 35-year service life.

The details of the work are given in the Technical Specifications (hereafter Specifications) and Contract Appendices herein mentioned which form a part of this Contract.

The Locomotive to be furnished and delivered under this Contract shall be designed for use on

the rapid rail transit lines of Port Authority Trans-Hudson Corporation (hereafter PATH). These Specifications are intended to set forth the performance requirements for the Locomotive. The Contractor is solely responsible for its design, arrangement, construction, satisfactory operation and conformance to the Contract Documents in a manner, which is consistent with the best engineering and construction practices.

The Locomotives, as herein specified, shall be delivered to a location on PATH property as designated by the Project Manager. Spare parts shall be delivered as follows:

PATH Harrison Car Maintenance Facility
Foot of Cape May Street
Harrison NJ 07029
Attention: Storeroom Supervisor

Parts which in the course of the normal operation and maintenance will require replacement or repair shall, whenever possible, be standard stock items. Non-standard items shall be designed for ease and speed of fabrication, long wearing and low maintenance. Sufficient drawings and/or technical information shall be submitted to the Project Manager to permit PATH to obtain or have the parts fabricated from other than the original equipment manufacturer except for proprietary equipment for which information for form, fit and function shall be provided. The Contractor shall submit a list of all items that are considered proprietary equipment with the Proposal, and the list shall be updated thereafter, on a monthly basis, beginning thirty (30) days after the Notice of Award date. The Contractor shall identify all the proprietary equipment and all off shelf software in the Proposal.

Where required, the Contractor shall submit documentation (drawings, analyses, etc.) with detailed technical information in order to demonstrate specification compliance. PATH's review, comments, or approval will not relieve the Contractor of his sole responsibility for the Locomotive's design. In addition, if requested by the Project Manager, the Contractor shall submit any additional documentation.

1.3 Compatibility Requirements

The Locomotives shall be capable of mechanically, pneumatically and electrically coupling with PATH’s PA4 work cars as well as mechanically and pneumatically coupling with all other existing PATH work car classes including PATH’s flat cars and ballast cars, through the use of the mechanical coupler. The Locomotives shall be compatible with the existing signal system and the CBTC system used on PATH. The Locomotives shall be capable of mechanically coupling to PATH’s PA5 passenger cars. When each Locomotive is mechanically coupled with any existing PATH PA5 passenger car(s) it does not have to control the brake system on these passenger cars.

1.4 Materials

Materials for the construction of the Locomotives shall be selected to obtain the maximum strength and reliability balanced against minimum weight and reasonable costs consistent with the Specifications. All materials shall be of sufficiently robust design and implementation to survive continuous 24-hour service and multi-person utilization. Components expected to withstand extensive handling include control handles, door latches, key switches, knobs, and buttons. All materials and equipment furnished by the Contractor shall be new and shall be subject to inspection by PATH. However, it shall be the Contractor's full responsibility for

inspection and quality of material and workmanship (see Section 15).

1.5 Microprocessor Hardware and Software

PATH requires the integration of microcomputer design, compatibility and documentation. This necessitates a high level of both technical management and technical guidance by the Contractor of the various sub-suppliers of microprocessor based equipment. The Contractor shall dedicate experienced people who are knowledgeable about the state-of-the-art use of microprocessor hardware and software in real time control systems design. Successful integration shall eliminate undesired redundant hardware and software, while providing optimum functionality and diagnostics.

1.6 Definitions and Abbreviations

1.6.1 Definitions

The following terms used in the Contract Documents shall, except where, by the context, it is clear that another meaning is intended, be construed as follows:

"Addenda" or" Addendum" shall mean revisions to the Contract documents, issued in writing by the Authority, subsequent to the issuance of the RFP and prior to the Award Date.

"Allowable Stress" shall mean the maximum stress permitted in a structure under specified design conditions. The allowable stress is less than the stress causing damage because of various factors, including: (a) uncertainty as to conditions of service, e.g., loads and forces imposed during the lifetime of the structure, (b) non-uniformity of material, and (c) inaccuracy of stress analyses.

“Anti-climber" shall mean a structural reinforcement at each car end to discourage either car in an end-to-end collision from overriding the other.

"Approved or Approved Type" shall mean the Contractor's design, type of material, procedure, or method given approval by PATH.

"Automatic Stop Arm" shall mean a mechanical device located on the wayside that when activated by the signal system places the passing car in emergency braking.

“Auxiliary System" shall mean any mechanism or structure, other than the carbody, which functions during Locomotive operation, e.g., lighting, communications, etc.

"Award Date" shall mean the date the Notice of Award is issued.

"Baseline Design" shall mean the design of the Locomotive or any of its components, apparatus, systems, subsystems, or materials which has received both drawing approval and first article approval by PATH.

"Braking, Emergency"-shall mean braking that results in an irrevocable open-loop friction braking effort to a stop, at the maximum design brake rate.

"Braking Full Service" shall mean a non-emergency brake application which obtains the

maximum brake rate consistent with the design of the primary brake system.

"Braking, Open-Loop" shall mean braking without a feedback control.

"Buff Load" shall mean a horizontal compressive load applied by the Locomotive, usually along the car centerline at the couplers or anti-climbers.

"Calculations" shall mean numerical computations performed to demonstrate compliance with the Specifications.

"Carbody" shall mean the underframe, decking, and all associated appurtenances.

"Change Order" shall mean a written order by the Port Authority to make changes within the general scope of this Contract in any one or more of the following: (a) drawings, designs, or specifications; (b) method of shipment or packing; and (c) place of delivery.

"Circuit Vital" shall mean any circuit that affects the safety of the Locomotive's operations.

"Comment" shall mean written critiques of the Contractor's submittals to PATH.

"Commercial Test" shall mean a test to determine if the equipment has been manufactured in accordance with the Specifications, within permitted tolerances and that all normal safety and quality assurance procedures have been met.

"Communications-Based Train Control" shall mean an automatic train control system, comprised of wayside and on board vital microprocessors and a high capacity, bi-directional, radio-based train-to-wayside communications network, capable of providing Automatic Train Protection and Automatic Train Operation functions.

"Component" shall mean parts, devices, and structure performing a distinctive function necessary to the operation of a subsystem or system.

"Conditional Acceptance" shall mean acceptance of any of the delivered Locomotives by the Project Manager on condition that the Contractor make repairs or other corrective action necessary to remedy any Open Items, such as defects or deficiencies.

"Consumable Items" shall mean those parts, components and materials of a particular system which, pursuant to the manufacturer's maintenance manual, are required to properly maintain such system for a one-year period.

"Contract Data Requirements List or" or "CDRL" shall mean each and every item to be delivered by the Contractor to PATH as defined in this Technical Specifications.

"Contract Drawings" shall mean drawings provided by PATH as part of the Contract Documents.

"Contractor's Drawings" shall mean items such as general arrangement drawings, detail drawings, graphs, diagrams and sketches which are prepared by the Contractor to detail its work.

"Critical Area" shall mean the region of a structure requiring higher than normal quality of material and manufacture because stresses are at or near the limits of allowable stresses.

"Critical System" shall mean each of the following: the power plant, friction brakes, trucks and hydraulic system.

"Day" or "day" shall mean one calendar day including Saturday, Sunday and Authority observed holidays, unless otherwise specified.

"Days, Working" shall mean those calendar days during which regular business is conducted, excluding Saturdays and Sundays and all PATH -observed Federal, State, and municipal holidays.

"Deliverables" shall mean all materials and equipment furnished by the Contractor to PATH under the terms of this Contract including but not limited to drawings, documents, samples, data, special tools or test equipment.

"Dead Load" shall mean weight at the rail of a fully equipped Locomotive.

"Diagnostic Test Equipment (DTE)" shall mean any test equipment, whether portable or not.

"Directed," "required," "permitted," "ordered," "designated," "selected," "prescribed," or words of like import used in the Specifications or upon the drawings (if any) shall mean, respectively, the direction, requirement, permission, order, designation, selection or prescription of the Project Manager; and similarly the words "approved," "approved manner," "approval," "acceptable," "satisfactory," "equal," "necessary," or words of like import shall mean, respectively, approved by, or acceptable or satisfactory to, or equal, or necessary in the opinion of the Project Manager.

"Display" shall mean an electronic device that visually presents textual and/or graphical information to a human operator in a computer-generated format; may also include provision for operator input.

"Draft Load" shall mean a tensile load applied to the Locomotive through the couplers; the opposite of Buff Load.

"Duty Cycle" shall mean the period or percentage of time associated with the activated state of operation, occurring during normal cyclic operations, in relation to the elapsed time of a full cycle.

"Dynamic Outline" shall mean the largest dimensional cross sectional area generated by a moving Locomotive under worst-case conditions.

"Endurance Limit" shall mean the maximum stress in a material that can be completely reversed an infinite number of times without causing fracture.

"Factor of Safety" shall mean the ratio of the design load to the load that would cause failure of a structure.

"Fail-Safe" shall mean a characteristic of a system, component, or device which ensures that any malfunction affecting safety will cause the system to revert to a state that is known to be safe.

"Failure" shall mean a malfunction or condition, which, in the sole determination of the Authority, jeopardizes the safety of the crew or the acceptable functions of the equipment.

"Fatigue" shall mean failure of a structure by progressive fracture under large number of repetitions of stress considerably less than the yield stress.

"Field Modification" shall mean any change, alteration, adjustment, or modification to the equipment or any part not done at the original manufacturer's plant.

“Final Inspection” shall mean PATH’s final on-site inspection to determine whether, after all of the post-delivery acceptance tests as set forth in the Contract Documents have been completed, the Locomotive complies with all of the specifications and requirements stated in the Contract and Drawings.

"First Article" shall mean the first one of any production components of the Locomotive that is produced. The Specifications require nothing be manufactured prior to approval; therefore, the First Article shall have been made to approved drawings.

"First Article Approval" shall mean the examination of and approval by PATH of a First Article, , including a part, major assembly, subassembly, system, subsystem, apparatus, or material, manufactured or assembled by either the Contractor or subcontractors.

"First Article Inspection (FAI)" shall mean an inspection that goes beyond the regular inspection of a First Article, which accomplishes two purposes:

- First, it permits PATH to see, in three dimensions, what could be seen only on two-dimensional drawings up to that point if the First Article Inspection is of a component that the Contractor is purchasing, rather than making itself, the First Article Inspection discloses details that were not visible beforehand. The First Article Inspection is usually the first point at which maintainability of the component can be evaluated, inasmuch as it is the first point at which relationships between elements can be appreciated. PATH may approve the design that is revealed at the First Article Inspection, or may require changes in order that the component can meet the requirements of the Contract.

- Second, it is used to establish the quality level of workmanship that will be maintained for the balance of the components. The level is established jointly by PATH and the Inspector.

“FRA” shall mean the Federal Railroad Administration of the United States Department of Transportation.

"Gauge Track" shall mean the distance between the inside face of rails measured 0.626 inch (15.9 mm) below the top of the running rails at right angles thereto.

"Ground Speed" shall mean the speed (If of he Locomotive relative to the ground it transverses in a given period of time.

“Holidays” shall mean New Years Day, Martin Luther Kings Birthday, Presidents Day, Memorial Day, 4th of July, Labor Day, Columbus Day, Veterans Day, Thanksgiving Day after Thanksgiving, Christmas Day.

"HUMP" shall mean a railroad classification yard in which the classification of cars is accomplished by pushing them over a summit, known as a "hump," beyond which they run by

gravity.

"Indicated" shall mean, "as shown on the Concept Drawings," or "as described in the Contract Documents."

"Inspector" shall mean any representative of the Project Manager designated to act as an Inspector for PATH for the purposes of quality assurance.

"Interchangeable" shall mean that two, modules or components that, although possibly of different design, perform identical functions and have identical interface characteristics.

"Interface"shall mean the points where two or more systems, subsystems or structures meet, transfer energy or transfer information.

"Law" shall mean the Constitution of the States of New York, New Jersey, and each and every other law, rule, regulation, requirement, order, judgment, decree, or ordinance of every kind 7whatsoever issued by any government entity, applicable to or affecting the Contract, the Work and all persons engaged in the Work (including any of the foregoing which concern health, safety, environmental protection, and non-discrimination).

"Legal Proceeding" shall mean every action, litigation, arbitration, administrative proceedings, and other legal or equitable proceeding of any kind whatsoever.

"Liens" shall mean any and every lien of any kind whatsoever against the Work, any monies due or to become due from the Authority to Contractor, and/or any other property of the Authority, for or on account of the Work, including any public lien.

"Live Load" shall mean weight at the rail of the crew and stock of a fully equipped Locomotive.

"Locomotive" as used herein shall mean a self-propelled vehicle that runs on rails and is used for moving Cars in a work train for purposes of PATH maintenance, which is in all respects compliant with the Technical Specifications. Reference to each Locomotive shall apply to all four (4) Locomotives to be provided hereunder.

"Maintainability" shall mean a characteristic of design and installation, expressed as the probability that an item shall be restored to a specified condition within a given period of time when maintenance is performed in accordance with prescribed procedures and resources.

"Maintenance Corrective" shall mean repair or replacement of components as a result of failure.

"Maintenance Scheduled" shall mean inspection and repair or replacement of components at intervals measured by time or usage.

"Major Supplier" shall mean a supplier of a System or of a Subsystem of a System.

"Manufacturer" See "Supplier."

"Mil-Std." shall mean Military Standard.

"Modification" See "Change Order".

"Modified Goodman Diagram" shall mean a diagram used to determine allowable stresses in a structure under fatigue design loads.

"New Jersey State" shall mean the State of New Jersey.

"New York State" shall mean the State of New York.

"No. 1 End" shall mean the end of the Locomotive where the cab is located.

"No.2 End" shall mean the end of Locomotive opposite to the No. 1 End.

"Noise Level" shall mean, as defined by the latest version of ANSI AI.4, the weighted sound pressure level measured by the use of a metering characteristic and weighting A, B, or C as specified in ANSI AI.4. The unit of noise level is the decibel (dB), and the reference pressure is 20 micropascals.

"Notice" or "notice" shall mean a written notice.

"Notice of Acceptance" shall mean a written notice given by the Project Manager to the Contractor certifying that all post-delivery acceptance tests as set forth in the Contract Documents have been successfully completed.

"Notice of Arrival" shall mean a written certification given by PATH that the entire Locomotive and all its systems and sub-systems, including; the trucks, have been delivered to the designated points.

"Notice of Award" shall mean a document that apprises the Contractor that this Contract has been approved by PATH.

"Notice for Inspection" shall mean a written certification issued by the Contractor notifying the Project Manager that each delivered Locomotive is ready for PATH on-site inspection.

"Notice of Rejection" shall mean a written notice issued by the Project Manager to the Contractor rejecting any or all Locomotive(s) where the Contractor failed to provide a Locomotive that meets the Technical Specifications or failed to remedy the respective Open Items as set forth in the Contract Documents.

"Open Items" shall mean minor defects or deficiencies on a Locomotive that has otherwise passed all required post-delivery Acceptance Tests, that the Contractor must correct in order to receive a Notice of Acceptance from the Project Manager.

"Operator" shall mean the individual who normally occupies the cab of a Locomotive and is responsible for performing functions necessary for Locomotive operation, movement and monitoring.

"Original Equipment Manufacturer" or "OEM" shall mean the standards, requirements, and recommendations of the respective Manufacturer.

"Party" or "Parties" shall mean entity(ies) entering into the Contract.

"Particulates" shall mean finely divided solid matter.

"Portable Test Equipment (PTE)" shall mean laptop computers for testing the Locomotive operation and all of its intelligent subsystems.

"Project Manager" shall mean the individual designated by PATH to administer the technical and payment aspects of this Contract or his duly authorized representative and any successor or successors duly appointed or any deputy or substitute for him who shall be appointed by PATH.

"Proof" (used as a suffix) shall mean an apparatus which is constructed, protected, or treated, i.e., splash proof, dustproof, so that its successful operation is not interfered with when subjected to the specified material or condition.

"Qualification Test" shall mean tests conducted to demonstrate compliance with Specification design requirements at operating and environmental extremes. These tests shall be performed on the first Locomotive only and at the Contractor's plant.

"Quality Assurance" shall mean the planned and systematic pattern of all actions necessary to provide adequate confidence that the end items will perform in accordance with original manufacturer's specifications and in accordance with the requirements set forth in these contract documents in actual operations.

"Quality Control" shall mean the discipline that ensures the manufacture of a product in accordance with specification requirements.

"Ready-to-Run" shall mean a Locomotive, ready for operation, with all the fluids filled, with all ancillary equipment.

"Redundancy" shall mean the existence of more than one means of accomplishing a given function.

"Reliability" shall mean the probability of performing a specified function without failure and within design parameters for the period of time specified under actual operating conditions.

"Roll" shall mean transverse rotational motion of a Carbody about a longitudinal axis.

"Safe" shall mean the condition in which the Locomotive Operator, crew, or repairmen is secure from threat or danger, harm, or loss arising from improper design, manufacture, assembly, malfunction, or failure of the Locomotive or any of its components or systems.

"Service" or "Service Use" shall mean the operation of the Locomotive under normal conditions.

"Standard Generalized Markup Language (SGML)" shall mean a vendor-neutral international standard for information exchange, incorporating hypertext.

"State" –See "New York State" and "New Jersey".

"Stop, Emergency" shall mean the stopping of a Locomotive by an emergency brake application.

"Subcontractor" shall mean an individual or organization that enters into a contract to furnish labor or services only or labor and materials or apparatus in connection with the Work directly or indirectly for or in behalf of the Contractor and whether or not in privity of Contract with the Contractor.

"Subsystem" shall mean a combination of components, parts and/or subsystems, whether or not mechanical in nature, which, when performing together or taken as a whole constitutes or provides the discrete function of a system of a Locomotive. For purposes of this definition, a component, part or other subsystem comprising a given subsystem may also comprise a different subsystem.

"Superelevation" shall mean the amount by which the outer rail within a curve is higher than the inner rail. Usually measured in inches.

"Supplier" shall mean an individual or organization that furnishes materials, equipment or supplies to the Contractor either directly or indirectly, for incorporation in the Work.

"System" shall mean a combination of subsystems components and/or parts whether or not mechanical in nature, which, when performing together or taken as a whole constitutes or provides a discrete operation, function or subdivision of a Locomotive. For purposes of this definition, a subsystem, component, or part comprising a given system may also comprise a different system.

"Tamperproof"" shall mean fasteners which are designated as tamperproof when they are selected so that they cannot be easily loosened with common tools such as a flat blade screwdriver, Phillips screwdriver, or pliers.

"Technical Specifications," "Specifications." or "specifications" shall mean that portion of the Contract Documents that detail the technical requirements for the supply of the Locomotive and associated equipment, including any changes or addenda made.

“Tight” (used as a suffix) shall mean an apparatus designated as watertight, dust-tight, etc., when so, constructed that the enclosing case will exclude the specified material.

"Track Tests" shall mean tests of the Locomotive or any subsystem which is run on PATH's track or a track simulating, as much as practicable, the actual track conditions found on PATH's system to verify performance parameters of the Specifications.

"Train" shall mean a configuration of at least 2 Work Cars to be used in service.

"Trainline" shall mean a wire, or bus, for transmitting signals and data to all Locomotives and/or cars in a work train, via a continuous circuit connected through appropriate coupling devices.

"Trip Cock" shall mean a mechanical device located on the train which when hit by an automatic stop arm, results in an emergency brake application.

"Truck No. 1" shall mean the truck located nearest to the No. 1End of a Locomotive.

"Truck No. 2" shall mean the truck located farthest from the No. 1 End of a Locomotive.

"Ultimate Tensile Strength" shall mean the maximum tensile stress that a material can sustain under uni-axial tension, calculated on the basis of the load at rupture and the original unstrained dimensions.

"Underframe" shall mean the main structure that supports the cab, engine compartment, and all associated equipment below the main structure.

"Unit" shall mean Locomotive, unless otherwise specified.

"Vital Circuit" shall mean any circuit and its elements, the function of which affects the safety of Locomotive operations.

"Weight, Actual" shall mean the measured weight of a finished Locomotive, with all fluid levels topped off, ready for service.

"Wheel Loads-Maximum" shall mean that loading representing total Locomotive weight transferred to the running rails from each wheel when Locomotive has a live load.

"Work" or "Project" shall be defined as all the required obligations of the Contractor hereunder, including but not limited to, the performance of any labor or services, the supplying of any goods or materials, the furnishing of any Equipment or any other resources or requirements or deliverables necessary to perform, construct, accomplish and complete this Contract's objectives.

"Work Car(s)" shall mean any non-revenue heavy rail vehicle used in service.

"Work Site" shall mean any of PATH's, Contractor's or Subcontractor's facilities where Work required by this Contract is performed.

"Yield Stress" shall mean the stress at which a material exhibits a specified deformation or set.

As used herein the singular shall mean and include the plural; the masculine gender shall mean the feminine and neuter genders; and vice versa.

Whenever in the Specifications or On the Plans the words "required," "determined," "directed," "specified," "authorized." "ordered," "given," "designated," "indicated," "considered necessary," "deemed necessary," "permitted," "reserved," "suspended," "established," "approval," "approved," "disapproved," "acceptable." unacceptable," "suitable," "accepted," "satisfactory," "unsatisfactory," "sufficient," "insufficient," "rejected," "condemned, or words of like import are used, it is understood as if such words were followed by the words, in writing, "by PATH," "to PATH," unless otherwise specifically stated.

Wherever the words "provided," "supplied" or "installed" are used in the Contract Documents in reference to work to be performed by the Contractor, it is understood to mean "furnished and delivered completed."

1.6.2 Abbreviations

The following is a list of abbreviations used in the Specification. The list is not intended to be all-inclusive.

AAR	Association of American Railroads
AATCC	American Association of Textile Chemists and Colorists
ac	Alternating Current
ADA	Americans with Disabilities Act of 1990
AFBMA	Anti-Friction Bearing Manufacturer's Association
AFI	Air Filter Institute
AGGS	Automatic Geometry Guidance System
AGMA	American Gear Manufacturers Association
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AMCA	Air Moving & Conditioning Association
Amp	Ampere
ANSI	American National Standards Institute
AP A	American Plywood Association
API	American Petroleum Institute
APS	Auxiliary ~~AC~~ Power Supply
APTA	American Public Transit Association
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigeration and Air Conditioning Engineers
ASC	Air Spring Cutout
ASCII	American Standard Code for Information Interchange
ASIC	Application Specific Integrated Circuit
ASM	American Society for Metals
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	Air Transport Association of America
ATO	Automatic Train Operation
ATP	Automatic Train Protection
ATS	Automated Timekeeping System
AVI	Automatic Vehicle Identification
AWG	American Wire Gauge
AWS	American Welding Society
BHP	Brake Horsepower
BNC	Baby "N" Connector
BTL	Battery Trainline
Btu	British thermal Unit
°C	Degrees Centigrade
C	Capacitance
CAD	Computer Aided Design
CBMA	Certified Ballast Manufacturer's Association
CBTC	Communications-Based Train Control
CCSS	Committee of Chemical Safety and Standardization

CGHAZ	Coarse Grain Heat Affected Zone
CDA	Copper Development Association
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CFC	Chlorofluorocarbon
cfm	Cubic Feet Per Minute
CFR	Code of Federal Regulations
CPM	Critical Path Method
CR	Conductor
CRF	Critical Radiant Flux
CTS	Console Touch Screen
DOT	United States Department of Transportation
dB	Decibel
dBA	Decibel, A Scale Reading
DB	Dry Bulb "
dc	Direct Current
DOD	Department of Defense
DOT	Department of Transportation .
Ds	Specific Optical Density
E	Modulus of Elasticity
ECR	Engineering Change Request
ECU	Electronic Control Unit
EER	Energy Efficiency Ratio
EIA	Electronic Industries Association
EMI	Electromagnetic Interference
EMC	Electromagnetic Compatibility
E.N	European Norms -standards developed and adopted by either the European Committee for Standardization (CEN) or by the European Committee for Electro-technical Standardization (CENELEC)
EPROM	Erasable Programmable Read Only Memory
ETFE	Ethylenetetrafluoroethylene
ETP	Electrolytic Tough Pitch
^{o}F	Degrees Fahrenheit
^{o}F dB	Degrees Fahrenheit Dry Bulb
^{o}f WB	Degrees Fahrenheit Wet Bulb
FAA	Federal Aviation Administration
FAI	First Article Inspection
FCC	Federal Communications Commission
FE	Finite Element
FEA	Finite Element Analysis
FET	Field-Effect Transistor
FHI	Floor Heat I
FH2	Floor Heat 2
FMEA	Failure Mode and Effects Analysis
FMECA	Failure Mode and Effects Critical Analysis

FMVSS	Federal Motor Vehicle Safety Standards
fpm	Feet Per Minute
FRA	Federal Railroad Administration
FRP	Fiberglass Reinforced Plastic
FTA	Federal Transit Administration
ft-lbs	Foot-Pounds
GP	General Purpose
GTO	Gate Turn-Off
HAZ	Heat Affected Zone
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HP	Horsepower ,
HPCU	Hydraulic Pressure Control Unit
HSCB	High Speed Circuit Breaker
HVAC	Heating, Ventilation, and Air Cooling
Hz	Hertz
I/O	Input/Output
IACS	International Annealed Copper Standard
IC I	Integrated Circuit
ICC	Interstate Commerce Commission
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Committee
IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
IGBT	Insulated Gate Bi-Polar Transistor
IPC	Institute of Printed Circuits
IPS	Iron Pipe Size
ISO	International Standards Organization
Is	Flame Spread Index
j	Joules
JEDEC	Joint Electronic Device Engineering Council
JIC	Joint Industrial Council
km	Kilometer
kHz	Kilohertz
kN	Kilonewton
kPa	Kilopascal
km/h	Kilometers per hour
LAHT	Low Alloy High Tensile Strength (Steel)
LAN	Local Area Network
lbs	Pounds
lbf	Pounds force
LED	Light Emitting Diode
LLRU	Lowest Level Replaceable Unit
LRU	Line Replacement Unit
LVDB	Low Voltage Distribution Bus

LVDN	Low Voltage Distribution Network
LVPS	Low Voltage dc Power Supply m Meters
mm	Millimeter
MA	Motor Alternator
MC	Master Controller
MOL	Monitoring and Diagnostic Logic
MOS	Monitoring and Diagnostic System
MHz	Megahertz
MIL	Military Specification
MKS	Master Key Switch
MOU	Memorandum of Understanding
mph	Miles Per Hour
mphps	Miles Per Hour Per Second
mphpsps	Miles Per Hour Per Second Per Second
ms	Millisecond
MSDS	Material Safety Data Sheet
MTBF	Mean Time Between Failure
MTTR	Mean Time To Repair
MU	Multiple-Unit
uA	Micro Ampere
N	Newton
NBS	National Bureau of Standards
NCA	Noise Criterion, Alternate
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NFL	No Field Lubrication
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology
NOA	Notice of Award
OD	Outside Diameter
OFE	Oxygen Free Electronic
OHDS	Overhead Heat Duct Sensor
OSHA	Occupational Safety and Health Administration
PATH	Port Authority Trans-Hudson Corporation
P A	Public Address
Pas	Pascals
PC	Printed Circuit
PCB	Poly Chlorinated Biphenyl
PCU	Pneumatic Control Unit
PCMCIA	Personal Computer Memory Card International Association
PDR	Preliminary Design Review
PEHU	Passenger Emergency Handle Unit
PFC	Pulling Face of Coupler
PlV	Peak Inverse Voltage
ppm	Parts Per Million

PROM(s)	Programmable read-only Memory (ies)
PS	Pressure Switch
psi	Pounds Per Square Inch
psia	Pounds Per Square Inch, Absolute
psig	Pounds Per Square Inch, Gauge
PTE	Portable Test Equipment
PTFE	Polytetrafluoroethylene
PTU	Portable Test Unit
PVC	Poly Vinyl Chloride
PDR.	Preliminary Design Review
PWM	Pulse Width Modulation
QA	Quality Assurance II
QFR	Quality Failure Report
R-C	Resistive-Capacitive .
RAM	Random Access Memory
RFI	Radio Frequency Interference
RH	Relative Humidity
rms	Root Mean Square
rpm	Revolutions Per Minute
ROM	Read-Only Memory
RTO	Rapid Transit Operations
R-22	Refrigerant 22
s	Second
S	Flexural Strength
SAE	Society of Automotive Engineers
SCFM	Standard Cubic Feet Per Minute
SCR	Silicone Controlled Rectifier
SDD	Software Design Description
SGML	Standard Generalized Markup Language
SIC	Standard Industry
SLDT	System Level Dynamics Tester
SMS	Scheduled Maintenance System
SPL	Sound Pressure Level
SSP	System Safety Program
S&I	Service and Inspection Facility
SIN	Signal To Noise
Ta	Ambient Temperature
Ti	Interior Temperature
TFE	Tetrafluoroethylene
TIG	Tungsten Inert Gas
TIR	Total Indicated Runout
TIO	Train Operator
TOD	Train Operator's Display
TOR	Top-of-Rail
TSC	Transportation Systems Center of the U.S. Department of Transportation

TTCS	Train Trouble Control System
TXV	Thermal Expansion Valve
UA-Factor	Carbody Heat Transmission Factor
US, U.S.	United States
UL	Underwriters Laboratories Inc.
UNC	Unified National Coarse
UNF	Unified National Fine
USASI	United States of America Standards Institute
USDOT	United States Department of Transportation
UV	Ultraviolet
Vac	Volts, Alternating Current
Vdc	Volts, Direct Current
VOM	Volt-Ohm Meter
VPI	Vacuum Pressure Impregnation
VSWR	Voltage Standing Wave Ratio
w	Watt
WAN	Wide Area Network
WB	Wet Bulb
WPS	Weld Procedure Specifications

1.7 Standards and Codes

The system shall be designed and built to comply in all respects with all applicable laws, regulations, standards, Railroad policies, procedures, and labor agreements, and recommended practices of the following agencies and organizations:

1. US Department of Transportation (USDOT)
2. Federal Railroad Administration (FRA)
3. Federal Communications Commission (FCC)
4. Federal Transit Administration (FTA)
5. American Public Transportation Association (APTA)
6. American Railway Engineering and Maintenance-of-Way Association (AREMA)
7. Association of American Railroads (AAR)
8. USA Environmental Protection Agency (EPA)
9. IEEE Standard 1473-1999, IEEE Standard for Communications Protocol Aboard Trains
10. IEEE Standard 1483-2000; Standard for Verification of Vital Functions for Processor-Base Systems used in Rail Transit Control
11. IEEE Standard P1558 Standard for Software documentation for Rail equipment.
12. IEEE Standard 1058 for Software Project Management Plans
13. Underwriters Laboratories (UL 900)
14. American Society of Heating Refrigeration & Air conditioner Engineers (ASHRAE)
15. National Fire Protection Association (NFPA)
16. National Electrical Manufacturers Association (NEMA).
17. Occupational Safety and Health Administration (OSHA)

18. International Standard ISO 3864
19. United States Military Standards (MIL).
20. National Electric Code (NFPA-70)
21. American National Standards Institute (ANSI)
22. American Society of Mechanical Engineers (ASME)
23. American Society for Testing and Materials (ASTM)
24. Institute of Electrical and Electronic Engineers (IEEE)
25. Insulated Cable Engineers Association (ICEA)
26. National Electric Code (NEC)
27. The Federal Railroad Administration's "Rules Standards and Instructions for Railroad Signal Systems" CFR 49 all parts and subparts as required.

If there is a conflict, the most restrictive requirement shall apply as determined by PATH.

SECTION 2

2.0 SYSTEM DESIGN

2.1 Design Basis and Parameters

2.1.1 General

This Section establishes the functions, subsystem performance, and general design criteria for the PATH Locomotive. Included are requirements for configuration, capacity, dimensions, performance, operating environment or environmental parameters, noise and vibration, weight and other requirements that impact system and subsystem design. These requirements apply to all aspects of the Locomotive and the Locomotive equipment design. Detailed system and subsystem requirements are further defined in the sections explicitly covering those systems and subsystems.

Quantitative values are stated both in customary North American English units and in metric S.I. units. In a case where the stated values for any quantity may be in or appear to be in conflict, the value in customary English units shall govern unless an explicit clarification is given by addendum.

The Locomotive shall be designed to have a minimum service life of 35 years for the Locomotive Carbody and truck frame and 20 years for the systems and subsystems, unless otherwise specified. The achievement of design life assumes compliance with the Locomotive maintenance intervals specified in Section 20.1.1.3, with subsequent PATH approved modifications arising from any Contractor recommendations, and assumes conventional PATH maintenance practices and normal industry-accepted operating procedures. A duty cycle of the Locomotive is defined as 6 days per week operation, 8 hours of operating per day, 8 hours of engine idling per day.

The Locomotive shall meet the requirements of, and be equipped as required by the U. S. Department of Labor Occupational Safety and Health Administration (OSHA) Standards, Federal Railway Administration (FRA), and all applicable laws of the City and State of New York and State of New Jersey.

The Locomotive shall be equipped with approved power plant, brake equipment, HVAC system, auxiliary electrical system, communication system and such other equipment as indicated on the drawings and specified herein.

The Locomotive shall be capable of operating under all thermal conditions in the PATH service area, meeting the Specification requirements without exceeding the equipment design ratings and without producing equipment temperatures in excess of those recommended by the manufacturers.

2.1.2 Arrangement

The Locomotive shall be equipped with a cab at one end designed for ease of bi-directional movement. The power plant and auxiliary equipment shall be located behind the cab in an engine compartment, and be completely covered by a roof and wall structure. External walkways as specified in Section 3.6 shall be provided to allow operating personnel access to and from the cab and to allow maintenance personnel to access both sides of the engine compartment. Handrails shall be provided on both sides and ends of the locomotive as specified Section 3.11.6.

2.1.3 Operating Locomotive Configuration

The Locomotive will be operated as a propulsion car for work train consists comprised of approximately two to eleven Work Cars. For consists with five or more Work Cars, multiple locomotives may be used. Alterations in train composition will be performed at any PATH system location, including shops and yards, by coupling or uncoupling of Work Cars and passenger cars.

The Locomotive will operate on the PATH System in the following configurations:

1. By itself.
2. Coupled to one or more Locomotives.
3. Pulling one or more PATH Work Cars with or without one or more Locomotives
4. Pulling one or more PA5 passenger cars with Brake Cut-Out (BCO), with or without one or more Locomotives in an emergency or to move empty cars.

In cases 2, and 3, the Locomotive shall be used to control the other Locomotive(s) in the consist, or it shall be controlled by the other Locomotive in the consist through appropriate trainline signals.

2.1.4 Operating Physical Environment

The Locomotive shall operate on all divisions of the PATH System, but shall be physically designed to fit in the most restrictive PATH Tunnels.

The Locomotive must meet the clearance requirements of being able to travel around a 115 foot curve with bench wall 2’11” (see drawing P0005) from gauge of running rail and third rail in highest position (Drawing P-0008), above track rail by a minimum of 1 ½ inches. The Contractor is ultimately responsible for the clearance.

The vehicle dynamic envelope shown on the drawing (Drawing P-0001) 2P395305-1041-C (Carbody Kinematic Envelope) represents the spatial envelope within which the Locomotive shall remain under all operating conditions. The dynamic envelope provides a safety zone relative to fixed facilities. The Locomotive shall be constructed so that it meets all of the clearance requirements for the worst case car and wayside conditions,

including wheel wear, rail wear and suspension deflection conditions. The Locomotive shall be able to travel safely on curves with a radius as sharp as 90 feet. There shall be sufficient clearance between the various parts to permit any rotation necessary to negotiate a 90-feet radius curve. Platform dimensions are approximately as follows: platform height above base of rail: 3'6" to 3'7 ½"; and minimum distance from edge of finished platform to centerline of track in tangent: 4 feet 7 1/2 inches (for curved platform, this dimension varies)."

The contact rail location is not uniform throughout the PATH system. Variances depend largely on the age of construction. The Contractor shall survey the locations of all third rail installations as part of the clearance study defined in this section.

The Contractor shall take into consideration the dimensions for the Automatic Train Stop Tripper Arm as shown in the Drawing P - 0009 - PATH Automatic Train Stop Tripper Arm.

2.1.5 Exterior Ambient Conditions

All equipment shall be capable of being operated, stored and maintained at the specific performance levels without impairment resulting from the impact of the natural or induced environment within which PATH intends to operate this Locomotive in service. If conditions exceed the design parameters, the equipment shall continue to operate but at a degraded mode. Exterior ambient conditions for design purposes shall be as follows:

- Summer -Surface.
  105° F (41 ° C) dry bulb temperature;
  35% Relative Humidity; 41 ° Latitude, maximum solar heat rate;
  and 105° F (41°C) condenser ambient; and 8 mph (13 km/h) wind velocity.
- Summer -Tunnel
  120°F (49°C) dry bulb temperature;
  35% Relative Humidity;
  105°F (41 °C) condenser ambient

- Winter -Surface
  -10° F (--23° C) dry bulb temperature;
  41° Latitude, (minimum solar heat rate); and 11 mph (18 km/h) wind velocity.
- Winter -Tunnel
  0° F (-18° C) dry bulb temperature

Except as otherwise specified, minimum temperature for material selection purpose shall be -20°F (-29°C) and for material operation purpose shall be 0°F (-18°C).

2.2 Locomotive Dimensions

The overall general dimensions shall be as listed below for a new Locomotive, ready for service. The dimensions given are nominal unless otherwise indicated. These dimensions shall be used with Drawing L1 – 001 – Locomotive Overview provided with this specification.

Parameter	**English Units (Feet-Inches)**
Maximum weight of carbody, trucks and dead load	120,000 lb.
Maximum length over anti-climbers	50’ 0”
Maximum length over coupler pulling faces	50’ 6”
Maximum length, center to center of trucks	33’ 0”
Minimum clearance top of rail to bottom of underfloor Equipment	0’ 4”
Minimum clearance top of rail to bottom of truck Equipment	0’ 2.5”
Height top of rail to top of anti-climber, new wheels	44.5”
Minimum height- top of rail to bottom of any equipment will overhang third rail protection board	21 ½”
Minimum clearance to protection board required	3”
Height top of rail to coupler centerline on tangent level track	2’3”
Maximum Height top of rail to top of Cab	140.44”
Height top of rail to top of platform	4’6” to 4’7”

Maximum length of Locomotive shall be determined by vehicle going around a 110- foot radius with tunnel walls located 2’11” from gauge of running rail, with PATH’s high third rail. Vendor may substitute different parameters than above if at time of bid drawings are shown the locomotive can fulfill all clearance requirements.

Parameter	**English Units** (Feet-Inches)
Truck maximum Wheelbase	6'-10"
Wheel Diameter New	34"
Worn (condemning limit)	31"
Wheel Mounting Dimension – Back to Back (Tolerance)	53.093” – 53.375”
Standard gauge of track:	4'- 8 1/2"

Minimum Curve Radii and Turnout Number for PATH Track

Parameters	Yard Value	+/-Tol.	Super-Elev.
Simple Curve Radius (ft.)	100	+/- 5	0" +/- 1/2”
Reverse Curve Radius R1 (ft.)	110	+/- 5	0" +/- 1/2″
Reverse Curve Radius R2 (ft.)	110	+/- 5	0" +/- 1/2″
Smallest Turnout Switch (Deg.)	3.5		

2.2.1 Super-Elevation

The maximum super-elevation on the PATH System is 5 inches.

2.3 Locomotive Loading and Assigned Weights

2.3.1 Maximum Weight

The Locomotive Ready-to-Run weight, with all fluids full, with all ancillary equipment and with a crew of three shall be kept to a minimum, consistent with strength and stability requirements and maximum wheel load requirements.

2.3.2 Maximum Wheel Loads

Maximum wheel loads for safe operation on the railroad structure of PATH system using specified locomotive and truck dimensions must be calculated by the Contractor.
The maximum wheel load shall apply to a fully equipped Ready to Run locomotive ready for operation. PATH will review the wheel loads as calculated by the Contractor to determine if they are within the acceptable limits. Maximum weight of fully equipped, ready-to-run Locomotive shall not exceed 120,000 pounds.

The Contractor shall provide all the required information early in the design stage, so that the design development of the locomotive will consider the maximum permissible wheel loads.
The maximum wheel loads are established in accordance with the length of the locomotive, truck centers, wheel base, speed, and weight of the adjacent rescue vehicles.

Excessive wheel loading could cause overloads that are likely to result in damage to the railroad structure. Hence, if any Locomotive has a wheel load exceeding the safe load at any wheel, it shall be automatically rejected. A monthly analytical maximum wheel load calculation shall be submitted to the Project Manager to verify compliance with the wheel load requirement.

2.3.3 Balancing

The Locomotive and trucks shall be designed and manufactured to achieve minimum weight, minimum side-to-side and end-to-end imbalance, and maximum weight uniformity on the axles. The side-to-side imbalance of the completed Locomotive shall not exceed 22,000 inch-pounds (2,4S6 Newton-meter). The end-to-end truck pivot weight difference of the completed Locomotive shall not exceed 550 pounds (250 kg).

2.3.4 Weight Records

The Contractor shall keep a detailed weight record for the Locomotive. This weight record shall itemize each major Locomotive item starting with the initial design estimated weight and continuing with refined design estimates, first piece measured weights, and production piece measured weights, as applicable, or shall maintain an accurate and up-to-date cumulative Locomotive weight and cumulative Locomotive balance data for review by PATH.

2.3.5 Weighing

The Contractor shall weigh the Locomotive at shipment using a scale that produces a printed record of the weight, measured in pounds. The weight ticket shall be furnished to the PATH in the shipping documents and data entered into the Car History Book.

2.4 Supply Voltages

2.4.1 General

All equipment on the Locomotive shall function normally, without failure or degradation of service or in-service life, at any voltage between the maximum and minimum voltages defined for the system from which the equipment is supplied for any duration, and shall not be damaged by the continuous application of any voltage between zero volts and the minimum or any polarity thereof.

Unless otherwise specified, rated performance shall be delivered at any voltage between nominal and maximum voltages. Between the minimum and nominal voltages, analog measured performance such as brightness of lamps, motor power output or rating of heaters may be reduced in proportion to the available voltage. The performance of control components such as energization of relays, solenoids or magnet valves shall be fully functional at any voltage between the minimum and the maximum.

All equipment on the Locomotive shall be self-protected from damage and improper operation due to:

- High-voltage transients across the supply terminals of that equipment;

- High-voltage transients impressed between either supply terminal and the Locomotive body;
- Long-term over-voltage and under-voltage conditions resulting from other equipment failure modes.

2.4.2 AC Auxiliary Power

All carborne rotating machines shall be three-phase ac powered, unless otherwise approved by PATH.

2.4.3 Low Voltage Power

The Locomotive shall contain an alternator and batteries to supply the control power for all Locomotive equipment (see Section 9.1 for details). An alternate method may be considered for PATH approval.

2.5 Performance Requirements

The propulsion shall be sized to approach the adhesion limits so as to obtain the greatest tractive effort possible for a 60-ton Locomotive.

The Locomotive shall be designed to pull a 260-ton Work Car consist (including the Locomotive's weight) while:

- maintaining a speed of 25 mph (40.225 km/h) on level tangent track.
- maintaining a speed of 5 mph (8.0 km/h) up to 5% grade.

The contractor shall design the traction horsepower to meet the above requirements and present the calculations to PATH for review prior to PDR.

2.5.1 Not Used

2.5.2 Response to Changes in Tractive Effort Command

Locomotive responses to the step changes in the motoring and/or braking tractive effort command requested by the operator shall be rate limited in order to provide for comfortable operation.

2.5.3 Maximum Speed

The Locomotive shall be capable of operating at a maximum speed of 25 mph (40.225 km/h). However, the traction motors shall be designed to withstand Locomotive speeds of up to 40 mph (64.374 km/h) to avoid damage to the motors due to overspeed conditions when the Locomotive is traveling down a grade.

2.5.4 Braking Performance

The braking performance shall be such that they are compatible with existing PATH Work Cars. The park brake system shall be integral with the Tread Brake Unit and shall be designed with a structural safety factor of 2.

2.5.4.1 Park Brake

The Park brake shall hold a fully loaded, Ready-to-Run Locomotive on a 5 *1/2* percent grade indefinitely.

2.5.6 Thermal Duty

The Locomotive shall be capable of operating under all conditions in the PATH service area. including those conditions listed in Section 2.1.5, meeting the Specification requirements without exceeding the equipment design ratings and without producing equipment temperatures in excess of those recommended by the manufacturers. The Contractor shall take into consideration any heat generated by the Locomotive, which may raise the ambient temperature (e.g., slow operation in the tunnel having an air exchange rate of 1.3 air changes/hour), when calculating the maximum design temperatures.

2.6 Equipment Design

2.6.1 General Equipment Requirements

Equipment shall be designed in accordance with the following requirements:

- Equipment boxes shall be mounted to allow adequate space for maintenance. Access covers shall be provided where access to lights, switches, breakers, PTU ports, maintenance indicators, fluids, filters, or other devices require maintenance.
- All systems and subsystems shall be functional and provide full performance within the temperature range of minus 29°C (-20°F) to plus 70°C (158°F). No damage to any system or subsystem shall occur within the temperature range of minus 30°C (-22°F) to plus 85°C (185°F).
- All equipment shall be designed for ease of handling. Protective guards, legs, or similar devices shall be provided, if required, on each component that may be removed for preventive or corrective maintenance or at overhaul.

Components shall be arranged by function and grouped so as to simplify diagnostic procedures and facilitate replacement

Components at all levels of assemblies and subassemblies shall be mounted so that the mounting hardware is completely accessible with standard tools. All enclosure mounting hardware shall be hex head bolts of an appropriate size.

Wire harnesses, pipes, support brackets and other appurtenances shall not obstruct mounting hardware. Replaceable components shall not be "stacked" in such a way that one component must be removed to access another, without approval. In cases where approval may be granted, obstructed equipment shall only consist of passive devices and there will never be more than two levels permitted.

Multiple PC board arrangements shall have the boards slide mounted with two-part quick disconnects. Terminal boards shall be used if current demands require AWG No. 16 or larger wire.

Terminal board hardware for terminals of the same size range shall be standardized throughout the Locomotive.

Refer to Section 15.24.4 for related equipment enclosure requirements.

2.6.2 Adjustments

2.6.2.1 Electrical Adjustments

Electrical adjustments are permitted only with PATH's approval.

2.6.2.2 Mechanical Adjustments

Mechanical adjustments will be allowed only to compensate for a device's manufacturing tolerances and wear. Once adjusted, like assemblies shall be interchangeable without further adjustment. Mechanical adjustments shall occur in fixed, discrete steps using serrations, notches, pins, or similar schemes to ensure positive adjustment retention. Mechanical adjustments shall include positive locking devices. Mechanical adjustments with threaded members and jam nuts are permitted only with PATH approval.

2.6.2.3 Software Adjustments

Adjustments to be made by stored parameters in software shall reside in non-volatile memory. The location and scaling of all adjustment parameters shall be clear to service personnel. Parameter values shall be in decimal notation and expressed in customary units. The use of both PTE password and a PTE hard key (dongle) used in tandem shall be required in order to initiate parameter changes. Parameter adjustment features shall not allow adjustment beyond safe and reasonable limits.

2.6.3 Illuminated Indicators

All illuminated indicators shall be LEDs and not incandescent lamps except where otherwise approved by PATH. They shall consist of individual LEDs or clusters of LEDs, depending on the requirements of the application, including brightness and safety.

In order to identify LED failures, each LED or group of LEDs shall have a push-to-test switch located conveniently near the LED or group. Alternative methods of LED failure identification may be proposed and shall then be submitted for approval. When depressed, this test switch shall disconnect the normal circuit feed and cause the LEDs to be illuminated. The requirement for a push-to-test-switch shall not apply to LEDs mounted on PCBs mounted within electronic assemblies and intended to be used exclusively for bench level testing, however all LEDs must illuminate transiently on board power-up. Indicators shall be clearly visible and comfortable to the eye, in all light conditions (sunlight and darkness).

Indicator colors shall be based on its function as follows unless otherwise approved by PATH:

- Red shall be used to annunciate failures or inoperative conditions. Red shall also be used to indicate a restrictive condition or to annunciate a function that has been bypassed.
- Yellow or amber shall be used for warnings. The illumination of a yellow or amber indicator does not necessarily indicate a failure; however, the condition may require close observation by a Train Operator or other personnel.
- Green shall be used to indicate the normal state of a device or system. Whether illuminated or not, no failure shall be indicated by the green indicator.

2.7 Electro-Magnetic Compatibility and Interference

2.7.1 General Requirements

The Locomotive shall be electromagnetically compatible within itself, with other Locomotives provided by the Contractor, with all other trains in operation at PATH, with the PATH signal system, with PATH communications systems, with other PATH electronic equipment as specified elsewhere within this Specification, and with equipment owned by neighbors of the PATH along its right-of-way. The Locomotive shall not be capable of any operation that causes unsafe conditions in the signal system. All transmission signal frequency allocations shall be approved by PATH.

The contractor shall conduct a compressive Electromagnetic Compatibility (EMI) design and test program to ensure that the EMI emissions comply with emission limits specified with in this specifications and with transit signaling circuits, communication circuits, and power substation supervisory circuits generated by the unit shall be at the minimum level acceptable to PATH and shall not affect any vital safety function. Conversely, EMI susceptibility of the unit from external. sources shall be at the acceptable minimum level to PATH and shall not affect any vital safety function.

The Contractor shall conduct a program which achieves and documents EMC of the Switching locomotive. The development of the EMC plan shall be in accordance with APTA SS-E-010-98. The Contractor shall apply the EMC program requirements to all subsystems and suppliers. The

Contractor shall ensure that all equipment, when operating individually or concurrently with other subsystems, complies with the EMC requirements. Successful testing at the car and subsystem level does not ensure EMC compliance. Final approval of EMC compliance will be based on testing of consist of two locomotives and eleven work cars, under worst case conditions on the Railroad's facilities.

Line transients generated by the Locomotive shall be suppressed to the extent that neither conducted currents nor induced currents will interfere with any on-board or wayside system.

2.7.2 Conducted Emission Limits

The conducted emissions for a single Locomotive with all individual component emissions acting coherently (i.e. in phase) and based on a 2 locomotive train shall not exceed:

22 to 27 Hz	1.9 Amps
55 to 65 Hz	1.2 Amps
88 to 95 Hz	0.6 Amps
2 kHz to 20 kHz	25 mAmps

The conducted emissions for any length train, with all individual locomotive emissions acting coherently (i.e. in phase), shall not exceed:

22 to 27 Hz	8.6 Amps
55 to 65 Hz	5.4 Amps
88 to 95 Hz	2.9 Amps
2 kHz to 20 kHz	120 mAmps.

2.8 Noise and Vibration

2.8.1 General

The Contractor shall incorporate effective materials and methods into the Locomotive design to adequately attenuate the noise and vibration generated by wheels, rails, wind, motors, and all other elements and equipment. Maximum permissible noise levels from equipment not specified herein shall be minimized such that the interior and wayside noise limitations are not exceeded for the complete Locomotive. The cab shall be designed to be free from objectionable vibration and shock. All equipment mounted in the cab area shall be free from resonance to avoid annoying audio and visual distraction.

2.8.2 Noise

Maximum noise level testing requirements shall comply with 40 CFR 201 Subpart B.

All auxiliary systems shall be active during the tests.

For the purpose of Locomotive noise measurements, an auxiliary system is defined as follows:

any functioning apparatus on the Locomotive. Auxiliary systems shall include but not limited to the following items: diesel engine, auxiliary power subsystems, other motors, pumps, etc. Auxiliary systems for the purpose of noise measurements shall exclude bells and horns.

2.8.3 Interior Noise

Measurements of interior noise levels shall be taken in a fully equipped vehicle with no personnel on board other than the operator and the person performing the measurements. Measuring points shall be as follows:

With the vehicle stationary, with windows and doors closed, with all auxiliary equipment operating simultaneously under any possible operating condition, the interior noise level shall not exceed the standards of 49 CFR 229.121.

With the vehicle operating on the PATH System, on non-corrugated rail, at any speed up to 55 mph (88.5km/h), in any curve on the PATH revenue operating tracks, and under any acceleration or deceleration condition, interior noise shall not the standards of 49 CFR 229.121.

2.8.4 Wayside Noise

Wayside noise shall comply with 49 CFR 210 subpart B switcher Locomotive.

2.8.5 Vibration

Except approved otherwise on a case by case basis, equipment and auxiliaries mounted anywhere on the Locomotive, or trucks shall not cause vertical or horizontal vibrations anywhere on those surfaces which provide a horizontal contact surface for the operator or other workers' hands, wrists, and forearms or on which the operator or crew will sit or stand in excess of the following:

- Below 1.4 Hz: Maximum deflection (zero to peak) of 0.10 inch (2.54 mm).
- 1.4 Hz to 20 Hz Peak acceleration of 0.0 1 g (0.10 m/sec^2).
- Above 20 Hz: Peak velocity of 0.03 inches/sec (0.76 mm/sec).

Mitigation steps will be taken to ensure that no annoying resonance response vibrations exist within the cab to provide audible distractions.

2.8.6 Design for Shock and Vibration Resistance

Shock and vibration requirements depend, in part, on the type of truck and spring system and roadbed conditions. All equipment shall be tested per IEC 61373 and be in accordance with Section 10.10.7 of this specification and IEEE Std. 11.

2.9 General Control Circuits

2.9.1 Bypass and Cutout Circuits-Hardwired

Some control circuits will include bypass switches and cutout switches. These switches will allow the Operator, or other personnel, to override or disable certain functions. Typically, a bypass switch is used when equipment has failed. Typically, a cutout switch is used when equipment is to be disabled. Unless specifically noted otherwise, all bypass and cutout circuits shall have the following features:

- An indicator shall be illuminated while the corresponding bypass function is engaged.
- All bypass switches must include provisions for approved wire or plastic seals.
- All bypass functions shall be monitored on the Locomotive, and logged on the Monitoring and Diagnostic System.
- Bypassed functions shall reset on operator key-out or command.
- Cutout functions shall be reset by Operator command only.

2.9.2 Automatic Fault Reset

Fault detection circuits and devices shall be configured to electrically reset using a manual switch, or automatic reset, or both, as specified for the application. However, automatic resets shall not be applied to safety-related functions. All automatic resets shall be configured as follows:

- No reset shall be allowed while the fault is still detected.
- There shall be an acceptable delay (to PATH) before an automatic reset.

The circuitry shall allow for an adjustable number of automatic resets after which the system shall lock out all resets, requiring a manual reset action at the auto-reset device.

Reset logic shall eliminate resets of progressively worse faults, thereby protecting equipment from increased damage.

The automatic reset device shall retain memory of the number of resets and memory of lockout status during control power interruptions. Memory shall be retained for at least 10 days of un-powered time.

To prevent random, unrelated trips from causing a lockout, the automatic reset device shall have a count reset. The number of resets before reaching the lockout stage shall be defined at preliminary design review (PDR). This count reset shall not function if the automatic reset device has reached the lockout stage. The mechanism for causing a count reset shall be approved on a case-by-case basis and in some cases will not be utilized.

The automatic reset device shall display the number of resets it has accumulated.
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SECTION 3

3.0 LOCOMOTIVE CONSTRUCTION AND ASSEMBLY

3.1 General

The locomotive shall comply with 49 CFR 229.141(b). The Locomotive shall be designed to meet the clearances for the wayside and track profiles. The design must allow for a minimum of 1 1/2 inches (38 mm) of clearance between the Locomotive and truck rigid surfaces, and 1/2 inch (13 mm) of clearance for flexible surfaces, for all operating conditions, except where approved by PATH. This is with the exception of any stops attached to the Locomotive for limiting truck movement or for truck lifting during maintenance. All conditions shall include horizontal and vertical curves, tracks super-elevation, worn wheels, maximum load, roll, yaw, lateral motion, and suspension system failures.

The Locomotive shall be designed for a minimum life of 35 years. The Locomotive shall be designed to permit access for the crewmembers from the roadbed. There shall be collision posts at the cab end, and anti-climbers at both ends of the Locomotive.

The structural design shall be based on the specified loads, stress requirements and factor of safety requirements specified elsewhere in this specification. For structures not covered by this Specification, the design shall be based on the Contractor's experience, subject to successful stress analysis and testing.

The underframe and body bolster shall be constructed of low alloy high tensile (LAHT) steel; see Section 15.4. Steels requiring pre- and/or post-fabrication heat treatment to develop acceptable strength or toughness are prohibited.

3.2 Construction Methods

3.2.1 General

A careful control of tolerances shall be maintained by use of proper dimensioning techniques. A sufficient number of jigs, fixtures, and templates shall be used to assure interchangeability of components and uniformity of structure throughout the fleet. Such parts of the bodies as under-frames, side frames, end frames, and roofs shall be built on jigs. All weld and bolt patterns shall be identical on all Locomotives. All equipment hangers shall be interchangeable on an Locomotives without the use of shims or elongated holes. No elongated holes shall be permitted without the express approval of PATH.

The Locomotive structure shall be assembled by welding. Sheathing shall be attached to the framing by fusion welding. Stiffeners shall be attached to the sheathing by fusion welding. Fusion welding shall be used for the construction of the remainder of the locomotive structure.

Alternate welding processes for the construction of the Locomotive structure may be considered for PATH approval. All welding and fastening shall be in accordance with Section 15. Where the

locomotive structure must be assembled with mechanical fasteners, the fasteners shall be high-strength huck bolts (see Section 15.2.2.3).

Hangers and brackets may be resistance welded to locomotive framing as subassemblies for subsequent attachment of equipment. Otherwise, brackets, supports, pipe hangers, conduit supports, and other attachments that are not part of the locomotive structure shall be attached to the structure with mechanical fasteners or other PATH approved welding. The Locomotive framing members shall be reinforced in subassembly to accept attachments during assembly. Except as approved by PATH, the holes for attachments shall be in the webs of framing members and not in the flanges. If attachment to a flange is permitted, suitable full height gussets shall be provided in the member at the location of the attachment to assist in transferring the load into the web. All connections are to be analyzed per Section 3.3.2.

Where dissimilar metals are joined, they shall be protected against electrolytic corrosion. Adequate drainage shall be provided in all body-structure members, and elsewhere as necessary to preclude water entrapment. Enclosed structural cavities shall be vented to prevent accumulation of condensate. In areas where water might be ingested, corrosion-resistant drain pans and drain lines shall be provided and shall be arranged to divert the discharge clear of all equipment and structure. Means shall be provided to prevent clogging of drain lines and drain holes. Any enclosed structural cavities of carbon steel members shall be treated with a rust inhibiting coating as specified in Section 15.21 or as approved by PATH.

3.2.2 Camber

Camber of the Locomotive is defined as its curved shape viewed in side elevation. Locomotive camber shall be a smooth arc from end to end of the Locomotive, and shall be measured from a datum line drawn between the intersections of the arc with the centerlines of the body bolsters to a line tangent to the arc midway between bolsters. A condition of the tangent point of the arc being above the datum line is defined as positive camber.

The Locomotive shall be built with positive camber of up to 5/8 inch (16 mm).

The maximum difference between the camber of each side sill, measured at the location of maximum deflection, shall not exceed 1/4-inch (6.35 mm).

3.2.3 Structural Connections

Rivets or bolts used in combination with welds in a structural connection shall not be considered as sharing the load with the welds. When used in a structural connection, welds shall be designed to carry the entire load across the connection.

Connections consisting of a primary structural member that resists the specified over-load conditions, end sill (Section 3.3.3.2), coupler (Section 3.3.3.3), collision posts (Section 3.3.3.5), truck-to- Locomotive connection (Section 4.3.4.2) shall be designed so that the ultimate strength of the connection exceeds the ultimate strength of the weakest member joined. All other

structural connections shall be designed to withstand the worst-case normal loading specified in Section 3.3.3.

All over-load requirements (loads over normal operating conditions) shall be analyzed as specified and then reanalyzed with the load magnitude increased until calculations show structural member crushing has commenced.

Detailed weld procedures shall be submitted as required by Section 15.20.6.

All mechanically fastened connections shall be designed using a factor of safety of 1.5 based on proof load of the fastener. Clamping force friction shall be ignored in the design and analysis of mechanically fastened connections.

There shall be no attachment to the Carbody by welding or drilling subsequent to completion of Carbody manufacturing procedures. The exception is for hangers resistance spot welded to the web of a beam for attachment. Additional welding to the Carbody may be allowed with the approval of the Project Manager.

Intermittent fillet welds on tension members are prohibited. Plug or slot welds on tension members are prohibited. Intermittent groove welds are prohibited.

Stud welding to Locomotive structure shall not be permitted. Stud welding to non-load carrying stiffeners and secondary structure is permitted.

Self-tapping screws shall not be used for structural connections. With the exception of attachment points for floor panels, Interior panels and trim, there shall be no tapped holes in the locomotive structure. Tapping plates may be used. Tapping plates shall be attached to the Locomotive structure with mechanical fasteners unless consideration of reduced material properties and stress concentrations have been considered in the original design and analysis. The tapping plate must be equal to or greater in thickness than the diameter of the bolt for which the tapping plate is intended, and a clearance hole shall be drilled in the structure for the bolt. Tapping plates shall be designed to the same strength standards as the equivalent nut; see Section 15.2.2.

Rivets, blind rivets, and huck-bolts shall be set with power tools. All holes for mechanical fasteners shall be clean and free of burrs. The Contractor shall devise a method of removing the burrs on the far (blind) side of a blind rivet hole, and a method for its inspection.

3.3 Strength Requirements

The framing and sheathing of the Locomotive shall form an integrated structure capable of resisting, without permanent deformation or fatigue failure, the buffing and other stresses inherent in the type of service for which the Locomotive is intended.

The Locomotive strength shall be sufficient to permit operation with up to maximum loading for

the design life of the Locomotive without structural damage, including fatigue cracks. The shell shall meet the static and dynamic strength requirements stated in this section.

3.3.1 Structural Sketch

A structural sketch shall be prepared and submitted for approval prior to PDR. The preliminary structural sketch shall be included in the Stress Analysis Plan as required by Section 3.3.2.1, and updated thereafter. Approval of the structural sketch shall be a prerequisite for approval of the finite element model (FEM). As a minimum, the following views shall be included on the structural sketch: side elevation; top view of the Locomotive and the underframe; and typical cross-sections of the Locomotive. Cross-sections of the structural members with shape, dimensions, material and thickness shall be shown.

3.3.2 Stress Analysis

3.3.2.1 General

The Contractor shall submit a stress analysis of the Locomotive structure and all equipment supports for equipment weighing over 200 lbs. (91 kilograms). Stress analyses for supports for items weighing less than 200 lbs. (91 kilograms) may be requested for review at the discretion of PATH. A Stress Analysis Plan shall be submitted not later than 30 working days after NOA. The Analysis Report shall be submitted not later than 60 working days prior to commencing manufacture of any Locomotive structural part.

The stress analysis shall be used to design the Locomotive structure to meet the requirements of this Specification. Structural tests shall be performed in accordance with Section 17.5.27 to confirm the accuracy of the analysis.

The stress analysis shall show the calculated stresses, allowable stresses, and margins of safety for all elements for all specified loading conditions. The stress analysis shall include calculations of stresses in joints, joint elements, and other important elements.

The approved stress analysis shall be a prerequisite for approval of the structural test procedures and structural drawings required by this Specification, and shall be used as an aid in determining strain gage locations for use during the tests.

During the design and manufacture of the Locomotive, the input to the stress analysis shall be updated to reflect the as-built structure's configuration.

The initial stress analysis will require temporary assumptions as to configuration and weights; also manufacturing and other considerations may require design changes. As these changes are made, the stress analysis shall be revised and submitted for review. The final submitted and approved stress analysis shall be for the Locomotive in the as-built configuration.

Critical connections, which cannot be adequately analyzed, shall be prototyped and tested to

demonstrate compliance with the requirements of the design and the Specification.

The elastic stability of plates, webs and flanges shall be calculated for members subject to compression and shear. In computing the shear strength of a beam, only that portion of the beam which is in line with the force vector shall be considered as resisting the force. If the force is skew to the beam's web, the force vector shall be divided into components, one in line with the web and the other in line with the flange; the shear resistance shall then be computed separately for each component.

For any portion of the proposed design that is based on a service-proven locomotive, the Contractor may provide data from previous tests, historical data from operations, or stress analyses as required to satisfy the corresponding portion of these requirements.

3.3.2.2 Definitions Permanent Deformation

A member shall be considered as having developed permanent deformation if one of the following conditions is met:

- The minimum yield strength as published by ASTM for the specified material and grade is exceeded.
- For materials. or grades not covered by an ASTM specification, the minimum yield strength as guaranteed by the manufacturer is exceeded.
- The material has buckled or deformed and will not return to its original shape or position after the load is released.

For materials without a specific yield point, the 0.2 percent offset method shall be used to determine yield strength.

Ultimate Load Carrying Capacity
The ultimate load carrying capacity of a member is the maximum load that the member can support before it separates at its ultimate strength or completely fails as a column.

Margin of Safety

Margin of Safety (MS) is defined as follows:

$$MS = \frac{Allowable\ Stress}{Calculated\ Stress} - 1$$

The calculated stress shall include the applicable load factors. MS shall be a minimum value, but a positive number.

Load Factor

Load factor is defined as a number by which the actual or specified load is multiplied in

computing the calculated stress. The load factor shall include all applicable safety factors.

3.3.2.3 Elastic Buckling Analysis

The buckling strength of major members shall be calculated. Any member in any of the analyses with a calculated compressive stress equal to or greater than, 35 percent of its material's yield strength shall be included.

3.3.2.4 Elastic Stress Analysis Submittals

3.3.2.4.1 Locomotive Stress Analyses

The stress analyses shall be discussed during the first design review meeting. The Plan shall be a working document that will be updated as the body design develops. Whenever the Plan for the analysis and testing of the Locomotive is revised, the Plan shall be updated and resubmitted, but not more than monthly. Each revision shall include revision level indications.

The Locomotive Stress Analyses and Tests Plan shall include an outline of the procedure that the Contractor -shall use to analyze and test the design of the Locomotive. It shall also include the following:

- Listing of load conditions to be used during analysis and test, with load magnitudes and points of application,
- Description of the analysis to be used for each load condition,
- Structural sketch as required in Section 3.3.1,
- Diagrams of load applications,
- Table of material properties,
- Description of the major assumptions concerning stress analysis, and
- Description of how analysis results will be correlated with test results, as required in Section 3.3.2.6.

3.3.2.4.2 Stress Analysis Report

A stress analysis report shall be prepared and submitted for review and approval. This report shall show that all structural members satisfy the requirements of this Specification and good practice in the rail transit industry. The report shall be organized and in sufficient detail so that the PATH reviewer can readily follow the theory and its application to this Locomotive.

The stress analysis report shall be signed by the author and signed by a second engineer, who has reviewed and checked the analysis. One of the two engineers must possess a valid Professional Engineering License (P.E.).

If a cited reference is not readily available to PATH, the Contractor shall provide the reference or copies of the pertinent pages. In addition to the pages that show the cited formula or data, the

pages that show the development and interpretation of the formula or data must be included. All references shall be in English. If an English reference cannot be found, an English translation shall be provided. Both the original and the translation shall be included in the report.

In addition to the body of the analysis, the stress analysis report shall include, at a minimum all of the following:

- A Table of Contents.
- The algebraic statement of all formulas and equations before the related calculations are performed. With the statement shall be all terms defined, and the values and units to be applied to these terms stated.
- Units shall be given with all quantities.
- References for all formulas, calcu1ation procedures, buckling coefficients, material strengths, fatigue strengths, and other physical and mechanical properties must be cited where these items appear in the stress analysis.
- For all manually produced stress analyses, each page shall be numbered, dated, and initialed by the stress analyst and reviewer of the stress analyses, one of whom must be a Professional Engineer. In addition, in the event of a revision, the revision letter shall be included with revision date and initials of the stress analyst and checker.
- All computer stress analysis input and output data shall have cover sheets listing all work performed and each section shall be signed and dated by the stress analyst performing the work and checked by a second stress analyst who shall also sign and date the appropriate cover sheets. In addition, in the event of a revision, the revision letter shall be included with revision date and initials of the analyst and checker one of whom must be a P.E
- The approved structural sketch (see Section 3.3.1).
- Diagrams displaying, for each load case, loads applied externally to the Locomotive and points of support.
- An analysis showing compliance with each design load and condition, as required by Section 3.3.3.
- Detailed calculations of stresses with Margins of Safety (MS) in all structural framing members and sheathing, with a summary of the results.
- A table showing locations where the MS is less than 0.20 along with the design or operating conditions (loads) which cause the stresses.
- Particular reference in the stress analysis shall be made to, but not limited to the following:

    - side sill
    - body sills (if used)
    - end sill
    - anti-climber
    - draft sills
    - coupler supports
    - body bolster
    - floor and floor beams

- collision posts
- equipment supports
- connections between structural elements
- A tabulation or diagram of calculated deflections of the Locomotive under combined vertical and compression loads specified in Section 3.3.3.
- Analysis of all critical and highly loaded connections, required in Section 3.3.3, showing the joint is stronger than the weakest member being joined.
- Analysis of the strength of the connection of the trucks to the Locomotive, including calculated vertical and horizontal connection capacities.
- Analyses of the Locomotive structure under the torsional1oading resulting from diagonal jacking described in Section 3.4.1.4.1, and under torsional loadings resulting from anticipated normal operations.
- A tabulation of the Contractor's selection of allowable fatigue stresses, with sources, and assumed applied fatigue stress ranges for structural members which are critical in fatigue.
- A table showing the engineering properties of each grade and temper of each material used in the Locomotive structure. This table shall include the material designation, yield strength, ultimate strength, elongation, Young's modulus for tension, and compression and shear elastic moduli. In each case, minimum-guaranteed values from the specifications for the corresponding grade and heat treatment of the material shall be used. Materials, grades and tempers not used in the Locomotive construction shall not be included in the tables.
- A table showing geometric properties, such as area and section moduli.
- Table(s) showing the minimum static and fatigue strengths of single and multiple spot welds. Values shall be given for each material, temper, weld size, and thickness combination used in the Locomotive. The source of the data shall be provided.
- If tests are conducted to provide the necessary data, the entire test report shall be submitted. This report shall show the test procedure, raw data as well as reduced data, and summary.

3.3.2.5 Finite Element Analysis (FEA)

As part of the stress analysis, a linear-static finite element analysis (FEA) of the complete Locomotive shall be performed. The FEA shall be performed using a computer program such as NASTRAN, ANSYS, Algor, or approved equal that according to its developer, and the developer of FEMAP generates both model and solution files compatible with FEMAP. The FEA software’s user manual shall be provided by the Contractor. The purpose of the locomotive FEA along with other analysis types shall be to show that the Locomotive design meets the requirements of Section 3.3.

The Contractor shall submit and receive approval of the finite element model prior to performing the analysis. The model shall be submitted not later than three months after NOA. The element mesh, all assumptions, and a complete printed copy of the input file which includes input data, such as loads, boundary conditions, area properties and material properties, shall be included as

part of the preliminary submittal and again as part of the complete analysis. A key to all symbols and colors shall be included. Boundary reaction forces of the shell at shall be included.

Each load condition submittal thereafter shall include diagrams areas of mesh refinement, all assumptions, all input data, reaction forces, and a table to show static equilibrium.
Wherever required to be submitted, the input and output shall have each page numbered, and columns of data shall be clearly labeled on each page using terms, symbols, abbreviations~ and units defined in the analysis report.

At the discretion of PATH, FE models and results shall be reviewed during live interactive sessions three weeks after each submittal. At these sessions, PATH shall have full access to the FE model input, output and use of the software *on* the computer used for the analysis. .

Color plots shall be prepared showing the following:

- Deflections in all three axes.
- von Mises, or other approved combination stresses.
- Maximum and minimum principal stresses.
- Direction of maximum and minimum principal stresses.
- Meshing accuracy index.

All plots shall show the maximum and minimum values and all values that are greater than 80 percent of the specified maximum value. Each drawing shall include a triad showing the direction of the global axes. Plots at high magnification shall be keyed to a plot showing the structure to an extent sufficient to orient the high- magnification plots.

The FEA input and output data shall also be submitted on electronic media as approved by the PATH. submittal of the input file is required with the model, and at any time the file is changed, but not more often than monthly. Criteria for final approval of the stress analysis shall include the Contractor's submittal of the fully configured input data files as required by this paragraph. Upon completion of the final design, the FE model and analysis report shall be updated to represent the final configuration of the structure.

3.3.2.6 Validation

For each test required by Section 17.5.27, the Locomotive structural test results shall be compared with the corresponding stress analysis results. This information shall be tabulated and submitted with the Locomotive structural test reports for each test.

The tables shall compare stresses calculated from the test strain gauge readings with analytical stresses from the FEA. Comparison shall be made for the highest-reading strain gauges, which shall not be less than half of the total number of strain gauges used during the test. The tables shall include the test stress value, the analytical stress value, the percent difference between the two values, and a space for annotation.

For any gauge location that has a margin of safety less than 2.0, with the predicted or measured stress from the FEA or load test, the percent difference between the compared test and analytical results shall agree within 15 percent.

Where the analytical values disagree with the test value by more than 15 percent, a detailed explanation of the reasons for the excessive variance shall be included in the Locomotive test report. This explanation may include supporting manual calculations.

Approval of the Locomotive test report shall depend, in part, on the adequacy of the analyses of excessive variance between analytical and test stress values.

3.3.3 Structural Design Loads

The Locomotive shall be designed to meet the load requirements in this Section.

3.3.3.1 Allowable Stress at Operating Loads

The completely equipped Locomotive shall be designed, with a load factor of 1.6, to carry its completely equipped Locomotive weight (not including truck weight), plus an allowance for vertical impact of 30 percent of Locomotive weight, distributed uniformly along the Locomotive. The stresses in the Locomotive, except the Locomotive bolster, shall not exceed the lesser of 80 percent of the guaranteed minimum material yield strength, and the buckling strength. The stresses in the Locomotive bolster shall not exceed 64 percent of the yield strength of the material, and the buckling strength of the structure.

Notwithstanding the previous paragraph, for each joint design, the static stress at the Locomotive load shall be less than the stress that determines the allowable fatigue stress range. The allowable fatigue stress range is computed by multiplying the static stress at the load by the dynamic factor (fatigue load range). This stress range must be within the design fatigue stress range (fatigue limit) obtained from AAR C-II, Section 7.2, or AWS D 1.1, for non-redundant or redundant structures as applicable and as approved by the Authority. The bolster, its connections to the Locomotive and truck, the side frame local to the bolster and the draw bar anchor support and its connections shall be considered non-redundant. The Contractor shall conduct fatigue tests to determine allowable fatigue stresses for joint designs not covered by AAR C-II, Section 7.2 or AWS D 1.1.

The fatigue design shall be based on applied and allowable fatigue stress ranges at 10 million cycles.

3.3.3.2 End Sill Compression Load

Under end compression load equal to a minimum of 320,000 pounds (1424 kN) applied longitudinally at the end sills of the Locomotive, the following conditions shall be met:

- There shall be no permanent deformation in any structural member, including sheathing,

the anti- climber, and its fasteners.

- Maximum stress in any material as a percent of the lesser of yield and critical buckling stress shall not exceed 80 percent outboard of the bolster and 64 percent between the bolsters.

- The vertical deflection of each side of the shell with respect to the body bolsters shall not differ from the analytically determined value by more than +/- 10 percent. The points to be measured shall be at the outer-bottom edge of the side sill.

3.3.3.3 Coupler Compression Load

Under an end compression load equal to a minimum of 200,000 lbs.(890 kN) applied longitudinally to the coupler pivot of a Locomotive, there shall be no permanent deformation in any structural members, including sheathing. In addition:

- There shall be no permanent deformation in any structural member, including sheathing, the anti- climber, and its fasteners.
- Maximum stress in any material as a percent of the lesser of yield and critical buckling stress shall not exceed 80 percent.
- The vertical deflection of each side of the shell with respect to the body bolsters shall not differ from the analytically determined value by more than +/- 10 percent. The points to be measured shall be at the outer-bottom edge of the side sill.

3.3.3.4 Combination Loads

3.3.3.4.1 General

Under the two combination loading conditions, the Locomotive structure and equipment supports shall have stresses within the allowable stresses stated in Section 3.3.3.4.5.

3.3.3.4.2 Combination A, Operating Condition

1. Dead load of completely equipped Locomotive plus
2. An allowance for vertical impact of 30 percent of the dead load, plus
3. A horizontal buff or draft of 50,000 pounds (222 kN) applied at the centerline of the coupler faces,
4. A force caused by the .maximum acceleration or deceleration resulting from a 25 percent coefficient of friction, plus
5. A force caused by running on a sharp curve at a speed sufficient to throw the entire weight of the completely equipped Locomotive including trucks on the four wheels on the outside rail.
6. Under this combination of conditions, the loading factors to be applied simultaneously to each Locomotive mounted equipment shall be as follows:

- Vertical (1.00 to 0.30) g
- Lateral +/-0.50 g
- Longitudinal +/-:l.00 g

3.3.3.4.3 Combination B, Buff or Draft Condition

1. A dead load of completely equipped Locomotive, plus
2. A horizontal buff of 200,000 pounds (890 kN) applied at the centerline of the underframe and distributed over a 15-inch *(380* mm) width of anti-climber, or a horizontal buff or draft of 150,000 pounds (667 kN) applied at the centerline of the coupler faces.
3. Under this combination of conditions, it may be assumed that the Locomotive will not be running at high speeds and, therefore, the allowance for vertical impact can be omitted.
4. The forces caused by operation on curves will not apply in this combination.
5. Under this combination of conditions, the loading factors to be applied simultaneously to each equipment unit shall be as follows:
   - Vertical 1.00 g
   - Lateral 0.00 g
   - Longitudinal +/- 2.00 g

3.3.3.4.4 Combination C -Lifting or Jacking

The Locomotive shall be designed to withstand lifting, supporting and jacking without binding or permanent deformation due to deflections. Jacking conditions shall include lifting at -two corners jacking pad until the truck, nearest the jacking pad is completely lifted off of the ground and the truck on the opposite side shall remain on the ground.

Jacking or lifting at the pads or supported by the support pads of the drop table shall not produce stresses greater than 75% of the yield point of the materials of the Locomotive structure.

3.3.3.4.5 Allowable Stresses for the Combination Loads

The maximum allowable stresses in the various Locomotive structural members, their attachments, and supporting structures, under the combinations of design loads specified above except Combination C, shall not exceed the following values:

Nature of Stress in Rolled Steel	Column I Allowable Stress for All Members Except As Specified in Column II	Column II Allowable Stress for Locomotive Bolsters Under Loading Combination A

Tension	0.50 Fy	0.40 Fy
Compression	0.50 Fy	0.40 Fy
Shear	0.33 Fy	0,26 Fy
Bearing	0.75 Fy	0.60 Fy

Fy = specified minimum yield

In no case, except in bearing stress, shall the maximum allowable stress exceed 40 percent for Column I items and 32 percent for Column II items of the minimum ultimate tensile stress of the material. The minimum factor of safety for buckling of the various portions of the Locomotive structure, under the design loads specified above, shall be 2.0.

The allowable stresses given above shall be reduced if necessary for structural elements or connections between structural elements that are critical in fatigue. Stress allowable for arc-welded structure shall not exceed the requirements of AWS D1.l, "Structural Welding Code", for New Bridges. Stress allowable for resistance-welded structure shall not exceed values selected by the Contractor and approved by the PATH.

3.3.3.5 Collision Posts

The Locomotive shall be equipped with collision posts for the cab. The collision posts, their attachments and the support structure shall withstand to a static load of 75,000 pounds (333.6 kN) applied to the collision posts at 1 6" (45.72 cm) from the top of the anti-climbers. The collision posts shall be constructed of nickel-copper- columbium steel per ASTM A- 710. If a steel is used such as ASTM specification A-558, then the design of collision posts is to have an energy absorbing performance equivalent to nickel-copper columbium steel per ASTM A-710

3.3.3.6 Anti-Climbers

Anti-climbers shall be attached to both ends of the Locomotive. The anti-climber shall be designed to engage the anti-climber of an opposing vehicle under the worst conditions of vertical and horizontal track curves and resist climbing forces between vehicles. The anti-climber shall be compatible with existing PATH equipment.

The anti-climber shall withstand a 80,000 lbs (356 kN) vertical load in either direction combined with a minimum of 275,000 lbs. (1,224 kN) longitudinal compression load applied at the Locomotive centerline, without permanent deformation of any Locomotive structure or failure of the means of attachment of the anti- climber to the end sill. One rib less than the total shall be used in computing and testing the vertical strength of the anti-climber.

If applicable, the anti-climber top surface shall include a PATH approved anti-skid surface. Adhesive backed, non-skid "tape" or sheets are not permitted.

3.3.3.7 Roof Load

All parts of the roof structure and sheets, roof walkway, screens and other guards shall have sufficient strength to withstand, without permanent deformation, the following loads applied separately:

- The load imposed by a mechanical car washer, consisting of a pressure of 60 pounds per square foot (2,900 Pa) over a 12-inch (305-mm) wide band extending transversely across the Carbody.

All parts of the roof structure and sheets, roof walkway, screens and other guards shall have sufficient strength to withstand, without permanent deformation:

- The load imposed by maintenance personnel carrying tools and equipment while working on the roof, consisting of three concentrated loads of 250 lbs. (1,112N) with a footprint of 6 in^2 (3870 $mm^{2)}$ spaced 30 inches (762mm) apart.

The roof shall also support, without yielding, the loads imposed by normal operating conditions, including loads imposed by roof-mounted equipment and specified jacking loads.
The roof shall also be coated with a yellow non-skid material as approved by PATH.

3.3.3.8 Jacking and Hoisting Loads

For location and other requirements see Section 3.4.1.4.2.

Each Locomotive jack pad and its supporting structure shall have a load factor of two based upon supporting a Ready-to-Run Locomotive weight. The vertical load on each jack shall be combined with a horizontal load of 10 percent of the vertical load (including the load factor of two) applied in any horizontal direction. Under this loading condition, there shall be no permanent deformation of any Locomotive structure. The same load factors as above shall apply for lifting pads and support pads.

The Ready-to-Run Locomotive, with trucks attached, shall be capable of being lifted with four jacks, one at each quadrant of the Locomotive at the corners or bolsters, in any combination, without permanent deformation of any Locomotive structure. The assembled Locomotive, with trucks attached, shall be capable of being lifted with two jacks at diagonally opposite corners without damage to the locomotive or any part of the assembled Locomotive.

3.3.3.9 Equipment Loads

The load factor for the design of all underfloor, side, end, roof, in-roof and interior equipment, any portion of the equipment, equipment boxes, equipment hangers, safety hangers, and the Locomotive supporting structure shall be five in the longitudinal direction, three in the vertical direction, and two in the lateral direction. The load shall be equal to the weight of the item multiplied by the appropriate load factor. The specified tri-axial loadings shall be applied separately; such loading may develop the ultimate load-carrying capacity of the item being

investigated.

With one less than the total number of supports, the remaining supports shall withstand not less than one-half of the required loadings without exceeding the ultimate load-carrying capacity of the members.

All supports shall be fatigue-resistant throughout the design life of the Locomotive. Equipment within an equipment box need not meet the above criteria provided it can be shown that the equipment will not penetrate the walls of the equipment box when exposed to these load levels. The equipment box shall conform to these load criteria with the rearranged equipment (*i.e.*, equipment that is presumed to have broken loose) in addition to its normal arrangement. Structural connections in equipment supports shall be subject to the requirements of Section 3.2.3. In particular, equipment support fastenings shall be designed so that in no case shall either the strength of a fastener, or the shearing of the fasteners through the base material, be the limit of the carrying capacity of the item .

3.3.3.10 Truck Connection Strength

Trucks shall be locked to the Carbody. The strength of the means of locking the truck to the Carbody shall be sufficient to resist an ultimate load of 150,000 lbs (667kN) in any horizontal direction applied to any point on the truck. When the Locomotive is raised off the track, the Carbody and the means of locking the truck to the Carbody shall resist a load equal to two times the full weight of the truck without permanent deformation.

3.4 Underframe

3.4.1 General

The Locomotive underframe shall be constructed of LAHT steel assembled by arc welding in accordance with Section 15 and AWS Structural Welding Code D 1.1 using AWS pre-qualified complete-joint penetration groove welded joints as defined by the AWS Structural Welding Code D 1.1 wherever primary loads are carried across the joint in tension or compression. AWS pre-qualified partial joint penetration groove welded joints may be used where primary loads are carried in shear along the length of the weld. Fillet welds may be used in joints that do not carry primary loads.

The Locomotive underframe shall consist of the draft sill, body bolster, end sill, anti-climber, collision post, shear lugs, and stubs for connecting the collision posts to the underframe sills. If heat treatment is required for stress relief, the assemblies shall be heat-treated after welding in accordance with AWS D 1.1.

The design of the underframe shall provide for continuity of flanges and webs at any location where load- bearing members intersect. The underframe shall be designed so that, in case of excessive impact, failure shall be caused by buckling or crushing of structural elements rather than by shearing of structural elements or by failure of connections between elements.

3.4.1.1 Not Used

3.4.1.2 Underfloor Equipment Supports

Underfloor equipment weighing more than 200 lbs. (91 kg) shall be supported directly by the side sills, body sills, transverse floor beams or longitudinal supports between transverse floor beams. All equipment shall be mounted with at least four supports, unless otherwise approved by PATH. Dissimilar metals shall not be allowed at connections.

Connection components shall not require disassembly for maintenance, or for removal and replacement of equipment. Equipment requiring removal and replacement for other than accident damage shall be supported so that both bolts and nuts are accessible.

Equipment supported on resilient mounts shall be provided with safety straps or other devices for support in case of mount failure. Bolts used to mount or support equipment shall not be less than 3/8-inch (9.5 mm) diameter.

All equipment weighing more than 25 lbs. (11 kg) shall be safety hung (not supported by threaded fasteners in tension or shear). No equipment shall be supported by bolts in holes tapped in the Locomotive structure. However, it is permissible to use tapping plates in accordance with Section 3.2.3.

All supports shall be fatigue-resistant throughout the Locomotive's design life.

3.4.1.3 Corrosion Protection

A corrosion-resistant coating, as specified in Section 15 and Section 3.2.1, shall be applied to the entire underframe.

3.4.1.4 Jacking and Lifting Provisions.

3.4.1.4.1 General

The lift, jack and support pads shall suit the construction of the Locomotive and the hoists, jacks, and stands in use in the PATH. The side frames shall be designed to provide lifting, jacking and support pads as specified below.

The jacking and lifting arrangement shall be designed so that the locomotive can be jacked or hoisted at one end, with the truck attached, while supported at the truck pivot at the other end. The jacks may be placed on one corner or both corners on the end being lifted. The Carbody shall be designed such that any of the 4 corners may be jacked in this condition.

The Locomotive shall also be capable of withstanding, with the load factor defined in Section 3.3.2.2, without exceeding yield or causing degradation of the water tightness of any glazing, all

loads caused by any lifting, jacking or supporting condition, and also torsional loads caused by diagonal jacking of the Locomotive with trucks attached as described in the diagonal jacking test in Section 17.5.27.2.11.

Trucks shall be retained with the body during jacking or hoisting unless intentionally disconnected as described in Section 4.3.4.2.

3.4.1.4.2 Jacking and Lifting Pads

The jacking, lifting and support pads shall have a bearing area at least 6-inches (152mm) long by 4-inches (102 mm)wide, with a *1/2* inch lip on either end, and project a minimum of 1/2 inch (13 mm) below the bottom of the side sill. Also, there shall be a minimum of 2 inches (51 mm) clearance to any obstruction around each jack pad. The bottom of all jack pads shall have a non-skid surface to provide frictional resistance against incidental horizontal loading between the jack pad and jack head.

The pads shall be located as follows:

- Jacking Pads shall be located at the extreme corner, or as close to the corner as possible subject to PATH approval, designed for jacking of the Locomotive along the right-of-way with Locomotive supported on one truck at the non-lifted end and with truck attached at the lifted end. There shall be no obstructions in the projected space below the jacking pad;
- Pads shall be located as near the centerline of bolsters as possible, to permit jacking the Locomotive with PATH standard floor jacks so that the truck can be rolled from under the Locomotive without removing any equipment or structure; and
- Pads shall be located between bolsters, designed for lifting of Locomotive with both trucks attached with an overhead crane with lift hooks.

The Locomotive shall also be capable of being supported at one end by the pads, without its truck attached, by the drop table support pads, while the other end is supported on its truck.

3.4.1.4.3 PATH Drop Table Support

The Locomotive shall be capable of being supported at one end by the lifting or jacking pads, without its truck attached, by the drop table support pads, while the other end is supported on its truck.

3.5 Equipment Identification Signs

3.5.1 General

The Contractor shall define a common format, subject to PATH approval, for identification signs and labels for use on all equipment enclosures supplied by the Contractor and sub-suppliers. The format shall define overall nameplate size, lettering fonts, and font sizes and colors. All lettering

and graphics, exclusive of manufacturer's logos, shall use the defined common font size and color. All Equipment Identification Signs shall be permanently affixed with screws or rivets. All Equipment Identification Signs shall be made of stainless steel with a mirror finish background. Lettering and graphics shall be engraved and paint filled.

All graphics layouts shall be submitted to PATH for approval. All warning or safety signs shall meet the requirements of ISO 3864 and shall be distinguished by using the word "warning" for personnel safety and "caution" for damage to equipment.

3.5.1.1 Exterior Graphics

Graphics shall be provided as follows:

- Locomotive Number Plate -Each Locomotive shall be provided with four Locomotive number plates located at the same height and near the ends of the outside of the Locomotive. The size and font of the plate shall be similar to those on PATH Locomotives and shall be approved by the Project Manager. The plates shall be applied to the Locomotive as approved by the PATH.
- The numerals shall be white, standard, Helvetica medium type face, spaced in accordance with PATH's graphic standards, on a black background. The Locomotive numbers will be assigned by PATH.
- Logo type -A logo type design shall be applied to the Locomotive exterior in areas to be selected by PATH. Logo design shall be furnished by PATH.
- PATH Ownership Plates: A small stainless steel or cast aluminum ownership plate shall be attached to the body side sill, right side, No.2 end of the Locomotive over the center of the bolster; and to each truck at the comer toward the center of the Locomotive, left side. The ownership plate shall include the words, "Property of PATH" and the serial number as stated below.
- Serial numbers shall be stamped on body and truck ownership plates to agree with the body and truck numbers, respectively, given above.
- The following items of under car equipment shall be stenciled. Color as noted with high visibility paint:
    - MR in 4-inch letters on both sides of the main reservoir -red.
    - SR in 4-inch letters on both sides of the supply reservoir -yellow.
- Miscellaneous Signs. Underfloor apparatus shall be marked by means of engraved metal plates, welded or mechanically fastened to the apparatus being identified and with the background and lettering in a contrasting color.
    - Each air brake reservoir and all cutout cocks, switches, fuses and junction boxes shall be marked as previously stated.
    - The cover of each apparatus box shall list each major item of apparatus contained therein. An additional label, readable from the side of the Locomotive, is required if the box cover label is not readable in the installed position. The application status of the BCO shall be clearly defined by mechanically fastened labels indicating Cut In and Cut Out.
    - Warning advice, including the normal maximum voltage of circuits therein, shall

be provided on the outside of boxes containing electrical apparatus energized at greater-than- battery potential. Identifying labels with black characters on a white background shall be provided for switches, circuit breakers, terminal strips and indicating lamps.

- The Locomotive number shall be clearly displayed on the car roof, as approved by PATH.

Except as otherwise specified, exterior signs and numbers shall be as approved by PATH. Where logotype is applied to Tedlar film, it shall be protected by a final lamination of clear Tedlar film. Edges of film shall be sealed in accordance with supplier recommendations.

3.5.2 Interior Graphics

Graphics shall be provided as follows:

- Inside the Train Operator's cab: The Locomotive car class, end number and the Locomotive number which is in agreement with the exterior mounted Locomotive number.
- A "V" shall be placed in an approved location over each High Voltage circuit breaker. The "V" shall be black, on a clear film.

- In the engine compartment, on the cover of each apparatus or apparatus box shall indicate the apparatus or list each major item of apparatus contained inside the box. An additional label, readable from the walkway, is required if the box cover label is not readable in the installed position. The application status of the BCO shall be clearly defined by mechanically fastened labels indicating Cut In and Cut Out.

3.5.3 Safety Signs

The Contractor shall define a common format, subject to PATH approval, for safety signs for use by the contractor and all sub-suppliers. Safety Signs (warning/caution) shall comply with the International Standard ISO 3864. Safety Signs shall be permanently affixed with proper adhesive, screws, or rivets, on or near all Equipment to alert Operation and Maintenance Personnel to exercise caution when working on or near this Equipment. All exterior Safety Signs and undercar signs shall be made of stainless steel with a mirror finish background. Appropriate messages shall be engraved as approved by PATH.

- "Warning" signs will be used in case of operating or maintenance procedures, practices, conditions, statements, etc., which, if not strictly observed, could result in injury or death.
- "Caution" signs will be used in case of operating or maintenance procedures, practices, conditions, statements, etc., which, if not strictly observed, could result in damage to or destruction of Equipment.

3.6 Engine Room Arrangement

The area of the cab and above the underframe shall be designated as the engine room.

The engine room framing and panels for walls, doors, and roofs shall be fabricated from steel. Alternate material may be used for panels and doors with the approval of the Project Manager. The engine room shall house the power plant and auxiliary equipment necessary for locomotive operation. It shall be arranged with stainless steel diamond plate external walkways located longitudinal of the locomotive. The cab shall be partitioned from the engine room. A door, as specified in Section 6.2.2.4, from the cab to the walkway shall be provided and it shall open towards the walkway. The engine room walls shall be insulated to meet the noise and vibration requirements of Section 2.8; the insulation material shall meet the smoke and flammability requirements of Section 15.22.

Equipment in the engine room shall be oriented such that inspection items and consumables are readily accessible from the walkways.

All electric or electronic equipment located inside the Locomotive shall be mounted in dust-proof, equipment enclosures meeting NEMA-4 requirements. Enclosures shall be consistent with interior construction methods and materials. All interior enclosures shall be readily accessible. Equipment weighing more than 5 pounds shall be mounted in a way that permits ease of installation by a single person, e.g. guide pins or key-hole mounting slots. These details, including special provisions for ceiling/overhead mounted equipment shall be included in the equipment design specification required by Section 3.3.3.9.

3.6.1 Equipment Access

The engine room shall be designed with exterior access panel doors on the side walls and removable panels on the roof to allow inspection and removal/replacement of equipment, including the power plant, diesel engine, main alternator, compressor, etc. These access doors and panels must be sized such that they will not affect the structural integrity of the Carbody. The access doors shall be provided with PATH -approved locking mechanisms. The access doors to allow maintenance and service of equipment, must also be designed such that they are captive and do not violate the limiting line clearance envelope when open in any position. However, each individual access door must also be capable of being removed, if necessary. Access doors must also be designed such that if there is a failure of hardware and/or locking device securing the doors, no violation of the clearance envelope will occur.

For heavy overhauls, the entire shroud containing the framework, walls, and roof shall also be easily removable. All access doors and panels, as well as the interface between the shroud and carbody shall be watertight. Lifting ears to allow overhead shop cranes to remove the shroud shall also be provided for this purpose. The Project Manager shall approve the engine room arrangement, as well as the provisions and method for access to meet the requirements in this section.

3.7 Underfloor Equipment Enclosures

3.7.1 General

Any equipment enclosure under the Carbody shall meet the requirements of this section. Undercar equipment with a direct line of sight to a wheel for any possible truck orientation shall be protected from water splash, flying rock ballast, or other objects thrown by the wheel. If separately mounted, solid-metal shields are used to provide such protection, they shall not hinder the flow of air from or to the underfloor to a degree which might allow overheating of wiring or apparatus.

The enclosures shall contain drain holes fitted with cotter keys or other approved, simple drain clearing mechanisms for discharge of condensation and leakage due to damaged or deteriorated seals.

All Locomotive equipment that must be operated by PATH personnel in case of propulsion or brake system malfunction must be accessible either from the interior or the ends of the Locomotive, unless otherwise approved by PATH.

All underfloor and interior equipment shall be arranged to allow ready access from the side of the Locomotive, the maintenance pits or scaffolding, and when the Locomotive is on lifts. Labels and warning indicators shall be applied as required by Section 3.5.1.

Equipment installed in boxes shall not be attached directly to the box by bolts or other fasteners through the enclosure walls, top or bottom sheets. They shall be attached to standoffs or subplates which are in turn welded to the box. In addition, sufficient clearance (1/2-inch [12.7-mm] minimum) shall be provided between the exposed sides and covers of the equipment enclosure and the internal equipment to protect the internal equipment from damage due to minor impacts.
All underfloor enclosures are to be openable and the equipment contained therein is to be maintainable and serviceable in PATH's shop environment.

All underfloor enclosures, with the exception of the battery box, shall be grounded to the Locomotive.

3.7.2 Hardware Requirements

All hardware, including hinges, used to secure access covers or access plates on equipment enclosures shall be made of stainless steel. All mounting hardware for access covers shall have captive nuts or bolts.

3.7.3 Access Cover and Maintenance Access Requirements

Equipment box access covers shall not be removable, unless approved by PATH, and shall be self-closing when the "hold open" feature is released. They shall be constructed of LAHT, or mild carbon steel; an alternate material may be considered for PATH approval.

All access covers shall be provided with quick-release, spring-loaded, or approved equal, latches that operate with a toggling-type action. The latches and latch catches shall be arranged so that

they do not protrude beyond the bottom of the box or cover in the latched position, except as approved. The latches shall not violate the Locomotive dynamic clearance outline if not engaged. The latches shall be spring-loaded to compensate for seal relaxation considering the worst case condition of hard contact between the cover and box, except as approved. In this extreme case, the latch must hold the cover firmly to the box without rattling. The latch and all its components shall be fabricated from stainless steel. Prior to delivery, cover latches shall be checked to ensure that the cover seals are compressed no more than 50 percent of the compressible height of the seal and water-tightness tested. The latches shall not have separable or non-retained parts.

A spring-loaded safety pin, Alstom part No. CX63CH-001, or PATH-approved equal, shall be provided for each underfloor box cover. The safety pin shall be designed to retain the cover within the Locomotive dynamic clearance envelope at all operating speeds without the cover latches engaged.

All undercar equipment boxes shall have identical latches, safety catch, and "hold open" devices, except as approved by PATH.

Underfloor equipment enclosures shall be provided with top-hinged access covers on the outboard side and, if required, the inboard side. Outboard covers shall swing open a minimum of 120° for quick examination of the interior without removing the covers. Inboard covers shall swing open to the maximum extent possible, but in no case less than 60°.

Openings provided upon opening of covers shall be of sufficient size to permit removal and replacement of any component in the box and easy access to equipment in the box for inspection and maintenance.

All outward facing covers shall have an internal "hold open" feature. The "hold open" feature shall not automatically open the cover and shall in no way interfere with or impede the easy opening of the cover, nor shall the "hold open" mechanism present the possibility of shorting or grounding internal electrical parts when the cover is opened or closed. The device shall automatically lock in the open position when the cover is opened fully and shall be easily unlocked when reclosing the door or panel. This device shall be the B-1450 series as made by Takigen Manufacturing Company, or PATH-approved equal.

The covers shall be arranged so that only one person is required to easily open, close, and latch any cover, regardless of size. Adequate clearances for all handholds, latches, and other appurtenances, shall be provided so that a person wearing gloves is not hindered.

3.7.4 Environmental Sealing

Environmental sealing shall be equivalent to a NEMA Standard No. 250, Type 4 enclosure. Seals shall be of a material that will ensure water-tightness and remain resilient for a period of at least 10 years, with proper maintenance.

Closed-cell foam tube or similar design shall be used for all cover seals. The seals shall have a

minimum free compression range (hollow tube inside diameter) of 3/8 inch (9.5 mm). Flat foam strips or glue-on attachments will not be permitted. The design shall allow for ease of seal replacement.

3.7.5 Electrical Interface

The arrangement for conduit, cable, wire routing, connections to equipment enclosures, and equipment contained in enclosures shall be configured so that structural, electrical and environmental integrity is maintained, and so that the removal and replacement of the equipment enclosure is facilitated. Each arrangement employed shall be approved.

All control and power cable terminations shall be made internal to the enclosures or in waterproof, gasketed junction boxes meeting NEMA 4-type requirements or using connectors as specified in Section 15.16.5. Cable entry shall be by means of watertight sealing glands. Glands and cable terminations shall provide for cable replacement without removal of lugs, terminals, or connectors from the wires.

Conduit shall be connected to underfloor equipment groups using watertight connectors as specified in Section 15.18. The entrance of conduit or cables in the top and bottom of equipment boxes will not be permitted.

Cable entry to an equipment enclosure within the engine room or the cab shall be no less than 8” above finished floor. Electrical conduits in the engine room and the cab shall be installed no less than 8” above finished floor.

3.8 Insulation

3.8.1 General

The floor, roof and walls of the Locomotive shall be thermally and acoustically insulated. The insulation shall meet the noise and thermal requirements per Section 2.8 and Section 12.
The insulation and all materials used for noise and vibration damping shall meet the smoke and flammability requirements.

3.8.2 Thermal

An approved insulation material shall be used throughout the roof, floor and walls of the cab for thermal insulation. If fiberglass insulation is used, it shall not mold, rot, or sustain vermin. It shall not corrode any metals or settle under Locomotive vibration. It shall not have an odor or be capable of absorbing odors.

3.8.3 Acoustical

A vibration and sound damping material shall be applied to inner surfaces of the cab, including the roof, sidewalls and floor. It shall be resistant to alkalis, greases, gasolines, aliphatic oils,

vermin, and dilute acids, and shall meet the smoke and flammability emission requirements noted elsewhere in this contract. It shall be unaffected by sunlight or ozone, and shall not become brittle with age.

3.8.4 Urethane Foam

Urethane foam insulation shall not be acceptable for use anywhere in the construction of the Locomotive.

3.9 Windows

All windows shall be of the single-glazed, fixed type, supported directly by the cab wall structure with an approved fastener arrangement. Cab windows shall be maximized in size to provide unobstructed views for the crew. All frames shall be designed to be vandal resistant. The ends of any glazing strip shall be joined together by the hot vulcanization process to form an endless glazing strip.

All sash frames, where used and glazing strips shall be so arranged such that they are easily removable from the inside of the Locomotive for repair or replacement. In all cases they shall have internally rounded comers, both inside and outside the Locomotive, to facilitate cleaning. The glazing sections shall be designed specifically for this Locomotive considering both cab wall thickness and configuration and window material thickness in order to make a watertight seal without the need for sealing compounds.

Front and rear-facing windows and their frames, glazing strips and their attachments shall meet the FRA Type I impact and ballistics requirements. All other cab windows and their attachments to the Carbody shall meet 49 CFR part 223 Safety Glazing, the FRA Type II impact and ballistics requirements.

All window and windshield panes shall be secured in frames through the use of aluminum retainer strips. The retainer strips shall be inserted into a slot in the frame and shall be secured with a vandal resistant mechanical fastener that penetrates through the retainer strip.

3.10 Interior Linings

3.10.1 General

The interior of the cab shall be pleasing in appearance, modular in design and shall be free of sharp comers or edges to eliminate the possibility of injury to operating and maintenance personnel.

Lighting fixtures shall be supported from the cab structure and not the lining. The design and layout of the interior lining shall minimize the size and number of the seams and moldings.

3.10.2 Moldings

The use of moldings is to be minimized; however, where necessary, moldings shall be used to cover all joints. Moldings shall be mechanically attached to the interior linings.

3.11 Exterior Accessories

3.11.1 Safety Appliances

All safety appliances such as climbing steps, grab handles, and walkways shall meet the requirements for support of locomotive-mounted equipment and shall conform to 49 CFR 231 Railroad Safety Appliance Standards.

3.11.2 Climbing Steps

Steel angled climbing steps with the same size and configuration shall be provided on both sides, at each end of the Locomotive to enable access to the locomotive walkways from the rail bed. The steps shall have an 8- inch (203-mm) clear depth and height and shall support the load of a 300 lbs. (136 kg) crewmember with a safety factor of 1.5 against yield. The climbing steps shall be secured to the Locomotive with approved mechanical fasteners. Welding of the climbing steps to the Locomotive will not be allowed. The steps shall be painted with PATH -approved safety yellow paint. The first step shall be as close to the rail bed as possible and comply with all clearance requirements in this specification.

3.11.3 Grab Handles

A stainless steel grab handle shall be located on both sides of the climbing steps located at each comer of the locomotive. Each grab handle shall be long enough to provide easy access to a crewmember. The grab handles shall be within the specified clearances.
Grab handles shall be a minimum of 5/8 inches (16mm) in diameter. A minimum clearance of 2 inches (50 mm) shall be provided between each grab handle and any part of the Locomotive, including doors and latch handles. Grab handles and their attachment to the Locomotive shall conform to 49 CFR 231.

3.11.4 Rain Gutters

Rain gutters shall be continuous and shall be located above the doors and windows at the roof. The rain gutters may be separately formed and attached, or may be integral with the roof structure.

Splashguards shall be installed at the ends of roofs and rain gutters to prevent accumulated rainwater from cascading over the cab ends of the Locomotive, and between coupled cars. If the roof is corrugated, the splashguards shall be adequate for the purpose intended with water accumulation up to the maximum possible with the form of corrugation used.

3.11.5 Snow Plows

The Contractor shall furnish two (2) snow plows per Locomotive, as approved by PATH. The snow plows shall be fitted, one (l) to each end of the Locomotive, and shall comply with the clearances specified PATH document, particularly avoiding interference with all trip arm mechanisms, and allowing the couplers to swing in both directions during switching, negotiating curves and turnouts. Snow plows shall comply with 49 CFR 229.123.

3.11.6 Safety Railings

Stainless steel safety railings shall be provided on both sides and at each end of the Locomotive. The safety railings shall run continuously from the back of the cab to the end of the locomotive on both sides. The height of the safety railings shall not be less than 30 inches above the walking surface. The safety railings and their attachments shall conform to FRA Safety Appliance Standards and be subject to PATH approval. The safety railings shall be removable for maintenance access and shall be within the specified clearances.

SECTION 4

4.0 TRUCKS AND SUSPENSION

4.1 General

Truck frames and bolsters shall be designed for reliable operation and low maintenance. They shall also be designed to maintain stresses within the endurance limits for the specified operational environment over the 35- year design life of the Locomotive. The trucks shall provide good ride quality, low noise and vibration, low wheel flange and rail wear and good rail adhesion. The design life goal for elastomeric components shall be no less than 7 years. The truck design shall be free of sliding metal-to-metal surfaces and shall not have lost motion or free play in any area.

Trucks with a proven design that meet all requirements in this section will be considered.

4.1.1 Configuration

The trucks and suspension subsystem shall be formed by all truck components from the rail up to the body bolster, including any suspension sub-system components rigidly mounted to the Carbody. It does not include gears, motors, wiring or the brake system. Any mechanical interface requiring welding or drilling on the truck shall also be considered part of the truck. The Contractor shall ensure that all truck-mounted equipment can be accommodated without physical interference. On each truck shall be mounted two traction motors, reduction gears and brake equipment/piping. Also, cables shall be installed and provisions shall be made for mounting of other necessary components.

The truck frame and bolster shall be an outboard bearing design of cast or fabricated steel; an alternate bearing design may be considered for PATH approval. Truck elements shall be heat treated if required by the supplier of the material, for stress relief or strength attainment. Longitudinal forces from traction and braking, between truck bolster and truck frame shall be transmitted through long life elastomeric elements. The truck wheelbase shall be 6 feet 10 inches (6’ 10”) for increased maximum wheel loads. Alternate dimensions will be considered by the Project Manager. Clamps for piping, cables, etc. shall be attached to tapping plates or raised bosses.

Truck serial numbers shall be applied to both sides of each truck at the center of the side frame. The figures shall be 3/4-inch (19 mm) high, with the bottom on the figures 1/4-inch (6.4 mm) above the tangent point of the bottom of the member and shall be distinctly stamped into the frame with low stress steel dies. The serial numbers for trucks will be assigned by PATH.

4.1.2 Interchangeability

Trucks shall be interchangeable between ends of the Locomotives, with no modifications to the truck except for installation and removal of park brake manual deactivation rigging, drawbar stop, truck piping and truck equipment. No welding, drilling, tapping, riveting, or cutting shall be necessary for application or removal of the aforementioned equipment. Any park brake, drawbar stop, piping assembly or truck equipment to be installed or removed from a truck shall be attached with bolted connections. Truck frames, bolsters, wheels, axles, bearings, gear units, and motor assemblies (brake equipment/piping) shall be interchangeable between all trucks.

4.1.3 Not Used

4.1.4 Truck Stress Analysis

4.1.4.1 General

The Contractor shall submit a stress analysis of the truck, including the truck-bolster. This analysis shall be submitted not later than 60 working days prior to commencing manufacture of any truck assembly structural parts. The stress analysis shall be used to design the truck structure to meet the requirements of this Specification. Structural tests shall be performed in accordance with Section 17.5.27 to confirm the theory of the design and the accuracy of the analysis.
The stress analysis shall show the calculated stresses, allowable stresses, and margins of safety for all elements for all specified loading conditions. The stress analysis shall include calculations of stresses in all joints, joint elements, mounting brackets, and other important elements.
The approved stress analysis shall be a prerequisite for approval of the static and dynamic truck test procedures required by this Specification, and shall be used as an aid in determining strain gauge locations for use during the tests.

During the design and manufacture of the truck, stress analysis shall be updated to reflect the as-built configuration. The initial stress analysis will require temporary assumptions as to configuration and weights; also manufacturing and other considerations may require design

changes. As these changes are made, the stress analysis shall be revised and submitted for review. The final submitted and approved stress analysis shall be for the truck in the as-built configuration.

Critical connections, which cannot be adequately analyzed, shall be prototyped and tested to demonstrate compliance with the requirements of the design and the Specification.
For any portion of the proposed design which is based on a service-proven truck, the Contractor may provide data from previous tests, historical data from operations, or stress analyses as required to satisfy the corresponding portion of these requirements.

4.1.4.2 Stress Analysis Definitions

Refer to Section 3.3.2.

4.1.4.3 Truck Stress Analysis Report

A stress analysis report shall be prepared and submitted for review and approval. This report shall show that the structure satisfies the requirements of this Specification and good practice in the Locomotive industry. The report shall be presented in sufficient detail and organized so that the PATH reviewer can readily follow the theory and its application to this truck.

The Contractor shall certify that the analysis and calculations have been reviewed and checked before the report is submitted to PATH.

If a cited reference is not readily available to PATH, the Contractor shall provide the reference or copies of the pertinent pages. In addition to the, pages that. show the cited formula or data, the pages that show the development and interpretation of the formula or data must be included.
All references shall be in English. If an English reference cannot be found, an English translation shall be provided. Both the original and the translation shall be included in the report.
All stress analysis sheets shall be signed and dated by the author and checked by a second stress analyst who shall also sign and date each sheet checked. One of the two analyst must poses a valid Professional Engineer (P.E.) license.

The stress analysis report shall include, at a minimum:

- Table of Contents.
- Wherever a formula or equation is used, it must first be stated algebraically with all terms defined and the values of these terms with units stated, before calculations are performed.
- All quantities wherever given must have their units given with them.
- References for all formulas, calculation procedures, material strengths, fatigue strengths, and other physical and mechanical properties must be cited where these items appear in the stress analysis.
- Each page numbered, dated, and initialed by the analyst and checker. In the event of a revision, the revision letter shall be included with revision date, reason for revision and initial of the analyst and checker.

- The truck structural drawings.
- Diagrams displaying, for each load case, loads applied externally to the truck assembly and points of support.
- An analysis showing compliance with each design and test load and condition.
- Detailed calculations of stresses with Margins of Safety (MS) in all structures with a summary of the results. Locations where the MS is less than 0.20 shall be shown in a table along with the design or operating conditions (loads) which cause the stresses.
- A tabulation, or diagram, of calculated deflections of the truck assembly under full loading specified in Section 4.1.5.
- Analysis of all critical and highly loaded connections.
- An analysis of the strength of the truck frame-to-truck bolster, and truck bolster-to-Carbody bolster connections, including calculated vertical and horizontal connection capacities.
- A tabulation of the Contractor's selection of allowable fatigue stresses, with sources, and assumed applied fatigue stress ranges for structural members which are critical in fatigue.
- A table showing the engineering properties of each grade and temper of each material used in the truck structure. This table shall include the material designation, yield strength, ultimate strength, elongation, Young's modulus for tension, and compression and shear elastic moduli. In each case, minimum-guaranteed values from the specifications for the corresponding grade and heat treatment of the material shall be used. Materials, grades and tempers not used in the truck assembly construction shall not be included in the tables.
- Table(s) showing the minimum static and fatigue strengths of all welds. Values shall be given for each material, temper, weld size, and thickness combination used in the truck assembly. The source of the data shall be provided.
- If tests are conducted to provide the necessary data, the entire test report shall be submitted. This report shall show the test procedure, raw data as well as reduced data, and summary.

4.1.4.4 Finite Element Analysis (FEA)

The stress analysis shall include a linear-static finite element analysis (FEA) of the complete truck assembly. The Contractor shall submit and receive approval of the finite element model prior to performing the analysis. The initial model report shall be submitted not later than five months after NOA. The element grid, all assumptions, and a complete printed copy of the input file which includes input data, such as loads, boundary conditions, area properties and material properties, shall be included as part of this preliminary submittal and again as part of the complete analysis. Boundary reaction forces due to a gravity loading shall be included in the report.

Wherever required to be submitted, the input and output shall have each page numbered, and columns of data shall be clearly labeled on each page using terms, symbols, abbreviations, and units defined in the analysis report.

At the discretion of PATH, FE models and results shall be reviewed during live interactive sessions four weeks after each submittal. At these sessions, PATH shall have full access to the FE model input, output, and software on the computer used for the analysis.

Color plots shall be prepared showing the following:

- Deflections in all three axes.
- von Mises, or other approved combination stresses.
- Maximum and minimum principal stresses.
- Direction of maximum and minimum principal stresses.
- Strain-energy density, if available.
- Meshing accuracy index.

All plots shall show the maximum and minimum values and all values which are greater than 80 percent of the specified maximum value. Each drawing shall include a triad showing the direction of the truck assembly (global) axes. Plots at high magnification shall be keyed to a plot showing the structure to an extent sufficient to orient the high-magnification plots.
The FEA input and output data shall also be submitted on electronic media as approved by the PATH. Submittal of the input file is required with the model, and at any time the file is changed. but not more often than monthly. Criteria for final approval of the stress analysis shall include the Contractor's submittal of the fully configured input data files as required by this paragraph. Upon completion of the final design, the FE model and analysis report shall be updated to represent the final configuration of the structure.

4.1.4.5 Comparison with Test Results

The stress results from the truck static load test required by Section 17.5.27 shall be compared with the corresponding stress analysis results. This information shall be tabulated and submitted with the truck structural test report.

The tables shall compare stresses calculated from the test strain gauge readings with analytical stresses from the FEA. Comparison shall be made for the highest reading strain gauges, which shall not be less than half of the total number of strain gauges used during, the test. The tables shall include the test stress value. the analytical stress value, the percent, difference between the two values, and a space for annotation. The percent difference between the two values shall be within the following specified tolerance for 75 percent of the compared values, test and analytical results shall agree within 15 percent.

If the analysis results do not agree with the test results within the above-specified tolerance, the builder shall revise the stress analyses, update the FE model, and re-run all FE analyses. This process shall be repeated until agreement of results is within the Specified tolerance. All manual analyses using data from the FEA shall be recalculated using the corrected values. The stress analysis report shall be revised and re-submitted. All results from re-analysis shall meet specification requirements, and, if they do not the design shall be corrected.

For any of the remaining 25 percent of the compared values where the analytical values disagree with the test value by more than 15 percent, and the test value is equal to or greater than 35 percent of the yield strength of the material, a detailed explanation of the reasons for the excessive variance shall be included in the truck test report. This explanation may include supporting manual calculations.

Approval of the truck test report shall depend, in part, on the adequacy of the analyses of excessive variance between analytical and test stress values.

4.1.5 Truck Design Load Requirements

The truck shall be designed to meet the load requirements indicated in Section 17.5.27.1.2.

The truck shall be capable of withstanding the maximum load imposed by the forces acting on the frame, including forces resulting from track shocks, motor torques, friction brakes, and any combination of these forces without developing stresses which are greater than the allowable stress.

Design allowable stresses shall not exceed 50 percent of the yield strength of the material and 60 percent of the endurance limit (either or both) for the specified materials. The fatigue allowable stresses shall not exceed the requirements of AWS D1.1 for non-redundant structures.

4.2 Ride Quality

4.2.1 General

The truck shall be designed to provide a comfortable ride for all crewmembers in the Locomotive.

4.2.2 Truck Vibration

The truck shall be free of oscillations at all operating speeds with new or worn wheel profiles. Vibrations shall be minimized to prevent damage to the Locomotive equipment as well as to provide a comfortable ride for the crewmembers.

4.2.3 Wayside Vibration

To minimize low frequency ground borne vibration and noise, unsprung weight should be minimized.

4.3 Truck Assembly

Truck assemblies shall be designed for easy removal and replacement from under the carbody without the use of special tools. Carbody-to-truck assembly connections shall not contain any press fit joints. Any joints which could become frozen or locked over time shall be sealed from

moisture and be provided with stainless steel pins and self-lubricating, corrosion-resistant bushing.

4.3.1 Performance

Unless otherwise specified, all performance requirements throughout the Technical Specification shall be applicable to a tare weight locomotive, a locomotive pulling a 260-ton work car consist while maintaining a speed of 25 mph on level tangent track and a speed of 5 mph up to 5% grade.

4.3.1.1 Lifting Provisions

The truck shall be provided with 4 lifting locations toward the far ends of the truck frame and capable of supporting the truck frame weight, although the truck assembly will be typically lifted from the wheel back rim. The lifting design must be approved by PATH. The truck frame shall be capable of being "lifted" with standard lift chains in use on PATH. The truck assembly shall be capable of being wheel-trued with use of standard tie-downs in use on the PATH.
Each truck side frame shall be fitted with two diamond pattern or similar slip-resistant jacking surfaces approximately 6 inches (152 mm) long by 4 inches (102 mm) wide to support the truck during propulsion check-out, including axle rotation. In addition, jacking pads shall be located beneath the axle boxes.

The truck frame shall be provided with interface pads to accommodate the progressor used in the wheel truing facility at PATH, Harrison Carshop Maintenance Facility (HCMF).

4.3.1.2 Operating Conditions

The truck shall meet the requirements under the track and operating conditions specified in Section 2.1.5.

4.3.1.3 Motion Restriction

- Motion -The suspension subsystem shall not permit carbody motion to exceed, under all conditions, the dynamic outline referenced in Section 2.1.4.
- Clearance -All truck parts, except wheels, third-rail ice scraper shoes, trip cocks, and axle-mounted equipment, shall clear the plane of the top of the rails by not less than 2.5 inches (64 mm) under all conditions referenced in Section 2.2.

Maximum wear is that condition in which a piece of equipment can be retained in service but beyond which it must be removed from service.

The Contractor shall provide for the clearances between the trucks and the Carbody and all its parts under all operating and loading conditions, including wheel and other wear. Clearances shall be provided for operation, body-truck cabling and piping, inspection, maintenance and

repair.

The completely assembled truck with motors and other equipment shall not exceed the clearance limits required between truck parts with maximum wear and load, primary or secondary suspension deflection and/or rubber creep, in accordance with the track requirements.

4.3.1.4 Carbody Height Adjustment

Provisions shall be made for vertical adjustment to compensate for wheel wear and other suspension tolerances to maintain the top-of-rail to floor height within the vertical tolerance. The Contractor shall provide a design to adjust the Carbody height for the full range of equipment and component wear. Each discrete adjustment position shall allow a height adjustment of no more than 3/8 inch. The design shall be subject to approval and shall permit adjustment with standard maintenance equipment and shall not impair the operation of the truck. Such adjustment shall not be accomplished with loose shims. Wheel wear shall not be compensated at the primary suspension.

4.3.2 Testing

The testing required for the truck is specified in Section 17.5.27.1. The Contractor shall provide all testing instruments, materials and labor necessary to perform the testing. The cost of all such testing shall be borne by the Contractor.

4.3.3 Construction

4.3.3.1 General

Where pockets or partially enclosed spaces exist, provision for adequate drainage shall be assured. Moving contact surfaces shall be permitted. Low friction elements shall not require lubrication. The frame shall be provided with attachments for the application of brake system parts, motors, gear units, third rail ice scraper, primary and secondary suspension elements, and dampers. All drilled or tapped holes in any part of the truck structure shall have deburred edges. Any drilled or tapped holes shall occur in an area of increased thickness for lower stress. Sharp edges on machined surfaces shall be deburred. The Contractor shall provide a working procedure for the attachment of accelerometers for truck testing. Frame attachments for accelerometers shall be provided as necessary according to the attachment procedure.

Truck parts adjacent to or above the third rail ice scraper assembly and uninsulated power connections shall be shielded against arc damage by dielectric, non-combustible barriers and protective shielding of adequate mechanical strength. All threaded fasteners shall be SAE Grade 5 minimum, but threaded fasteners connecting parts essential to operating safety shall be Grade 8. All nuts and cap screws shall be retained by locking devices as specified in Section 15.2.2.5.

4.3.3.2 Materials

Truck frames and bolsters shall be of cast or fabricated welded steel.

The trucks shall be free from sharp corners, sharp edges or burrs which may cause injury to maintenance personnel. All machined, ferrous surfaces shall be free from surface defects and shall be coated with a strippable rust preventive paint.

All truck surfaces, except those listed in Section 15.21.5, shall be painted as specified in Section 15.21.3. Straightening of truck fabrications or castings by cold-pressing is not permissible unless subsequently stress-relieved or unless the fatigue test sample has been cold pressed in the same manner to the maximum limit subsequent to stress-relief and before the fatigue test.

4.3.3.3 Inspection

Inspections shall be as specified in Section 18.1.5.

4.3.3.4 Welding

All welding on the truck including application of brackets, pads and other attachments shall be entirely completed prior to stress relieving. Drilling, tapping and machining of finished surfaces shall be accomplished only after stress relief.

4.3.4 Truck Frame and Bolster

4.3.4.1 General Requirements

Truck frames and bolsters shall be of a service-proven outboard bearing design fabricated by welding or casting; a service-proven inboard bearing design may be considered for PATH approval. Materials shall be according to Section 15.4 (weldments) or Section 15.5 (castings). All welding shall be in accordance with welding and brazing requirements specified in Section 15.20. Steel plate welds shall be inspected to AWS D 1.1, Section IX requirements. Inspection non-destructive sampling provisions of Section 15.20.4 shall be applied to plate steel weldments. Quality control of steel castings shall be in accordance with Section 15.5.3.

Pedestal tie bars, if used, shall be attached to the truck frame pedestals in a manner which provides a positive, metal-in-bearing path for loads which may be taken through the tie bars. A pedestal tie bar attachment design which depends solely on clamping friction to transmit loads between it and the pedestals shall not be acceptable.

There shall be no sliding surfaces involved in the method of retaining the journal bearings in their proper positions. The design of the truck shall allow compensation for normal creep or settlement of the primary suspension springs.

Where pockets or partially enclosed spaces exist, adequate drainage shall be provided so that no moisture collects anywhere within the frame and bolster.
Threaded fasteners, adjustment points, and structurally critical locations shall be accessible for

inspection and work using conventional means and tools.

4.3.4.2 Carbody Connections

- Configurations -Positive mechanical connections shall be provided between the Carbody and trucks, such that the trucks shall be raised with the Carbody, without causing any part of the suspension system to disengage or be displaced. This feature shall provide protection against inadvertent vertical separation of truck and Carbody. The connection shall be readily separable with ordinary hand tools.

  The truck shall be capable of rotating about a vertical axis with respect to the Carbody and shall operate freely over all curves and turnouts specified in PATH.

  Truck rotational stops shall be provided.

  Positive stops shall be provided on the Carbody and truck bolsters to limit the vertical and transverse movement of suspended trucks.

- Strength -The strength of the connection shall provide a factor of safety of not less than two times the yield strength of the material when lifting a fully assembled truck. These connections shall be designed and located in a manner, which shall minimize Carbody damage during derailments.

Truck lifting hooks and/or other members used to attach the truck to the Carbody shall be capable of resisting a vertical load of 50,000 lbs. (222.4 kN) without permanent deformation. The lifting hooks and/or members used to attach the truck to the Carbody shall be designed and located in a manner which shall minimize the possibility of damage during derailments. The ultimate strength of the truck-to-Carbody connection shall be sufficient to secure the entire truck to the Carbody under conditions in which a horizontal load of 150 000 lbs, (667.2 kN)applied in any direction at any point on the truck, without separation of the truck and Carbody. The ability of the truck to-Carbody connection to sustain this load shall be independent of the presence of vertical load. The horizontal load may be transmitted from the truck to the Carbody through structural members, positive stops, or other rigid, mechanical safety devices, Bolster anchor rods shall not be used to provide any portion of this strength.

The truck center plate design, if utilized, and each side bearing shall each be capable of carrying the maximum car to truck loads.

4.3.4.3 Components

All shock-susceptible components shall be suitably shock mounted. Safety support members shall be provided for emergency support of major components, including traction motors and gear units, so that they shall remain clear of the track in the event of primary mount failure. Safety support members shall be an integral part of the truck frame and shall not support any

weight until a failure has occurred. Equipment mounting bolts shall be as specified in Section 15.2.2.

4.3.5 Maintenance Access

The truck shall provide unobstructed access to all parts, which require periodic inspection, lubrication, and/or removal and replacement without requiring removal of any other apparatus or detrucking of the car. Detrucking is permitted for replacement of traction motors, gear units, wheels, axles, primary suspension and wheel bearings. All other items requiring detrucking shall require PATH approval. Inspection covers on equipment, when removed, shall provide visibility of all apparatus requiring lubrication and fittings on the truck shall be readily accessible for servicing either from a pit or from the side of the Locomotive.

Trucks are removed after suitable release of the locking device by jacking the end of the Locomotive until the engaging members clear the truck. The truck is then rolled out and in this condition must clear the Carbody including coupler draft gear. Neither the truck being removed nor the truck remaining nor any of its mounting equipment shall suffer-any distress or damage during this operation.

All major bolted, threaded, keyed or pinned connections shall be readily accessible for visual inspection. Threaded fasteners shall be standard, readily accessible without removal of truck components or the truck from the car, and located to permit removal by standard hand tools. The motors shall have suitable truck clearances to permit each motor to be removed from above the car truck without interference with members of the truck frame or truck mounted equipment, including cables, conduit, piping etc.

4.3.6 Wiring

All cables and conduits shall be supported on each truck in an accepted manner. Wiring supports shall withstand the expected levels of vibration without failure.

Truck ground connections shall be as specified in Section 9.2. The axle ground ring assembly shall be as specified in Section 10.12. The axle ground ring assembly shall be mounted such that visual inspection can be made from an inspection pit using normal line of sight.

4.3.7 Piping

The air piping on the truck for the brake system shall conform to the following:

- Air lines shall be black iron per ASTM A106, Schedule 80, or approved equal.
- Piping shall be clamped to prevent vibrating, rubbing, and chafing. Clamps shall be installed to prevent noise generation. Insulation shall be provided to protect piping in close proximity to electrical installations.
- Hoses shall conform to the latest revision of AAR Specification M-618 with AAR-approved reusable fittings, AAR Specification M-927. Air hose applications shall not be

permitted in locations where adequate visual inspection cannot be assured.

- Piping shall be installed with a minimum number of fittings. Unions shall be used where necessary to permit replacement of apparatus and hoses. All other connection shall be brazed or welded.
- All piping, fittings, and valves shall be protected from damage caused by flying ballast and other foreign material, which might be encountered during Locomotive movement.
- No water pockets (traps) shall be permitted and materials shall be as specified in Section 15.12.

4.3.8 Third Rail Ice Scraping Contact Shoe Assembly

Current collector shoe assemblies shall be mounted on the truck frame on each side of the #2 end truck. The contact shoes shall not collect power from the third rail, but shall serve only as ice scrapers for the third rail during adverse weather conditions. The contact shoes shall clear the dynamic envelop of the Locomotive. The contact shoes shall be suitable for operation at any speed up to 40 miles per hour. The contact shoes (ice scrapers) currently used in PATH, shown on drawing P – 0008, entitled PATH - Location of Contact Rail in Highest Position Above Track Rail, may be used for reference. The contractor shall propose suitable journal bearing adapters to support the shoe beam and submit to PATH for review and approval.

4.3.9 Trip Cocks

A trip cock shall be mounted on both outer corners of both trucks. A diversion valve for each truck shall be mounted on the underframe to select the active trip cock. See Section 11.3.3 for details.

4.3.10 Tread Brake Unit Mounting

Each truck shall have supports for the mounting of four tread brake units. The tread brake units shall be removable without the need to detruck. See Section 11.3.1 for further information.

4.4 Wheels and Axles

4.4.1 Wheels

Wheels shall conform to the referenced documents and this Section.

4.4.1.1 Requirements

Wheels shall be ring-damped, wrought-steel, multiple wear type per AAR Specification M-107/M-208, Class C. In addition to being ring-damped, wheels may also be lightweight, not to exceed 740 pounds. Wheels shall be compatible with existing wayside wheel detector systems.

The wheel design for the existing PATH commuter cars can be used for reference only. The final

design of the wheel shall be subject to PATH's approval.

The Contractor shall only supply the appropriate wheels from the manufacturers from an approved AAR certified wheel and axle shop and approved by PATH:

The Contractor shall furnish accurate gauges and templates for inspecting the assembly of wheels and axles.

4.4.1.2 Marking

Wheels shall be stamped in conformance with the requirements in the above referenced documents. The Contractor shall provide the PATH with a record of these numbers together with the numbers of the axles to which each wheel is mounted and the numbers of the trucks on which they are installed in the car history book.

4.4.2 Axles

4.4.2.1 Requirements

Axles shall be forged carbon steel in accordance with ASTM A- 729 and inspected in accordance with AAR M- 101. The heat treatment shall be in accordance with AAR Grade G. All axles shall have an exterior finish in accordance with AAR Specification M-l01 as a minimum, and shall have been subjected to a magnetic particle inspection following machining.

All axles shall be ultrasonically inspected in accordance with AAR Specification M-101A. Axle design shall be in accordance with applicable AAR requirements, except as otherwise required in this Specification.

4.4.2.2 Inspection

Requirements for inspection shall be based on AAR standards. All axles when finished shall be free from cracks, flaws, seams or other injurious imperfections. The interpretation of injurious imperfections shall be made in accordance to the ASTM Specification A-21. Test reports shall be forwarded to PATH.

Axles shall be rejected that are galled or otherwise scarred when pressing on wheels or gear components. In the absence of visible evidence of such galling or scarring, the use of excessive force shall be taken as cause for rejection of the assembly.

4.4.2.3 Marking

Each axle shall be marked in accordance with provided drawing and shall be assigned a unique serial number which shall be legibly and permanently stamped on the gear seat end of each axle

with characters not less than 0.25 inch (6.35 mm) high. The serial numbering shall be as directed by the PATH. The Contractor shall include the PATH with a record of the manufacturer's serial and heat numbers listed together with the appropriate serial numbers of the cars and trucks on which they have been installed in the car history books.

4.4.3 Bearings

4.4.3.1 Journal Bearings

Journal bearings shall be roller-type, NFL-type (no field lubrication), and sealed by contact seals. The bearings shall be of approved design and manufacturer SKF or Timkin or PATH approved equal.

The bearings shall be adequately protected against the passage of electric current.

4.4.4 Assembly

The wheels, axles, gears, roller bearing journals, etc., shall be mounted using pressure and fit recommended by the manufacturer except as noted below and approved by PATH. All wheel and axle assembly work shall be performed in an approved AAR certified wheel shop.

4.4.4.1 Wheel and Axle Sets

Wheel sets shall be concentric within 0.1005 inch (0.127 mm) total indicated run-out when rotated on their bearings. Mounted wheels shall not exceed 0.015 inch (0.38 mm) out of paralleled to a plane perpendicular to the centerline of the axle (wobble), nor 0.030-inch (0.76 mm) out of parallel with each other.

Wheel gauge shall be 55-11/16 +0, -1/16 inches (1414.5 +0. -1.6 mm).

Wheel-axle sets shall be mounted in pairs matched in diameter within one-half tape size. Wheels shall be pressed on axles by suitable and approved apparatus at a load of from 68 to 105 tons (605 to 934 kN) and shall be measured and recorded by means of an approved recording gauge which shall be frequently checked with a standard gauge. Prior to the start of pressing wheels on axles, the pressure gauge shall be calibrated in the presence of the Project Manager or his designee. Pressure diagrams shall be provided with each set of wheels to permit monitoring of the pressing operation. Only those pressings showing a uniform buildup of force with displacement shall be accepted.

Two wheels mated to the same outside diameter shall be pressed on an axle and upon completion of this operation the axle shall be revolved on its; centers, in the presence of the Project Manager, to determine that the wheels are concentric with the axle, are of the same diameter and that the inner faces of rims are true and parallel within allowed tolerances.

4.4.4.2 Journal Box

The journal box shall be mounted outboard of the wheels; an alternate design may be considered for PATH approval. The journal box shall contain a roller bearing as described in Section 4.4.3.1 and provide sufficient clearance to prevent seizure of the bearing within the journal box.

The journal boxes shall be readily removable from the axle. Bearings and boxes shall permit easy insertion into axle centers of the centering spindles of PATH's Simmons-Stanray wheel truing machine. Trucks shall incorporate a lip on the outside top of the journal box for support of the axle tie down cables of the wheel-truing machine.

4.5 Suspension

The suspension shall be of elastomeric elements or combination of elastomeric and coil springs arranged in such a manner as to preclude rotation of the journal box with changing vertical load. The suspension system, except for components otherwise specified, shall be designed to provide satisfactory service for 10 years under the operating conditions specified.

The truck configuration together with the primary suspension elements shall allow movement of each wheel for load equalization. Lifting or dropping any wheel of a truck 2 inches (50.8 mm) shall not change the load on any wheel of that truck more than 50 percent. The raising or lowering of any whee1 2 1/2 inches (63.5 mm) shall not result in loss of contact between any other wheels and the rail.

The suspension of each truck shall be designed to minimize Carbody roll. The method of controlling roll to keep the Carbody within the dynamic clearance outline shall be by a service-proven method approved by the PATH.

The trucks shall be equipped with shock insulating materials to minimize audio noise transmissions into both the cab and wayside areas. The noise levels shall conform to the standards listed in Section 2.8.1.

The Contractor shall obtain from the spring manufacturer and include in the car history book, a certified guarantee against failure of the springs caused by defective material and/or workmanship.

4.6 Truck Connection

The truck connections to the Carbody shall include a safety connection as specified in Section 4.3.4.2. Clearance shall be provided between the bolster anchor rods and all parts of the Carbody and apparatus under all operating conditions.

Propulsion and braking forces shall be transmitted between the truck and the truck bolster in a manner which minimizes weight transfer between axles of a truck, and therefore maximizes adhesion and minimizes stress levels, wear, and displacements in the truck.

4.7 Tram

The truck frame assembly, when loaded through normal load paths shall maintain the axles parallel to within 0.09 inches (2.29 mm) at the journal centers, and shall limit the difference between diagonally opposed bearing locations to 0.20 inches (5.1 mm), unless otherwise approved by the Project Manager.

The Contractor shall submit for approval a test procedure (6 months prior to the delivery of the first Locomotive) for verifying the above requirements, and one truck shall be tested. An analysis showing the adequacy of the design in this respect shall be included in the FEA deflection analysis required by Section 4.1.4.4, fifth paragraph, first bullet.

All frames shall have tram marks above and below (where applicable) each journal bearing location, located within 0.005 inches (0.13 mm) of the true position.

4.8 Park Brake

Provision shall be made for the installation of a park brake as defined in Section 11.3.10.

SECTION 5

5.0 COUPLER EQUIPMENT

5.1 General

Each end of the Locomotive shall be equipped with a coupler arrangement per drawing P-0010 and P-0011 as manufactured by Wabtec Passenger Transit or PATH approved equal capable of negotiating minimum curves as specified in Section 2.2, and must be capable of being coupled to another PATH Locomotive, flat car, ballast car, PA4 car and PA5 car. The Locomotive shall mechanically couple to, and be able to operate the brake system on, PATH's flat cars, ballast cars and PA4 cars. The Locomotive shall mechanically couple to PATH's PA5 cars but is not required to operate the brake system on that car..

The Locomotive shall be able to negotiate the fixed facilities of PATH as described in Section 2.1.4 without considering coupler swing and all tolerances and wear on the coupler equipment and track when coupled with any car indicated in the above paragraph unless otherwise approved by PATH.

Two (2) Ohio Brass Form 8501 Hook Type Coupler systems as manufactured by Wabtec Passenger transit, or PATH-approved equal, shall be installed with each Locomotive. The coupler system shall include the mechanical coupler, anchorage, radial carrier, centering devices, electric coupler and control box assemblies.

5.2 Couplers

- Both ends of the Locomotive shall be provided with the Ohio Brass Form 8501 Hook Type coupler or a PATH-approved equal. The coupler carrier and its connection to the body structure shall be designed to resist a vertical thrust (both directions) from the coupled shank of 100,000 pounds for any horizontal position of the coupler without exceeding the yield points of the materials used. An uncoupling valve shall be provided for each coupler and be operable from the respective end platform of the Locomotive. The Ohio Brass Form 8501 Hook Type Coupler, or PATH-approved equal, is an integral part of the air brake system of the locomotive and the cars it will be designed to operate. In addition to mechanically coupling with the trailing cars, through this coupler are the straight air, feed valve and brake pipe air lines that operate in conjunction with each of the trailing cars air brake operating units. As coupling occurs, the tappet valves that are part of the coupler assembly for each of the three aforementioned air lines come together and are opened, allowing the air to pass through to the next car. These couplers are designed only to function with each other, both mechanically and pneumatically. Without this compatibility, the cars will not mechanically couple nor will the air brake system for the cars function properly.

When uncoupled, the coupler assembly shall move laterally in both directions when a force not to exceed 75 lbs. is applied to the face of the coupler head.

The coupler shall be designed and constructed to permit coupled vehicles to negotiate all horizontal and vertical curves for all operating conditions including operations with maximum mismatch between vehicles due to spring deflection, wheel wear and track irregularities. Under no condition shall the couplers interfere with truck parts, wheels, cables or other equipment.

5.3 Strength Requirements

The various components of the coupler structure shall withstand the following static loads without yielding or buckling and shall meet or exceed all FRA regulations:

Coupler Loading

Component	Draft lbs. (kN)	Buff lbs. (kN)
Coupler Housing	200,000 (890)	200,000 (890)
Coupler Anchor Assembly and Attachment to the Locomotive Structure	300,000 (1,330)	300,000 (1,330)

- For any horizontal position of the coupler, its carrier and the Locomotive structure shall withstand, without yielding, a vertical load (both directions) 50,000 lb. (225 kN) applied at the coupler face.

- The coupler housing shall withstand a working load of 100,000 lb. (445 kN), and shall not fail under an extreme load test of 400,000 lb. (1,780 kN) in tension or compression.

5.4 Mechanical Details

A device shall be provided within the mechanical coupler to lock the couplers automatically in close mating contact.

- Wearing surfaces -All wearing surfaces of the coupler shall have ample surface area and the material shall be rolled manganese steel to perform the functions required for a minimum of 25 years. All wear plates shall be installed for ease of replacement. Drainage shall be provided for rain and car wash water
- Mating Surfaces -All surfaces mating to carbody attachments shall be machined.

Means shall be provided in the coupler to permit manual uncoupling from the track level. The operations shall be possible from the side of the Locomotive without personnel going between the vehicles. The force required for uncoupling shall not exceed 30-lbs. (133 N) applied at the center of the handgrip surface.

SECTION 6

6.0 CAB AND CAB CONTROLS

6.1 General

A cab shall be provided at the No.1 end of the Locomotive. The cab shall contain all appurtenances necessary, for the operation of the Locomotive from the cab or from a trailing Locomotive.

The cab shall contain all equipment described in this Section.

The cab layout shall maximize the use of available space and shall employ sound human factors and industrial design principles in its design. The train operator's space and equipment shall be properly designed to ensure safe and optimal train operator performance and a maximum field of view for train operators in the range of the 5th percentile female to the 95th percentile male of the general population.

Alternate materials in lieu of steel as specified in this section for non-structural applications for the interior of the cab may be considered for PATH approval.

The cab shall be free of sharp edges, protruding objects, safety hazards and floor obstructions. The cab design shall not allow hidden areas in which paper and other debris can accumulate.

The cab shall be insulated and sound dampened to meet the requirements of Section 2.8.1 and designed for all weather conditions.

The cab shall be designed for minimum vibration transmission to cab surfaces and shall be sound insulated to meet OSHA requirements. In addition, the cab shall be designed as a modular structure for future replacement, if necessary. Alternate cab mounting designs may be considered for PATH approval.

6.2 Arrangement

6.2.1 General

The cab shall be arranged to permit Locomotive operation by a train operator seated or standing at the control stand and shall accommodate up to two (2) additional workers. The cab shall contain one (1) operator seat and two (2) jump seats. Recessed handles shall be provided for standing crewmembers. The cab shall be of a full width design. The operator must have a clear line of sight in both directions.

6.2.2 Construction

6.2.2.1 Cab Walls

The cab walls shall be constructed with steel sheet metal panels attached to structural wall supports. The walls shall be insulated for cab comfort and to minimize noise and vibration. The wall panels shall not vibrate for all operating conditions.

6.2.2.2 Cab Ceiling

The cab ceiling shall be constructed with steel sheet metal attached to the roof structural supports. The ceiling shall be insulated for cab comfort and to minimize noise and vibration. The ceiling panels shall not vibrate for all operating conditions.

6.2.2.3 Flooring

The cab floor shall be insulated, dampened against noise and vibration and skid resistant. The cab floor shall support the loads for the intended use without any deformation for the life of the Locomotive.

6.2.2.4 Cab Doors

The cab shall have two doors, one cab door shall allow entry from the end platform and the other shall allow entry from the walkway of the locomotive. The cab door to the end platform shall be hinged and swing into the cab and shall be provided with a wedge-type jam latch. The jam latch shall be operable from both sides of the door and be located approximately midway between the door handle and the top of the door. The cab door from the walkway will be hinged and swing

into the walkway. The cab door shall be lockable using a PATH door key currently used on PATH PA-5 cars. Stops shall be provided to hold the doors in the open position. All doors shall contain off set hinges for the door to swing out of the way of the door opening and not require a key to open. The upper portion of all cab doors shall contain a fixed rectangular window. The window shall meet the requirements specified in Section 3.9. The cab door windows shall be provided with electric heater elements for de-frosting purposes. The heater elements shall follow the requirements specified in Section 6.3. 1. A wiper shall be installed on the windshield on both ends of the cab. The wiper requirements shall follow the requirements specified in Section 6.4.3.

6.2.2.4.1 Strength Requirements

The door panel skin, structure and mounting hardware shall sustain a concentrated load of 200-lbs. (91 kg) applied perpendicularly to the plane of the door at the center of the front edge. The load-bearing surface shall not exceed 16 square inches (10,300 square mm) for this requirement. The allowable maximum deflection under these conditions with the door simply supported at the top and bottom shall be limited to *3/8-inch* (9.5 mm) maximum with no permanent deformation after the force is removed.

6.2.2.5 Cab Access

A platform shall be provided on each end of the Locomotive. The platform shall have steps on both sides to allow for access from the roadbed. In addition, the front end platform shall be accessible from station platforms. Access to the cab shall be provided from each end platform. Handrails and a crossover step, which allows for access from the Locomotive to adjacent cars, shall be provided.

6.2.2.6 Cab Mock-up

A full-scale cab mock-up is to be provided by the Contractor that includes the following items:

- Simulated control stand including all locomotive controls, switches and gauges.
- Simulated cab side walls, end walls with electrical cabinets, front and rear doors, ceiling and window cutouts.
- Cab seats and lighting fixtures.
- Simulated TOD's.
- Simulated front end walkway, drop step, handrails and collision posts.

The mock-up will be appropriately elevated to illustrate sightlines from the cab to coupler.

The Contractor is to have the cab mock-up available for initial PATH review following the cab PDR. A second review by PATH will follow any necessary revisions to the mock-up. Approval of the cab mock-up is required prior to conducting the cab CDR.

6.3 Cab Windows

All windows and windshields shall be sized as large as possible to provide unobstructed views for the train operator and crewmembers. All windows shall meet the window construction requirements of Section 3.9.

The cab shall be equipped with horizontal sliding windows on both sides of the cab. The sliding windows shall be large enough to allow access to signal pushbuttons located on the wayside.

Latches shall be provided on the window assembly to allow the window to be locked in multiple open positions.

6.3.1 Heated Windshield and Windows

Integral window heaters shall be provided for the windshield and front and rear-facing windows to eliminate condensation. An on-off control and a visual indication of the heaters activation shall be provided on the control stand. A resettable high limit thermostat or timing device to remove power from the heating elements shall be provided to prevent excessive temperatures. The device shall be designed to protect the windshield and windows from overheating at any ambient temperature.

A metallic film type heater shall be used for de-misting and de-fogging purposes. The heater shall be capable of clearing 85 percent of a windshield/window area, through which the view is completely obscured by condensation, within six (6) minutes. The heater shall have this capability with an occupied cab at 75°F (24 °C), the Locomotive in normal operating condition and the exterior having been soaked for eight hours at an ambient temperature of 40°F (4°C).

6.4 Cab Equipment

6.4.1 Cab Seat

A contoured, adjustable train operator's seat, with a lumbar support, foldback armrests, and footrest, shall be provided in the cab per APTA PR-CS-S-011-99 Standard for Crew Cab Seating design and Performance which has a mechanically height adjustable suspension mounted on a 6 inch fixed pedestal with 180 degrees of swivel. The cab seat shall be located to maximize the train operator's visibility in both directions of travel. The train operator's seat shall be designed with spring and cushions to withstand shock and vibrations associated with all operating conditions for the comfort of the train operator.

Seat adjustment controls shall be operable from the seated position. All locking mechanisms shall have positive engagements.

The seat material shall meet smoke and flammability requirements noted in Section 15.22.

6.4.2 Heating Ventilation and Air Conditioning

The cab shall be provided with heating and ventilation for comfort of the train operator and up to 2 additional crew members for all ambient conditions as described in Section 2.1.5. A self-contained air conditioning/heat pump unit with thermostat shall be installed in the cab to maintain 70° F dry bulb and 55% relative humidity inside the cab for all PATH ambient conditions.

6.4.3 Windshield Wipers

Wipers shall be provided on the entire windshield on both ends of the cab. At least 80 percent of the width without hitting the windshield/window frames and 60 percent of the height of the total of windshield/window areas shall be swept.

The drive units shall provide two speeds of synchronized operation and the wiper blades shall return to a **PARK** position at extreme ends of their sweep in the **OFF** position. There shall also be a fixed intermittent, five-second delayed mode of operation. Drive units shall be electrically operated and drive motor shall be rated to sustain stalled conditions. Provision shall be provided to operate the wipers manually at the event of an electrical outage. Wiper operating mechanisms and drive units shall be accessible for repair and replacement from inside the cab. The operating mechanisms shall be enclosed. The wipers shall be mounted at the top of the windshield/window glass. The exact location of the front and rear wiper control switches shall be determined during the design of the cab layout. Switch positions shall be **OFF, INTERMITTENT, LOW**, and **HIGH**.

6.4.4 Windshield Washer

The windshield wiper shall be equipped with a windshield washer. The spray head shall uniformly distribute the fluid over the windshield. A translucent reservoir with 2-gallon (7.6 L) capacity, minimum, shall be provided. The reservoir shall be vented externally to prevent fluid fumes within the cab. The reservoir shall be located so as to permit filling from the inside of the cab. The reservoir fill cap shall be gasketed to prevent leaks into the cab, and shall be permanently tethered to the tank. The tank fill opening shall include a screen to prevent debris from entering. There shall be a sight glass to view the level of fluid.

6.4.5 Visors

Adjustable sun visors shall be provided in the cab for the windshield and front and rear-facing windows such that the crew can limit sunlight coming through the windshield/windows.

The visors shall be the Rosco 927FLX sun visor, or PATH-approved equal, except vertical adjustment shall be by means of a grip type handle, as approved by PATH. The visors shall cover the width of the windshield/windows. The sun visor blades shall be sized to fit the windows. The visors shall be positionable over the full height. Vibration and normal Locomotive motions shall not cause the visor's adjusted position to change. The visor blade color shall be grey No. 2074.

6.4.5.1 Not Used

6.4.6 Coat Hook

Three folding, flush, nickel-bronze coat hooks shall be provided in the cab at locations to be approved by the Project Manager.

6.4.7 Cab Lights

LED lights shall be provided in the ceiling of the cab. The lights shall provide lighting for all crewmembers. The lights shall be located to minimize glare for the operator on all surrounding windows and the windshield. The cab shall be provided with an approved LED cluster reading light for the train operator. The reading light, mounted on the ceiling of the cab will focus over the operator's shoulder to facilitate reading any instructions, bulletins or other work related material when LED lamps are turned "OFF". The illumination intensity measured on the Train Operator's controls using the ceiling-mounted lamps shall alone be 20 foot-candles (215 Lux).

6.4.8 Fire Extinguisher

A portable, multipurpose, dry chemical fire extinguisher with a rating of 20-A: 120-B:C (20 pounds) shall be installed in the cab interior of the locomotive. A base and bracket assembly with a band clamp shall be used to securely hold the fire extinguisher in the correct orientation within the cab. The fire extinguisher gauge shall be visible for inspection without removal.

6.4.9 Monitoring and Diagnostic System Connectors

The cab shall include conveniently located connectors to permit access to the Monitoring and Diagnostic System (MDS). The MDS shall use a type of universal connector to access all systems.

6.4.10 Battery Switch

There shall be a main battery switch inside the cab. This switch must be capable of cutting off all low voltage battery power to the Locomotive. When the battery switch is closed it shall be possible to start the engine without a key.

6.4.11 Radio

6.4.11.1 Two Way Radio Communication System

The radio communication equipment shall be compatible with the present PATH system in service and shall be installed in such a way to ensure ease of accessibility

to, and maintenance or replacement of, the main power unit, converter unit, fuse blocks and cross mute assembly. The cross mute assembly shall have one microphone, one foot switch and one TX lamp located for convenient use of the operator. Radios shall be Vertex Standard or PATH-approved equal compatible with PATH's existing on-board radios. In addition to the two way radio, there shall also be an intercom system with external speakers to enable communication to those outside the car. Radios shall be 50 Watts VHF / 45 Watts UHF. The VHF shall range between 134 – 174 MHZ and UHF to range between 440-470 MHZ: 450-512 MHZ.

6.4.12 Buzzer

A buzzer system shall be installed on the Locomotive. A momentary buzzer activation button shall be located on the control stand. When the buzzer button is depressed, it shall activate the buzzer line in the appropriate trainline wire(s) resulting in activating an audible buzzer in the cab and activating a buzzer on any other Locomotive and flat car in the consist which is connected to this Locomotive through appropriate trainline wires.

6.4.13 Intercom

A headset-based intercom system shall be installed on the Locomotive. A headset jack receptacle shall be provided on the control stand to permit a portable headset jack to be connected on the control stand. The receptacle shall be connected to required trainlines to allow the train operator of the Locomotive to communicate with another train crew member in another Locomotive in the same consist.

One (1) David Clark Inc., Permissible Sound Powered Headset, Model # H5040 or PATH-approved equal (see section 13.1.1) shall be furnished for each Locomotive to allow communications between the cab of the Locomotive and another cab of a Locomotive in the same consist.

6.4.14 Emergency Brake Control

The cab shall include two conductor's emergency brake activating devices and handles. One handle shall be located above and centered over each cab side window, arranged for easy actuation by an operator standing next to the window. A protective cover shall be installed around the handle such that there is enough clearance at the bottom of the cover to activate the valve. The protective cover shall be painted with PATH approved red color paint. Activation of the brake valve shall immediately exhaust air pressure from the brake pipe and shall immediately cause an emergency brake application to be initiated. Exhaust air shall be piped to discharge

below the floor and a vent protector shall be provided at the exhaust outlet that does not compromise the safety or reliability of the function. The conductor's emergency activating devices shall be active at all times. The force required to operate the brake valve shall be between 20-50 lbs. (88.9- 222.4 N). In addition to the conductor's brake valve an emergency stop pushbutton switch shall be provided. The switch shall be a red mushroom two position switch. When pushed it shall provide emergency braking both pneumatically and electrically by directly venting the brake pipe and by opening the emergency brake trainline circuit. The pushbutton must be pulled out to allow recharging of the brake system.When multiple locomotives are used in a consist, the mushroom switch in any locomotive cab shall perform the same function. Location of these should be determined during design of the cab layout. The location of the Mushroom switch shall be on the operator's console and it shall be ergonomically positioned. The final location of the Mushroom switch shall be subject to PATH's approval.

6.4.15 Rear View Mirror

An adjustable rectangular rear view mirror shall be provided to allow an unobstructed view along the non-operator's side of the Locomotive from the operator's position. The size and location of the mirror shall be as approved by PATH.

6.4.16 External Cameras

A minimum of two vandal-resistant, front facing, color cameras shall be provided in each Locomotive to provide a complete view of the entire Locomotive exterior and track area. The cameras shall be low light, high sensitivity type, capable of recording in settings with little to no illumination. Each Locomotive shall be equipped with digital recording device(s) having a 96 hour circular buffer when recording at an approved frame rate and resolution. The recording rate shall be adjustable. Video memory shall be downloadable via PTE and via extracted memory module. Downloading of video images shall include an approved method of authentication. An approved method of securing the memory module shall be provided. Power interruptions shall not cause loss of stored images.

6.5 Cab Controls and Indications

6.5.1 General

The cab shall be provided with the control and indicator panels specified in this Section. The cab and control layout shall be approved by PATH. All controls and indicators shall be located and identified in a logical and orderly manner. Controls shall be located such that they are conveniently reached, based on their importance or frequency of use.

6.5.2 Identification

All controls and indicators on the train operator's control panel shall be clearly identified by etched or engraved lettering and graphics with a depth of 0.012" to 0.015" on the panel. The

panel shall be black with the white lettering. Multi-position controls shall have all positions identified. Continuously variable controls shall have all salient positions identified.

6.5.3 Panel Construction

All controls and indicators shall mount to steel panels fastened to the panel cabinet or enclosure. The control stand and all other panels not in a vertical position shall be designed so that liquid spilled on the surface will not damage or interfere with operation of controls, indicators, or wiring. All panels shall have a finish that can be cleaned with a soap solution in water.

6.5.4 Control and Indicator Devices

Switches, knobs and pushbuttons, where used, shall be of the heavy-duty type, shall be arranged to prevent entrance of dirt or dust, and shall comply with the requirements of Section 15.27.3. Switches and controls shall be designed to prevent inadvertent actuation. Pushbuttons shall be flush with the top of the bezel in the undepressed state, unless otherwise approved. Clearance between each pushbutton and its housing shall be as tight as practicable to prevent unauthorized insertion of devices, such as pins, to hold buttons down. Switch guards may be applied where approved. All devices shall be tamper resistant and shall not be removable from the front of the panel.

Indicators, where provided, shall be illuminated from the low-voltage power supply by a minimum of two LEDs in parallel. Indicators and individual LEDs shall be capable of being replaced from the rear of the panel; lenses shall not be removable from the front of the panel. All cab controls and indicators shall be arranged to withstand, without damage, intermittent exposure to water and car-washing fluids that may occur when the cab window is inadvertently left open.

6.5.5 Train Operator's Display

6.5.5.1 General

The cab shall be provided with a Train Operator's Display (TOD) which shall provide pertinent information and information from the Monitoring and Diagnostic System. The controls and indicators necessary for operation should not be integrated into the TOD, but shall be provided as discrete interfaces.

The location and orientation of the TOD shall be suitable for reference to and actuation of the TOD by the train crew or maintenance personnel, as approved by PATH, without discomfort or fatigue beyond that which would be experienced with conventional controls and indicators. The TOD shall be arranged to be clearly visible to the crew in both the sitting and standing position, under all lighting conditions encountered in normal operation, ranging from bright sunshine to darkness, without at any time developing a brightness level that interferes with the train operator's or crew's vision. Fixed shields, display dimming, window tinting and similar methods shall be employed as required, and shall be approved by PATH. Display dimming, if

employed, shall be automatic, requiring no action on the part of the crew; however, pre-set brightness levels shall be adjustable by the crew.

6.5.5.2 Construction

The TOD shall be a high contrast, color, touch screen display of the infrared type or other approved type, with associated processor(s) and logic, suitably rugged for the application, and requiring no adjustment or maintenance except that which is consistent with PATH current practice for cab-mounted equipment. The viewing area of the TOD screen shall be no less than 12 inches in diagonal, without approval. The actual screen size shall be determined during the cab design review. It shall support both text and graphic presentation of information. The touch screen function shall be suitable for easy manual actuation, including actuation by a crew member wearing driving-type gloves. The human interface for the TOD shall comply with Section 6.6.2 of MIL-STD-14 72.

The TOD shall be self-contained, requiring no external controls, other-than clearly indicated touch screen interface buttons, and/or menus to allow the crew and maintenance personnel to communicate with the Monitoring and Diagnostics System.

The TOD shall perform logical processing related only to the presentation of information on its screen, to the interpretation of crew inputs from its screen, and to communication with other processors and devices on the Locomotive.

PATH will consider alternate designs or a conventional “off-the-shelf” electronic display unit proven and used in locomotives.

6.5.5.3 Screens

The TOD shall provide three primary screen displays for interface with the train crew and maintenance personnel: Operator Screen, Trouble Screen, and the Maintenance Screen.
The Contractor shall provide preliminary screen layouts of the TOD for the Authority's approval as part of the design process. The screens shall be similar to those used on other locomotives currently being manufactured.

Each screen may employ one or more levels of subsidiary screens which present more extensive information and control choices. No subsidiary screen shall be employed unless the complexity and scope of the information to be presented preclude its inclusion directly on a higher level screen. Subsidiary screens shall be arranged hierarchically, with a consistent interface to facilitate moving up and down the hierarchy. Where the same information is provided on several different screens, it shall be presented the same way (text, graphics, color) and in the same location, but not necessarily the same size. Screen areas designated for touch activation shall be arranged for convenient, reliable use by a crew member wearing gloves, under the dynamic conditions encountered in the Locomotive cab. Activation of a touch area shall be acknowledged by highlighting of the area, such as by reverse video. The interface for screen selection shall be consistent among all of the screens.

Information shall be divided among and presented on screens in a logical and orderly manner. Information shall be displayed textually and/or graphically, depending on the clearest and most efficient way to present each item of information. No information shall be displayed in any code that is not immediately understandable by human beings, such as hexadecimal numbers or arbitrary alphanumeric designators. Abbreviations, reference designators, and mnemonic codes already conventional in PATH operations may be employed with PATH approval.

The TOD screens shall be the same in content and layout regardless of where it is displayed, but selected control functions may be locked out where not appropriate to the particular display location, as indicated by a "graying-out of the affected screen areas, or comparable techniques. The TOD screed layouts shall be part of the design approval.

6.5.5.3.1 Operating Screen

The operating screen shall present information and control functions useful to the crew when the Locomotive is in motion or stationary. Information displayed on the Operating Screen shall be arranged according to relevance to operation of the Locomotive. Items of greater importance shall be centrally located. Items of less importance to the crew shall be given peripheral display. Items with urgency shall flash to catch the crew's attention. Flashing of such items shall be cancelled by the user's activation of a Fault Acknowledge control provided on the control stand.

6.5.5.3.2 Trouble Screen

The Trouble Screen shall provide pertinent information to the crew or Road Car Inspector concerning conditions which affect the immediate operation of the Locomotive. The events and faults to be displayed on the Trouble Screen shall be approved by the Project Manager.

6.5.5.3.3 Maintenance Screens

The Maintenance Screens shall provide pertinent information to assist in maintenance, troubleshooting, and repair of the equipment in the shop environment. The events, faults and messages to be displayed on the Maintenance Screens shall be approved by the Project Manager.

6.5.5.4 Screen Operating Modes

The TOD shall be active after the cab control stand is activated.

The TOD shall have a "sleep" mode with an adjustable timer. The timer adjustment shall include a setting for "never sleep". The sleep mode timer shall be adjustable by maintenance personnel through use of the PTE. The "sleep" mode shall initiate a screen saver with a Locomotive or train oriented motif when the cab control stand is active but stopped for a certain interval with no user interaction. The Locomotive shall be delivered with the sleep mode timer set to "never sleep." Each time the cab control stand is activated the "Fault Acknowledge" button on the Trouble Screen should flash if there are existing faults.

Display and menu activity shall occur concurrently with normal data collection and processing activities, without impacting any of the functions.

6.6 Control Stand

6.6.1 General

The control stand shall include controls and indications for train activation, train supervision, and train operation, as specified in this Section. They shall include controls for propulsion, brakes, auxiliary equipment and direction. A deadman's feature shall be incorporated in the propulsion control such that if activated, it will deactivate propulsion, and activate the emergency brakes (see 6.6.8.3).Control stand control and indication functions shall be implemented as conventional switches, pushbuttons, indicators, and the like. Except as specified below, the assignment of controls and indicators shall be conducted as part of the design development process, shall reflect the policies and practices of PATH, and shall be approved by PATH.

The speed shall be controlled by a throttle lever with the integral dead man feature, which regulates the diesel engine output when traveling. The control equipment shall disengage motive power when any pneumatic emergency brake application is initiated.

The control panel shall have an audio and digital display to warn the operator that the engine's electronic control system has put the engine in degraded mode, or has shut down the engine because of overheating, overspeed, loss of fuel pressure and/or loss of oil pressure.

A voltmeter, a zero-centered ammeter, a red battery discharge warning light and an audible alarm shall be provided in the battery charging circuit and shall be located on the control stand.
The control stand shall be located so that it does not obstruct the operator's vision and the function of all controls, gages, and switches shall be clearly identified. The control stand shall be illuminated and designed to prevent glare in all cab glass for all operating conditions.

The Contractor shall submit layouts of the cab and panels, and deadman's feature for approval by PATH within 90 days of issuance of the Notice of Award.

6.6.2 Arrangement

The control stand shall be readily accessible to the train operator with the operator facing the front windshield or the rear window. The operating face angle and operating face height shall be properly positioned to accommodate a seated or standing train operator.

6.6.3 Construction

The cab control stand shall be constructed of steel, with a robust design consistent with control stands of locomotives currently in production. It shall be permanently mounted to the structural members on the cab floor. Access ports shall be provided to allow access of components

mounted on and inside the control stand.

The control stand operating face shall be constructed of cigarette-burn-resistant, flat black, non-reflective steel. Control stand operating face not occupied by controls or indicators shall be covered by an easily replaceable metallic upset/textured surface, as approved by PATH. This surface shall be secured with tamper-proof screws. Distinct, functionally integrated subassemblies shall be installed as connectorized modules to facilitate their rapid removal and replacement, shall be replaceable from the front of the control stand. The remaining portion(s) of the control stand face panel shall be hinged and shall be provided with hold-open device(s) to facilitate replacing indicators, switches or repairing wiring.

6.6.4 Not Used

6.6.5 Control Stand Individual Controls

The control stand shall include controls and indicators to operate the Locomotives. As a minimum, the following individual controls, with the type of switch indicated, shall be included on each control stand.

- Propulsion Interlock Device as described in Section 10.1;
- Engine start and stop switch (non-key operated switch);
- Cab Interior Light On/Off Switch;
- Locomotive Exterior Light On/Off Switch;
- Gauge Control Stand Light On/Off Switch;
- HVAC On/Off and adjustment Controls;
- Cab Heater On/Off Switch;
- Cab Heated Windshield Windows Control, with integral indicator;
- Windshield Window Wipers, and Windshield Washer Controls
- Horn Pushbutton;
- Buzzer Pushbutton;
- Emergency Stop Mushroom Pushbutton;
- Throttle Controller and Brake Master Controller;
- Emergency Brake Activation Handles (Conductors Valves);
- Bell Actuator;
- Sand Actuator;
- Indicator Test: Momentary "On" for all indicators;
- TOD Alarm Silence Push Button.

6.6.6 Control Stand Visible Indications

As a minimum, the following visible indications shall be provided as part of the cab control stand or alternate location as approved by PATH. Indication colors shall conform to the convention established in Section 2.6.3, unless otherwise approved. Individual indicators shall be provided, or may be combined with the approval of the Project Manager.

- Train Speed Indication (digital);
- Engine Fault Display;
- Brake System Pressure Indicators:
    - Brake Cylinder Pressure;
    - Brake Pipe Pressure;
    - Main Reservoir Pressure; and
    - Straight Air Pipe Pressure
- Time and Date Indication (hh:mm in the 24-hour system and MM-DD-YY);
- Heated windshield/window, integral to the control switch;
- Digital Engine Coolant Temperature Gage;
- Digital Engine Oil Pressure Gage;
- Digital Engine Tachometer Gage;
- Digital Odometer Gage;
- Digital Engine Running Hour Gage;
- Digital Engine Fuel Level Gage;
- Buzzer Activation Light;
- Battery Charge Indicator;
- TOD Alarm Indicator;

6.6.7 Control Stand Audible Indications

Audible indications shall be provided in the cab for at least the following events:

- Buzzer Activation
- Engine Fault (from the engine's electronic control system)
- Battery Discharge
- TOD Alarm (alarm events to be approved by PATH)

6.6.8 Locomotive Control

6.6.8.1 Throttle

A notched-type control throttle shall be provided to control the propulsion for the Locomotive. The throttle location and handle design shall minimize strain fatigue for the train operator. The throttle shall be an off-the-shelf component, used on similar locomotives currently in production.

6.6.8.2 Air Brake Controller

An air brake controller shall be provided on the control stand to provide control of the brakes on the Locomotive and trailing cars such as PATH’s existing flat car, crane car, hopper car, current PATH locomotive, or any other PATH work equipment, see drawings P-0012A, P-0012B and P0013. The air brake controller/brake valve shall be Wabtec Passenger Transit type ME43, or

PATH approved equal, as found on drawing P-0014 with manually operated handle controlled device giving the train operator the ability to initiate air brake applications and releases of the vehicle and/or train through its electro-pneumatic feature or through a straight air operation of the braking devices; brake valve handle position determines train's brake system operation (i.e. release, running, snow brake, service to full service, emergency and handle off); cam shaft within the brake valve body allows air to pass through, or seals off preventing air to pass through depending upon handle position, thereby effecting operation of the electro-pneumatic air brake system; and the ability to Function within and effect operation of the RT-2 type air brake system currently in use on PATH's PA4 and work car fleets.

Both trainline and independent brake controls shall be provided.

6.6.8.3 Deadman Control

A deadman control shall be provided that determines incapacitation of the train operator. Once the deadman control has been activated, then propulsion shall be deactivated and emergency trainline brakes shall be applied.

One of the following two features must be met in order to nullify an active deadman feature:

- The locomotive tread brake units shall be at a minimum effective pressure.

OR

- The automatic brake handle in the cab shall be moved to "suppression" or beyond "handle off' position. The movement of the automatic brake handle into suppression position shall be verified by monitoring air pressure.

The deadman control, typical of those used on current locomotives, shall be proposed by the Contractor for review and approval by the Project Manager.

6.6.8.4 Not Used

SECTION 7

7.0 TRAINLINE CONTROL

7.1 General

A multiple unit trainline control system shall be provided so that the Locomotive shall be capable of controlling or can be controlled by other Locomotives in a multiple unit operation. When locomotives are operated in multiple unit configurations, all locomotive propulsion and braking controls shall be trainlined through the 27-Point Trainline control system, see drawing P-0010. The Locomotive will be operating in various configurations as described in Section 2.1.3. During the preliminary design review (PDR), the contractor shall provide drawings for a 27-point trainline jumper cable assembly . All wiring must meet the requirements of Section 15.14.1. Trainlines to include the ability to trainline audio, including public address, intercom and buzzer.

As a minimum the following trainlines shall go through the electric coupler such that they are operable in a coupled locomotive as well as a coupled PATH PA4 railcar:

- B+ To be used for battery power to PA-4 car (Must be common with B+ on the 27-pin Locomotive Control Trainline Receptacle.)
- B- Return feed to battery (Must be common with B- on the 27-pin Locomotive Control Trainline Receptacle.)
- 11 Brake application magnet valve.
- 12 Brake release magnet valve.
- 23 Buzzer (Must be common with Buzzer pin on 27-pin Locomotive Control Trainline receptacle.)
- SS Slip Slide alarm (Must be common with slip-slide alarm on 27-pin Locomotive Control Trainline Receptacle.)
- CC1
- CC2
- CC3 Coupler control circuits
- CC4
- HB Hand Brake ON (Must be common with hand brake warning light on 27-pin Locomotive Control Trainline Receptacle.)

A separate three-prong plug and receptacle assembly to power Flatcar taillights shall be provided at each end of the Locomotive attached to the mechanical coupler. The feed to this receptacle shall be the 37.5 V battery power. The bracketry and attachment method used, as well as the length of plug cable employed shall be to exclude any interference with the mechanical coupler operation and be compatible with existing Flatcar’s corresponding plug-and receptacle. Electrical schematics of this circuit is shown in Attachment P0005 of this Specification.

All wiring from each Electric Coupler shall go into a terminal board within a waterproof NEMA

approved junction box mounted under the Locomotive frame before distribution into the Locomotive circuitry.

The Locomotive shall use a standard 27-pin MU cable jumper for controlling the operation of another Locomotive. Two male connectors, Pyle National (P/N: WWRF-27) or PATH approved equal shall be mounted on a post at each end of the center of the Locomotive, high enough above the coupler to allow the cable to loop a minimum of one foot clearance above the anticlimbers and from interfering with the other end of the jumper cable when it is plugged into the receptacle of the adjacent coupled railcar or Locomotive. All wires used for on-board communication (and others as needed) from this connector/jumper to the Locomotive junction box shall be properly shielded and the shielding properly grounded to address noise immunity of the signals involved.

Signals common between the Locomotive and the PA-4 cars performing same function (i.e., B+/B-, Buzzer, etc.) shall be connected in common so that corresponding signals on both the Electric Coupler portion as well as the 27-pin Locomotive Control Trainline Receptacle wires are energized simultaneously.

7.2 Pin Designation

The following pins shall be assigned for the 27-pin Locomotive Control Trainline Receptacle/Jumper cable assembly:

Pin 1	Train Communication “Listen” wire (shielded)
Pin 2	Alarm Signal
Pin 3	Engine Speed Solenoid DV
Pin 4	Battery Negative (Common)
Pin 5	Emergency Sanding
Pin 6	Generator Field Control
Pin 7	Engine Speed Solenoid CV
Pin 8	Forward
Pin 9	Reverse
Pin 10	Wheel Slip Light
Pin 11	Battery Positive (Common)
Pin 12	Engine Speed Solenoid BV
Pin 13	Positive Control / Fuel Pump
Pin 14	Train Communication 24 Vdc Positive Power (shielded)
Pin 15	Engine Speed Solenoid AV
Pin 16	Engine Run
Pin 17	Headlight (Work Train)
Pin 18	Buzzer (Receive and Send Signal) (Common)
Pin 19	Battery Negative (Common)
Pin 20	Hand Brake Warning Light (Common)
Pin 21	Taillight (Locomotive)
Pin 22	Train Communication 24 Vdc Negative Return & Common (shielded)
Pin 23	Manual Sanding

Pin 24	Power Reduction Override
Pin 25	Headlight (Locomotive)
Pin 26	Taillight (Work Train)
Pin 27	Train Communication “Talk” (shielded).

Alternative pin assignments shall be subject to PATH approval.

Each end platform of the Locomotive shall contain a mounting rack for this standard 27-pin Trainline Jumper cable assembly. The jumper cable shall be chained at one end to the Locomotive, on a chain long enough to allow the head to be plugged into the receptacle. The Locomotive manufacturer shall furnish and mount at two ends of each Locomotive Pyle-National Jumper cable assembly Part Number WWPCJ-2746-S762, or its PATH approved equal (see section 7.1).

The pin designation for the 27-pin train line control system shall be indicated on the contractor’s 27-pin.

7.3 Trainline Conductors

The trainline wiring shall consist of single conductors, size #12 AWG (19 strands of #25 AWG) wire, tin coated copper, 600 volt insulation, have a conductor temperature rating of 110° C/2300 F 8 (normal operation) encased in rigid conduit. The trainline wiring shall run between two junction boxes on each end of the Locomotive. The insulation material shall be flame retardant, irradiated, cross-linked polyolefin. The conductors shall have color-coded striped insulation in accordance to Section 15.14.1.

7.4 Trainline Cable Receptacles

A 27-pin trainline cable receptacle, with spring-loaded, self-closing cover, shall be mounted on each end of the Locomotive. Drawing L1 – 002 – Trainline 12 Point Jumper Cable shall be used as an example for information only. The receptacle shall be mounted for ease of access and installation.

7.5 Trainline Jumper Cables

The cable shall be attached to the end of the Locomotive with the cable and clamp assembly to prevent misplacement of the cable.

7.6 Miscellaneous

7.6.1 Trainline Junction Boxes

An approved weather-tight galvanized steel junction box shall be provided at each end of the Locomotive. Each junction box shall contain at least two (2) 15-position terminal blocks with double screw type terminal posts. The posts shall be mounted on insulating strips treated to

render them impervious to moisture. Each post shall be plainly marked with the circuit designation. The boxes shall have hinged gasketed covers and be provided with "knockouts" for conduit connections.

7.6.2 Conduit

The conduit between junction boxes shall be a rigid conduit and all boxes shall be provided with openings of a diameter to suit the conduit fittings. The junction boxes shall be connected to the receptacles using an approved flexible steel conduit.

7.6.3 Material and Workmanship

The cables and ancillary equipment including, terminals, fittings, raceways, etc. for the car borne 12-point trainline system, shall comply with the requirements in Section 15.14. Workmanship procedures and guidelines for the installation of the 12-point system shall also meet the requirements of Section 15.14.

SECTION 8

8.0 MONITORING AND DIAGNOSTIC SYSTEMS

8.1 General

A microprocessor-based diagnostic system shall be provided to assist PATH personnel in monitoring, inspecting, maintaining, troubleshooting, and testing the major subsystems on the Locomotive.

The diagnostic system shall record and annunciate events and failures to the train operator, road car inspector, and maintenance personnel for the Locomotive. The subsystems to be monitored shall include, but not be limited to, the engine, propulsion, brakes, train control, and auxiliary electrical system. An alarm from any other Locomotive in the consist shall also be annunciated to the train operator using the existing trainline spare(s) to indicate that a critical event(s) or failure(s) has occurred in that other Locomotive.

The diagnostic system shall make it possible for the train operator or the road car inspector to immediately determine the cause of an existing or impending serious problem and take corrective or preventive actions. The system shall also make it possible for maintenance personnel to troubleshoot problems.

A monitoring and diagnostic unit for the engine shall be provided as part of its electronic control unit. No moving parts, such as a hard drive, are permitted for the Monitoring and Diagnostic System (MDS).

The status of high and low voltage breakers shall be monitored and indicator lights for each breaker shall be provided within the MDS.

8.2 On-Board Equipment

The Contractor shall provide a monitoring and diagnostic unit (MDU). The function of the MDU is to gather, process and record information from the monitored systems, and to report its findings through the Train Operator's Display (TOD), located in the cab. The monitoring and diagnostic system shall use the control sensors to the greatest extent possible and independent sensors only where essential. The system shall display data for diagnostics, performing of self-tests, monitoring operational data, viewing alarm data, and entering setup parameters.

8.2.1 Physical Requirements

The system shall have sufficient memory capacity to save fault event data for the time intervals between periodic maintenance (not less than 100 days). If the memory capacity is full, then the next fault or event shall overwrite the earliest fault or event in memory. The memory capacity shall be sized to prevent overwrites between periodic maintenance.

There shall be a conveniently located, standard, robust connector in the cab for the portable diagnostic unit to fully interface with the diagnostic system, to download faults and to make any needed changes to user settings.

The diagnostic system shall have an integrated, computer industry standard USB 1.1,or latest revision removable flash memory slot to allow user-selected downloads of fault logs without the use of the portable diagnostic unit. Such downloads shall not clear or reset the logs. The removable flash memory card shall be sized to hold all faults recorded between periodic maintenance. The Contractor shall furnish ten (10) removable flash Thumb drivers.

8.2.2 Interface with Train Operator Display (TOD)

The TOD shall employ one or more levels of subsidiary screens which present more extensive information. No subsidiary screen shall be employed unless the complexity and scope of the information to be presented precludes its presentation directly on a higher level screen. Subsidiary screens shall be arranged hierarchically, with a consistent interface to facilitate moving up and down the hierarchy. All screens shall indicate the time and date, with the time displayed in the hh:mm 24-hour system format and the date displayed in the MM-DD-YY format Graphics shall be employed on the screens to simplify its use and as an aid in providing information.

8.2.2.1 Trouble Screen

The trouble screen shall provide pertinent information to the Locomotive crew or road car inspector concerning conditions, which affect the immediate operation of the Locomotive. Information provided on the trouble screen shall be a subset of information being collected by the MDU.

8.2.2.2 Maintenance Screens

There shall be a selection of maintenance screens, as approved by the PATH, arranged to provide access to all MDU functions and capabilities. Access to the functions shall be protected by a hard key (maintenance key). Key shall be pin-in-head torx key as manufactured by Switztool Safety Torque Driver #3 as currently used by PATH, or PATH-approved equal.

Status screens shall display real time status information from system, subsystem, and sensors on the Locomotive. Status shall include "active" faults.

Fault logging screens shall display the major failures of the Locomotive's subsystems. The fault data shall include the time, the system, and a brief description of the fault Format of the individual subsystem fault logs shall be consistent regardless of the source of the fault data. The maintenance screens shall allow scrolling through all logged faults by subsystem. All fault logs shall be available to the maintenance personnel for review on the screen or to be downloaded to the portable test equipment. A message "Fault Log Full" shall indicate when newer faults began to overwrite older faults in any fault log.

One of the maintenance screens shall allow a maintainer to select customized subsets of historical or status data, such as a time frame of interest or specific data from different subsystems for display on the same screen.

One of the maintenance screens shall allow the maintainer to initiate self-tests of all intelligent subsystems and view the results without changing screens.

A maintenance screen shall allow access to the Monitoring and Diagnostic Unit's internal fault and event logs.

8.2.3 Monitoring and Diagnostics Unit Functions

The MDU master clock shall be changed through the use of a portable test equipment. Daylight Savings Time corrections shall be made automatically.

Downloading the fault and event information to the portable diagnostic unit shall not automatically clear the log. A separate action shall be taken from the portable diagnostic unit to clear the log and reset faults and events. An event shall be logged when a fault log is erased or MDS time has changed.

8.2.4 Interfaces with Other Systems

The diagnostic system shall be designed and suitably buffered such that a failure of the system does not adversely affect the systems it is monitoring and failures of monitored systems and sensors do not adversely affect the Diagnostic System.
Wherever possible, the Diagnostic System shall be capable of distinguishing between a complete failure of a specific system and a failure to communicate with it.

An LED display on each system shall allow visual verification of the health of the system without the use of either the Diagnostic System or the portable diagnostic unit.

The MDS shall have a time stamp co-ordination with all other systems.

8.2.4.1 Monitoring and Diagnostic Unit for the Engine

A monitoring and diagnostic unit shall be provided as part of the electronic control unit for the engine. This unit shall interface with the Train Operator's Display (TOD), and shall display engine failures as a separate screen on the same display. The MDS shall include a self-test on demand function. If the self-test failed an event indicating why that self-test failed shall be logged by the MDS.

8.2.5 Fault Criteria

The criteria of all messages, events and faults capable of being displayed on the TOD and recorded in the MDS, and the diesel engine monitoring and diagnostic system shall be provided. The list of MDS messages, events and faults shall be separated by each system being monitored. The list shall include the item being measured and the criteria required to trigger a message, event or fault to be displayed on the TOD and recorded in the MDS. Every triggered fault must have a corresponding reset event to indicate when the failure condition cleared.

8.3 Data Collection and Management

8.3.1 Portable Diagnostic Unit (PDU)

The Contractor shall provide two-(2) battery operated portable diagnostic units (PDU) to interface with the main MDU and to interface with the diesel engine's monitoring and diagnostic unit The PDU shall allow the transfer of data from the MDU to a desktop PC unit to analyze the faults and events. There shall be two (2) sets of any accessories for each system required as part of the downloading or monitoring process.

If software is not available to interface with the diesel engine's monitoring and diagnostic unit, then two (2) separate PDU's and accessories are required for the engine's MDU.

8.3.2 Software

The Contractor shall provide all software for the Locomotive's Monitoring and Diagnostic Unit and for the diesel engine's monitoring and diagnostic unit.

The Contractor shall provide two (2)-licensed sets of all software for the Portable Diagnostic Unit (PDU), and the diesel engine's monitoring and diagnostic unit. It shall be in a format such that PATH may reinstall it onto the MDU and onto the diesel engine's monitoring and diagnostic unit in case of failure. Complete instructions for the installation of the software onto the MDU and onto the diesel engine's monitoring and diagnostic unit shall be provided in the inspection

and maintenance manuals.

8.3.3 Miscellaneous

The Contractor shall provide two (2) sets of accessories, complete with carrying case, for the PDU and two (2) sets of accessories for the Monitoring and Diagnostic Unit for the diesel engine. Accessories shall include but not limited to cables, batteries, battery chargers and connectors.
The Contractor shall minimize the amount of batteries required for the microprocessors. Batteries must have a minimum life of 10 years before replacement.

8.4 Event Recorder

8.4.1 General

Independent of the Monitoring and Diagnostics, there shall be a separate Event Recorder. The Event Recorder shall be a standalone unit that complies with 49 CFR 229.135 and IEEE Standard 1482.1 and allows achieving the periodic inspection requirements of 49 CFR 229.25. The Locomotive shall have one Event Recorder, located above floor, in a secure location, inaccessible to unauthorized personnel. The location shall be approved by PATH. A dedicated memory shall retain 48-hours of data history before write-over. The sampling and storage rate requirements specified in paragraph 4.2 of IEEE Standard 1482.1 apply to all signals, including the spare channel signals. Upon change of state of a digital signal and upon change of an analog signal, the changed signal shall be recorded. A removable memory unit shall store the data. Data shall be retrievable by; standard USB 2.0 or latest, removal of the memory unit and through a serial port to a notebook computer. The contractor shall provide software to evaluate the downloaded data on the notebook computer. It shall not be possible to erase the data via the serial port. The Event Recorder shall be meet the requirements of the Association of American Railroads (AAR) new Standard S-5512, "Locomotive Event Recorder Download Standard", complete with test mode. The Event Recorder shall log a fault when any of the input channels, except for spares have not changed state in over 90 days . Event Recorder shall have a self test mode that follows the recommendations specified in paragraph 4.3.1 of IEEE Standard 1482.1.

8.4.2 Signals to Monitor

The Event Recorder shall record the Train Operator's actions, the resulting trainline commands and various system responses. The Event Recorder shall include, but not be limited to the following analog signals common to locomotive operations:

- Brake Cylinder Pressure
- Tractive Effort Request
- Brake Pipe Pressure
- Deadman Control
- Direction Fwd/Rev
- Emergency Brake Application

- Friction Brake Application
- Speed
- Time
- Throttle Position
- Horn
- Ditch Lights
- Line Voltage
- Trip Cock Activation
- Achieve Torque
- MDS Time
- Three (3) Spares

8.4.3 Construction Requirements

The event recorder shall be designed to protect critical data in incidents, such as derailment, collision that could result in a subsequent need to download event recorder data as part of post-incident investigation. To this end, the requirements in the following table shall be met as a minimum. The requirements may be met by the design of the data storage device, or by placing the device in a box meeting the requirement, or by judicious placement of the device within the Carbody envelope to take advantage, for example, of the crashworthiness and tire-barrier properties of the Carbody, or by a combination of these approaches. In any case, the event recorder shall be located in-board of the collision posts.

The construction of the event recorder shall meet the requirements of IEEE Std. 1482.1-1999, IEEE Standard for Rail Transit Event Recorders. If the construction of the event recorder does not meet this requirement, the Contractor shall perform tests to verify that it meets the following requirements (test procedures shall be submitted nine months prior to the delivery of the first Locomotive and the tests shall be conducted six months prior to the delivery of the first Locomotive):

Condition	Requirement
Fire	1200°F (650°C) for 30 minutes, followed by 570°F (300°C) for 60 minutes, followed by 212°F (100°C) for five (5) hours.
Impact Shock	+/-100 g peak, 65 ms duration, separately in the direction of each of the three principal axes.
Penetration	50 lbs. (23 kg) weight with a protruding 0.25-inch (6.4-mm) diameter steel pin dropped from a height of 5.0-ft. (1.5 m)
Static Crush	25,000 lbs. (110 kN) for 5 minutes.

Fluid Immersion	Immersion in any of the following individually for 48 hours: grade 1 and 2 diesel fuel, regular and salt water, and lubricating oil;
and	Immersion in fire-extinguishing fluids for 10 minutes, followed by 48 hours 8 in a dry location without being otherwise disturbed.
Hydrostatic Pressure	Immersion in salt water at a depth 50 feet for 48 hours.

The final acceptance of the event recorders on all locomotives shall be by downloading the data and checking all channels are operative and conducting a second run after/before 48 hours to make sure data is not overwritten before specified time. This final acceptance of the event recorders will be determined after the Locomotive has entered into general service

SECTION 9

9.0 AUXILIARY ELECTRICAL EQUIPMENT

The Locomotive shall contain an alternator, connected to the diesel engine, to supply power for the low voltage system. The low voltage system shall supply power to the control system, auxiliary power system, to the B+ line in the Flatcar Taillight Trainline Plug/Receptacle circuit and to the batteries.
The requirements for the engine alternator are indicated in Section 10.8. The requirements for batteries are indicated in Section 10.7.1. The requirements for the Flatcar Taillight Trainline Plug/Receptacle is outlined in electrical drawing P0013.

9.1 Low Voltage Power

The low voltage power system shall meet the following requirements: .

- Maximum Voltage: 42.5 Vdc
- Nominal Voltage: 37.5 Vdc
- Minimum Voltage: 23.0 Vdc

When apparatus and circuits are powered through train lines, powered apparatus shall function satisfactorily in all Work Cars, including the last Work Car of a maximum-length train when the train lines are powered from the lead car, using battery power only. The minimum voltage at the load apparatus under these conditions shall be sufficient to reliably operate these loads.

Additionally, all train line-powered apparatus and apparatus powering train lines must be compatible with the non-passenger fleet, which utilizes a low voltage power range of 23 to 42.5 Vdc. Alternate low voltage levels of non-train line functions may be considered for approval by

the Project Manager.

9.1.1 Low Voltage Power Supply

The Contractor shall comply with this section if a PATH -approved alternate to an auxiliary alternator is chosen. The Low Voltage Power Supply (LVPS) shall supply control power to all Locomotive systems, power all lights, charge batteries, and power other loads as may be defined in the course of the vehicle design. The LVPS shall receive its power from the variable DC distribution system. The LVPS shall provide full performance for voltages within the distribution system operating voltage range. The Contractor shall coordinate the proper relationship between the LVPS capability and the load requirements, including battery charging.

The output efficiency shall be greater than 80 percent at 10 percent of full rated load or above. The LVPS shall not be dependent upon Locomotive motion. The LVPS enclosure shall be isolated from both the input and output circuits.

9.1.1.1 Low Voltage Output

The LVPS output shall conform to the following requirements:

- The output shall be transformer-isolated from the input.
- The nominal output shall be adjustable from 36.0 to 39.0 volts dc, initially set to 37.5 volts dc.
- Allowable Ripple: Maximum peak-to-peak voltage of 3 percent of nominal dc voltage.
- Operating tolerance: +/- 1 percent, except that a load-dependent voltage variation may be applied in order to promote load sharing between L VPSs in the Locomotive. Such a "droop" characteristic shall not be more than 1 volt, from no load to full load.
- Capacity: With all LVPSs on the Locomotive operable, combined LVPS capacity shall be capable of supplying 120 percent of the full load requirements of the Locomotive, including battery charging. With one or more inoperable L VPS, load shedding per Section 9.10.4 is permitted.
- Output transient response: +/-10 percent for any step load change with the battery connected. In all other cases, the maximum overvoltage shall be 42 Volts.
- Load transients: step application and removal of any load value up to the maximum, or over 18 the maximum in the case of dead batteries.

9.1.1.2 Control and Annunciation

Faults shall be uniquely identified on a display within the converter and shall be communicated to the monitoring system as described in Section 8.

9.1.1.3 Protection

Protective features shall include a limited number of automatic resets. The exact implementation

methodology shall be approved by PATH.

Isolation: The Locomotive's distribution circuit breaker that supplies high voltage power to the LVPS shall be located within 5 feet of and on the same side as the LVPS enclosure and shall remove all high voltage inputs. PATH approved signage shall be installed on the LVPS that instructs the maintainer to open the main high voltage circuit breaker and wait 5 minutes prior to servicing the equipment. The sign shall also advise the maintainer that low voltage power is present with the high voltage circuit breaker open.

Input circuit protection: A fuse or circuit breaker shall be provided within the converter. This is in addition to the Locomotive's distribution circuits protection.

Input Voltage Range: automatic shutdown outside of the operating range and automatic re-start when the voltage is within range. Hysteresis and timing functions to be approved by PATH.
Input Diode: The high voltage input shall include a diode to minimize the possibility of capacitor discharge into third rails and to protect the unit from negative transients.
Over temperature Protection: The converter shall be self-protected against internal over temperatures.
The converter shall detect internal failures.

Output Circuit protection: An output fuse or circuit breaker shall be provided in the converter and sized to protect the Locomotive wiring.

Output Short Circuit Capability: An output short circuit shall not damage the converter and not result in the need to manually reset any protective device. A means shall be provided to limit the current supplied to a fault. The current into a short circuit shall not exceed 150 percent of normal full load current Upon removal of the short, the power supply shall resume normal operation.

Output Voltage Range: If the output voltage is out-of-limits, the converter shall shut down. The upper limit is 42 Vdc. The lower limit is 36 Vdc, except for low input voltage and brief periods of current limit. After a shutdown and a brief delay, the converter shall restart automatically. Repetitive restarts in a short period of time shall cause the converter to be locked out, requiring manual reset.

Output Current Limit: If the current demand exceeds the current limit, then the output current shall be held at constant and the output voltage shall be reduced such that the output power remains constant The limit shall be adjustable up to the converter rating. The final adjustment must consider all load scenarios, including an appropriate value for dead battery charging. Continuous operation at maximum current, but below an expected operating voltage shall cause the LVPS to shut down.

9.2 Carbody Grounding

9.2.1 General

All equipment on the Locomotive shall be safety-grounded to the Locomotive structure. Equipment boxes and enclosures with the exception of the battery box shall be grounded as specified in Section 15.16.7.

Each system or circuit fed from a circuit breaker or fuse shall have its own return wiring. Each circuit return wire shall be connected, via its own separate terminal, to a return bus located with circuit breaker or fuse that supplies the circuit, or to a negative bus as specified in Section 9.1. Circuit breakers or fuses shall not be installed in the return wiring, unless the source and the return path are broken by the same device.

9.2.2 Safety Grounding and Ground Fault Detection

The Locomotive structure and truck frames shall be grounded to the axles. Carbody shall be grounded to all four axles in the Locomotive through axle mounted ground brushes.

Carbody grounding circuits, including wires and brushes, shall be sized so that each brush circuit can independently carry the maximum fault current without damage and while limiting the voltage difference between the Carbody and the running rail to 50 volts. Ground fault detection shall be provided for all traction power high voltage circuits and all 3-phase and single- phase 115V AC auxiliary power circuits.

9.3 Circuit Breakers

Circuit breaker panels for all low voltage and high voltage circuits shall be provided in the cab. Separate panels shall be provided for low voltage and high voltage circuits. Circuit breaker panels shall conform to the requirements of Section 15.27.4. Each circuit breaker shall be identified to indicate the circuit it protects.

A protective device shall be provided to secure the Event Recorder circuit breaker from accidental manual tripping. The circuit breaker shall be protected by a safety metal or plastic wire.

9.4 Three-Phase Auxiliary Power

Three-phase auxiliary power shall be provided to the cab HVAC unit, equipment ventilation blower(s), air compressor motor, and all other rotating machines necessary for locomotive operation. Nominal voltage for the 3-phase distribution shall be according to the current rail industry standards, with the exception of the companion alternator, which will produce variable voltage. The circuit design shall include circuits which afford protection and which are resettable. The application or removal of any load shall not result in the nuisance activation of protective devices.
A 115- V ac /10 Amp receptacle shall be provided in the cab for auxiliary test equipment, etc. The receptacle shall be protected by the ground fault current interrupter (GFCI).

9.5 Equipment Ventilation

All Locomotive components that require forced air cooling shall be ventilated with filtered air. Inertia/spin type filters with the filter elements common for the locomotive industry shall be used to remove dirt and moisture. Filter element selection is subject to PATH approval. All cooling air intakes shall be screened to minimize the possibility of ingestion of snow, debris, and water, including water from a high-pressure car wash facility and blockage by plastic bags, newspapers, and other debris typical for the PATH operating environment.

SECTION 10

10.0 PROPULSION EQUIPMENT

10.1 General

The Locomotive shall have an approved diesel-electric power unit designed to meet the performance requirements specified in Section 2.5, including an electronically controlled, self-diagnostic diesel engine coupled to an alternator with the associated rectifier unit. Primary DC power from the rectifier shall be fed to two independent IGBT traction inverters, one per truck, driving two (2) AC or DC traction motors each. The power unit shall be capable of being controlled from the cab or the cab of another locomotive via the 27-Point Trainline System. The propulsion control system shall be electrically interlocked to prevent simultaneous operation from the cab and the 27-Point Trainline System. Any ventilation inlets shall be designed and located to prevent debris (e.g., newspapers, plastic bags, etc.) from covering the inlet(s). Inlets shall be designed and located similar to those on Class 1 production locomotives manufactured in the United States. All faults communicated to the monitoring systems shall be diagnosed using a PTE. Relevant parameters for each fault will be recorded and readable using the PTE.

10.2 Diesel Engine

At the time of delivery, the engine shall be new, and certified to the applicable U.S. Environmental Protection Agency (EPA) regulation given in Federal Register 40 CFR 89 "Control of Emissions from New and In-Use non-road Compression-Ignition Engines."
The engine shall be capable of using Ultra-Low Sulfur Diesel Fuel that meets the requirements based on EMA and DDC's 2006 Diesel Fuel Specifications.

The Locomotive shall include a heavy-duty diesel engine equipped with thermostatically controlled radiator cooling, fuel oil pumps, graduated fuel level gage, filling connection, drain valves, air cleaner, and spin-on type oil, water and fuel filters and an emergency engine shut off. Quick and convenient access shall be afforded to operational engine checklist items, such as oil dip sticks, coolant level, fan drive and battery charger drive belts.

Suitably sized radiator(s), of one-piece core construction, shall be provided for the engine to cool the pressurized engine jacket coolant system. An alternative radiator configuration may be considered for PATH approval. An engine driven fan(s), or electrical driven fan(s) using an ac

fan motor(s) with a 3- phase inverter(s), shall provide air to sufficiently cool the radiator(s). The average radiator cooling airflow exhaust velocity and temperature across all exhaust outlets concurrently, shall not exceed 26 mph and 191° F respectively, at 100% load and 115°F ambient. If the radiator is located such that it requires a maintainer to go to the roof to refill the radiator, then a site gage shall be provided inside the engine room so that the coolant level can be inspected without accessing the roof. The radiator cap shall be located for quickly and conveniently checking the coolant levels and shall be chain-secured to the radiator. All heat exchangers shall have a separate fan. Heat exchangers shall not be installed back-to-back, unless the arrangement is approved by the PATH Project Manager. An approved alternate shall be tested by the Contractor to demonstrate compliance with the requirements of the specification. The approved arrangement shall be proven to perform its function prior to the completion of the general warranty period of the last Locomotive. If any design or manufacturing defects are found during that period, the defects shall be corrected and the heat exchanger arrangement shall be re-designed, if necessary, at the Contractor's expense. The engine shall have automatic shutdown and power reduction features to protect the engine from damage in the event of overheating, overspeed and /or loss of lubricating oil pressure. All shutdowns and power reduction nodes shall be annunciated to the Operator.

The engine shall be equipped with a paper type air filter suitably sized for operation in a dust-laden environment. The air filter element shall be designed for maximum protection against the entrance of dust including steel dust, dirt, and moisture normally encountered in PATH subway environment. The air filter element shall be sized for a minimum of 92-day replacement cycle for all PATH System conditions.

The engine shall have a pressure lubricating system with a full-flow by-pass valve to by-pass oil filter and oil reserve. The by-pass valve shall operate to permit oil flow when the oil is cold or if the full-flow filter becomes clogged to assure a constant flow of oil to the engine.

The engine, alternator, radiator, rectifiers, inverters (as required), and associated accessories shall be mounted on an easily removable platform for quick power plant replacement

SAE standards shall apply to fuel and oil line fittings, throttle connections, and engine mounting. All components such as oil gages, oil dip sticks, belts, fill openings, and filters shall be located for easy access to inspection or replacement.

The Contractor shall furnish drain hoses with a lockable shut-off for radiator coolant, compressor oil, and engine oil systems. The hoses shall be suitably routed, as approved by the Project Manager, to the outside of the Locomotive and protected from damage.

All components on the power unit which may be damaged by vibration or which may induce damaging vibration to the system shall be equipped with suitable vibration isolators and shall be connected to other components by means of approved flexible connectors. The lengths of flexible connections shall be minimized.

10.3 Exhaust

The engine exhaust shall comply with all “TIER 4” requirements regarding air pollution. The engine exhaust system shall cause no adverse pressure or temperature rise to the engine or any other part of the engine enclosure. The system shall be designed so that the manufacturer's maximum allowable exhaust backpressure requirements are not exceeded.

The airflow from the engine exhaust shall be routed to the top of the hood. The Contractor shall provide a system to diffuse the exhaust from the tailpipe. Under no circumstances shall the velocity and temperature requirements specified in Section 10.2 be exceeded for the engine exhaust.

10.4 Air Contaminants

The Contractor shall provide the engine emission data for carbon monoxide (CO), oxides of nitrogen (NO & NO2) and aldehydes for various operating conditions.

10.5 Fuel Tank

The fuel tank(s) shall have a minimum total capacity of 500 gallons of fuel and shall be mounted below the deck. An easily accessible fuel filter shall be located at the fuel tank(s). The fuel tank(s) shall be outfitted with a fuel tank sump, drain valve and clean out ports to facilitate removal of dirt and sludge and shall be vented. The drain valve shall be positioned at the bottom of the tank(s) and protected from debris on the roadbed. Placement of the vent shall be higher than the filler mount to avoid overflow. The tank(s) shall be designed to reduce fluid motion or imbalance when the Locomotive is traveling at rated speed, accelerating or decelerating. Fuel baffle plates, if required for reduction of fluid motion, shall not obstruct removal of dirt and sludge. The tanks(s) shall be located to minimize fire hazard from spilling, overflow, or draining of fuel.

The tank(s) shall be LAHT steel and be corrosion and fuel resistant. The tank(s) shall be designed in such a way that it can be filled with fuel from sources other than the fuel pump in case of an emergency.

The Contractor shall ensure that the fuel tank(s) shall have sufficient clearance for the PATH System as described in PATH MW-l, Track Standards and Reference Manual. The tank(s) shall be FRA-compliant and shall include shields on both ends for protection from roadbed debris.

The tank(s) shall contain filler openings accessible from both sides of the Locomotive with a minimum internal diameter of 1 1/2" (3.81 cm), a strainer, a chain-secured or hinged filler cap and a flash arrester as manufactured by Protectoseal Co. or PATH-approved equal. The filler neck shall be located and oriented to prevent the fuel nozzle or fuel can from contacting electrical components during refueling.

A fuel level pressure sensing transducer shall be installed in a housing at the bottom of the fuel tank. The housing shall have a removable cover designed to permit quick and convenient access

to the pressure transducer for inspection.

The tank(s) shall include a sight-glass type gage with float balls visible from the side of the Locomotive. A digital gage displaying the remaining gallons of fuel shall also be installed on the operator's control stand inside of both cabs.

10.6 Starting Equipment

The engine starter shall be mounted on the diesel engine. The starting equipment shall be operated from the control stand, and shall include an interlock so that the starting button is inoperative when the engine is running.

For emergency starting, two receptacles, SMH Part Number: SY6326G1, or PATH-approved equal shall be mounted one on each end of the Locomotive. The receptacles shall be permanently connected to the batteries and connected so that each receptacle may be used to start the diesel engine from an outside source with a jumper. A 25-foot jumper cable with a plug shall also be provided and stored in the Locomotive. This plug shall be a SMH Part Number: SY6326G1, or PATH-approved equal. Note that the SMH Part Number: SY6326G1 includes both a plug and a receptacle. Receptacles and permanent wiring shall be rated with a safety factor to carry the starting current and current required for auxiliary loading for all operating and ambient conditions.

10.6.1 Provisional Battery Starting Procedure

The Contractor shall provide a provisional engine starting procedure in the case where a battery is below 50% charged. The provisional engine starting procedure may include portable charger or permanently affixed charging equipment.

10.7 Battery with Battery Enclosure

The Contractor shall provide lead acid batteries capable of supplying power for engine starting and for auxiliary power, including lighting required by the Locomotive. All intercell connectors shall be corrosion resistant with low joint resistance and have ample current carrying capacity as recommended by the battery manufacturer. All connections for lighting circuits shall be across the entire battery.

The proposed low voltage battery, case, and tray shall be submitted for PATH review and approval.

10.7.1 Battery Capacity

The battery shall have sufficient capacity to supply all auxiliary power loads with adequate current (measured at the load) while the engine is not running for a one-hour period. During the one-hour period, the following loads, as a minimum, shall remain energized.

Lights, including cab interior, headlights/ditch lights, marker lights, engine room lights and any other exterior lights

- Brake and Propulsion Control
- Event Recorder
- Buzzer Signal System
- Monitoring and Diagnostics

After the one-hour period, the battery shall also be capable of six (6) consecutive cranking starts of 30 seconds each, with 60 seconds open-circuit between each attempted start. A battery switch shall be mounted at a PATH -approved location in the cab.

The Contractor shall provide load calculations to size the battery to meet the above requirements under all operating conditions for PATH review.

10.7.2 Battery Enclosure

The battery enclosure shall be a structural frame of welded steel construction located under floor. Maximum accessibility shall be provided to permit quick and convenient inspection and maintenance. The battery enclosure shall be electrically insulated from the car body. The interior surfaces of the enclosure shall be of an approved electrolyte resistant, glass fiber reinforced polyester resin. No flammable or hygroscopic materials shall be used for any part within the battery enclosure. The battery cells shall be cushioned from vibration under all operating conditions.
The batteries shall be enclosed in a battery box which shall be mounted on a single pull-out, drawer-type roller tray to permit ease of installation and servicing accessibility from the side of the Locomotive. The pull out force required to move the drawer roller tray shall be 25 lbs. (11.34 kg) maximum, measured after passing the initial peak force required to overcome the inherent inertia. The peak force required to initiate the movement shall not exceed 31 lbs. The rollout tray shall have a failsafe locking mechanism whereby buttons are depressed or tabs pulled in order to pull out the tray. The tray shall automatically lock when it is fully pushed back, (stowed position) inside the battery box to absolutely prevent the tray from moving. This lock shall be arranged so that it must be in the "tray locked" position before the battery box cover can be closed.

The cover retaining mechanism shall be corrosion resistant and shall not interfere with access to, or normal maintenance of the batteries nor shall it, under any circumstances, contact any part of the battery. The cover shall be hinged on top and shall have a passive locking device(s) which automatically engages when closed, the battery box cover shall also be removable without the use of hand tools and light enough for one person to remove. This device would then need to be pressed for the mechanism to release the cover. The cover shall open so as to permit full access to the battery compartment without cover removal. The cover shall be designed to be easily opened and closed by one person and it shall not be necessary to hold the cover in place while operating latching or fastening devices. The cover shall not swing open or fall off if the Locomotive is moved with the cover unlocked.

The batteries are not to be located in the engine room, the batteries shall be placed on a single pull-out, drawer-type roller tray as specified in this Section.

Drains shall be provided at the bottom of the enclosure/tray so that electrolyte leakage and wash water will drain clear of other Locomotive parts. The enclosure/tray shall have a drain plug accessible from the outside. The drain plug shall be held captive to the enclosure by means of a cotter pin or a chain. If a chain is used, removal of the plug without disengagement of the chain shall be possible.

Ventilation openings shall be provided to prevent the buildup of gasses, such as hydrogen. The location of the openings shall ensure air circulation throughout the enclosure with the Locomotive in motion or stationary. As a minimum, the ventilation shall be provided on the top and in the upper back of the enclosure.

10.7.3 Battery Protection System

A battery voltage monitoring system shall be provided on the Locomotive to continuously monitor the voltage of the batteries. A battery voltmeter shall be provided in the cab. Battery voltage that does not meet the manufacturer's recommended voltage shall be annunciated to the MDS via a visual and audible alarm in the cab. A means shall be provided to manually adjust the limits to an appropriate predefined value. The adjustment device shall be protected by a cover, requiring tools to remove the cover, to limit access.

A sensor to prevent overheating from overcharging shall be located in the battery box to disconnect the battery from the alternator whenever the battery temperature exceeds the temperature specified by the battery supplier, but in no case greater than l60^{o}F (71°C). The protection system shall disconnect the battery in the event of an over temperature condition and shall require manual reset. This condition shall be reported to the MDS.

A double-pole battery circuit breaker of adequate capacity and approved design shall be mounted in an environmentally protected enclosure mounted as close to the battery as possible. This breaker shall incorporate a shunt-trip device and disconnect the battery from car wiring when the battery temperature or battery voltage is excessive. It shall also incorporate a series trip to protect against fault currents.

10.8 Alternator

A battery-charging alternator equipped with built-in rectifier and regulator shall be furnished and installed. It shall be capable of fully charging the batteries in 4 hours when at 50% discharge and while also supplying full auxiliary power. Ambient temperature shall not affect the charging rate.

The alternator shall have suitable voltage regulation to provide constant battery charging potential to the battery and the auxiliaries over the full operating range of engine speed.

Alternative arrangements to provide battery charging function may be considered for PATH approval.

10.9 Traction Alternator and Primary Power Distribution

Each motored axle shall be individually driven by a three-phase AC or DC traction motor, with its gearing. The traction motor shall be of a totally enclosed, or drip-proof, splash-proof, or open design. The diesel engine shall be coupled to an AC alternator with the associated rectifier, feeding IGBT inverters to produce electrical power to be distributed through appropriate cables and control equipment to four (4) AC or DC traction motors.

10.10 Traction Motors

10.10.1 General

The propulsion system shall be designed to power four (4) alternating or direct current traction motors, or, one propulsion system per truck powering (2) traction motors. The proposed propulsion system shall be submitted for PATH review and approval. The traction motor shall be designed in accordance with IEEE Std 11-2000 Standard for Rotating Electric Machinery for Rail and Road Vehicles, and IEC Std 60349-2, Electric Traction-Rotating Electrical Machines for Rail and Road Vehicles.-Part 2: Electronic Converter-Fed Alternating Current Motors as applicable. The traction motors shall convert electrical power from the traction alternator to mechanical energy to be applied through appropriate gear units to the wheel and axle assembly. The gear housing shall be axle-mounted and supported by the truck frame with resilient noise suspensions.

10.10.2 Insulation

The completed motor frame with insulated coils shall be given two (2) vacuum-pressure impregnations with Westinghouse B-7-373 resin, a solventless polyester resin, or PATH-approved equal, with at least a temperature rating class equal to the temperature rating class of the motor winding insulation. Other insulation processes may be used upon PATH approval.

10.10.3 Rotor

For the traction motors, the traction motor rotor cage shall be of copper alloy bars with brazed or welded rings. The rotor and cooling fan shall be dynamically balanced separately so that, after they are assembled, net dynamic unbalance measured at each bearing is less than 1.0 inch-ounces (.72 mm-kg) without any balancing following assembly. Balance correcting weights shall be metal, either welded in place, secured in retention grooves, or bolted in place. Supplier shall present evidence that rotor bars are designed sufficiently robust as not to suffer fatigue fractures for the life of the Locomotive.

10.10.4 Terminals and Leads

Traction motor power connections shall be made by means of bolted connections to bus bar terminals built into the motor housing. Terminals and terminal blocks shall be protected from weather and the operating environment and shall be clearly marked for positive identification. The terminal block design shall use neoprene polyester glass or other approved type blocks or cleats having a high insulating and flame retardant value. Motor leads shall be clearly marked to prevent cross connecting. The Contractor may propose the use of motor leads of varying lengths to prevent cross connection. Motor leads on all motors shall be provided with Amp, Thomas and Betts or approved equal compression-type, quick-disconnect knuckle joint connectors. Terminals shall be covered with highly insulating hose-type covering clamped so as to be weather tight at both ends or with an approve equivalent method of protection. Cable from the traction motors on each truck shall run from the terminal block on the motor frame to the Carbody cable through a clam-shell-type quick-disconnect connector. The current value used in determining the minimum size of motor leads shall conform to NFPA 130.

10.10.5 Bearings and Lubrication

Traction motors shall be equipped with anti-friction bearings. Bearings shall not require servicing more often than 200,000 miles or 10 years, whichever occurs first. The supplied motors shall be ready for operation. The bearings shall have an ANSI/AFBMA L_{10} rating life of 1,000,000 miles (1,609,000 km).
Insulated bearings shall be used with the AC traction motors, unless otherwise approved by PATH.

10.10.6 Mounting Details

The traction motor shall be isolated by resilient elements from equipment below the primary suspension, including the gear unit if the latter is axle-mounted. The motors shall be designed for coupling by means of a gear-type coupling to the gear unit. Bolts shall be grade 5 bolts as a minimum and shall be tightened with a torque wrench to a repeatable torque value. If grade 8 bolts are used, they are not to be plated but corrosion protection is required. Hardened steel flat washers shall be used under bolt heads and nuts. The traction motor shall be provided with lifting lugs. The motor configuration shall ensure stability when the motor is placed on the floor. Motor mounting bracket shall be integral to the motor frame; bolting of the bracket to the motor and then to the truck shall not be allowed.

The traction motor shall be provided with safety straps, tabs, or hangers to prevent the motor from falling in the event of failure of the primary motor mounts as specified in Section 4.3.4.3.

The motors shall be designed with suitable truck clearances to permit each motor-and-gear-unit combination to be removed from the truck without interference with members of the truck frame. In addition, it shall be possible to remove the traction motor from above the truck without removal of the gear unit. Clearances beneath the motor and gear unit shall be as specified in Section 4.3.1.3.

10.10.7 Vibration Limits

The vibration of any traction motor detached and supported on resilient mountings providing at least 0.25- inch (6.3 mm) static deflection, shall not exceed 0.0015-inch (0.038 mm) peak to peak displacement at the motor bearing housing and at the motor mounting points while the motor is rotating at any speed between 50 percent and 100 percent of the maximum normal operating speed. Each assembled motor shall also meet the vibration requirements of IEEE Std. 11.

10.10.8 Ventilation and Noise

Traction motors shall be either self-ventilated with an integral low-noise type fan or forced air cooled. If self-ventilated motors are proposed, supplier shall submit necessary calculations to demonstrate adequate thermal capabilities of the motor for PATH approval.
For the drip-proof, splash-proof or open designs, openings shall be provided for inspection and ventilation. The openings shall be arranged to minimize ingestion of snow and dirt from the track bed, and the possibility for objects being dropped Into the motor during maintenance.

10.10.9 Over-Temperature and Motor Overload Protection

The Contractor shall apply over temperature protection of the motors. The measurement of winding temperatures with embedded sensors is not permitted.

10.11 Gear Units

10.11.1 General

Each axle shall be driven by a gear unit, which shall be parallel single-reduction or double-reduction drive designed and manufactured for bi-directional service. The gear ratio shall be selected to provide the performance specified in Section 2.5 and shall conform to established Locomotive gear design practice. The motor and gear unit drive and mounting arrangement provided shall meet the specified noise, vibration, shock loading and maintenance requirements. Gear unit noise shall meet the requirements of Section 2.8.1.

10.11.2 Gears

Gears shall be designed and installed for a minimum inspection and adjustment interval of 200,000 miles or 10 years, whichever comes first. One break-in inspection during the first interval shall be acceptable. Gears shall have a minimum fatigue design life of 1,000,000 miles (1,609,000 km) with no degradation of performance. Gears shall be fabricated from high-quality gear steel, designed and heat-treated/hardened in accordance with AGMA 140.01, Gear Material Manual.

10.11.3 Bearings

The gear unit shall be equipped throughout with tapered roller bearings, or approved equal, which shall require a minimum inspection or adjustment interval of 200,000 miles or 10 years,

whichever comes first. Bearings shall be quality, grades of steel. All gear unit bearings shall be selected and applied to have an ANSI/AFBMA L_{10} rating life of 1,000,000 miles (1,609,000 km). External bearing shaft seals shall be the labyrinth type, with supplemental sliding contact seals, if necessary to keep high velocity splashed water from entering the gear units.

10.11.4 Lubrication

The gear unit shall be oil-lubricated. The gear unit shall be provided with sufficient baffles, dams, passages and similar structures to ensure an adequate flow of lubricant to all bearings and gears under conditions specified herein of rotation, speed, load, temperature, and weather, including continuous operation in either direction, at maximum speed. The unit shall be so designed that adequate lubrication will be provided to all bearings and gears under the most severe operating conditions and prevent moisture infiltration into the lubricant.

The gear unit shall not lose more than one quart within 60,000 miles and shall not require change more frequently than every 120,000 miles (other than one break-in type lubricant change). The gear unit shall have sufficient oil capacity for adequate cooling. All gear lubrication shall be in accordance, with the applicable sections of ANSI/AGMA 9005.

The gear unit shall have at least one oil drain opening located at the lowest point in the case or sump. Drain plug(s) shall be installed in the opening(s) and properly secured. Both the drain and fill plugs shall be Magnetic. Alternatively, the plugs may be nonmagnetic, provided that a magnet is included in the gear unit, located for maximum contact with the lubricating oil and readily removable for cleaning. Removable and accessible oil-tight and airtight inspection covers with elastomeric gaskets or an approved equivalent method of sealing shall be provided for visual inspection of the gears. All fill drain and inspection plugs shall be safety-wired and shall be of a type or be located to prevent damage by obstacles on the track.

The gear case shall be provided with a readily accessible glass sight gauge protected by an PATH approved captive cover for use by maintenance personnel.

The quantity and grade of lubricant shall be indicated either on the filler cap or on the gear unit housing adjacent to the caps. Seasonal changes of lubricants shall not be required. The gear unit lubrication system shall be readily accessible without de-trucking and shall be designed to prevent overfilling.

10.11.5 Not Used

10.11.6 Maintenance

Gear unit components requiring repair or replacement shall be readily accessible with a minimum amount of gear unit disassembly. Parts requiring replacement or adjustment prior to achieving the design life of the system shall be individually replaceable. Adequately bolted and gasketed openings shall be provided for inspection and routine maintenance.

Disassembly, re-assembly and service maintenance shall be possible to the maximum extent with tools and items of maintenance equipment in common usage. Special tools, where required, shall be subject to approval and shall be provided by the Contractor as specified in Section 20.2.2.

10.11.7 Mounting

The gear unit shall be fully suspended from the truck frame with a flexible connection to the axle or shall be axle mounted with a resilient mount at the end opposite the axle. If the latter, the resilient mount shall be the vertical bolt type using bonded rubber pads at the tongue of the gear unit and at the point of suspension from the truck. Bonded rubber pads shall meet the following physical specifications.

- Tensile strength, minimum: 3,000 psi (20.7 MPa)
- Elongation, percent minimum: 450
- Decrease in tensile strength and elongation, after aging (heating in air at 158°F (70°C) for 288 hours), percent maximum: 20.

The drive train design shall not increase the stiffness of the axle suspension within the truck.

10.11.8 Manufacturing

Particular attention shall be given to thoroughness of welding, forming, machining and assembling of parts. After assembly, units shall be thoroughly cleaned of loose, spattered, excess metal chips, and other foreign material. Burrs and sharp edges shall be removed. Standard commercial parts shall be used to the maximum extent. Supplier and part numbers shall be identified on drawings, bill of materials or parts list.

10.11.9 Coupling

A double internal-external, self-aligning gear-type coupling shall be provided between each gear unit and the associated traction motor. The coupling shall be suitably balanced to minimize noise or vibration produced at Locomotive speeds up to 44.3.1.10 mph (65 km/h) with fully worn wheels. The arrangement shall provide for lateral, vertical, longitudinal. and angular motion. The coupling shall be grease-lubricated. Suitable seals shall be provided. Lubricant shall be selected from the PATH List of Lubricants for All Car Classes.

10.12 Grounding

A ground brush holder shall be mounted to provide a good electrical connection between the carbody and the axle. The brush shall have ample capacity and be of a type suitable for the service. A housing shall be provided to enclose the ground brush holder and ring to prevent entrance of dust including steel dust, moisture and dirt for all operating conditions. Ground brushes must be readily accessible from under the car for maintenance purposes.

10.13 Multiple Unit Operation

The Locomotive shall be designed for multiple unit operation so that it can control propulsion. automatic braking, and other systems when coupled to another Locomotive.
or other PATH locomotives, or be controlled by a Locomotive or other PATH locomotives.
See Section 7 for complete details.

10.14 Automatic Fire Suppression System (AFSS)

10.14.1 General

A UL Listed, and FM Approved automatic fire suppression system complete with a protection control panel, vehicle interface, and extinguishing system shall be provided within the engine compartment of the diesel engine.

Qualification: The provider of the AFSS must be factory trained and have been in the train fire protection business for at least three years prior to the contract award. The contractor shall have provided similar systems on at least three types of railroad MOW (maintenance of way) equipment to PATH and one Class One railroad in the preceding thirty six months.

The system shall operate as follows: Upon detection of a fire the protection control panel shall alert the operator of the machine with visual and audible signals as the system is automatically, and immediately activated.

The system shall be manufactured in the United States of America and is electronically actuated.

10.14.2 Protection Control Panel

The protection control panel shall be clearly visible and within reach of the machine operator. The function of all controls, gauges and switches shall be clearly identified. The control panel shall be supplied with a self-recharging nickel metal hydride back-up battery to provide protection to the machine in the event of a temporary power loss for up to twenty-four (24) hours.

The protection control panel shall incorporate the following operator controls:

Alarm Silence
Visual and audible alarm test which verifies LED, alarm, and relay function.
Delay engine stop
Relay Reset
Relay circuit that includes both closed and open contacts which transfer at the end of the time delay period.

The protection control panel shall provide a programmable time delay after activation (0,15,or 30 seconds) prior to activating the engine shutdown circuits. The audible alarm shall produce 85 decibels at three feet distance. A green light will indicate system is operating normally. Red service lights will indicate system trouble, and Red Fire lights will indicate system activation.

10.14.3 Manual Discharge Switch

The manual discharge switch shall be provided within easy reach of the operator and clearly marked. The switch shall be protected against inadvertent activation by means of a protective guard held in place through the switch. The protection control panel shall indicate a manual discharge event with a unique visual display that cannot be reset by the operator. A second manual discharge switch shall be located outside the operator's compartment easily accessible by ground personnel.

10.14.4 Fire Detection

Fire detection shall be located in the engine compartment of a modular linear detection type assembly utilizing AMP connectors. The linear detection shall have a spring guard cover on it to protect it from false-sensing due to vibratory or mechanical damage. Detection shall be placed under all horizontal bulkheads, above and downwind of heat sources, and in areas where fluid leakage from the engine may be present. The sensor shall have a detection value of 356F degrees, and a length of at least ten (10) feet. The Contractor and the AFSS manufacturer shall determine the location of the sensor. The sensor shall be immune to typical false alarm sources found on a railroad MOW machine.

10.14.5 Fire Suppression

The pre-engineered fire suppression system shall consist of a cylinder with fire suppression agent, at least four nozzles, and a distribution system designed for the application for a railroad MOW machine that shall be installed in accordance with the AFSS manufacturer installation manual.

10.14.6 Suppression Agent Storage Cylinder

The agent tank shall be of the stored pressure type and consist of a valve and Department of Transportation (DOT) approved cylinder. The cylinder shall be functional in a horizontal position charged with a minimum of twenty-five (25)pounds of BC rated Purple K pressurized to a minimum of 350 psi. The valve shall incorporate the pressure gauge and accept a linear actuator via a brass electric control head which retains an actuator piston and locking ring, which presses down on the cylinder valve when the linear actuator is activated.

10.14.7 Electrical Requirements

The input voltage shall be 24Vdc. The fire suppression system shall be compatible with SAE recommended practice J1211, and has passed SAE J1113. It also shall have passed UL 1254 Environmental Test Standards. The AFSS shall not require more that 47ma (milliamps) of current for normal operating conditions, 47-52ma in a fault condition, and no more than 78ma in an alarm condition.

Harness -The harness shall be easily maintained and repaired using standard hand tools. Only commonly available wires and connectors shall be used.

10.15 Locomotive Heating & Standby Battery Charging

An independent coolant circulating heating system with automatic start/ automatic stop functionality, and one cab-mounted manual shutdown switch shall be provided by the Contractor. This system shall be powered by a dedicated diesel engine/generator.

When the main diesel engine is shutdown, this system shall: maintain coolant temperature at an acceptable level and circulate warm coolant through the main diesel engine so that the main diesel engine may be started during cold weather; provide power for the cab's interior space heating system; and provide power for auxiliary electrical systems, including the air conditioning system.

This system shall maintain the Locomotive engine's operating temperature during shutdown and layover periods to limit overall Locomotive fuel consumption and limit exhaust emissions.

Additionally, the Locomotive Marker Lights shall be illuminated whenever the main diesel engine is shut down and the Battery Main Switch is opened.

This same auxiliary diesel engine/generator shall power the permanently installed standby automatic battery charger system in order to maintain the batteries at full charge.

The fuel for this diesel engine/generator shall be supplied from the main fuel tank of the Locomotive.

SECTION 11

11.0 AIR BRAKE SYSTEM

11.1 General

The air brake equipment shall be the Wabtec Passenger Transit RT2 transit car system, which is used on PATH's PA4 railcars, or PATH-approved equal, and is to be compatible in operation with PATH's PA4 cars, flat cars and ballast cars. The attached piping diagram shows the PATH PA4 system to be adapted to the locomotive.

All electric terminals, studs, and air connections on each part of the air brake apparatus shall be clearly and permanently marked. All drawings of equipment and manuals shall reference such markings.

11.2 Brake Performance

11.2.1 General

The braking performance of the air brake systems shall be compatible with the performance of work cars existing on the PATH system. The existing PATH work cars are equipped with composition shoes. The brake system shall have the following performance parameters:

Maximum Service Brake:	3.0 mphps
Minimum Service Brake:	0.7 mphps
Emergency Brake:	3.0 mphps

In addition there shall be B5 uncoupling valves mounted at each end of the locomotive. One valve shall be mounted on the hand brake post and the other valve on a channel at the opposite corner of the locomotive, accessible to the ground crew but protected from flying debris. It shall not impede walkway or ladder accessibility. Final installation is to be approved by the Project Manager.

An automatic pneumatic emergency brake shall be available after the system is charged. The emergency brake will be activated when the automatic brake valve handle is placed in the emergency position, the emergency brake valve or a trip cock is actuated, or upon the parting of the brake pipe or the brake pipe hose.

In order to ensure that the emergency brake brings the Locomotive to a full stop before emergency braking can be released, an emergency brake shall result in an irretrievable brake application that cannot be released for a time interval (adjustable by replacement of a choke orifice between 15 and 35 seconds), initially set to 17 seconds following venting of the brake pipe.

A deadman's feature designed to disengage propulsion and initiate emergency braking shall be

incorporated into the throttle and be operative at all times when the system is charged except when the brake handle is in the suppressed position.

11.3 Air Brake Equipment

11.3.1 Tread Brake Unit

A tread brake unit, mounted on the truck frame and able to withstand the forces and motions associated with that location, shall be provided for each wheel. Each unit shall receive air pressure from the control unit and apply braking effort to the wheel tread through a composition brake shoe. The unit shall provide lateral restraint to the brake shoe heads to ensure proper location of the brake shoe relative to the wheel to preclude uneven pressure or shoe slide-off when unflanged brake shoes are used. The tread brake unit shall automatically adjust to compensate for brake shoe and wheel wear. The unit shall be readily accessible for maintenance and inspection without the need to detruck.

11.3.1.1 Brake Shoes

Composition brake shoes which are used on existing PATH passenger or work cars shall be provided. Brake shoes shall be two-inch thick flangeless composition shoes and shall meet the criteria set forth in AAR Specification M-926 for High-Friction Composition Brake Shoe. Brake shoes shall have a good fit with typical brake heads. The composition shoe shall not generate noise or harmful gases exceeding levels specified by federal, state and city codes.

If the currently used PATH composition brake shoes cannot be used, then the composition brake shoes shall be service-proven in similar applications, available from at least two suppliers, and shall be approved by the Project Manager. The Project Manager reserves the right to request test data and supporting documentation prior to approval.

Brake shoe heads shall be made of material which has been proven in service on PATH, and shall be designed to permit the brake shoe keys and brake shoes to be readily removed and replaced. The heads shall have a 17 3/4 inch (450 mm) radius surface.

Brake shoe keys shall be top mounted and shall secure the standard brake shoe to the brake head.

11.3.1.2 Brake Levers, Rods, Hangers, Pins and Bushings

Tread brake unit and parking brake lever, rods and hangers (if needed) shall be steel or other approved material conforming to the requirements of Section 15 and shall be designed to meet the following requirements:

Allowable stresses of brake parts are based on mild open hearth steel having an yield point of 33,000 psi (227.5 MPa) and shall not exceed the requirements in psi.

	Tension		Compression		Shear		Bearing	
	psi	MPa	psi	MPa	psi	MPa	psi	MPa
Rods	15000	103.4						
Levers	23000	158.6	23000	158.6	10000	69	10000	69
Jaws	10000	69			10000	69	10000	69
Pins					10000	69	12000	82.7

Brake rigging stresses are based on a brake actuator pressure of 100 psi (690 KPa) and shall not exceed 90% of the yield point of the material at a cylinder pressure of 140 psi (965 KPa) combined with the normal parking brake forces.

Brake pins shall be induction hardened to an effective depth of 0.100 inch (2.5 mm) and minimum hardness of Rockwell C60 and shall have a surface finish of 32 micro inches (0.81 micro meters). Other hardness and surface finishes may be submitted for approval. Pins internal to tread brake units shall be the supplier's standard.

Bushings shall be provided for all holes in brake levers, rods and hangers. Bushings shall be of cold drawn seamless steel tubing case hardened to Rockwell C60 and finished to 32 micro inches (0.81 micrometer). Bushings are to be pressed into holes with a press fit of from 0.003 to 0.007-inch interference.

11.3.2 Not Used

11.3.2.1 Emergency Brake Actuating Valves

Wabtec B3C emergency brake actuating valves, or PATH-approved equal, shall be provided inside the cab. When activated, propulsion power shall be removed and the train's emergency brakes shall be applied. All emergency brake actuating shall be reported to the MDS. See Section 6.4.14 for valve locations and additional information.

11.3.3 Trip Cocks

Two self-resetting pneumatic trip cock valves shall be installed on each Locomotive. The trip cock shall be located so that the lever will positively engage the track trip arm. Trip cock mounting bolts shall be SAE Grade 5 with castellated nut, cotter pin, lock-washer and one hardened flat washer. Trip cocks activity while the car is in motion shall be reported to the MDS. Trip cocks shall be Wabtec type D1, or PATH-approved equal.

Each D1 trip cock shall be mounted on the left side of each truck (when the truck is on the forward moving end of the locomotive). The center line of the trip lever shall be 7-3/4” to the left of the inside face of the ball of the rail, and 2” (+3/16”, -0) above the rail. The opening of

the trip cock valve shall remove propulsion and cause an emergency application of the train line air brake.

11.3.4 Air Hoses

All flexible connections on the trucks, including those on the brake cylinders, between carbody and trucks, and carbody and couplers shall be made with hoses. Air hoses between the truck and car body shall be arranged and of a length sufficient to allow for maximum rotation of the trucks on the PATH system without crimping nor stretching of the hoses and provide clearance with all adjacent equipment. All air hoses shall conform to the latest revision of the AAR M-618, with AAR approved reusable fittings meeting AAR M-927. Vulcanizing of any label to any hose shall not be permitted. Air hose applications shall not be permitted in locations where adequate visual inspection cannot be made.

Air brake hoses between the couplers and the cut out cocks at the ends of the locomotive shall be arranged so that with all combinations of maximum truck rotation in one direction and maximum coupler rotation in the opposite direction (a condition which occurs on PATH in reverse S bends with no immediate tangent track) that the hoses do not crimp, stretch or drag.

11.3.5 Air Brake Pipe and Fittings

Air brake pipe and fittings shall be in accordance with the latest AAR standards for freight brake equipment. Union fittings shall be provided for any new brake pipe, so that lengths of brake pipe between tees may be replaced without disassembling or cutting the brake pipe.

Any air piping on trucks shall be black pipe or other approved finish open hearth, extra heavy, welded steel pipe conforming to ASME A-53. All air hose fittings shall be cast malleable iron conforming to ANSIB.16.3 with an approved finish. Locomotive car body piping shall be seamless copper tubing with DOT approved compression type fittings. Pipes shall be clean and free of imperfections such as cracks, scale and burrs and sharp edges. All pipes shall be blown out with dry compressed air at the time of assembly.

Brake piping shall be adequately supported to withstand vibration encountered on the PATH system with approved bolted clamps or other approved means. No pipe shall be left unsupported for lengths greater than 8 feet, all pipes and fittings shall be arranged to assure moisture drainage into reservoirs installed at the lowest points in the system. The Contractor shall obtain concurrence of the friction brake supplier regarding piping procedures and arrangement, and those details shall be submitted for approval.

11.3.6 Reservoirs

The Locomotive shall have a main reservoir and a supply reservoir with a volumetric capacity capable of supplying the air brake system, to make five consecutive full-service braking applications and releases at full load, with a full crew, without initiating an emergency

application due to low air. After the five consecutive full-service braking applications, it must be possible to make an emergency application. It shall be assumed that compressor loss occurs when the main reservoir air is at the cut in pressure setting of the air compressor control. The reservoir sizing calculations shall be submitted to the Project Manager for approval and shall consider all PATH temperature conditions.

Only braking air shall be supplied by the supply reservoir, and all other air requirements shall be taken from the main reservoir. The air supply to the supply reservoir shall be protected by a check valve. Reservoirs shall conform to Section 15.13. Reservoirs shall be low alloy steel with flange fittings and coated with an PATH approved system inside and outside to resist corrosion. The main reservoir shall be provided with a manual drain valve. The drain cock shall be installed to open by a pull toward the nearest side of the Locomotive. The supply reservoir shall be provided with a manual drain plug. Drain valves and any similar fittings on the bottom of reservoirs shall be provided with protective shrouds to prevent their being knocked off by debris on the track.

11.3.7 Cutout Cocks

Cutout cocks shall be provided for all pneumatic components and subsystems. All handles shall be of the locking type, except for multiple access cutouts, and shall be arranged so that in the open position, they shall be crosswise of the flow of the air and in the closed position, parallel with the flow of the air. All cutout cocks shall be permanently marked for identification and to indicate the direction of flow. As a minimum, cutout cocks shall be provided as shown on the attached air brake piping diagram.

The Brake Pipe, Straight Air Pipe and Feed Valve Pipe cutout cocks shall be located on each end of the Locomotive and be easily accessible from the side of the car.

A single brake cylinder cutout cock lever should extend to the side of the locomotive frame and should have the handle painted red and be clearly identified to personnel standing beside the locomotive. Pulling the handle away from the locomotive should close the valve. A bracket arrangement shall be made to safety wire the cutout cock in the open position.

11.3.8 Test Fittings

Pressure test fittings shall be provided in the various pneumatic lines and pipe brackets. These test fittings shall permit quick connection of gauges or transducers for testing and troubleshooting. Test fittings shall be provided, as a minimum, to measure brake pipe, brake cylinder, equalizing, main reservoir and supply reservoirs. All test fittings shall be protected by either a flow-limiting orifice or isolating cock.

11.3.9 Dummy Couplings

Brake hose dummy couplings, conforming to AAR Standard E-127, shall be provided for each trainline hose provided at both ends of the Locomotive. The dummy couplings shall be retained

on the ends of the Locomotive by steel chains. The dummy couplings shall hold all hoses within car clearance limitations.

11.3.10 Park Brake

The park brake shall be an AAR approved type, suitable for the application. It shall be a hand crank, lever style parking brake to be approved by the Project Manager. It shall be mounted on the #2 end of the locomotive at a place to be approved by the Project Manager. A park brake "on" light shall be illuminated on the operator's console as well as on the TOD and energize the appropriate trainline when the park brake is applied. The park brake unit(s) shall provide sufficient braking force to hold the Locomotive with the maximum load, including all fluids (full), all equipment on-board and with the maximum number of personnel on-board, on a 5.5 percent grade indefinitely with a structural safety factor of 2.

11.3.11 Not Used

11.3.12 Horn

There shall be two pneumatic horns installed on the Locomotive. The horns shall be compliant with 49 CFR 229.129.The horns shall be mounted longitudinally one facing fore and the other facing aft. Each horn shall have two tones. Air consumption of the horn shall not exceed 20 cubic feet per minute. A cutout cock shall be provided in the air supply line to each horn. Horn shall be protected from ingress of snow and rain.

11.3.13 Air Compressor

An air compressor, sized to meet the performance requirements of Section 11.2, shall be provided to supply air to the air brake system and any other auxiliary system. The inlet air filter shall be sized such that the replacement interval is greater than 92 days. The air compressor shall be chosen, taking into consideration the highest ambient operating temperature for the locomotive, including slow moving operation in the PATH tunnels, including heat generated by the locomotive equipment, including the engine, traction alternator, compressors, HVAC unit, etc., for all operating modes.

11.3.13.1 Air Dryer

A regenerating-type air dryer, twin tower design, shall be provided. The dryer shall have adequate capacity to reduce the relative humidity of the compressed air to 35 percent at working pressure under all ambient conditions specified in on section 2.1.5 , throughout the desiccant's minimum one-year life. Replacement desiccant for dryers shall be available in bulk, prepackaged bags or other suitable containers from multiple sources. The desiccant shall be located for replacement without removing any other equipment on the Locomotive. The air leakage of the dryer, if any, shall be included in the allowable system leakage specified in Section 11.4.2.

11.3.13.2 Automatic Drain Valve

An automatic drain valve shall be applied directly to the sump reservoir. An automatic drain valve that is in satisfactory use on the PATH shall be provided. The automatic drain valve shall be actuated by a device to - guarantee the periodic actuation of the drain valve with the compressor running continuously. The drain valve heater shall be thermostatically controlled as described in Section 11.3.13.3. Before leaving the manufacturer's plant, all automatic drain valves shall be tested to withstand an air pressure test of 160 pounds per square inch (1,103 kPa) minimum, and operate satisfactorily under all ambient conditions.

11.3.13.3 Drain Valve Heater

A thermostatically controlled 37.5 Vdc heater shall be installed in the air compressor drain valve.

11.3.13.4 Air Compressor Cutout Cock

A vented cutout cock shall be provided on the pneumatic line between the air compressor and the main reservoir tank. The cutout cock will be on the air compressor side and will allow for the isolation of the air compressor from the pneumatic system.

11.3.14 Sander

A sanding system, similar to those supplied on currently manufactured locomotives, shall be included to improve traction on the Locomotive. The Sander shall comply with 49 CFR 229.131. A sanding actuator shall be provided on the control stand to manually activate the sanding. Four sanding nozzles shall be provided for each truck. The sander controls shall be interlocked with the directional control switch such that only those nozzles that are in front of the wheels shall be active when sanding is requested. Sanding reservoirs shall have capacity in excess of 10 cubic feet of dry sand at each end. The reservoirs shall be capable of being filled from the maintenance platform and emptied from the road bed. The Contractor shall provide completely filled reservoirs of clean silica sand, free from clay, loam, mica, and other foreign material, with the locomotive when it is initially delivered to PATH. The Contractor shall employ current available methods (e.g., heated nozzles) to prevent the sand from caking and the nozzles from clogging due to moisture.

11.3.15 Bell

One electronic, non-swing type bell shall be provided on the Locomotive. A control to adjust the bell actuation interval shall be provided on the control stand.

11.4 Air Brake Requirements

11.4.1 Not Used

11.4.2. Air Leakage Rate

Allowable air leakage for any Locomotive shall not exceed 5 psi (34.0 kPa) in 10 minutes

following a five minute settlement period from the point at which the subsystem had been charged to 140 psi (1,000 kPa) and the air compressor(s) have been shut off. The Air Leakage shall comply with CFR 229.59.

11.4.3 Apparatus Supports

The brake apparatus shall be "safety-hung" and supported to comply with the requirements of Section 3.4.1.2.

11.4.4 Marking

The air connections on each part of the air brake apparatus shall be clearly and permanently marked. All equipment drawings and manuals shall indicate such marking.

11.4.5 Mounting and Interchangeability

All parts of the air brake system shall be mounted in close proximity to minimize piping and so that it will not be necessary to remove piping, conduits, or the complete subassembly for replacements, repairs, lubrication or inspection. All parts of the air brake apparatus shall be made to templates, jigs and gages to ensure interchangeability.

11.4.6 Painting

Exterior surfaces of all metallic components shall be thoroughly cleaned of rust, scale and other foreign matter, and while in a clean condition shall be painted at the place of manufacture with an approved rust-resisting paint Paints, coatings, and colors shall conform to Section 15.21.

SECTION 12

12.0 HEATING, VENTILATION, AND AIR CONDITIONING

12.1 General

The Locomotive shall be provided with a heating, ventilation and air conditioning (HVAC) system to meet the requirements identified in this Section. The HVAC system shall be a self-contained unit.

It shall be designed for easy servicing, including HVAC unit removal/reinstallation, easy access to inspection items, such as gages and filters, and easy removal replacement items such as filters and refrigerant.

The electrical compartment, air filters and fresh and return air thermostats shall be a part of each HVAC unit and shall be accessible for servicing and replacement from the cab.

All other components shall be accessible for ease of servicing and replacement from the top of

the HVAC unit, once the HVAC unit has been removed from the Locomotive.

All electrical connections between the Locomotive and the HVAC unit, and to subcomponents within the HVAC unit, with the exception of the grounding strap, shall be by means of quick disconnects, in accordance with Sections 15.16.6 and 15.16.7 for each voltage level. Alternate electrical connections (i.e., hard wiring by means of a terminal block) may be considered for PATH approval.

If the HVAC unit is mounted on the cab roof, then it shall be secured to the cab structure in a safety hung arrangement The mounting system shall be such that the HVAC unit shall be safely retained to the Locomotive even in the event of failure of one or more fasteners. A ground strap shall be provided between the HV AC unit frame and the Carbody. The HVAC unit shall be furnished with lifting bolts and shall be removable without disassembling refrigerant piping.

The control system shall include controls to turn on/off the HVAC unit, for various ventilation fan speeds (e.g., low, medium, high,) and a thermostat control for heating and air conditioning. Routine HVAC inspection shall not be required more often than once every one hundred (100) days.

The Contractor shall consider the design of the HVAC unit to meet the noise and vibration requirements of Sections 2.8.1 and 2.8.2.

12.2 Ventilation

12.2.1 General

The ventilation system shall maintain a positive static pressure within the cab for all Locomotive operating speeds.

All fresh and re-circulated air shall be filtered within the HVAC unit. The HVAC unit shall prevent wind-driven rain or snow from accumulating and leaking into the cab interior. Temperature sensors shall be positioned and protected (if required) to ensure they sense the correct unbiased fresh, recirculated or supply duct air as appropriate.

12.2.2 Air Distribution Ducts

Air diffusers shall be provided. The diffusers shall have manual air volume and directional adjustments.

They shall be located to prevent condensate from forming in the immediate area. The return air grille shall be located away from the air diffusers.

12.2.3. Air Filters

The fresh and return air shall be filtered by commercially available, disposable type filters.

The fresh and return filters shall allow 100 days of normal operation between required filter changes.

Filters shall be easily accessible from inside the cab. Air filers shall meet the requirements of UL Standard 900, Class 2.

12.3 Heating System

12.3.1 General

The cab heating system shall be through the self-contained HVAC unit. Controls shall include fan speeds (e.g., low, medium, high), and thermostat control.

The heating system shall be designed to maintain the cab temperature at 70°F with the maximum amount of fresh air for all ambient conditions as specified in Section 2.1.5 at the nominal input voltage level. Blowers must be on to ventilate whenever the HVAC system is energized. These requirements shall be met without the benefit of solar or crew load.

Electric resistance type heaters may be provided in the self-contained HVAC unit to provide tempering of fresh air intake. The heater elements shall withstand corrosion, and shall not change materially in conductivity during the life of the Locomotive.

Access to the heater units shall be through the cab interior.

12.3.3 Floor Heat

12.3.3.1 General Arrangement

Cab heat may also be provided using electric strip heaters mounted behind steel heater guards along the side walls of the cab at the floor level.

The cab floor heaters shall be manually controlled and shall be operational only when the cab is active (i.e., M/C in Run position).

12.3.3.2 Heater Elements

The floor heater elements, if used, shall be the electric strip heater type and of one size.

12.3.3.3 Heater Guards.

Heater guards shall not have a surface temperature that exceeds 125°F (51. 7°C) when heaters are operational.

12.3.3.4 Heater Grille Panels.

Heater grille panels shall be fabricated of steel, perforated in a suitable pattern and rigidly supported. Hole size and shape shall preclude insertion of ballpoint pen-size instruments. The panels shall be designed so as to prevent the collection any materials on its surface. The panel shall be secured at all edges with accessible fasteners. Heater access shall determine the panel length and attachment method. The steel shall have sufficient thickness to resist denting as a result of kicking impacts.

12.3.4 Protective Heaters

No protective heaters to prevent equipment from malfunction or damage due to freezing in low temperatures are allowed. All microprocessors shall be designed to withstand the range of ambient temperatures, as specified in Section 2.1.5, without heaters.

12.4 Cooling System

12.4.1 General

The HVAC system shall be capable of cooling and dehumidifying the cab with electromechanical vapor-cycle equipment based on refrigerant R407c. Controls shall include fan speeds (e.g., low, medium, high), and thermostat control. All components within the system, including seals, shall be compatible with synthetic lubricants.

If recommended by the compressor manufacturer, the refrigerant system controls shall include an automatic pump-down cycle or other PATH approved system. Pump-down shall be initiated by closing the liquid line solenoid valve, after an "OFF" signal has been received. System refrigerant shall be transferred to the condenser until the compressor suction pressure drops below the low-pressure cutoff set point, and the low-pressure switch opens and stops the compressor. Pump-down shall not be initiated if the system shut down is initiated by a protective safety device such as excessive pressure, temperature or current protective devices.

Every pressure-containing component of the equipment, except piping, shall be listed as having been pressure tested and approved by a nationally recognized testing laboratory. Alternatively, each component shall be designed, constructed, and assembled to have an ultimate strength sufficient to withstand five times the design working pressure. All such components shall be factory tested to at least 1.5 times the design working pressure for which it is rated.

Except for the pressure switches and the low and high pressure gauge connections, the refrigerant system shall be non-field accessible. Pressure switches and gauge connections shall be equipped with Schraeder valves or PATH-approved equal.

12.4.2 Design Criteria

The air cooling equipment shall have sufficient capacity to maintain cab interior conditions as specified below. The cab's cooling capacity shall be determined by the methods described in ASHRAE Standard 37, and shall be submitted for PATH approval:

· Ambient tunnel temperature: (fresh air and condenser intake)	105°FDB (40. 56°CDB) 80°FWB (26.67°CWB)
· Ambient surface temperature:	95°F (35°C) DB 73°F (22.8°C) WB
· Car interior temperature:	70°F (21°C) maximum dry bulb; 50 percent RH
· Crew load:	3 people 450 Btu/h per person with a sensible heat ratio of 55 percent
· Total air flow:	Sufficient to meet the internal temperature, humidity and cab pressurization requirements of this equipment Specification
· Solar load:	In accordance with the latest edition of the ASHRAE Cooling Load Calculations Manual
· Interior & exterior noise limits:	In accordance with Sections 2.8.1. 12.4.3 Evaporator Section

12.4.3.1 Condensate Drain System

A condensate drain pan shall be provided beneath the evaporator coil, headers, thermal expansion valves, and coil "U"-bends in order to collect condensation. The drain pan shall be made of stainless steel, with stainless steel or copper-alloy fittings. The drain pan shall be connected to an outside line to prevent water from dripping into the cab interior under all operating conditions. These conditions also include the worst case combination of grade, superelevation, acceleration (positive or negative) and car (Locomotive) roll.

Condensate drain lines shall be sloped for positive drainage to the underside of the Locomotive and shall not be routed through electrical or electronic cabinets. The condensate drain lines, coil housing, and pan shall be insulated to prevent condensation formation.

12.4.4 Compressor/Condenser Section

12.4.4.1 Refrigerant Compressor

The compressor shall be resiliently mounted to the HVAC unit frame. A flexible copper strap shall be provided to electrically ground the compressor to the unit frame.

12.4.4.2 Other Condensing Section Components

Other components which shall be included as part of the condensing section are as follows:

- A filter-drier assembly in the liquid line. The filter-dryer's water capacity, refrigerant flow, filtering area, and acid removal ratings shall comply with ARI Standard 710.

- Discharge line and suction line vibration eliminators to minimize transmission of noise and vibration along the rigid piping.

- Protection against refrigeration system explosion: pressure relief device as recommended by UL 1995, paragraph 33.

- All necessary tubing which shall be arranged to prevent any metal-to-metal rubbing caused by vibration.

12.4.5 Refrigeration Control Compartment

The control equipment compartment within the HVAC unit, shall contain a low-pressure cutoff switch, high- pressure cutoff switch, and a modulation-pressure switch. All pressure switches shall be service proven and non-adjustable. Set-point tolerance shall not exceed +/-10 psig (69 kPa) for the discharge sensing pressure switches, and +/-3 psig (20.7 kPa) for the low-pressure switch. All pressure switches shall be replaceable and shall be provided with pulsation snubber as required. Alternate means of performing the functions specified in Sections 12.4.5.1, 12.4.5.2 and 12.4.5.3 listed below may be submitted, subject to approval by PATH.

12.4.5.1 Low-Pressure Cutoff Switch

An automatically resettable low-pressure cutoff switch shall be provided to monitor compressor suction to protect the compressor and other system components from potentially damaging low-pressure operation.

12.4.5.2 High-Pressure Cutoff Switch

An automatically-resettable high-pressure cutoff switch shall be provided to monitor the compressor discharge to protect the system from excessively high system pressures, as required by ASHRAE Standard 15 and UL Standard 1995, paragraph 33. The pressure switch shall directly interrupt the power supply to the compressor contactor coil, The circuit shall be arranged such that condenser fan(s) operation is not interrupted by the high pressure cutoff control. When the reset pressure is reached, the compressor shall restart following a time delay period recommended by the system supplier and approved by PATH.

12.4.5.3 Modulation-Pressure Switch

An automatically-resettable modulation-pressure switch shall be provided to monitor discharge line pressure and maintain system operation by reducing the air conditioning system capacity when conditions cause discharge pressures to approach the high-pressure cutoff set-point.

12.4.5.4 Pressure Switch Mounting

A shut-off valve with Schrader fittings, or PATH-approved equal, shall be provided for mounting interface of each pressure switch. The fittings shall automatically isolate all pressure switches from the system to minimize loss of refrigerant during removal and replacement of any pressure switch.

12.4.6 Insulation

All insulation and adhesives shall meet flammability and smoke emission requirements of Section 15.22.

12.4.7 Refrigerant Charge Determination

The refrigerant charge weight shall be included in the inspection and maintenance manual.

12.5 HVAC Control Arrangement

12.5.1 General

The HVAC system shall be energized only when the cab control stand has been activated.

12.5.2 Temperature Sensors

Thermostats shall be encapsulated in a corrosion-resistant metal tube. Temperature sensors shall be mounted to preclude the influence by local sources of heat, such as motors, resistors or air streams with different temperatures. The sensors shall be accessible for maintenance and replacement, and protected from damage during routine air conditioning servicing, such as replacing filters.

12.5.3 Overheat and Loss of Air Flow Protective Devices

The blower control circuitry shall be so arranged and interlocked that power cannot be supplied to the heaters, at any time, unless ac power is available to the evaporator blowers. In addition, three levels of backup overheat protection shall be provided as listed below:

- Blower Motor Current Monitor or Airflow Switch installed in the HVAC unit, which shall remove control power from the heating equipment contactors upon the loss of the blower motor.

- Automatically resettable high-limit thermostat installed adjacent to the HVAC unit. Upon detection of over-temperature, the high-limit thermostat shall directly open the heat control circuit The high-limit thermostat shall be designed to cycle indefinitely, if conditions dictate, while preventing over-temperature, which could cause activation of the back-up protection device, or otherwise cause damage to the equipment and other

Carbody components.

- A manually re-settable shunt trip circuit breaker shall be provided in the line to the heater coils to remove power in the event of excessive heat and failure of all other protection devices. The location of the sensing device and its setting temperature shall be coordinated with the high-limit thermostat to avoid nuisance activations but prevent damage to the equipment and other Carbody components. The shunt trip circuit breaker and its sensing device shall be accessible for inspection and maintenance in the installed HVAC unit

- All protective devices shall have their ratings, type, and location designed such that maximum protection is provided, without the hindrance of nuisance activation, under all possible combinations of operating conditions.

12.6 Design Approval

Design calculations for the HVAC system including cooling analysis, heating load analyses, and drawings shall be submitted for approval by the Project Manager.

Calculations shall assume the worst case ambient conditions to maintain the cab as required in Section 12.4.2.

SECTION 13

13.0 COMMUNICATIONS

- The Locomotive shall have the following communication systems and services, with all crew controls located on the Train Operator's control stand in the cab and easily accessible for effective operation.

- CBTC (Communication Based Train Control).

13.1.1 Sound Powered Two-Way Communication

One headset and headset jack Hose/McCann Part Number: 702019-390 or approved equal shall be provided on the cab control stand to allow a crewmember to plug in a headset for communicating with a crewmember in another Locomotive in the consist. A cap and chain set: Hose/McCann Part Number 701017-553 or PATH-approved equal, shall be provided to protect and cover the jack, which is attached to the control stand. One (1) David Clark Inc., Permissible Sound Powered Headset, Model # H5040 or PATH-approved equal, to be worn behind the head, dual ear, acoustic boom for noise levels up to 100 dB, adjustable overhead strap, fits under a safety helmet, foam filled ear seals, meets MSHA Approval Number 9B-67 or approved equal, shall be furnished for each Locomotive.

13.1.2 Buzzer Signal System

The Locomotive shall be equipped with a buzzer system to be used solely for train operation. Pushing the buzzer button in the cab of the Locomotive shall cause all buzzers to sound and all buzzer indicating lights to illuminate in all locomotives and PATH PA4 cars in the same consist. The buzzer system shall be energized from the 37 1/2-Vdc low voltage supply. One electric buzzer shall be furnished for each cab of the Locomotive. A buzzer pushbutton shall be provided on the cab control stand and a buzzer indicating light shall be installed on the control stand to signify an activated buzzer.

13.1.3 Equipment and Components

13.1.3.1 Trainline Conductors

The trainline wiring shall consist of size #12 AWG (19 strands of #25 AWG) wire, tin-coated copper, 600-volt insulation, and have a conductor temperature rating of 110°C/230°F (normal operation) and run between two junction boxes on each side of the Locomotive.

The insulation material shall be flame retardant, irradiated, cross-linked polyolefin and meet the requirements of Section 15.14.3.1 General Wiring Insulation.

Solid color insulation with color coded/striped tracers shall be provided as follows:

- the red and green color conductors shall be used for the buzzer circuit -red for the B+ 1ine and green for the buzzer line;
- the black and white color conductors shall be used for the telephone circuit -black for telephone line # 1 and white for telephone line #2;
- the orange color conductor shall be used as a B- (return).

13.1.3.2 Trainline Junction Boxes

A weather-tight galvanized steel junction box shall be provided at each end of the Locomotive. Each junction box shall contain two (2) 15-position double screw type terminal posts. The posts shall be mounted on insulating strips treated to render them impervious to moisture. Each post shall be plainly marked with a circuit designation. The boxes shall have hinged gasket covers and be provided with "knockouts" for conduit connections.

13.1.3.3 Conduit

The conduit between the junction boxes shall be a rigid conduit and all boxes shall be provided with openings of a diameter to suit the conduit fittings. The junction boxes shall be connected to the receptacles using a flexible steel conduit.

13.5 Communication Based Train Control (CBTC)

CBTC will progressively replace the conventional wayside signal. Tripstop technology is the prime signal system until CBTC is installed. The Locomotive shall be equipped with interfaces that will allow its subsequent equipping with a CBTC subsystem. The Contractor shall construct the Locomotive with sufficient brackets and other mounting points, cable raceways, conduits, and equipment space and locating provisions to allow an easy subsequent retrofit of CBTC equipment The Contractor shall provide for space in which to locate the equipment, sufficient power capacity, brackets, raceways, and conduits, and other requirements as described in this Specification to make the Locomotive CBTC-ready. Maintenance access to the enclosure(s) shall be in compliance with similar equipment described elsewhere in this specification. Provisions must be made to ventilate the compartment(s) to allow dissipation of heat generated by the CBTC electronics. An allowance of 900W heat generation shall be used in the design calculation.

The Contractor shall work with PATH during the design phase to develop the details of the interfaces including raceway and conduit dimensions, and the mounting arrangements of each piece of CBTC equipment.

13.5.1 Space and Equipment Mounting Requirements

Space and mounting provisions shall be provided for an enclosure(s) above the locomotive floor and adjacent to the cab to house the following CBTC electronics equipment:

CBTC Electronics Equipment

Communications Interface Unit

Miscellaneous Interface Unit

On Board Control Unit OBC

Carborne Radio Electronics CRE

PATH is currently installing a CBTC system on its current PA5 car fleet. In the Attachment 2, requirements for the PA5 mechanical and electrical aspects for the ATC system to be installed.

SECTION 14

14.0 LIGHTING SYSTEMS

14.1 General

All lighting fixtures shall be designed to provide ease of cleaning lenses, lamp and ballast

change-out, adjustments, and housing removal. Lamp access shall be by gasketed enclosure covers secured by captive, stainless steel fasteners or other approved methods. Where possible, covers shall be retained by hinges. tinges located on the Locomotive exterior shall be made from stainless steel.

All interior and exterior fixtures shall be watertight. All fixtures shall be dustproof to minimize the accumulation of airborne dirt and dust within the fixture. All lamps and lamp fixtures shall be US standard, off-the-shelf items.

All lamps shall be powered by the low voltage system. Power shall be provided to the fixtures through positive and negative leads. Both power feeds to the lamp fixtures shall be insulated from Carbody ground. Lighting systems shall not use the fixture housings or sockets as a ground return. All fixtures and their exposed metallic surfaces shall be grounded to the vehicle structure as described in Section 15.16.7.1.

All wiring shall meet the requirements of Section 15.15.

14.2 Interior Lighting

The cab interior shall be illuminated by LED lamps. The illumination intensity measured on the Train Operator's controls, as well as in the other areas designated for crewmembers shall be 20 foot-candles (215 LUX*)*.

The lamps shall have an average rated life in excess of 30,000 hours. The lamps shall be located such that the light beams will not produce glare on the windshield/windows for both operating directions. The cab interior lamps shall be controlled from the Train Operator's control stand.

The LED lamp sockets shall be spring-type, designed to provide support at the end of the lamp in addition to that obtained from the terminal pin. The spring-type sockets shall be designed to preclude contact of the terminal pins to the grounded fixture. The socket shall provide an automatic engagement of the lamp on insertion. The use of lamp retainers that engage the glass portion of the lamp shall not be permitted.

The light fixture shall be mounted to the cab interior by captive mounting screws. It shall be designed to prevent the lens from vibrating under all operating conditions. Lens material shall meet the flammability and smoke emission guidelines of Section 15.22.

14.3 Exterior Lighting

All exterior lighting assemblies shall be set in waterproof enclosures. All bezels and trim shall have captive stainless steel fasteners, and be consistent with good mechanical mounting principles. All exterior lights shall be incandescent or LED clusters. The re-lamping of all exterior lights shall be from the exterior of the Locomotive.

The headlights, ditchlights and marker lights shall operate as follows:

- Headlights: Two headlights shall be located on each end of the locomotive. Headlights shall comply with 49 CFR 229.125.The cab shall have two control stand switches to control each set of head lights independently, one switch shall control the No.1 End headlights, and the second switch shall control the No.2 End headlights. Each switch shall have ″OFF,″ "LOW" and "HIGH" positions. The headlight circuit shall not be interlocked with the direction of the travel controller (reverser). The headlights shall. include a two stage intensity feature.

- Ditchlights: Two ditch lights shall be located on each end of the locomotive Ditch lights shall comply with 49 CFR 229.133. The cab shall have two control stand switches to control each set of the ditchlights independently, one switch shall control the No.1 End ditchlights, and the second switch shall control the No.2 End ditchlights. Each switch shall have *"ON" "OFF"* and "*FLASH*" positions. The ditchlights shall flash alternately (side-to-side) in the direction of travel when the bell or horn is activated. Flashing of the ditchlights when the bell or horn is activated shall be independent of the position (on/off/flash) of the ditchlight switches. The flashing rate shall be verified and adjusted to be acceptable to PATH. The headlights and ditchlights shall be arranged in a triangular formation at each end of the locomotive as approved by PATH.
- Marker Lights: Two marker lights shall be located on each end of the locomotive.. All four marker lights shall be illuminated whenever the main battery switch and individual marker lights circuit breaker are activated. Additionally, the marker lights shall be illuminated whenever the main diesel engine is shut down and the Battery Main Switch is opened. There shall not be any control stand marker light switches.

In a towing situation where there is no battery voltage available, the headlights and marker lights shall be able to be illuminated by power supplied by another vehicle through the trainline receptacle. The locomotive battery shall be protected from voltage back feed from the train line.

The headlights, ditchlights and marker lights shall be provided with individual circuit breakers located in the electrical control panel box of the cab. There shall also be a visual indication for the headlight, ditchlight and marker light operation provided on the control stand.

14.3.1 Headlights and Ditchlights

Two, LED headlights in a horizontal dual housing shall be provided on each end of the Locomotive. Two ditchlights identical to the headlights shall be provided on each end of the Locomotive. The headlights shall be mounted near the top of the Locomotive at the longitudinal centerline and adjusted such that the center of the beam will project at a 3” slope downward from the horizontal plane to strike the running rail at approximately 150 feet (45.72m) in front of the Locomotive. The ditchlights shall be mounted on each side of the locomotive, at floor-level height. The headlight and ditchlight housing shall incorporate provisions for adjusting the beam centerline over a range of 3” in any plane.

14.3.2 Marker Lights

Two marker lights with a 5" diameter red LED-cluster assembly, Luminator Part Number 110103-001 or PATH-approved equal, shall be provided at each end of the Locomotive. Marker lights shall be located near the top of the locomotive.

14.3.3 Strobe Light

A strobe light shall be mounted on the top of the cab. The strobe light shall be visible 360° to alert anyone in the surrounding vicinity that the locomotive is approaching and/or moving through the immediate area. The strobe light shall be controlled by a single switch operable from inside the cab.

14.4 Emergency Lighting

The following lights, powered by the 37.5Vdc, shall remain functional and be powered by the storage battery under the loss of alternator output:

- Interior cab lights,
- Interior control stand lights,
- Headlights, and Marker lights.

14.5.2 Engine Room Lights

The engine room shall be illuminated for inspection and maintenance of equipment. The light switch shall be located in the cab.

14.5.3 Walkway and Step Lights

Lighting shall be provided on all exterior steps and along the length of the walkways on both sides of the Locomotive as approved by PATH. The walkway and step lights shall be controlled by a single switch located on the cab control stand.

SECTION 15

15.0 WORKMANSHIP, PROCESSES AND MATERIALS

15.1 General

Material and workmanship shall be in accordance with the requirements of this Section, unless approved by PATH.

Inclusion of a material or method in this Section does not indicate approval for application or use in a specific situation. When a material or method is specified in this Section, this Section shall

be applicable; however, specific requirements detailed in appropriate Technical Specifications take precedence over this Section.

Material Safety Data Sheets (MSDS) shall be submitted for all materials, including lubricants, used in the fabrication of these cars, except for non-hazardous metallic materials. Information shall be in a form compliant with ANSI Z400.1-1993.

15.1.1 Quality

In accordance with Section 18.1, the Contractor's Quality Assurance (QA) Program shall assure that all aspects of the Contract are in conformance with the design materials and workmanship requirements provided in this Specification.

15.1.2 Standards

The following domestic standards and specifications define materials for this contract: Federal or Military Specifications or Standards, the Specifications of the Aluminum Association of America. AAR. ANSI, ASME, ASTM, FRA, IEEE, and additional requirements, as specified herein. Where other or foreign standards are proposed by the Contractor, the Contractor shall submit documentation for PATH review and approval demonstrating the proposed standards are the equivalent of the foregoing standards and specifications. Proposed substitute specifications shall be submitted in both English and the language of the country of origin.

15.1.3 Marking

All materials intended for use on the Locomotives shall be marked or stored so as to be readily identifiable, and shall be adequately protected during handling and storage. Rejected material shall be clearly marked and stored in an area specifically designated for that purpose.

15.1.4 Cleaning Agents

A list of recommended cleaning agents shall be provided to PATH for all materials exposed to normal cleaning operations. This information shall also be included in the maintenance documentation for the Locomotive.

15.1.5 Lubricants

A list of recommended lubricants shall be provided to PATH. This information shall also be included in the maintenance documentation for the Locomotive.

15.1.6 Prohibited Materials

The following materials are prohibited from use on the cars:

- PVC

- Asbestos
- Cadmium (except for battery)
- Lead (except for battery)
- PCBs
- Carcinogenic materials
- Materials listed in 29 CFR 1910.19

15.2 Joining and Fastening

15.2.1 Joining

15.2.1.1 General

Certain combinations of materials require particular care in joining to avoid the possibility of corrosion. Isolating and moisture-proofing materials, appropriate to the materials being joined. shall be used at all times where these combinations exist.

15.2.1.2 Joint Fitting

Joints shall be properly fitted, whether exposed or concealed. When not otherwise specified in Contractor drawings or specifications, gaps between joints shall be held to a dimension not greater than 10 percent of the thinner material being joined, or 0.002 inch (0.05 mm), whichever is greater. Gaps shall be uniform in width. The edges of panels shall have a smooth, finished appearance.

Where excessive gaps (greater than those permitted by approved drawings or standards) are found to exist at the faying surfaces of structural bolted or riveted connections, metal shims of the same material as that of the deficient part may be used, but only with the written permission of PATH. Shims, if used, shall be permanently fastened to one of the base parts being joined.

The use of epoxy or other plastic filler at such locations is expressly prohibited.

15.2.1.3 Metal-to-Metal Connections

Where metals contact each other, the contact surfaces shall be free of dirt, grease, rust, and scale. Unless specified otherwise, the contact surfaces shall be coated with a metal-based primer which conforms to Federal Specification TT -P-664. Metal primer may be omitted for austenitic stainless steel to austenitic stainless steel joints.

For proper treatment of a connection involving aluminum, refer to Section 15.6.3.

15.2.1.4 Wood-to-Metal Connections

Where wood and ferrous metal surfaces are placed together, the wood shall be coated with aluminum paint conforming to Federal Specification TT-P-38, and the metal shall be coated with a primer which conforms to Federal Specification TT-P-664.

All bolts or rods passing through wood shall be coated with aluminum paint conforming to Federal 8 Specification TT-P-38.

15.2.1.5 Wood-to-Wood Connections

Where wood and wood are placed together, both abutting surfaces shall be coated with aluminum paint conforming to Federal Specification TT-P-38.

15.2.2 Fasteners

15.2.2.1 General

The Contractor and suppliers are responsible for selecting fastener types, sizes, styles, lengths, materials, grades, and finishes that will meet the requirements of this Specification. The Contractor shall minimize the number of different sizes and styles of fasteners used.

Fasteners used throughout the Locomotive shall be inch standard fasteners, except that ISO Metric fasteners may be used in conformance with Section 15.2.2.2.2.

All fasteners used on this Locomotive shall be specified under one of three categories: electrical and electronic; structural and safety-related; or decorative. Fasteners internal to electrical or electronic components are specified in appropriate Materials and Workmanship subsections for electrical devices and wiring. All structural and safety-related fasteners are specified under Structural Fasteners. Fasteners used to attach interior lining or trim and exposed to passenger view are specified under Decorative and Appearance Fasteners. All fasteners, in any category, which attach to Locomotive structure, shall be in accordance with Section 3.4.

Safety-related fasteners include, but are not limited to, those applied to trucks, bolsters, brake equipment, couplers, and power collection devices. A fastener is safety related if failures cannot be tolerated, that is, if even a single fastener fails there is a possibility of brake failure, derailment, or an accident. In the event of a dispute, PATH will be the final arbitrator on which fasteners are safety related.

All fasteners used to secure access covers, doors, or panels to equipment boxes or interior panels shall be made captive to the panel in which they are used. Where access for service is expected more often than every 5 years, access panels shall be equipped with quarter-turn fasteners. Quarter-turn fasteners shall have a minimum shank diameter of 1/4 inch (6 mm), be of adequate strength, and as manufactured by Southco, or PATH-approved equal.

Unless otherwise approved by PATH, threaded fasteners shall not be threaded directly into non-metallic materials. Metal thread inserts shall be used when a threaded fastener is secured to a

non-metallic material.

15.2.2.2 Threaded Fasteners

15.2.2.2.1 Inch-Standard Fasteners

All inch-standard threaded fasteners shall conform to ANSI BI.I Standard, Unified Inch Screw Threads, (UN and UNR Thread Form) or Industrial Fasteners Institute Fastener Standards. Prevailing-torque type locknuts shall be nylon insert type, ESNA or approved equal, conforming to IFI Fastener Standards or Military Standard MS-2l044. All metal prevailing-torque type locknuts shall only be used where there is insufficient clearance to install ESNA type locknuts, or where the locknut is exposed to temperatures above 200°F (93°C).

When making connections to heat producing apparatus, thermal expansion of the components shall be taken into consideration for selection of fastener materials. If the joined components are high expansion alloys such as copper or austenitic stainless steel, austenitic stainless steel fasteners shall be used. If the joined components are low expansion materials such as carbon steel or ferritic stainless steel, zinc plated carbon steel fasteners of minimum Grade 5 shall be used. Cadmium plated fasteners are not permitted.

All screws or bolts used to secure access panels to the interior, undercar, or roof equipment shall be made captive to the panel in which they are used.

When bolts are used to secure apparatus where the bolt head is not accessible, a reusable mechanical locking device shall be used to prevent the bolt head from turning when the nut is being turned.

At least 1 1/2 screw threads shall be visible beyond all nuts. When used without elastic stop nuts, bolts shall not project more than 1 1/2 threads plus l/4-inch (6 mm) for bolts 1/4 inch (6 mm) diameter or less and shall not project more than 8 threads for larger diameter bolts, unless otherwise approved. With elastic stop nuts, bolt threads shall not project more than 1/4 inch (6 mm), regardless of bolt size. Undercar equipment shall not be supported by bolts in tension.

15.2.2.2.2 Metric Fasteners

Upon approval, specific Line Replacement Units (LRU's) that are supplied by a supplier or sub-supplier to the Contractor, may be supplied with metric fasteners to ANSI B 1.13M (ISO-metric) Standards. All internal fasteners and threaded components of the approved unit shall have ISO-metric threads. Internal to components there shall be no mixing of metric and inch threaded fasteners. External mounting fasteners and threaded connecting components shall have ISO-inch threads to ANSI B 1.1 Standards. Each unit, component, or group containing ISO-metric threads shall be indelibly identified, in an approved manner and in a conspicuous approved location, to signify that the unit contains metric threaded fasteners. All repair and maintenance manuals shall be conspicuously marked on each page where metric threaded fasteners were used within the unit. Replacement, repair, or maintenance parts supplied under this Specification shall contain all

necessary replacement fasteners of the correct size and grade.

Metric fasteners shall be marked as required in "Metric Fastener Standards", Industrial Fasteners Institute, latest edition.

15.2.2.3 Structural Fasteners

All structural fasteners shall have documentation identifying manufacturer and purchase specifications available for examination by PATH at the Contractor's QA department. This documentation shall include the fastener material or grade, and finish including plating material and specifications, when applicable. The Contractor shall obtain and hold this documentation for a period of not less than termination of the last Locomotive's warranty period.

All safety-related fasteners shall either a): be manufactured, tested, and distributed in accordance with ASME FAP-I-1990, Quality Assurance Program for Fastener Manufacturers and Distributors, including the requirements of ASME accreditation or b): have a representative sample of each production lot of fasteners tested for conformance to purchase specifications by an independent laboratory accredited by the American Association of Laboratory Accreditation (AALA), or approved equal. A production lot is defined as one size of fastener, from one manufacturer, and produced during one continuous production run. Fasteners not meeting this definition of production lot shall be treated as separate lots. Testing shall be performed using sample quantities as proposed by the Contractor and approved by NYGT. Tests conducted shall confirm that fastener material meets specified chemistry and strength requirements. The buyer shall obtain certified test results from the testing laboratory and hold the documents for a period of not less than the termination of the warranty period of the last car.

All safety-related fasteners that are plated or chemically cleaned shall have certifications showing freedom from hydrogen embrittlement. If non-standard, structural, or safety related fasteners are plated by other than the O.E.M, a representative sample of these fasteners shall be tested for hydrogen embrittlement by the Contractor or a supplier following ASTM F5I9 procedures. An ASTM F606 wedge test sample may be used in place of the F519 standard samples. Test loads shall be a minimum of 80 percent of yield strength or proof load and held for a minimum of 168 hours. Any failures shall reject the entire lot.

All structural bolts for undercar equipment shall be a minimum Grade 5 and the bolt diameter shall be no less than 3/8 inch (10 mm), regardless of design load. Stronger fasteners shall be used if the application requires. The mounting and attachment bolts for undercar-mounted equipment and equipment support structures or brackets shall be sized to the design strengths for Grade 2 bolts and Class A nuts.

15.2.2.4 Torqueing

All safety-related fasteners. including truck and brake equipment bolts and all fasteners exposed to fatigue loads, shall be torqued to a minimum preload equal to 75 percent of their proof load and "torqued striped" after torqueing by paint or other approved means. All other fasteners shall

be torqued to a value appropriate to the application. so that they do not loosen in service.

Fastener installation torque for standard oiled or waxed bolts with standard or heavy hex nuts may be calculated from Industrial Fasteners Institute, Fastener Standards, equations using values for "K" of 0.18 for unplated and 0.15 for plated threads. Locknuts shall be torqued in accordance with their manufacturer's recommendations or the Contractor may conduct tests to' determine installation torque. For those nuts or bolts requiring "torque striping", PATH may require bolt torque-tension tests to verify that installed preload is equivalent to 75 percent of proof loads.

15.2.2.5 Washers and Lock Washers

Washers shall be used under the heads of all bolts and under all nuts. Where high strength fasteners are applied, washers shall be hardened and comply with IFI Fastener Standards.
Lock washers, when applied, shall conform to IFI Fastener. Standards. Lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. If applicable, prevailing torque nuts shall be used for these applications. Other types of washersmay be used for special applications with PATH's approval.

15.2.2.6 Rivets and Lock Pins

Rivets and lock pins exposed to passengers shall be austenitic stainless steel or aluminum, as appropriate to the materials being joined. Structural steel rivets shall conform with ASTM A 502 or American National Standard B 18.1.2 standards. Rivets may be hand driven when hot and shall completely fill the rivet holes. Rivets driven cold shall be mechanically driven. Exposed heads shall be concentric with the shank and free from rings. fins, pits, and burrs.
Swage-locking (Huckbolt type) fasteners shall conform to Military Specification MIL-P-23469. All rough surfaces of the collar end of these fasteners shall be machined or ground smooth where accessible to passengers. crew, or maintenance personnel performing routine maintenance functions. PATH shall be the final arbiter in determining whether an application is hazardous to maintenance personnel.

15.2.2.7 Plating of Fasteners

All carbon, alloy, and martensitic stainless steel fasteners shall be plated with zinc, unless specifically waived by PATH.

Grade 8, Metric 10.9, or stronger, fasteners shall not be plated if the OEM finish is other than plating. Zinc plating shall conform to ASTM-B-633; Type II, and SC2, SC3, or SC4.

15.2.2.8 Rivet and Bolt Holes

Rivet and bolt holes shall be accurately located and aligned, and, when necessary during assembly, holes shall be reamed round to specified size in position. Bolt hole clearances shall not exceed the Industrial Fasteners Institute's requirements. All removed and replaced rivets shall have the holes reamed to the size required such that the next larger rivet may be driven securely.

15.3 Stainless Steel

15.3.1 General

Permitted uses of structural stainless steels uses are specified throughout this Specification. Ferritic stainless steels shall be painted where exposed to the weather. Austenitic stainless steels may be unpainted.

15.4 Low-alloy, High-tensile Steel

15.4.1 General

Low-alloy high-tensile (LAHT) steel structural shapes, plates, and bars shall, as a minimum, conform to the requirements of ASTM A 588, where available. Plate steel may alternatively conform to ASTM A 710, Grade A, Class 1, 2 or 3. Where not available in A 588, hot rolled or formed structural shapes conforming to ASTM A 36 may be used for limited applications including equipment supports and jack pads. General requirements for delivery of LAHT shapes, plates, and bars shall be as required by ASTM A 6. Welded LAHT steel shall develop 15 ft-lbs (20 Joules) Charpy V Notch impact strength in the CGHAZ (Coarse grain heat affected zone) 1 mm from fusion area at -20°F (-29°C).

Cold and hot rolled LAHT sheet and strip shall, as a minimum, conform to the requirements of ASTM A 606, Type 4. General requirements for delivery of these products shall be as required by ASTM A 568.

Other low-alloy, high-tensile steels which meet or exceed the above minimum requirements may be used, provided their detailed specifications are submitted and approved as equivalent, or better material, for the proposed applications. All LAHT steels shall be applied according to their specification properties.

15.5 Steel Castings

15.5.1 General

The Contractor is responsible for selecting casting grade, composition, strength and finishing. However, steel castings used in the car body structure and truck assemblies shall meet AAR Specification M-20 1 latest revision, Grade "B", plus 2 percent nickel, minimum. These castings shall be heat treated to develop a minimum tensile strength of 75,000 psi (517 MPa), a minimum yield strength of 48,000 psi (331 MPa), elongation of not less than 25 percent in2 inches (50 mm), and reduction of area of not less than 50 percent. Also, steel castings used for coupler, drawbars and anchors shall meet AAR Specification M-201, latest revision, Grade "C" quenched and tempered.

Where cast steel of superior properties is required for a specific application, the Contractor may

propose such castings for PATH review and approval.

15.5.2 Design Qualification of Structural Castings

One casting, selected by PATH from the first lot of production castings, shall be subjected to a qualification test of the casting design by the Contractor. Qualification tests shall include radiographic examination for material soundness using reference radiographs to ASTM E 446 and any mechanical testing.

Acceptance levels for the design qualification radiographic examinations shall be selected by the Contractor as appropriate for the service intended, subject to the approval by PATH before any castings are produced. Radiographs shall meet the requirements of ANSI/ASTM E 94 and E 142, and the quality level in the area of inspection shall be at least 2 percent (2-2T).

A qualification test report shall be prepared and submitted to PATH for approval. The production of any castings before receipt of PATH's approval of this report shall be at the Contractor's risk. All radiographs that resulted from the qualification test shall be made available to PATH for review. In case the casting selected for qualification fails to qualify, a plan of action including details of how failed material will be handled shall be included in the qualification test report. Once a design is qualified and accepted by PATH, no changes shall be made in the casting pattern, technique, heat treatment, or material composition without re-qualification in accordance with the requirements of this Section.

15.5.3 Quality of Structural Castings

All structural castings supplied shall be equal to or better than the design qualification castings in all respects. The casting supplier or Contractor shall test, inspect and accept castings in accordance with procedures described in AAR Specification M-201. In addition, the inspections below shall be performed and a written report of the results of the tests and inspections shall be furnished for each lot of castings produced.

15.5.3.1 Magnetic Particle Inspection

Magnetic particle inspections of all surfaces of each casting shall be conducted according to ASTM E 709, by personnel certified to MIL-STD-410. With respect to structural castings, including coupler, castings, the maximum permissible magnetic particle indications shall be 1/4 inch (6 mm) in the direction transverse to the usual direction of loading, and 3/4 inch (19 mm) in the direction parallel to the usual direction of loading.

15.5.3.2 Radiographic Inspection

Radiographic inspection shall be conducted according to the requirements of ASTM Standards E-94 and E-142 using reference radiographs to ASTM E 446. A sampling frequency shall be proposed by the Contractor and submitted for PATH approval.

Structural castings shall not exceed severity level 3 of ASTM E 446 in all critical areas of such castings and shall not exceed levels in all other areas of the castings. During demonstration that the stated severity level requirements of ASTM E 446 have been met, successively-produced castings shall be re-inspected by radiography in the defective areas shown in the prior radiographic inspection. After such severity levels have been proved, the sampling frequency for structural castings shall be one casting out of each ten produced. If no castings are rejected by radiographic inspection, this frequency may be extended to one casting in 25.

15.5.4 Repair Welding and Cast-Weld Design

Repair welding of castings is permitted, provided the casting supplier performs all repair welds according to the structural welding requirements of Section 15.20. Castings requiring repair or modification by welding after completion of heat treatment may be stress relieved locally by using electrically controlled heating to not greater than 1150°F and slow cooling. Manual torch stress relief shall not be permitted. For cast-weld designs, the entire length of all assembly welds on any welded assembly of several separate castings selected for design qualification shall be radiographically inspected to ANSI/ASTM E 94 and E 142, using reference radiographs from the International Institute of Welding's "Collection of Reference Radiographs of Welds", quality level Green. Portions of assembly welds stressed in tension by service loads shall meet quality level Blue.

15.5.5 Disposal of Non-Conforming Castings

If castings are found to be non-conforming to requirements determined by the design qualification castings, the material shall be repaired, retested, and re-inspected or destroyed at the Contractor's expense.

15.6 Aluminum

15.6.1 General

Aluminum alloy mill products shall be identified by Unified Numbering System designations and shall conform to The Aluminum Association specifications contained in the Association's publication "Aluminum Standards and Data." Aluminum alloy forgings shall conform to ASTM B-247. Copies of all test reports for sheet, extrusion, and forgings used in the car structure shall be submitted to PATH.

15.6.2 Design Stresses

All aluminum structural members shall be designed so that calculated stresses under the maximum load do not exceed the allowable stresses listed in the latest revision of the Aluminum Association of America's "Specification for Aluminum Structures" for bridge and similar type structures and "Engineering Data for Aluminum Structures." Proper allowance shall be made for the effects of fatigue, for column and plate stability effects, and for strength reduction at welded regions.

15.6.3 Protection of Contact Surface

The specific measures to be taken by the Contractor to prevent the risk of direct metal-to-metal contact and resultant possible electrolytic corrosion shall be approved and shall depend upon the determination of the most suitable method which can be adapted to the design involved. The following instructions shall be the minimum protection.

Aluminum alloy surfaces shall not be secured to or make direct contact with the surfaces of copper, copper bearing aluminum alloy, brass, bronze, silver, nickel, nickel alloys, nickel plated parts, lead, tin, or wood.

The contact surfaces of aluminum alloy with a1uminum alloy shall be painted with zinc chromate primer or approved equal before securing.

The surfaces of aluminum alloy parts secured to steel parts, where exposed to weathering or harsh environments, shall be protected with a one-part polysulphide sealant, zinc chromate paste, mica insulation joint material or an approved equivalent material, which completely covers the faying surfaces. The insulating material shall be non-hygroscopic and, if fibrous, shall be impregnated with bitumen or an approved, non-corrosive, water and moisture-repellant substance. After driving, fasteners shall be primed and painted with red oxide or aluminum paint. Stainless steel and carbon steel fasteners plated with zinc shall be coated with zinc chromate paste or approved equal before installation. Where possible, only the head and the shank of the bolt shall be in contact with the aluminum part when secured in place. Suitable bushings may be used in place of the zinc- chromate paste.

15.7 Elastomers

15.7.1 General

Elastomers shall be compounded and cured to perform as intended in PATH environment specified in Section 2.1.5. Elastomers shall have high resistance to ultraviolet and other solar radiation, weather and to all PATH car washing and cleaning fluids. All elastomeric parts shall be resistant to ozone, oxidation.

The following elastomeric parts shall be of neoprene unless otherwise specified or approved:

- Glazing Rubber
- Door Seals
- Other parts exposed to the outdoor ambient environment, except where otherwise specified.

The following elastomeric parts shall be of natural rubber. Synthetic rubber compounds are not permitted unless approved.

- All resilient mounts

Elastomers used within pneumatic or hydraulic equipment shall be as necessary to meet the performance requirements of this specification for the pneumatic or hydraulic device.

All elastomers shall have the test data for properties including tensile strength, elongation, accelerated aging and ozone resistance using ASTM test procedures.

A test specimens shall be cut out from the extruded material, and at least one tensile strength and elongation test and one accelerated aging test shall be made on the material used for each order. If the compound or cure, or both, are changed during the production of material for one order, at least one test of each type shall be made for each different batch.

When testing the 6 inches (152.4 mm) by 1/*2* inch (12.7 mm) ASTM "dumb bell" type test specimen (or smaller size if the size of the part necessitates) by the methods specified in ASTM D 3182, D 3183, D 3190, and D 412, the tensile strength shall not be less than 1,500 psi (10,343 kPa) and elongation shall be a minimum 350 percent. The tensile strength of the elastomer shall not be reduced more than 25 percent when subjected to accelerated aging by the methods specified in ASTM D 573, for a period of 96 hours in an air oven at 158°F (70°C).

The ozone resistance of the elastomer shall be tested in accordance with ASTM D 1149 using an ozone concentration of 100 PPM, an exposure time of 100 hours at 100°F (38°C), and a specimen elongation of 20 percent. The elastomer shall not exhibit any cracks during the test period.

15.7.2 Life Expectancy

For all parts made by vulcanizing an elastomer to metal, any premature failure (less than six years) between metal and the elastomer or in the elastomer, occurring when the parts are used in normal service and according to the provisions of this Specification, shall be considered as having been caused by defect of materials or workmanship.

15.7.3 Metal Parts

Metal parts to which elastomeric material is vulcanized shall be made of SAE 1020 or 1045 hot-rolled steel.

15. 7.4 Bonding

The joining of elastomeric pieces shall be conducted by the hot vulcanization process. Bonding of elastomers shall not be allowed unless the Contractor submits the application, bonding procedure and bonding agent technical data for approval prior to the purchase of any materials.

15.7.5 Seals

Glazing strips shall be of neoprene conforming to ASTM C 542, or approved equal material. All door mating edges, door and window seals, and glazing strips shall be of neoprene material. The durometer hardness measured with a Shore Type "A" durometer at a temperature between 70°F (21°C) to 90°F (32°C) shall be 70+/-5.

15.8 Glazing Materials

15.8.1 Safety Glass

Safety glass shall meet the requirements under Item 1, Table 1 of ANSI Z26.1, "American National Standard for Safety Glazing Materials for Glazing Motor Locomotives and Motor Locomotive Equipment Operating on Land Highways -Safety Code" and 49 CFR 223 Type I or II test as appropriate for the application.

15.8.1.1 Glass Type

All safety glass shall be of the laminated type.

15.8.1.2 Flatness

When an individual light of glass is laid on a truly flat surface, such as a surface plate, the glass shall not indicate a bow of more than 0.030 inch per linear foot.

15.8.1.3 Dimension Tolerance

The overall dimensions of individual lights as supplied shall be held within 0.06 inch (15.24 mm) of the dimensions ordered.

15.8.1.4 Overlap Tolerance

The overlap of one laminate of the light with respect to the other at an edge shall not exceed 1/32 inch (0.8 mm). Comers and burrs shall be ground smooth and all edges shall be treated in accordance with ANSI Z26.1, Section 6.3.

15.8.1.5 Color

The color of the glass shall have no more than +/-4 percent variation in the color of individual lights of laminated sheet glass when examined over a white background.

15.8.1.6 Haze

All the laminates of the safety glass shall be so nearly free from haze that the glass shall have approximately the same clarity as a light of the same nominal thickness of plate glass when viewed against a north light.

15.8.1.7 Specks and Scratches

Occasional specks of foreign material and scratches are permissible, provided such specks do not exceed 0.020 inch (0.5 mm) in greatest dimension and scratches do not exceed a total of 3 inches (76.2 mm) in length and neither are within the central three-quarters area of the light.

15.8.1.8 Bond Separation

The bond between, two sheets of glass and the membrane shall be of such quality that when the glass is broken by twisting or by direct impact, there will be no separation between the glass sheets. Lights that contain unbonded areas ("let-go's") shall not be used.

15.8.1.9 Marking

All safety glass shall be marked with proper identification in accordance with ANSI Z26.1, and appropriate FRA Type designation. The window light shall be installed so that the identification marking can be read from the inside lower right hand comer.

15.9 Rubber Floor Covering

15.9.1 General

Rubber floor covering shall contain 44 percent (nominal, by weight of compound) Butadiene Styrene rubber, shall be non-staining, non-discoloring, and 100 percent non-oil extended. Only high quality, fine, hard clay shall be used as a filler. No whitening (limestone) shall be used in the compound. The rubber tile shall be free from reground rubber, natural rubber or coarse fillers.

At 68°F (20°C), the rubber flooring shall bend 180 degrees around a 3/4 inch (19 mm) diameter mandrel without breaking, cracking, crazing, or showing my change in color. The rubber flooring material shall be fully homogeneous throughout and shall meet the requirements of ASTM F 1344.

15.9.2 Inspection Criteria

This Section addresses defect items that may be cause for rejection, their allowable limits, and repair methods, where repairs are permitted.

15.9.2.1 Thin-Skinned Blister

A thin-skinned blister is a blister which, when finger-pushed, will collapse upon itself. Any thin-

skinned blisters which exceed the limits listed below shall be cause for rejection of the floor sheet.

- Maximum Size -0.030 inch (0.76 mm) high, 0.80 square inch (516 mm2) area with longest dimension of 2 inches (50.8 mm).

- Maximum Population- 3 blisters in a 12 inch by 12 inch (305 mm by 305 mm) area with only one other blister within 3 feet (914 mm) of this area.

- Repair Method -using a hypodermic needle, apply just enough Super Bond 420 or Bostik 1685 or equivalent, compress the blister and to bring to a flush surface.

15.9.2.2 Thick-Skinned Blister

A thick-skinned blister is a blister which, when finger-pushed, will collapse and then return to its original condition.

- Maximum Size -0.030 inch (0.76 mm) high, 0.80 square inch (516 mm2) area with longest dimension of2 inches (50.8 mm).

- Maximum Population -3 blisters in a 12 inch by 12 inch (305 mm by 305 mm) area, and only one other blister within 3 feet (914 mm) of this area.

- Repair Method -no repair authorized.

15.9.2.3 Lump

A lump is a blister without a void, consisting of solid material.

- Maximum Size -0.030 inch (0.76 mm) high, 0.80 square inch (516 mm2) area with longest dimension of 2 inches (50.8 mm).
- Maximum Population - 3 lumps in a 12 inch by 12 inch (305 mm by 305 mm) area. and only one other lump within 3 feet (914 mm) of this area.

- Repair Method -no repair required.

15.9.2.4 Hole

A hole is a defect, which is 50 percent through the material. Any holes found in the floor sheet shall be cause for rejection of the sheet.

15.9.2.5 Thin Area

A thin area is a defect where the sheet is of reduced thickness locally.

- Maximum Size -0.030 inch (0.76 mm) deep at the lowest-point. 3 square inches (1,936 mm2) with the longest dimension of 5 inches (127 mm).

- Maximum Population -one thin area in a 40 inch by 40 inch (1.02 m. by 1.02 m) area, and no other thin area within 3 feet (914 mm) of this area.

- Repair Method -rub with #00 steel wool to blend this area into the normal thickness material and then buff to a normal surface finish.

15.9.2.6 Color and Speckle Distribution

Color is an appearance judgment and shall be subject to the approval of PATH.

15.10 Wood and Panels

15.10.1 Lumber

Lumber shall be sugar or black maple, sweet or yellow birch, only. Lumber shall be thoroughly air seasoned or kiln dried before using, so as not to have a moisture content of greater than 12 percent.

Lumber shall be dressed on all surfaces to full dimensions. Lumber shall be straight-grained, free from dry rot knots, checks, and other defects which may impair its strength and durability or mar its appearance.

15.10.2 Plymetal

The term "plymetal" as used in this Specification means metal-faced plywood. All plymetal panels shall conform to the following requirements:

Mechanical Properties	Minimum Metal to Wood Average Shear Value or 80 Percent Wood Failure
Dry shear	250 lbf/in2
Boil shear, 3-hr. boil, tested wet at room temperature	150 lbf/in2
Soak shear, 48-hr. soak wet at room temperature	150 lbf/in2
Creep or cold flow, under static load for 48-hrs., at room temperature	250 lbf/in2

15.10.3 Plywood

All plywood shall be manufactured to conform with the requirements of Grade -Structural I of the National Bureau of Standards Voluntary Product Standard (American Plywood Association) PS 1-95, and then stored under cover. Scarf or finger jointed panels are not allowed. All plywood shall be sealed with two coats of epoxy paint on all edges and cutouts as soon as possible after fabrication. All exposed edges of the panels, joints between panels, fastener heads, and openings of panels used in areas accessible to moisture shall be water-proofed and sealed with an approved coating prior to installation in the car.

15.10.4 Honeycomb Panels

The term "honeycomb panels" as used in this Specification refers to an assembly of honeycomb material bonded to melamine-faced metal panels or to metal panels. Aluminum honeycomb material shall be commercial-grade meeting the requirements of MIL-C-7438G. Bonding shall be sufficient to develop the full strength of the honeycomb material.

Stainless steel honeycomb panels shall be constructed in accordance with the requirements of MIL- A- 9067. The adhesive bond strength of the honeycomb core to the stainless steel face shall not be less than 15 lb/inch (2.68 kg/cm) climbing drum strength when tested in accordance with MIL-STD-401. The adhesive bond strength of the integral stainless frame to stainless steel face shall not be less than 30 lb/inch (13.6 kg/2.5 cm) climbing drum strength when tested in accordance with MIL-STD-401. Stainless steel honeycomb panels shall be tested in accordance. with MlL-STD-40 1 B to demonstrate the following requirements:

- Core shear yield at 200°F (93°C) — 250 lbf/in2 (1.72 MPa)
- Flatwise tension at 200°F (93°C) — 250 lbf/in2 (1.72 MPa)
- Beam flexure at 200°F (93°C) — 75,000 lbf/in2 (517.13 MPa)
- Core shear fatigue at R.T. — 150 lbf/in2 @ 106 cycles (1.03 MPa)
- Flatwise tension at R.T. — 250 lbf/in2 @ 106 cycles (1.72 MPa)
- Beam flexure at R.T. — 50,000 lbf/in2 @ 106 cycles (344.75 MPa)

No other honeycomb materials are permitted.

15.10.5 Panel Contour Tolerance

Surfaces exposed to the crew shall not deviate from the specified contour by more than 3/32 inch (2.38 mm) in any 36-inch (914-mm) distance. The slope of any such deviation shall not exceed

3/32 inch (2.38 mm) in 12 inches (304-mm).

15.11 Cab Seat Cushion

Cab seat cushion fill material shall be low-smoke flexible foam constructed of inherently fire-retardant materials. The thickness shall be approved during design review. The material shall have a polymerized or vulcanized homogeneous (free from foreign material), cellular structure with a porous surface and open cells. The cells shall be interconnecting and uniform in size. Cellular material may be molded in one piece or may be assembled by laminating to achieve the required thickness. Laminated cushions shall be bonded together. Cushion material shall be properly cured to prevent any objectionable odor.

15.11.1 Cab Seat Upholstery Material

Fabrics used for cab seat upholstery shall be made of woven, transportation grade fabrics of a 90 percent wool and 10 percent nylon blend. The maximum fabric shrinkage shall be two percent in either the warp or fill direction.

15.12 Piping and Tubing

15.12.1 General

All piping valves, fittings, installation methods, and testing shall be in accordance with the Code for Pressure Piping, ANSI B31.1. All joints shall be easily accessible.

Following installation, all piping systems shall be cleaned to remove dirt, metal chips, oily contamination, and moisture. After cleaning, all piping systems shall be pressure tested in accordance with the latest edition of the Code for Pressure Piping, ANSI B31.1. All leaks shall be repaired and the system re-cleaned and retested until leak-free.

Pipes must be supported throughout their length and at all connections to prevent vibration or noise and to limit stresses in the pipe to less than 50 percent of the pipe's fatigue endurance limit. Pipes and their connections shall not interfere with the removal of other components. Pipe routing and support shall be planned and accomplished in an efficient, organized manner to keep the total length and number of fittings and bends to an absolute minimum. All changes in direction shall. be accomplished by bending the pipe to a radius of not less than specified by AAR Specification No. 2518, Standard S-400, or as approved by the Project Manager. Direction-change fittings are not permitted in the train lined brake pipe or in the brake cylinder pipe. Support and clearances provided between adjacent pipes and between pipes and surrounding structure, equipment or other appurtenances shall be sufficient to prevent chafing or contact due to any combination of car loading and deflection, car dynamics, and thermally induced movement. The minimum clearance shall be 1/8 inch (3 mm).

At all locations where pipe or tubing passes through holes in the floor, bulkheads, structure, or any fixed member, it shall be rigidly clamped to protect against possible damage or noise due to

bearing, abrasion, or car dynamics-induced rattling. Clamps shall not be welded, brazed or otherwise permanently fastened to any pipe or tubing.

Pipe and tubing interfaces with clamps shall be insulated with an elastomeric or woven non-asbestos mineral fabric tape material to protect and sound-insulate the pipe or tubing.

Wherever car body piping interfaces with vibration-isolated rotating equipment such as the air compressor and air conditioning compressor-condenser unit, approved flexible vibration eliminators shall be used. The pipe connection at either end of the flexible elements shall be rigidly clamped no farther than 2 inches (50 mm) from the flexible elements. All pipe clamps shall be inherently rigid and shall be firmly attached to car structure. Cantilevered clamps or clamp supports that are weaker than service-proven designs will not be accepted. All clamps shall be of a suitable material for the application.

15.12.2 Air Piping, Tubing, and Fittings

The main reservoir pipe and brake pipe shall conform to ASTM A 53, or ASTM A 106, Schedule 80, seamless pipe, Type "K" annealed copper tube per AS1M B 88, latest revision, may also be used, provided it is installed no lower than 2 inches (50 mm) below the floor sheet or structural member and is protected by means of equipment or approved steel guards from any potential impact damage from rail debris, especially in the truck and outboard of the bolster areas. Where suitable protection in damage-prone areas is not possible or practical, approved steel or stainless steel piping sections shall be provided. "The diameter of the main reservoir pipe and brake pipes shall meet the brake supplier's requirements; however, in no case shall these pipes be less than 7/8 inch (22 mm) O.D.

All air pipes shall be sized in accordance with the function intended and may be either ASTM A 53 or ASTM A 106 schedule 80 pipe or seamless copper tubing as described previously. All joints for copper tubing shall utilize fittings of wrought copper or non-porous cast brass in accordance with ANSI B 16.22 and BI6.18.

All air piping must comply in all respects with the air brake supplier's design and installation requirements.

Where ASTM A 53 or ASTM A 106 piping is provided, its application shall also comply in all respects to AAR Specification No. 2518, Standard 400, latest revision. Approved copper tube shall also comply with any relevant requirements of AAR Specification No. 2518.

All air piping shall be installed in a manner to provide drainage away from devices, or branch pipes leading to devices, when the function of those devices could be impaired by the accumulation of water or ice.

All air hoses shall conform to the latest revision of AAR Specification M-618 for Wire-Reinforced Air Hose, with AAR-approved reusable fittings meeting AAR Specification M-927 for Wire-Reinforced Air Hose Fittings and Hose Assemblies.

All cut-out cocks shall be of the vented type, except where function prohibits.

Where steel piping is used, all connections and joints where disassembly for service may be required shall utilize swivel type, butt-welded flange fittings with an "0" ring type seal. The use of threaded fittings is expressly prohibited.

15.12.3 Air Conditioning System Piping, Tubing, and Fittings

Air conditioning refrigerant lines shall be of seamless copper tubing, type "K" or type "L ", with wrought copper sweat type fittings. Joints shall be kept to a minimum and all inaccessible runs of tubing shall be without joints. Finned tubing in evaporators and condensers shall be copper. Instead of elbows, tubing may be bent utilizing a bending tool designed specifically for bending of the tubing to be used.

Condensate drain lines shall be seamless copper tubing, type "K" or seamless stainless steel tubing.

Suction lines shall be designed and installed without traps. The suction line shall be sized for 3 psi (gauge) (21 kPa) maximum system pressure drop and the liquid line shall be sized adequately to prevent flashing due to pressure drop.

Lines subject to condensation shall be insulated with an approved insulation, applied with an approved contact cement. The liquid line shall be insulated in all areas where required to provide additional mechanical or thermal protection. Insulation at all joints and fittings shall be mitered and sealed with an approved material. The insulation, adhesive, and sealant shall meet the Specification requirements for thermal, smoke emission, and flammability performance.
All piping and pipe subassemblies shall be de burred, cleaned, dried, and capped with tight fitting plastic caps, or approved equal on all openings after fabrication. Caps shall remain in place until immediately prior to incorporation into the final assembly.

Vibration eliminators shall be used in piping connections to the compressor unless deemed unnecessary by PATH. Tubing installations shall be designed to allow any single length of tubing to be replaced without dismantling or removing surrounding equipment, piping, wiring, or other appurtenances.

15.12.4 Brazing and Soldering of Piping, Tubing, and Fittings

All brazing and soldering shall comply with the applicable parts of Section 15.20, and the following requirements. All refrigerant piping and air system copper tubing shall be joined using silver solder conforming to Federal Specification QQ-B-654A, Bag-5, BCuP-5, or for copper to copper connections only BCuP-3. Refrigeration piping and tubing shall be internally swept with a continuous flow of a non- oxidizing gas such as dry nitrogen during brazing. Condensate drain tubing shall be joined using 95-5 solder or Silver Solder as above. Solder joints shall be wiped and have flux cleaned from tubing and fittings after soldering. After fabrication, the refrigeration

and air systems shall each be cleared of all dirt and foreign matter, flushed with a de greasing agent and dried, all according to a written procedure prepared for each by the Contractor and approved by PATH.

15.13 Pressure Vessels

All pressure vessels shall conform to the latest revision of Section VIII of the ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels and applicable FRA requirements. Test reports shall be furnished for each pressure vessel, and each pressure vessel shall be stamped to document the test.

15.14 Wire and Cable.

15.14.1 General

A minimum number of wire types and sizes shall be used in the Locomotive.

Selection of wire sizes and insulations shall be based on the current carrying capacity, voltage drop, mechanical strength. temperature and flexibility requirements in accordance with applicable AAR, ICEA, ASTM, NEC, and MIL Specifications. However, in no case shall the properties of the wire and cable be less than those properties delineated in this Specification. Extra-fine wire stranding shall be utilized on applications subject to repetitive motion.

All applications of shielded cable shall be approved. The Contractor and each manufacturer of equipment through the Contractor shall submit Manufacturer's specifications of each size and type of wire and cable specified, for approval, before utilizing said wire and cable.
Only wire or cable shall be used for carrying electrical current. Where this Specification uses wire insulation trade names the use of an approved equal is acceptable.

15.14.2 Conductors

Conductors for wire AWG No. 12 and smaller shall be soft annealed nickel-plated copper. constructed in accordance with MIL-W-22759/6B. Conductors for irradiated cross-linked polyolefin wire shall be soft, annealed tinned copper, in accordance with ASTM B33. Minimum stranding shall conform to AAR Standard S501, S502 (No. 589) or ASTM B-172 Class K or ICEA S-66-524, Table L-7, Class K for AWG No. 10 or larger, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 12 to AWG No. 16 shall be in accordance with ASTM B-174 Class K or ICEA S-66-524, Table L-8. Class M, as appropriate for the application.

Stranding and conductor construction for wire sizes AWG No. 18 and smaller shall be in accordance with ASTM B-174 Class L or ICEA S-19-81. Table L-8, Class M, or shall be 19 strand construction as appropriate for the wire size.

The use of solid wire is not permitted except for approved wire wrap applications.

Wiring shall be sized for the intended load, voltage drop, installation method, and applicable codes. Maximum wire ampacities for irradiated cross. linked polyolefin wire shall conform to the National Electric Code (NFP A 70) Table 310-16, 90°C column for wires in raceways or conduit. and 310-17, 90°C column for wires in free air. Maximum wire ampacities for insulation rating of 110°C to 250°C shall conform to NEC (NFPA 70) Table 310-18 or 310-19, as appropriate for the application. When the free air rating is used, the Contractor shall furnish data to show that the cables will not exceed their rated temperature at the rated current. Where more than three conductors are routed in a raceway or conduit, the ampacities shall be derated as detailed by Note 8 to Tables 310-16 through 310-19. Wire ampacities shall be derated to meet the temperature requirements of all devices to which the wire connects. When short time ratings, short time overload temperatures, and thermal time constants are used to determine cable size, the parameters used will be submitted for approval.

In no case shall wire smaller than the following sizes be used:

- Wire which is pulled through conduits or wireways -AWG No. 14.
- Wire on electronic units, cards, and card racks -AWG No. 28.
- Wire within control compartments -AWG No. 18.
- Multi-conductor cables where current is not a factor in wire size selection -AWG No. 18.
- All other wires, including those which are not pulled through wireways and conduits - AWG No.16.

15.14.3 Insulation

15.14.3.1 General Wiring Insulation

Teflon, mineral filled, abrasion resistant insulation may be used on all sizes AWG No. 12 to AWG No. 28. Otherwise, all general car body wiring insulation shall be a thermosetting, flame retardant, flexible, irradiated cross- linked polyolefin material having a continuous temperature rating of 257°F (125°C). The polyolefin material shall be tight-fitting over the stranded conductors and shall strip freely. The insulation thickness and voltage rating shall be in accordance with ICEA S-66-524. The insulation thickness at any point shall not be less than ninety (90) percent of the average insulation thickness as shown in ICEA S-66-524 when measured according to ICEA S-66-524.

The insulation shall be rated at 2000 volts dc in the case of wires carrying a nominal voltage greater than 100 volts ac or dc, and rated at 600 volts dc in the case of wires carrying a nominal

voltage of 100 volts or less, ac or dc. For wire sizes AWG No.6 and larger, the insulation material shall be formulated for extra flexibility.

The irradiated cross-linked polyolefin wire insulation shall be constructed and tested in accordance with the requirements of AAR RP-585 Wiring and Cable Specification. The polyolefin wire insulation shall also conform to the smoke and flame requirements of NFPA-130 for rail transportation equipment and ICEA S-95-658 for power cables rated 2000 volts or less. In addition, the following additional special requirements shall also be met:

- Flexibility Tests for Cables
- Flexibility tests for cable sizes up to AWG No. 2/0 shall be performed in accordance with AAR Standard S501, paragraph 5.9.7.1, for the appropriate wire size.
- Flexibility tests for cable sizes AWG No. 2/0 and larger shall be performed in accordance with AAR Standard S501, paragraph 5.9.7.
- Single Conductor Thermal Overload Test

A continuous current of 115 amperes shall be applied to an 18' length of AWG No.1 0 test wire in 250°C still air. A 3000-volt dc potential shall be maintained between the test wire and an AWG No. 18 bare copper wire wrapped snugly around the outer insulation surface of the test wire. Failure shall be defined to occur when a short circuit is established between the bare copper wire and the test wire. Minimum time to failure shall be three (3) minutes.

- Bundle Overload

A bundle overload using a seven-wire bundle shall be performed in accordance with AAR Standard S501. paragraph 5.9.1. and test results recorded.

- Temperature Cycling Tests

This test shall be done on an 8-ft. length sample of AWG No.1 0 wire with 2 kV insulation.

Thermocouples shall be attached to the outer jacket surface, and on the conductor, under a small incision in the insulation about 12 inches from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.

Prior to temperature cycling, the sample shall be conditioned for 2 hours at a temperature of 150°C.

The sample shall then be temperature cycled between ambients of 125°C and -30°C by transferring the sample between an air-circulating oven set at 125°C and an air-circulating cold box set at -30°C. The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.

One cycle shall be defined as an approved dwell time at both 125°C and -30°C. The sample shall

be subjected to a total of 250 cycles, with a visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of 5 kVac for 5 minutes and also examined by microscope to verify that no cracks exist.

Flame-retardant, flexible, irradiated cross-linked polyolefin insulation rated at 125°C may be used, provided it meets all the above standards, modified to reflect the temperature rating related characteristics. The revised values, and the use of such wire, must be approved by PATH. Cross-linked polyolefin insulation is not permitted for use on wires connected to heater elements or any other high-temperature device.

All insulation other than irradiated cross-linked polyolefin shall meet the following test requirements based on MIL-W-22759 and using the following parameters:

- Dielectric -Test per MIL-W-22759/10B (for 1,000 V wire with tests at 9.5 KV impulse) or MIL- W-22759/6B (for 600 V wires with tests at 8 KV impulse).
- Insulation Resistance -Test per ASTM D-470. Minimum accepted value shall be 1,000 megohms per 1,000 feet (304.8 m), using a 1,000 Vdc megohmmeter.

- Spark test -One hundred percent of all single conductor cables and all single conductor cables being used in a multi-conductors cable shall be inspected by Impulse Dielectric Test or by chain electrode Spark Test. Spark Test Apparatus and Procedure shall be in accordance with MIL-W-22759. Spark Test voltages shall be equivalent to impulse test voltages by corresponding RMS value at 3 kilohertz.

Impulse Test Voltage kV Peak	3 kHz Test Volta e kV RMS
8	5.7
9.5	6.7
10	7.1

- Air aging -Test per ASTM D-638. Age sample for seven days at 302°F (150°C) in an air oven. Minimum tensile strength and elongation shall not be less than 85 percent of the un-aged values. Also test per IEEE STD 383-1974 and ASTM D-573 for extended life.

- Cold Bend -Test per NEMA WC3, except test temperature shall be -58°F (-50°C).

- Weight Loss -Weight loss of the insulation material shall not exceed one percent when subjected to an oven temperature of 266°F (130°C) for 500 hours.

- Chemical Resistance -An appropriate length of sample shall be measured for insulation diameter and total weight to record initial values. The wire shall be immersed to within 3 inches (76.2 mm) of each end in the test fluid for 24 hours at l490p (65°C). During the immersion stage, the~ minimum bend radius of the wire shall be 10 times the diameter of the wire being tested. Upon removal from the test fluid, the specimen shall be cooled to

room temperature for one hour and the diameter gauged and reweighed for comparison with the original values. The maximum diameter and weight increase shall not exceed 30 percent. Typical fluids for this test include:

- Humble No. 2214 Railroad Diesel Lubricating Oil and lubricants (100 percent solution);
- Humble Diesel 260 or Railroad T fuel oil (100 percent solution);
- Mineral oil (100 percent solution);
- Hydrochloric acid, nitric acid, sodium hydroxide,. sulfuric acid (0.1 percent solution);
- Potassium hydroxide (0.1 percent solution);

Petroleum distillates and other graffiti removers and cleaning compounds listed in PATH Cleaners and Related Material Qualified for Car Equipment Use .

- Kerosene solvents (100 percent solution);
- Trisodium phosphate solution (50 percent solution);
- Skydrol 500 B hydraulic fluid (100 percent solution); and
- Water

Temperature Cycling Testing -The test shall be done on an 8-foot (2,438.4 mm) length sample of AWG No. 12.

Thermocouples shall be attached to the outer jacket surface, and on the conductor under a small incision in the insulation about 12 inches (304.8 mm) from one end of the sample. Both ends of the sample shall be securely clamped using hose clamps.

The sample shall be conditioned for 2 hours at a temperature of 150°C. The sample shall then be temperature cycled between ambients of 125°C and -30°C by transferring the sample between an air-circulating oven, set at 125°C and an air-circulating cold box set at -30°C. The time during which the sample stays in each chamber shall be sufficient to allow both thermocouples on the sample to read the same temperature as the environment.

One cycle shall be defined as an approved dwell time at both 125°C and -30°C. The sample shall be subjected to a total of 250 cycles, with visual observation at the end of each cycle for cracks and for other damage. After 250 cycles, the sample shall be immersed in water for 6 hours with both ends out, and then subjected to a dielectric test of 5 kVac for 5 minutes and also examined by microscope to verify that no cracks exist.

- Single Conductor Thermal Overload Test -A continuous current of 115 amperes shall be applied to an 18-inch length of AWG No. 12 test wire in still air. A 1,000-volt dc potential shall be maintained between the test wire and a AWG No. 18 bare copper wire wrapped snugly around the outer insulating surface of the test wire. Failure shall be defined to occur when a short circuit is established between the copper wire and the test wire. Minimum time to failure shall be three minutes.

- Seven-Wire Bundle Thermal Overload Test -A seven-wire cable bundle shall be formed by twisting six insulated AWG No. 12 conductors around a center insulated AWG No. 12 conductor. A 120 ampere current shall be passed through the center conductor for seven minutes. After a test period the cable bundle shall be examined for visible damage to the outer six conductors. Failure shall be defined to occur if any of the outer conductors split, rupture or melt and adhere to the center conductor insulation.

- Qualification and Production Tests -The tests required for this Specification concerning Qualification and Production shall be in accordance with tests required in MIL-W-22759 for all lots produced, as called for in this Specification. All test reports covering Production and Qualification tests shall be furnished to PATH with requested samples prior to any shipment of materials.

15.14.3.2 Wire Insulation for High Temperature Applications

High temperature insulation shall be used where connected to heat-generating apparatus, where the ambient temperature can exceed 125°C, or where Teflon is specified as a requirement The insulation shall be rated at 1,000 volts dc in the case of wires carrying a nominal voltage greater than 100 volts ac or dc, and rated at 600 volts dc in the case of wires carrying a nominal voltage equal to or less than 100 volts ac or dc. The insulation shall have a continuous temperature rating of 150°C or above and be in accordance with the following requirements:

- For wire sizes AWG No. 16 and larger: abrasion resistant Teflon (polytetrafluorethylene - PTFE) meeting MIL- W-22759/6B or l0B, as appropriate for the voltage level used, or silicone rubber meeting AAR Standard, S503.

- For wire sizes AWG No. 18 and smaller: abrasion resistant Teflon (PTFE) meeting MIL-W -22759/6B or l0B, as appropriate. When used for interconnecting pieces of apparatus, this type wire shall be in bundles with a protective covering of high temperature rated, low smoke generating insulation.

The Contractor may propose other insulated wire specifications for approval in a specific high temperature application, specifying the design ambient temperature, routing, RMS ampere value, worst-case ampere value, worst-case temperature rise, stranding, and insulation material specification.

No high temperature insulated wire shall be used in conduit or raceways without specific approval. The Contractor shall submit all applications of high temperature wire insulation for approval.

15.14.3.3 Wire Insulation within Equipment

Insulation on wiring within replaceable modular units, electronic apparatus such as cards and card racks, and other equipment, as approved, shall be Tefzel (Ethylenetetrafluoroethylene - ETFE) per ASTM D3159 and insulation construction per Military Specification MIL-W-22759/16 (AS), irradiated cross-linked polyolefin per Section 15.14.3.1, or Teflon (Polytetrafluoroethylene -PTFE) type EE per Military Specification MIL W-16878/5.

15.14.3.4 Wire Insulation at Crowded Locations

Wire for connections to the control stand, or in any other locations where there are equally crowded concentrations of low voltage control wiring, may be insulated with Tefzel (ETFE) per ASTM D 3159 and insulation construction per Military Specification MIL- W -22759/16 (AS), except the wall thickness shall be 0.025 inches (0.64 mm). When used for this application, these type wires shall be bundled with a protective covering of irradiated cross-linked modified polyolefin or similar, approved, high temperature rated, low smoke generating insulation.

15.14.4 Multi-Conductor Cables

15.14.4.1 General

Multi-conductor cables, where approved, shall be constructed using wiring as described in Sections 15.14.2 and 15.14.3. For high temperature applications, the cable shall conform to MIL.-C-27072, with Type V connectors, Style 4 sheaths, Class D jackets, if needed, and shields, if needed. All conductors in multi-conductor cables shall be color coded or otherwise permanently identified as approved. Materials used in the construction of multi -conductor cables shall meet the requirements below. In applications where current is not a factor in wire size selection, such as LED indicator lights or status displays, AWG No. 16 may be used between repeater devices and displays. For multiconductor cables carrying low-voltage, high-speed, serial data, exceptions to the wiring requirements may be submitted for approval, based upon availability of wire to meet the application requirements.

15.14.4.2 Fillers

Where required to obtain a circular cross-section, fillers shall be made of non-hygroscopic materials compatible with the wire insulation and jacket, and shall be of the same or of a higher temperature rating than the wire insulation.

15.14.4.3 Tape

A binder tape shall be employed over the assembly of conductors in multi-conductor cables if needed to assist in cable manufacture, or as required to permit the cable to function as intended in its application. The binder tape material shall be non-hygroscopic and shall be of the same (or better) temperature class as the wire insulation, and shall be of a compatible material.

15.14.4.4 Shield

The shield, if required, shall consist of either tin plated copper braid, concentrically served copper, or aluminum/polyester tape with a drain wire, as is appropriate for the application. Tape shields will be permitted for fixed installations only. The shields shall have the following minimum properties:

- Copper shield shall be made of either tinned, coated copper strands which conform to ASTM B 33, or silver-coated copper strands which conform to ASTM B 298, as is appropriate for the wire insulation. Shield coverage shall not be less than 85 percent. Shield strand size and application shall be as recommended by the cable manufacturer for the particular application, but shall not be smaller than AWG No. 38.

- Aluminum/polyester tape shields shall consist of a helical wrap of aluminum/polyester tape with a nominal thickness of 0.0004 inch (0.01 mm) aluminum on a backing of 0.001 inch (0.025 mm) polyester. The tape shall have a minimum overlap of 10 percent of the tape width to ensure complete coverage. In contact with the aluminum side of the shielding tape shall be a AWG No. 22 7/30 tinned copper drain wire conforming to ASTM B 33 and B 174.

15.14.4.5 Jackets

The overall jacket of multiconductor cables shall be of flame retardant, irradiated, cross-linked, modified polyolefin; Tefzel (ETFE); or Teflon (PTFE) to be fully compatible with wire insulation and application as approved. The coupler cable shall have a jacket of low temperature arctic grade neoprene per MIL-C-13777, with a wall thickness suitable for 600 volts. The jacket shall be extruded and vulcanized over the cabled conductors, and shall be centered, with a smooth appearance without objectionable roughness or irregularities, consistent with good industry practice. The nominal jacket thickness for polyolefin, Teflon, Tefzel and Neoprene shall be that shown below, with the minimum wall not less than 80 percent nominal value.

Nominal Jacket Wall Thickness in Inches

Cable Diameter Under Jacket	Modified Polyolefin	Teflon or Tefzel	Neoprene
0.000-0.250	0.045	0.010	0.072
0.251-0.500	0.045	0.015	0.087
0.501-0.750	0.060	0.021	0.1
0.751-1.000	0.080	0.021	0.1

1.000-1.500	0.080	0.025	0.115
1.501-2.000	0.11	-	0.135
2.001-2.500	0.13	-.	0.152
2.501-3.000	0.14	-	0.195

15.14.5 Wire Wrap

- Wire wrap connections may be used in selected electronic applications, where approved. Where used, the following standards, as a minimum, shall be followed:

- Only soft or annealed oxygen-free solid copper conductor shall be used. Wire size shall be AWG No. 28.

- A silver conductor coating, with a minimum coating thickness of 40 micro-inches (1 um), shall be applied to the wire.

- Wire shall have "MIL-ENE" insulation, or approved equal manufactured to MIL-W-81822/1A. The insulation shall have a minimum 300 Vac/Vdc voltage rating and shall allow a 135°C maximum conductor temperature.

Wrapping shall be "modified" wrap, nominal 7-1/2 turns, including 1-1/2 turns for strain-relief.

15.14.6 Insulation Smoke Test

This test applies to all wire insulation in Section 15.14.3, except for irradiated cross-linked polyolefin. For testing irradiated cross-linked polyolefin insulation, refer to Section 15.14.3.1 General Wiring Insulation.

The smoke test shall be in accordance with the requirements in ASTM-E662 Optical Density of Smoke Generated by Solid Materials.

15.14.6.1 Scope

This test method describes the equipment and the procedure for preparing insulated wire samples from which the specific optical density (Ds) of smoke generated can be determined in the Aminco-NBS Smoke Chamber. This method is used for wire sizes up to and including AWG No. 12. For wire sizes above AWG No. 12, the standard procedure outlined in ASTM E 662 shall be used. Equipment calibration, standardization, and operation are to be in accordance with ASTM E 662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.

15.14.6.2 Apparatus

- Aminco-NBS Smoke Chamber and Recorder.

- Aminco 6 tube, 900 burner assembly for flaming mode testing. Burners are all directed in
- one plane at the sample.
- Notchless wire frame (Aminco AWG No. 20 wire frame with notches machined off)
- Aminco troughless wire specimen holder assembly.
- Air oven.
- Humidification chamber.
- Heavy duty aluminum foil 0.001 +/-0.0005 inch (0.0254 mm + 0.0127 mm).
- Razor blade.
- Tape measure.

15.14.6.3 Procedure

Determine the length of insulated wire required for testing. The individual sample length shall be calculated to produce a sample area of 35 square inches (22,582 mm2).

Calculate the sample length as follows:

$$l = \frac{35}{3.1416 \text{ x } d}$$

Where:

l = sample length
d = diameter of insulated wire (inches)

Cut and identify a minimum of three samples of the required length.

Condition samples prior to testing by pre-drying in an air oven for 24 hours at 140°F +/-5°F (60°C +/-3°C) followed by humidification at 73°F +/-5°F (23°C +/-3°C), and a relative humidity of 50 percent +/- 5 percent, for a minimum of 24 hours. After conditioning, wind a sample uniformly around the wire frame so that the frame opening is uniformly covered.

Cover the wire-wrapped frame with aluminum foil across the back, along the edges and over the front surface's periphery with a single sheet of aluminum foil, with the dull side in contact with the wire.

Place the foil-wrapped wire in a troughless sample holder such that the wire is vertically oriented. Insert millboard backing, spring, and retaining clip.

Carefully trim the aluminum foil from the front opening of the sample holder.

Adjust wire turns, if necessary, to assure that the sample holder opening is uniformly covered.

Perform smoke testing in accordance with ASTM E 662, noting any unusual behavior that occurs during the test; for example, self-ignition of the sample in the non-flaming test mode or any

extinguishment of a - burner triplet during the test. Report the sample orientation, test conditions, results, and observations made during the test.

15.15 Wiring

15.15.1 General

All Locomotive wiring shall be in conformance with Chapter 3 of the NFPA 70, National Electric Code, and the AAR Manual of Standards, Section F S-538, "Wiring Practice and Rolling Stock Standard", except where otherwise specified, and except that all wire shall be as required in this Specification. Circuit protection shall be in conformance with Chapter 2 of NFPA 70, Article 240.

15.15.2 Wire Handling

All wiring shall be performed by qualified, experienced wiring personnel using appropriate tools for stripping insulation, cutting, tinning, soldering, harness making, attaching terminals, and other wire fabrication tasks. All wiring tools and equipment shall be used as recommended by the tool and equipment manufacturer.

Wire shall be protected from damage during all phases of equipment manufacture. Wire shall not be walked on, dragged across sharp or abrasive objects, kinked or twisted, or otherwise mishandled. The ends of wire shall not be permitted to lay on wet floors or other damp areas where moisture may be' absorbed into the conductors.

When removing insulation, wire strands shall not be nicked or broken in excess of the requirements of FAA Specification No. AC 43.l3-IA, Section 449, "Stripping Insulation". Additionally, the following criteria applies:

Wire Size	Maximum Number of Nicked Strands*
Wires smaller than No.1 0	None
No. 10 through 1/0	7.4 percent
Above 1/0 through 1600/24	4.4 percent
Above 1600/24	graduated scale

Definitions:

- A cutoff strand shall count as two nicked strands.
- A nick is defined as 25 percent or more of the strand area damaged, or cut more than 33 percent of its diameter.
- Longitudinal scratches in a copper strand are not considered cause for rejection.

15.15.3 Wiring Layout and Installation

15.15.3.1 Wire Harness

The layout of wiring, for both Locomotive and equipment. shall be designed in advance of its installation and in cooperation with the suppliers of the related equipment. Wiring shall be pre-fabricated into standard harnesses, wrapped or tied with spiral wrap or tie wraps. Harnesses shall be installed with identical arrangement and location in each car having similar equipment. Separate harnesses shall be provided for major circuit groups or types, or as required for specified circuit separation. Wire entrances shall be no more than 8 inches from top of roof or bottom of floor depending where the equipment box is located. All circuits and branches shall be separated by means of terminal boards to isolate portions from others for troubleshooting and searching for undesired grounds. All circuits subject to periodic, high potential tests shall be so arranged that they can be conveniently set up for the tests.

Alternative methods for fabricating and installing wiring, which are standard Contractor practice, will be considered for approval by PATH.

Harnessed wires shall not be installed in conduit. Wires from different conduits or other openings shall not be harnessed together with wires running within the box or entering the box through another entrance point. Each harness or group of wires between equipment enclosures shall contain a minimum of 10 percent spares, but no fewer than two spares for each wire size.

15.15.3.2 Circuit Separation

Circuits shall be physically separated to reduce the possibility of unsafe conditions, interference, or equipment damage.
The following major circuit groups shall not be harnessed or bundled together, shall not run in the same conduit. and shall be physically separated and secured in enclosures, wire ducts, junction boxes, or other wire routing devices:

- High voltage circuits,
- AC circuits,
- Communication circuits,
- Battery voltage level circuits,
- Semiconductor gating voltage level circuits,
- Conductors carrying in excess of 100 amps.

Wires which are connected in circuits with potentials differing by 50 volts or more shall be separated by a physical barrier. Whenever possible, the wires shall not be cabled together and shall not be placed in the same conduit, junction box, or enclosure. Where a raceway, duct, junction box or enclosure is divided into- two or more distinct areas by metallic partitions, each area may be considered separately in the application of this rule.

Where it is impossible to avoid having wires at different voltages in the same equipment enclosure, the wires shall be physically separated, bundled, and secured separately such that contact between wiring is not possible. All wiring within an enclosure shall be insulated for the highest voltage in the enclosure, unless approved otherwise. All wiring connected to a piece of apparatus shall be insulated for the highest voltage connected.

Wiring connected to transient-generating apparatus, such as unsuppressed contactor coils, shall not be run adjacent to wiring carrying signals to, from, or between semiconductor circuits, logic circuits, vital no-motion circuits, or communication circuits. In cases in which adequate physical separation is impossible, shielded wire shall be used for all conductors involved.

15.15.3.3 Wire and Cable Runs

Wire runs shall be continuous and unbroken between connection points, shall be supported at no greater than 2 foot (609.6 mm) spacing, and be protected at each support point against mechanical crushing and abrasion. A watertight bushing and drip loop shall be provided on all exposed cable entries. All cable bundles and wires shall be routed a minimum of one inch (25.4 mm) above the bottom of equipment enclosures.

All undercar wiring smaller than AWG No.6 shall be run in closed wire ducts, conduits, or open wire mesh wireways in an approved manner. Wire and cable shall be secured within ducts or open wireways, including each entrance and exit point, to prevent chafing movement. Wire ducts and conduits shall be of waterproof construction. Permanently retained watertight strain relief bushings, with insulated throat liners, of an approved design, shall be used at locations where wires, cables or harnesses enter or exit conduit, ducts, apparatus and equipment enclosures. In addition, strain relief bushings on equipment enclosures shall include a permanently retained O-ring type seal.

Lead wires to resiliently-mounted electrical apparatus shall be carried in conduit to a point as close to the apparatus as possible. The length of the leads between the end of the conduit and each piece of apparatus shall be as approved. Short runs of cables or harnesses entering or leaving conduit and apparatus shall have an approved guard mounted to the car body to protect the wires from mechanical damage. Lead wires to solidly mounted, electrical apparatus and equipment enclosures shall run in conduit connected to the apparatus or enclosure.
Any wiring run through the floor shall be run in ducts or conduit. Wiring, even if enclosed in loom, must not be run through partitions without suitable bushings being provided at such points of passage.

Cables shall be laid in place with sufficient slack at the bends so that cables will clear the inside bend surface of the wireway/wire duct.

All wire and cable shall be free of kinks, insulation damage, insulation abrasions, and nicked strands. Wire installation shall not be subject to accumulations of water, oil, or other foreign matter.

Wires or cables shall not pass through or over the battery compartment and shall not pass over heat generating equipment such as acceleration and braking resistors, even if the wires or cables are in conduit.

Harness exposed, short cable runs or harness entering or leaving exposed raceways shall have approved, fire-resistant flexible dielectric sleeving over the raceway edges and grommet-type insulation of any penetration holes. Wiring shall be retained to the sleeving with tie-wraps.

15.15.3.3.1 Cable Cleating and Support

All cable and wiring exiting wireways/wire ducts, or that, which is not installed in conduit, shall be cleated using split-block cleats of fiberglass. Cables shall be cleated and bushed when passing through bulkheads and structural members. The cushioning material shall be non-conductive, fire retardant insulating material with a durometer of 50 to 60 meeting the requirements of Section 15.7. Each cleat shall have a stiffener of at least 10-gage material on the side away from the mounting bracket, which shall act to spread the bolt clamping force over the entire length of the cleat. Bolts shall have lock nuts. The Contractor shall minimize the quantity of different configuration cable cleats. Alternate cleat material may be permitted on a case-by-case basis with the approval of the Project Manager.

AWG No.6 or larger insulated wire may be cleated in place without conduit, duct or open wireway. However, in the areas over the truck, in the wheel wash and not protected by underfloor-mounted equipment, the wire shall be mechanically protected by an open mesh, expanded metal or other type of approved guard. The guard may be attached to the bottom of each cleat with the cleat clamping bolts or other approved arrangement.

Cleats shall be designed to grip each cable individually and firmly, but without causing any damage to cable insulation, including cold flow of the insulation. Each cable in the cleat shall have its own cutout sized to the correct wire diameter. Cleated cables shall be routed and supported such that they cannot, under any combination of forces and car movement, touch each other or any other part of the car, except the cleat cushioning material.

Wire and cable runs shall be continuous and unbroken between terminations and shall be supported at not greater than 24-inch (610 mm) intervals in ducts, open wireways or when cleated. The wire shall be protected at each support point against mechanical crushing and abrasion.
Wire splices will not be permitted, except with express written approval and in accordance with the wire splicing requirements of Section 15.16.8.

Concealed wires, such as within conduits and wire ducts shall be such that wires may be replaced or added to without the removal of other than an access panels. It shall not be necessary to disconnect or disassemble conduit to accomplish this task.

Wiring run in loom shall not be carried over a potential chafing hazard.

Wires entering any removable box shall be harnessed and secured to facilitate removal of the box.

All wires and cables shall be fully protected against any contact with any surface other than that designed specifically to support or protect them. This applies to all current carrying wires, cables or buses on the Locomotive.

15.15.3.3.2 Wire Securement and Termination

All wiring shall be secured and protected against movement, chafing, and any contact with conductive, sharp, or abrasive objects including the inside surfaces of wire runs.

All wiring shall be located and secured such that normal equipment motions, maintenance access, heat sources, and the environment do not damage or reduce the life of the wiring.

Junction boxes, with terminal boards, shall be used. as required, for wire terminations. Harness connections to the boxes, as well as internal wiring to terminal boards, shall be as specified in Section 15.16.2. Exterior junction boxes shall be weathertight.

In cases where it is necessary to anchor wires or cables to metallic parts of the Locomotive, cleats or approved stainless steel bottle clamps shall be used. Wires and cables shall not be allowed to chafe or rub against any part of the car or each other under any circumstances.

Wire and cable dress shall allow for sufficient slack at equipment terminals to provide for movements induced by shock and vibration, equipment shifting, alignment, cover removal and component replacement sufficient lengths shall be provided at points of termination for additional re-terminations without applying tension to the wire and without splicing the wire, as follows:

- AWG No.10 and smaller -Three re-terminations
- AWG No.8 and larger -Two re-terminations

A drip loop shall be provided on all exposed wires and cables to prevent fluid runoff into connected equipment

Spare wires, which are part of a wire harness, shall be bundled separately inside of the equipment box to which the harness is being terminated. Spare wires shall have enough length to reach any location within the box, including sufficient slack for the required number of re-terminations. The spare wire "break-out" bundle may be ty-wrapped to the main harness, but shall be easily removed from the main harness without. disassembling it The ends of the spare wires shall be insulated against inadvertent contact with any nearby conductive surfaces or terminals.
W ire tying devices shall be of such material and construction that they will adequately retain the wires for the life of the wiring and shall be resistant to ozone and ultraviolet light. Wire and

cable ties shall be trimmed and located to eliminate any hazard to personnel from sharp edges. Wire tying devices shall be snug, but shall not be so tight as to cause indentation and cold flow damage to the insulation. Wire tying devices shall be mechanically fastened to a permanent structure. Adhesive-installed mounting bases shall not be used for ties or for cable support.

All wire bundles and cables within an enclosure shall be supported by the use of tape rails, shall be spaced away from the equipment box structure, metal edges, bolt heads and other interference points, and shall have electrical clearance from the covers, regardless of the insulation properties of covers. Wire bundles shall be located above or alongside the apparatus rather than at the bottom of the box wherever possible. In all cases, wire shall be a minimum of 1 inch above the bottom of the box. Wire entry into control or junction boxes shall not be permitted through the bottom of the box.

Truck wiring shall be designed to ensure sufficient slack, and shall be provided with clamp supports and " abrasion protection. T-splices will not be permitted.

All jumpers, jumper heads. and jumper receptacles shall be sealed in an approved manner to prevent the entry of water at any operational speed of the car.

Any wiring needed to calibrate and test Locomotive functions shall be a part of the permanent Locomotive wiring to enable PATH to conveniently maintain the equipment. This wiring shall terminate in approved connectors in the respective control groups and cabinets.

PATH desires to have wiring and cabling readily accessible for inspection and maintenance. Extensive wiring and cabling in the Locomotive interior is contrary to accessibility, even though access panels, false floors, and other portals may be provided.

Wire and cables that are subject to high currents in fault conditions or normal operation must be secured against secondary damage due to the high magnetic forces that are developed. This includes damage to bus bars or devices to which the cables terminate.

15.15.3.4 Circuit Shielding

Wire shields used in train line circuits shall be continuous up to the Locomotive's receptacle" contacts. The wire shields shall be connected through all applicable connectors and junction boxes. Circuits shall be categorized. Shields contained in one circuit category shall not be interconnected with shields contained in another category. Shields used to protect against interference shall not carry signal current.

Shields on low-level signal wires shall not be interconnected with shields on high-level signal wires in the same category. Each group of shields (other than at the electric couplers, including the jumper cable connectors at the intermediate coupler) shall be carried through on a connector pin or pins, or on terminal strips which shall be in the immediate proximity of the categorized group of circuits. Loops due to interconnections of shields shall not be permitted.

Coaxial cables used as constant impedance transmission lines shall be terminated as dictated by the circuit; termination design and shall not be considered to be shielded conductors. Triaxial cables may be used as coaxial impedance transmission lines with the outer conductor employed as an RF shield.

The following three items shall be considered as guidelines and are not absolute requirements:

- Shields used to suppress electromagnetic interference (EMI) at all frequencies shall be terminated only at the low potential side of the interference circuit, at the termination, which exhibits maximum susceptibility.

- Shields used to protect against the effect of, or to exclude, EMI at frequencies below 150 kHz. shall be terminated either to the low potential side or at the balance point of the protected circuit at the termination which exhibits maximum susceptibility.

- Cables requiring both audio frequency (AF) and radio frequency (RF) shields shall be electrically isolated from each other. The resistance between these circuits shall be at least 500 megohms when 500 volts dc is applied. Double shielding shall be required on circuits that are both AF-susceptible and RF-susceptible.

15.15.4 Insulation Resistance

Refer to Section 17 for insulation resistance requirements.

15.15.5 Marking and Designation

The Contractor shall devise, and submit for approval, a wire and terminal marking and designation system that shall coordinate all electrical circuits in the Locomotive into a unified system. The system shall identify all wiring, including circuit return wiring and terminals according to their respective circuit function(s) and shall accurately correlate these designations with the Locomotive schematic diagrams. Each circuit shall be individually designated from point to point. Common designations for return circuits are not permitted.

Each wire and cable shall have printed on the outer surface, the manufacturer's identification, conductor size, temperature rating, and voltage rating. For wire size 1/0 and larger, stranding shall be given in addition to the other parameters.

Except for spares, TFE Teflon insulated wires and wires entirely within an equipment enclosure, each wire #8 AWG and smaller shall be permanently and legibly marked along its entire length. Wires larger than #8 AWG and TFE Teflon insulated wires may have wire markers applied at each end of the wire. Blank spaces between markings shall measure approximately 1.5 inches. Spare wires and wiring entirely within an equipment enclosure may have a single wire marker at each end, subject to approval by PATH in lieu of continuous marking. Wires shall be marked with their alphanumeric circuit designation. A circuit designation shall change only when it goes

through an active or passive component such as a relay coil or relay contact, fuse or circuit breakers, lamp, motor or resistor. A circuit designation shall remain unchanged when it goes through a terminal strip or junction box stud regardless of how many wires of that circuit, are common to that point. There shall be no duplication of wire codes in unrelated circuits throughout the Locomotive. Where there are more than one of a particular assembly per Locomotive, each assembly shall be wired identically to the other(s) and wire marking of harnesses shall be identical in each assembly.

For pre-manufactured multiconductor cables and for cases where individual circuit identification markers may be approved the following requirements apply:

- All wires and terminals shall be clearly identified. Wires attached to terminal studs shall also have a marker indicating the terminal stud to which it is attached.
- Identification of wires and terminals shall be by white or yellow permanent markers, with black printing or by continuous wire marking printed on the wire. All wires shall be marked 6 inches (152 mm) from of the end of the wire, every 12 inches (305-mm) within 10 feet (3.05 m) of the end of the wire, and every 24 inches (610-mm) over the remainder of the wire. Wire markers shall be stamped in two places, approximately 180 degrees apart, to facilitate readability of the marking. Wires in multiple-conductor cables shall be color-coded.
- Wire markers shall meet the adherence and solvent resistance requirements as specified by MIL-M-81531 latest revision, and shall withstand all combinations of ambient and equipment temperatures. Hand printing is prohibited.
- For cable identification, the contractor shall use a basic identification system in conformance with ANSI/IEEE 200 and shall submit the system selected for review by PATH.

8 15.15.6 Pulling Compound

Pulling compound shall be non-conductive, non-hygroscopic, non-odorous, shall not support bacterial activity, and shall not attract vermin.

15.15.7 Solder

Solder shall be in accordance with ASTM B 32, Grade Sn60. A flux of non-corrosive type shall be applied immediately before soldering.

15.15.8 Tape

Electrical tape shall be in accordance with AAR Standard S-540 of Section F of the AAR Manual Standards and Recommended Practices, or equivalent approved railway practice. Electrical tape shall meet or exceed the voltage rating of wire where the tape is applied.

15.16 Wire and Cable Connections

15.16.1 General

All equipment enclosures and junction boxes, except primary power circuits, shall be fitted with terminal boards or connectors. Primary power circuits shall be fitted with compression terminals and knuckle joint connectors as described herein.

The Contractor shall submit the proposed design and product line for all connections for approval. Terminal boards with M4 or Number 6 or smaller screws and quick-disconnect terminals, other than those stated herein, will only be permitted with approval.

15.16.2 Terminal Boards & Terminal Points

All electrical terminal points and terminal boards shall have brass studs and connections, each of which shall be locked using a single brass nut with brass flat washer and a plated spring-type lock washer. Studs, nuts, and washers may also be made of corrosion-resistant, plated steel, where approved. Each board or connector shall have the necessary number of terminations plus a minimum of 10 percent spares, but not fewer than one spare unless approved. Binding head, screw type terminal boards will be permitted only where approved. All terminal boards shall be in accordance with Military Specification MIL-T-55164A.

Threaded studs shall have a minimum of 2-1/2 threads exposed beyond the final nuts. Adequate space shall be provided to permit connecting wire terminals with standard tools. All terminals shall be properly torqued to assure sound connections. Spacers shall not be used.

Jumpers between terminal board points shall be brass or plated steel. Wire jumpers between adjacent terminals of terminal boards will not be permitted.

An approved permanent marking strip on each terminal board shall be provided and attached adjacent to the wire junction point to identify the wires attached thereto and/or the wires connected to terminal boards shall have the terminal point location printed on the wire.
A maximum of two terminals shall be connected to any one binding screw. A maximum of four terminals shall be connected to any one threaded stud, provided that there is no interference between terminal barrels. On terminal boards, the wiring shall be arranged so that no more than two terminals are connected to a stud, from each side of the terminal boards.

15.16.3 Wire Terminations

Terminals and connections used throughout the Locomotive shall be the mechanical, solder less, crimp type made by AMP Incorporated or other approved manufacturer with a comprehensive line of terminals, connector pins, and application tools available. All terminals for the same wire size shall be crimped with the same model tool. The Contractor shall minimize the total number of crimping tool types needed for all crimp connections. Terminals fitting wire sizes AWG No.10-22 shall require no more than three tool models to provide certified crimp connections. The Contractor shall submit the proposed product line for approval. Terminals to be approved

shall be tested to Military Specification MIL- T -16366F for temperature rise, voltage drop, vibration, current overload, and corrosion. Test results shall be submitted for approval on a by part number basis.

Terminals and connections shall be attached to the wiring with proper crimping tools and dies as recommended by the manufacturer. The terminals used on conductors of size AWG No.1 0 or smaller shall be of the type which securely grips and holds the insulation of the conductor, unless approved. Terminals shall be ring lugs in accordance with Military Standard MS-25036; spade and hook-type terminals shall not be used. Corrosive protection shall be provided for all base materials.

Conductors subject to motion relative to the terminal shall be protected by suitable means to prevent breakage of the conductor at or near the terminal. Sufficient slack shall be provided in all wires and cables to prevent breaking or pulling out of bushings and terminals. A maximum of one wire shall be crimped in anyone terminal.

Wherever several wires are connected to terminals of a terminal strip on a device which is removable from the car for maintenance, the wires shall be terminated, with double ring terminations which shall be screwed to an insulating fanning strip which shall serve to keep the terminations in the correct relative locations while removed from the device, unless otherwise approved by PATH.

15.16.4 Power Cable Terminations

Power cables shall be terminated with an approved compression terminal. Sufficient cable slack shall be provided to preclude breaking or pull-out from bushings or terminals and to allow two terminal changes. Cable conductors shall be clean prior to installation of terminals. Compression terminals shall be applied using tools and procedures recommended by the terminal manufacturer for that purpose. Swaging tools shall be of a type that ensures complete swaging in every case.

15.16.5 Cable Connectors

All cable connector applications shall be approved. All cable connectors shall conform to MIL.-C-5015, or an equivalent standard as approved. They shall employ removable crimp contacts of the correct size for the wire being terminated. Except as noted below, the connector contact area shall be plated with a minimum of 0.000030 inch (0. 76 um) of gold over a minimum of 0.000050 inch (1.27 um) of low stress nickel. For high current applications, the connector contact area shall be plated with a minimum of 0.00010 inch (2.54 um) of silver. Adjacent connectors shall either use different inserts or different insert orientations to prevent erroneous connections. The receptacle half of all cable connectors shall be rigidly mounted.
All cable connectors used in exterior locations shall be of the environmental watertight variety. Cable connectors shall be equipped with sealing gaskets on the front mating surface and on the back where the cable enters. The cable jacket shall be held by a clamp within the connector body. Unused connector pin positions shall be sealed with either connector contacts or plastic sealing plugs designed for that purpose. Plastic body connectors shall not be used in exterior

locations. Quarter turn, bayonet-lock, quick- disconnect type connectors shall not be used on train line jumper cables. Trainline jumper cables shall be secure to the locomotive by means of a safety wire.

Except as specified above all cable connectors in exterior locations, shall be quarter turn, bayonet-lock, quick disconnect type CIR connectors as made by Litton-Veam SPA, or approved equal. Quarter turn, bayonet-lock connectors shall conform to all provisions in MIL-C-5015, or an approved standard, except for the screw coupling requirement. Cable Connectors shall require all under floor connectors in wheel splash areas to be protected from excessive amounts of grease and dirt that would inhibit visual inspection.

Connectors in high vibration or high motion areas, such as speed sensors and trainline jumpers, shall have the wire connections soldered and potted and shall have a watertight jacket molded over the cable and connector to form a unitized assembly. Trainline jumper connectors used shall be as made by Pyle-National, or approved equal. The Contractor shall conduct an approved vibration test on these unitized assemblies.

In waterproof interior locations, the use of non-weatherproof connectors will be allowed as approved. All other connector requirements specified in this section shall be met.

15.16.6 Quick-Disconnect Terminals

Approved quick-disconnect terminals shall be utilized to facilitate maintenance and inspection. They shall provide positive terminal engagement and be shock and vibration proof. All terminals shall be provided with insulation equal to that of the wire. No "Push-to-fit" (FASTON) type terminals will be permitted unless specifically approved by PATH.

15.16.7 Grounding Return Connections

15.16.7.1 Grounding

Grounding connections to the car body and equipment shall be made through copper pads of an adequate area, silver soldered or brazed. Alternative ground pad material may be permitted in certain cases as approved by PATH. Transition (base) plates if used, shall be made from the same alloy group as the respective car body and piece of equipment. The base plate shall be welded to the car body or equipment. Grounding connections shall not be made to aluminum alloy members. All ground pads shall be visible and accessible for inspection and troubleshooting. The ground connections shall be attached by a bolt, washer, and nut designed for the purpose. An anti-corrosive grease shall be applied over the connection.

All equipment enclosures and shock-mounted equipment, except the operator cab lights shall be grounded with flexible, grounding leads bolted between a car body grounding pad and the equipment's grounding pad. Braided, strap-type leads shall be used where there is relative motion between the two items being connected. The ground strap termination method shall apply uniform pressure to the conductive surface and the current density shall not exceed the bonding

requirements of Section 15.16.7.2.

The Contractor shall submit, for approval, a complete grounding scheme, which shall indicate the means by which it is proposed to prevent currents from passing through journal, motor; and truck-center bearings. Refer to other sections of this Specification for ground brush and related requirements. Low voltage and high voltage circuits shall not be grounded to the same ground. .

15.16.7.2 Bonding

All grounding and bonding jumpers and straps shall be sized to handle fault current and lightning discharge current, for which the voltage drop shall not exceed 25 volts. The bonding method employed shall not produce a dc resistance in excess of 0.0025 ohms, or more than 0.025 ohms at 150 kHz for any applied ac voltage. Grounding and bonding jumpers, and brazed shunt straps shall be "extra-flexible".

15.16.8 Wire Splicing

Splicing of conductors shall be avoided and shall be permitted only with approval on a case-by-case basis. Splicing of conductors in conduit will not be permitted. In the event a splice is approved, it shall be in a junction box and the spliced joint shall be mechanically as strong and have the same conductivity as any other part of the conductor. The splice shall be an insulated permanent crimp splice in accordance with Military Specification MIL- T -7928G, Type II, Class I, and shall be installed with the crimping tool and die of the splice manufacturer. All splices shall be insulated with a self-sealing, weathertight, seamless shrink tubing. The outside diameter of the spliced portion of the cable after the insulation is applied shall not exceed the outside diameter of the unspliced portion by more than 40 percent. Splices shall be identified in the integrated schematic.

15.17 Conduit

15.17.1 Types

All conduit and conduit couplings shall be of an ANSI-approved type. All conduit shall be standard weight, galvanized steel with threaded fittings. All conduit ends shall be deburred inside and out to remove sharp edges and all pieces shall be blown out with compressed air and cleaned before installation to remove filings and other foreign material.

Steel conduit shall be mild steel in standard lengths with threaded ends and hot-dipped zinc-coated exterior and interior surfaces. It shall be free of burrs and projections, circular in cross-section, of uniform wall thickness and shall conform to the requirements of ANSI Standard C-80.1. The threads per inch and length of threading shall conform to ANSI Standard B-2.1 on Pipe Threads.

Steel fittings shall be used to assemble steel conduit. Elbows, nipples, and couplings shall be made of the same grade of steel as that employed in the conduit. All fittings shall be treated,

coated, and threaded according to the requirements for zinc-coated, rigid steel conduit and shall conform to UL 6.

Flexible conduit, if used, shall be watertight and interlocking aluminum, Anaconda Seal-Tite or PATH-approved equal, or PATH-approved steel strip-protected fitting, with a PATH-approved rust resistive coating. Flexible covering on conduit shall not contain polyurethane or PVC vinyl.

Liquid tight flexible nonmetallic conduit, if required for special applications, may be used with PATH's approval. Liquid tight flexible nonmetallic conduit shall not be used where subject to physical damage or in lengths longer than 6 feet.

Conduit shall be color-coded: red for those carrying circuits above 100 volts and yellow for under 100 volts.

15.17.2 Size and Fill

Conduit shall be sized such that the sum of the cross-sectional areas of the conductors and their insulation does not exceed 40 percent of the cross-sectional area of the conduit for three or more conductors. For two conductors, a limit of 31 percent shall be used, while for a single conductor, a limit of 53 percent will be permitted. Where conduit having a length not exceeding 24 inches (610 mm) without bends of more than 15 degrees are used between enclosures, a maximum fill of 60 percent will be permitted.

15.17.3 Installation

A run of conduit between junction boxes and/or pulling outlets shall not contain more than the equivalent of four quarter bends, 360 degrees total, including the outlet fittings. Bend radii at the inner surface of the bend shall be no less than eight times the nominal inside diameter of the conduit.

All conduit bends and offsets used shall be made by the use of special forms or tools and shall have the largest radius possible so that wires can be pulled without the use of tackle or power.

Conduit shall be securely clamped with all runs electrically grounded to make a continuous ground, Conduit installation shall not create situations of dissimilar metals.

All conduit shall be arranged to prevent moisture traps and shall drain toward control boxes, except that all open-ended conduits shall be installed in such a manner as to ensure gravity drainage out the end. The conduit arrangement and installation shall be subject to approval.

15.18 Conduit Fittings and Junction Boxes

15.18.1 General

The conduit fittings and junction boxes for Locomotive wiring shall be as manufactured by the

Contractor or by a supplier of a comprehensive line of parts. The Contractor shall submit the proposed product line for approval. All conduit fittings and junction boxes shall be provided with gasketed covers as described in Section 15.18.4. All conduits and their connections to electrical equipment shall be installed to make a continuous ground.

15.18.2 Boxes

All exterior junction boxes shall be fabricated of minimum 14-gauge steel. All exterior junction boxes shall be weatherproof and shall be connected in such a way that drainage from equipment groups will not pass through conduit into the junction boxes. Interiors of all junction boxes shall be primed and then protected with a white, insulating coating as specified in Section 15.21.6.

15.18.3 Conduit Interface

The open ends of conduit shall be provided with strain relief type fittings with extended rubber bushings, bell-mouth fittings, or insulated throat box connections as approved. All conduit entries into removable equipment boxes shall be secured by means of a bolt-on watertight access panel.

15.18.4 Covers

All junction box covers shall be dust proof, retained by compressive spring-type latches, or captive screws as approved on a location-by-location basis. All fasteners used in junction boxes shall be stainless steel. All covers shall be designed to accept or mate with a bulb-type clamp-on seal.

15.19 Wireways

All wireways shall be of rigid, stainless steel construction. Wireways shall be color-coded; red for those carrying circuits above 100 volts and yellow for under 100 volts. The trays shall be adequately supported throughout their entire length in an approved manner. The trays shall be completely de-burred, leaving absolutely no sharp edges, before installation on the Locomotives. Grommet clamps shall be provided at all locations where cables or wires enter or leave the wireways. Under no circumstances shall leads be draped over the edge of the wireways, with or without wireway edge protection. Heads of screws or bolts inside the raceways shall be flush with the metal surface. Metal wireways, elbows, couplings and similar fittings shall be flush with the metal surface. Points of screws or fasteners shall not be directed toward the interior of wire ways. Removable wireway covers shall be secured with captive fasteners.

The wireways shall be routed such that they avoid:

- Sources of heat such as the diesel engine and the radiator
- Wheel splash areas; and

- Areas along the Locomotive where the trays may be subject to foreign object damage. Wireways shall be located to provide access to the harnesses contained within for maintenance action. They shall be provided with approved covers which may be interrupted wherever desired for entry and ex-it of wires and cables. Edges of such interruptions shall be completely covered with protective bushings.

Wireways shall be designed to prohibit the collection of dirt and debris, and shall be perforated, without compromising their requisite strength, to permit ventilation and drainage. They shall preclude water entrapment.

Metal raceways and the elbows, couplings, and similar fittings shall be electrically and mechanically coupled while protecting wires from abrasion and shall make a continuous ground with the Locomotive structure.

Bends in wireways shall be avoided; however, if they are required, approved protection shall be provided to avoid insulation chafing at the bends.

Wireways shall not contain more than 30 current-carrying (i.e., power source as opposed to signaling) conductors at any cross-section. The sum of the cross-sectional areas of all conductors contained at any cross-section of a wireway shall not exceed 40 percent of the interior cross-sectional area of the wireway.

All wire and cable shall be securely fastened within wireways to eliminate movement and resultant chafing.

15.20 Welding and Brazing

15.20.1 General

The Contractor shall be responsible for the quality of its own we1ding and brazing and that done by its suppliers and subcontractors. Cleaning prior to welding shall be in accordance with applicable parts of Section 2, MIL-HDBK-132, "Protective Finishes".

15.20.2 Structural

All structural welding practices shall be according to requirements of the AWS D 1.1; "Structural We1ding Code -Steel"; and the AWS Handbook. Requirements for dynamically loaded structures shall be applied. Cast steel welding shall be according to ASTM A 488/488M, "Steel Castings, Welding, Qualification of Procedures and Personnel". Resistance welding shal1 be in accordance with MIL- W -6858.

15.20.3 Welder Qualification

Welders shall make only those welds for which they have been qualified according to the requirements of the AWS, ASME Section IX, ASTM A 488/488M, or other approved qualifying

procedures. Records of welder qualification tests shall be made available for review.

15.20.4 Inspection

The Contractor shall visually inspect all structural welds in accordance with AWS D 1.1 requirements. A record of all inspections shall be included in the car history book.

In addition to visual inspection specified for all welds, nondestructive surface inspection (dye penetrant or magnetic particle methods, as appropriate) shall also be used to inspect all welds for the first Locomotive. The Contractor shall specify a sample nondestructive inspection rate for all subsequent welds. Trucks on first Locomotive: The non-destructive surface inspection (dye penetrant or magnetic particle) shall be completed on all critical welds and the results submitted for review and analysis.

Additionally, all non-critical external welds of the trucks on the first Locomotive shall be examined by magnetic particle inspection and the results submitted for review and analysis. On the first structure, all full penetration welds shall be nondestructively, volumetrically inspected (ultrasonic or radiographic methods) according to AWS D 1.1 requirements. The Contractor shall specify a random sampling plan for volumetric inspection of subsequent full penetration welds for approval. The minimum acceptable inspection plan shall require inspection of one portion of a full penetration weld for every 200 production welds made. The proposed test welds shall be selected from among welds that are most critically loaded as decided by calculations. With approval, destructive sectioning and metallurgical examination may be substituted for some or all of the required volumetric inspection requirements for production welds.

15.20.5 Post-Weld Cleaning Requirements

All welds exposed to the crew or on sliding contact surfaces of truck frames and bolsters shall be completely cleaned of all spatter.

15.20.6 Contractor Documentation

All welding procedures and documents, including Welding Procedure Specifications, Procedure Qualification Records, and Resistance Spot Welding Schedules, shall be submitted for approval before application. Specifications for purchase of welding electrodes, welding wires, and cover gases shall be submitted for approval before their application.

15.20.7 Special Welding

Procedures for structural welding of stainless steel to LAHT, or other combinations of metals or conditions not covered by AWS specifications or codes, shall be submitted for approval.

Austenitic stainless steel electrodes or wire shall be used to join carbon or LAHT steels to stainless steels.

Galvanized steel shall not be welded to stainless steel.

15.20.8 Resistance Welding

Resistance welding of stainless or carbon steels shall be according to MIL-W-6858, Class B for structural applications and Class C for non-structural applications. Contractor-proposed deviations from MIL- W- 6858, including, but not limited to, weld nugget diameter, tension shear strength, and minimum spacing, shall be submitted and approved before application on production hardware.

Design strengths higher than standard certification and production strength requirements shall be qualified according to MIL-W-6858, Figure 11b for one thickness. This requires a test lot size of 180 spot welds. Additional thickness combinations with the same increased strength ratio may be qualified by 25 spot weld shear tests plus three macro-sections. Twenty of the 25 shear test specimens may be recorded from production witness tests taken from 20 consecutive production days (not calendar days). The Contractor shall submit records of the settings, ultimate shear strength, weld diameter, and weld penetration for approval.

Surface indentation shall not exceed 20 percent of material thickness (t) or 0.01 inch (0.25.mm), whichever is greater. However, for exterior resistance-welded areas exposed to passenger view, indentation shall not exceed 10 percent or 0.005 inch (0.12 mm), whichever is greater. For exposed welds, the Contractor shall vary welding parameters and conditions within their acceptable .ranges to minimize indentations.

Surface bum and discoloration shall be removed by chemical cleaning, or an approved equal method, and sanding or polishing to match the surrounding surface.

15.20.9 Resistance Spot Weld and Intermittent Weld Spacing

Spacing of resistance and spot welds shall be according to approved structural drawings. Spacing shall not exceed two inches plus twice the weld nugget diameter for any structural application, including car body side sheets, roof sheets, and corrugation. Intermittent fusion-weld spacing pitch shall not exceed five inches for 2-inch (50.8 mm) (minimum) weld lengths (40 percent minimum of length welded).

For any corrugation application, if the pitch of the corrugation nodes does not allow the above weld spacing, there shall be two spot welds between each node.

15.20.10 Toughness of Welded Assemblies

The Contractor shall prove all welded steel structures are above the ductile-brittle transition temperature for the specified environmental exposure. Specifically, the weld heat-affected zone (HAZ) and base metal shall resist service impact loads at the lowest specified operating temperature without brittle failure. In the -absence of prior operating history, and if the

Contractor's approved design does not require greater toughness, the minimum impact value for Charpy V-notch specimens shall be 15 ft-lbf (20.34 N m) of absorbed energy at the lowest specified operating temperature. PATH shall have the right to require impact tests to verify the specified toughness.

15.20.11 Torch Brazing

All brazing, defined as heating above 840°F (450°C), shall follow the recommendations contained in the AWS Welding Handbook, Volume 2, latest issue. Procedures and personnel who do brazing work shall be qualified in accordance with AWS B2.2, Standard for Brazing Procedure and Performance Qualification.

15.20.12 Torch Soldering

All structural (not electrical) soldering, defined as heating below 840°F (450°C), shall follow the recommendations contained in the AWS Welding Handbook, Volume 2, latest issue. Procedures and personnel who do torch soldering shall be qualified through the preparation and testing of samples of production torch soldering. Test samples shall be prepared and submitted for approval before production torch soldering.

15.21 Paints and Coatings

15.21.1 General

The portion of the car body, or any of its components, receiving paint shall be painted as required by the Specification and in accordance with the specified color scheme. Paints and coatings shall meet the requirements of the latest version of the PATH Paints and Coatings Specification. All painting to be applied on the car body or any component is to be conducted in accordance with the paint manufacturer's recommendations.

15.21.2 Materials and Preparation

Preparation of the substrate surface and application of painting materials by roller, brush or spray shall be in accordance with the paint supplier's recommendations. All paint materials shall be used at the consistency recommended by the paint supplier. If thinners are necessary, they shall be approved by the paint manufacturer and shall be used only to the extent recommended. Painting shall be done by experienced labor, using proper equipment under competent supervision.

All painting materials for all surfaces shall be a high quality finishing system resistant to corrosion, chipping, and fading and shall retain the gloss level. The coating shall be a two-part, high solids, low VOC, 2-part polyurethane paint system with a solids content between 50 to 70 percent. Alternate paint systems, such as base coat-clear coat systems, or direct-to-metal paint systems will be considered if the paint performance equals or exceeds two part polyurethane. All paint and filler materials which are to be superimposed to form a finish system shall be mutually

compatible and shall be warranted for use as a system by the manufacturer of the components. The metal portions of the car body shall, after fabricating, be prepared for painting by grit blasting and immediately painted with an approved epoxy primer, or washed with an alkaline solution, properly rinsed, phosphate coated or painted with a coat of wash (etch) primer, and then coated with an approved epoxy primer. After erection of the framing structure and body sheets, all undercar metal, shall receive a polyurethane finish as specified above. The color of the underframe paint shall be black. The supplier shall submit color samples and corresponding tri-stimulus values for approval.

Use of water-based paint is prohibited.

15.21.3 Exterior Painting

All exterior surfaces that are to be painted shall be prepared as specified and the paint shall be applied according to the paint manufacturer's recommendations. The paint shall be uniformly applied over all surfaces to be covered and shall be free from runs, sags, or other application defects. Painting shall be done in a clean, dry atmosphere at an ambient temperature as recommended by the paint manufacturer.

Before painting any car surface that is exposed to view, all dents, gashes, nicks, roughness, or other surface imperfections or depressions shall be removed so far as possible by straightening and shall be properly prepared to receive the filler material. These surfaces shall be properly cleaned and wash primed following straightening. Any remaining dents or other surface imperfections shall then be filled with approved filler and sanded smooth. The maximum allowable filler thickness shall be as recommended by the filler manufacturer for the environment and service to which it is to be exposed, but in no case shall it exceed 0.125 inch (3 mm).

Safety Stripes: An approved arrangement of alternating yellow and black diagonal safety stripes shall be painted on the surfaces of the car facing the car ends. Safety stripes shall be 12 inches wide inclined at an angle of 45°. Diagonal black stripes shall be applied on yellow background. The yellow background shall be applied with one coat of approved reflective yellow paint and overlie the carbody paint application.

The following equipment shall be stenciled with high visibility white paint:

- MR in four inches (102 mm) letters on both sides of the main reservoir.
- SR in four inches (102 mm) letters on both sides of the supply reservoir.
- Cutout cocks on reservoirs and drain cocks.

15.21.4 Apparatus and Underfloor Equipment

All underfloor apparatus (fuel tank, brake valves, and other equipment as specified) shall be primed and painted in accordance with the following requirements unless otherwise indicated. All other apparatus shall be painted in an approved color.

The exterior surfaces of undercar equipment enclosures and apparatus, other than propulsion control equipment, made from carbon steel shall be prepared, primed, and painted as specified in Sections 15.21.2 and 15.21.3. The interior and exterior surface of all propulsion control equipment enclosures shall be coated with an approved insulating, thermosetting, resin-based, powder coating or polyurethane paint system. The interior of the boxes, including insides of covers, shall be white and the exteriors shall match the undercar paint scheme.
Parts of undercar equipment enclosures made from plastic or fiberglass shall be painted in accordance with the above requirements for metal portions except that the paint system shall be compatible with the plastic used, and an insulating coating need not be applied. The fuel tank shall be painted black.

15.21.5 Painting Restrictions

Any equipment or parts of equipment which would be damaged or suffer impaired operation from painting shall not be painted and shall be corrosion resistant.

The following items shall not be painted:

- Copper tubing, piping, and fittings,
- Wire and cable,
- Heat transfer surfaces,
- Electrical insulators,
- Elastomeric portions of air and refrigerant lines, and
- Grounding pads.

15.21.6 Interior Painting

Carbody interior surfaces including inside surfaces of hoods and cab shall be primed, and painted as specified in Sections 15.21.2 and 15.21.3.

15.21.7 Corrosion Protection

Concealed surfaces capable of rusting or oxidation shall be properly cleaned receive a wash primer, then primed with an epoxy paint, and painted with an approved finish coat of paint
Where arc welding is performed on joints between stainless steel and other materials, the joint

shall be de-scaled, cleaned, receive a wash primer coating, then painted in accordance with Section 15.21.2 and 15.21.3.

15.21.8 Acoustical Insulation

Acoustical insulating materials shall be applied to properly cleaned cab, sides, ends, roof and floor sheets, as required in Section 6.2.2 to the supplier's recommendations. The materials shall be resistant to dilute acids, alcohols, grease, gasolines, aliphatic oils, and vermin. The material shall be unaffected by sunlight and ozone and shall not become brittle with age. It shall be Daubert Chemical Company's No. 368 sound deadening compound, Aquaplas No. V, or PATH-approved equal.

15.21.9 Safety Devices

All safety devices as required shall be painted red.

All valve handles shall be painted with high visibility white paint.

15.21.10 Lettering and Numbering

All other lettering and numbering shall be standard medium type face lower case except for the first letter of the first word of the sentence, which shall be in upper case, all of approved colors. The Locomotive shall be provided with a number, assigned and approved by the Project Manager, affixed at four (4) locations on the exterior of the Locomotive. The numbers shall be white, standard, Helvetica medium typeface, spaced in accordance with PATH Graphics Standards Specification 3061-MA ll-87 on a black background.

Truck serial numbers shall be applied to both sides of each truck at the center of side frame 0.746 inch (19 mm) high figures, with the bottom of the figures 0.252inch (6.4 mm) from the tangent point of the bottom of the member, and shall be distinctly stamped into the frame with steel dies. The serial number for the trucks shall be assigned by PATH.

PATH Ownership Plates: A small stainless steel ownership plate shall be attached to the body side sill, right side, "A" side, No.2 end of the Locomotive over the center of the bolster; and to the left side of each truck at the comer toward the center of the Locomotive. The ownership plate shall include the words, "Property of PATH" and the serial number as stated below.

Serial numbers shall be stamped on body and truck ownership plates to agree with the body and truck numbers, respectively given above.

15.22 Flammability and Smoke Emission Requirements

15.22.1 General

All combustible material used in the construction of the Locomotive shall satisfy the

flammability and smoke emission requirements cited in this Section.

Documents indicating that the material has met the flammability and smoke emission requirement shall be submitted for approval. If no such documents exist, then, PATH approved, independent laboratory test results indicating successful compliance with these requirements are required for those materials. Testing must be conducted within the Contract duration period, and preferably on a production batch of material. Each laboratory must have tested a standard test sample no greater than 30 days prior to performing the tests, which will be submitted to PATH. The Contractor shall be responsible for complete conformance with these standards for itself and its subcontractors and suppliers. PATH may, at its discretion, require that the current batch of material being provided for this contract be retested for conformance with these standards.
As a minimum, all materials used in the construction of the Locomotive shall meet the requirements of this Section and the Urban Mass Transportation Administration's "Recommended Fire Safety Practices for Rail Transit Materials Selection -January 1989" as it appeared in the Federal Register, Volume 54, No.1 0 of January 17, 1989, pages 1837 through 1840 inclusive, subject to the conditions cited in Section 15.22.3, and NFPA 130, latest version. In case of conflict, the most restrictive requirement shall prevail.

Should the Contractor feel that the quantity of a particular material is such that it would not contribute significantly to a fire, the Contractor may request a waiver from testing for this material. The waiver shall be submitted in writing and shall include the total weight of the material to be used, the location and the distribution of the material in the Locomotive, and any previous test reports available. Waivers shall be accompanied by proper justification and will be reviewed on a case-by-case basis.

15.22.2 Combustible Content

The design of the Locomotive shall minimize the total combustible material content of the Locomotive. Each combustible material shall be specifically identified by supplier's name and type, use in the Locomotive, total weight; and heating value in BTU/lb. and BTU/hour.

15.22.3 Flammability and Smoke Emission

Materials used in the Locomotive shall comply with the following requirements:
REQUIREMENTS FOR PASSENGER LOCOMOTIVE MATERIAL
FIRE RISK ASSESSMENT

Function of Material	Test Procedures	Performance Criteria
Seat Cushion	ASTM D 3675	Is < 25
Seat Frame and Shroud;	ASTM E 662	Ds (l.5) < 100
Wall, Ceiling, Exterior	ASTM E 662	Ds (4.0) < 175 Exterior Non-
metallic Shrouding	ASTM E 162	Is < 35
and Equipment Box Covers;	ASTM E 662	Ds (1.5) < 100 Battery Cases
	ASTM E 662	Ds (4.0) <200

Upholstery	FAR 25.853 (Vertical) ASTM E 662	Flame Time < 10 sec. Burn Length < 6 in. (152mm) Ds (4.0) < 125 (cloth)
HVAC Ducting	ASTM E 162 ASTM E 662	Is < 25 Ds (4.0) < 100
Light Diffusers and Non-glass Window Glazing	ASTM E 162 ASTM E 662 ASTM E 662	Is < 100 Ds (1.5) < 100 Ds (4.0 < 200)
Flooring	ASTM E 648 ASTM E 662 ASTM E 662	CRF> 0.5 W/cm2 Ds (1.5) < 100 Ds (4.0) < 200
Thermal and Acoustical Insulation	ASTM E 662 ASTM E 162	Is < 25 Ds (4.0) < 100
Elastomers	ASTM C 542 ASTM E 662 ASTM E 662	Pass Ds (1.5) < 100 Ds (4.0) < 200
Wire Insulation	Flammability ASTM E 662	Per Section 15.14.3.1 Ds (4.0) < 200 (flaming) Ds (4.0) < 75 (non-flaming) When tested in accordance with Section 15.14.6.

NOTES:

- Materials tested for surface flammability shall not exhibit any flaming running or flaming dripping. except light diffusers.
- The surface flammability and smoke emission characteristics of woven or coated fabrics shall be demonstrated to be permanent in accordance with one of the following methods:
- Washing, if appropriate, according to FED-STD-191A Textile Test Method 5830. .Dry cleaning, if appropriate. to ASTM D 2724.
- Materials that cannot be washed or dry-cleaned shall be so labeled and ~hall meet the
- applicable performance criteria after being cleaned as recommended by the manufacturer. ASTM E 662 test limits must comply with Specification limits in both modes.
- Seat cushion material that is to be tested for surface flammability and smoke emissions shall be first preconditioned in accordance with the procedures in ASTM D 3574, Test 12, Dynamic Fatigue Test by Roller Shear at Constant Force, Procedure B. After conducting the roller shear test, the same test sample shall be tested for flammability and smoke emission. Test reports for the roller shear test shall be forwarded for review with the flammability and smoke emission test reports.

- The following information shall be supplied for all materials tested:

  1. Test Description,
  2. Test Facility, and
  3. Test Results.

15.22.4 Toxicity

Those materials and products generally recognized to have highly toxic products of combustion shall not be used.

All materials used in the Locomotive construction, except for materials used in small parts (such as knobs, rollers, fasteners, clips, grommets, and small electrical parts) that would not contribute significantly to fire propagation or to smoke or toxic gas generation, shall be tested for toxicity using Boeing Specification Support Standard BSS- 7239. Materials shall meet the following maximum toxic gas release limits (ppm) as determined per BSS-7239.

- Carbon Monoxide (CO) 3500 ppm
- Hydrogen Fluoride '(HF) 200 ppm
- Nitrogen Dioxide (NO2) 100 ppm
- Hydrogen Chloride (HCL) 500 ppm
- Hydrogen Cyanide (HCN) 150 ppm
- Sulfur "Dioxide (SO2) 100 ppm

The tests are to be run in the flaming mode after 240 seconds using the NBS Smoke Density Chamber for sample combustion. The gas sampling may be conducted during the smoke density test. The test report shall indicate the maximum concentration (PPM) for each of the above gases at the specified sampling time.

15.22.5 Electrical Fire Safety

Electrical equipment shall conform to NFPA 130, Section 4-3, except where more restrictive requirements are imposed by this Specification.

15.23 Air Filters

15.23.1 HVAC and Equipment Ventilation Filters

Filters shall be the throwaway type, except reusable filter may be approved for specific applications where throw-away filters are not available. All filters shall have an integral frame. Filters shall be designed to meet the performance requirements of each installation, and shall be approved. All filters shall be freely accessible for maintenance. Filters shall meet the requirements of UL 900, Class 2.

15.23.2 High Pressure Air Filters

Air filter assemblies with replaceable filter elements shall be provided in the air line that connects each subsystem to the air supply system. The air filter filtering capability, flow rate capability, and overall size shall be appropriate for the application so that the filter replacement interval is greater than one year. It shall be possible to gain access to the filter element for replacement without requiring any pipefitting to be disconnected or loosened. Filters shall be provided for each of the following systems and any others operated from the air supply system:

- Each air brake control assembly,
- Coupler controls,
- Horn.

15.23.3 Low Pressure Air Filters

Replaceable media type filters shall use resin-bound, spun-glass fiber materials having an uncompressed thickness not less than 3-1/2 inches (89 mm). It shall be non-absorptive of fluids and gases, shall be processed in such a manner that material density increases progressively from air inlet to air exit side, and shall be coated with not less than 24 grams per square foot (258 g/m2) of a dust-retaining, viscous adhesive film. This film shall be stable at temperatures up to 150DF (65.6DC). The filter medium shall be cut not less than ½ inch (13 mm) oversize to ensure adequate sealing between the edge of pad and its integral frame.

15.24 Electrical and Electronic Designs

15.24.1 General

Except as otherwise noted herein, electronic equipment shall conform to IEC 60571, Electronic equipment used on rail Locomotives. All standard type tests shall be performed. All mandatory type tests and routine .tests within IEC 60571 shall be performed. The source impedance for the 1800V -surge test shall be no greater than five (5) ohms without approval from PATH on a circuit by circuit basis.

15.24.2 Ability to Repair

All electrical assemblies, where practical, including such items as PC boards, shall be designed for repair by PATH, in their electronics laboratory.

Assemblies shall not be sealed, potted, or constructed to prohibit repair by PATH. Assemblies that must be potted or sealed by design shall have a minimum 10-year warranty.

15.24.3 Hardware

Refer to Section 15.2.2 for general hardware requirements. All hardware associated with

electronic and electric at control systems shall be protected against moisture, oxidation, and common airborne contaminants.

15.24.4 Enclosures/Racks

All circuit boards that are rack-mounted shall plug into racks containing the mating half of the circuit board connector. The circuit board rack shall mount in an enclosure conforming to requirements in this document. The rack, circuit board, and circuit board hardware shall be designed as an integrated system.

The rack and enclosure shall provide environmental and EMI shielding as required to meet the requirements of this document.

Printed circuit boards shall be positively retained by means of keeper bars or other approved method. The enclosure or rack cover shall not be used to retain the circuit boards, unless specifically designed to do so.

Each circuit board shall be fitted with an ejector or hand grip to assist in board removal. The rack and the edge of each board, or the card ejector, shall be labeled with corresponding numbers to identify board location within the enclosure. A brief functional designation shall also be included on each label.

The enclosure/rack shall not be connected to the power supply return or signal common. Where it is necessary to use printed circuit boards that are not plug-in and not mounted in an enclosure, the following additional requirements apply:

- The PC board must be protected from mechanical damage and hostile environments such as arc discharge or contact with high voltage.
- If the PC board is part of a high voltage circuit,. special caution shall be used in its design with regard to strike distance and creepage in the transit Locomotive environment. This includes between PC board components and with respect to any grounded mounting surfaces.
- Any test points required in routine testing or fault isolation to the user replaceable level, shall be easily accessible with no disassembly or tools.
- If replacement of the PC board is required (as part of secondary maintenance), no special tools or soldering shall be required.
- Each PC board use and application of this type is subject to PATH approval.

15.25 Semiconductor Standards

15.25.1 General

Semiconductors shall be selected to withstand all continuous and transient voltage and power demands present in the circuit application without damage or reduction in life. All circuit designs

shall provide for the presence of high current switching equipment on the Locomotive and the resultant induced voltages and currents in electrical equipment.

15.25.2 Ratings

Discrete semiconductors shall have the following minimum voltage breakdown ratings:

- Semiconductors, except diodes (see below), operated from the battery supply, or those
- connected to trainlines, shall have minimum breakdown ratings of four times the maximum achievable circuit voltage. Suppression devices shall be provided as necessary, to protect the devices and limit the circuit voltage.
- Diodes operated from the battery supply, used as suppression devices, or connected to train lines shall have a minimum breakdown rating (PIV) of 1,000 volts. Diodes with less than 1,000 V PIV rating may be used if adequate circuit transient protection is also provided.

- All discrete semiconductors operated from inverters or other isolating devices shall have a minimum breakdown rating of two times the maximum circuit voltage, except where specifically detailed otherwise. Suppression devices shall be provided necessary to protect the devices and limit the circuit voltage.

All semiconductor junction temperatures shall be limited to 150°C (or to the maximum rated temperature for the device, whichever is less) or less at maximum ambient temperature and at maximum rated output power.

All semiconductors shall be operated at less than 50 percent of the maximum continuous current rating or 50 percent of the maximum continuous power rating, whichever is more restrictive. High power/current devices may be exempt from this requirement with prior approval, on a case-by-case basis. The Contractor shall submit complete device information, including all manufacturer's application recommendations, and calculated current and power demands with all waiver requests. If approved, such waivers do not reduce other requirements, including reliability.

Integrated circuits operated from the battery supply through inverters or other isolating devices shall be operated within the voltage and current ratings specified by the manufacturer, de-rated to less than 50 percent of the maximum stress level at the maximum operating temperature of the device as specified by the manufacturer.

Where the supplies to integrated circuits are regulated and surge protected, the voltage rating shall be 15 percent below the manufacturer's recommended maximum. In addition, the maximum power shall be limited to 50 percent of the manufacturer's specified maximum at the maximum operating temperature.

Silicon semiconductors shall be rated for operation over the temperature range of -40°F to 185°F

(-40°C to +85°C), and shall be hermetically sealed to the extent required by the application. All Gallium Arsenide and similar optical semi-conductors shall be rated for operation over the temperature range of -40°F to 185°F (-40°C to +85°C).

15.25.3 Availability and Identification

All semiconductors shall be available from at least two manufacturers and available from U.S. distributors. Single source devices, such as high voltage power devices, microprocessors, ASICs, and related support chips may be used only if approved by PATH. Such devices shall be essential to the proposed equipment, shall meet the proven service requirements, and shall be supplied by veteran manufacturers likely to support the device.

Each device shall be labeled to identify both the manufacturer and the complete part number.

Operational characteristics of the device shall be published and available to PATH.

15.25.4 Burn-in

A Burn-in shall be performed for a minimum of 72 hours, cycling through the high and low temperatures extremes as noted in MIL-HDBK-217F.

At a minimum, during the last eight hours of the Burn-In, the following system functions shall be monitored and recorded by the Event Recorder System and the download shall be provided to PATH in a test report:

- Brake Cylinder Pressure
- Tractive Effort Level
- Emergency Pipe Pressure
- Cab Status (Train Operator (T/O)
- Deadman Control
- Direction Fwd/Rev
- Distance
- Emergency Brake Application
- Speed
- Time
- Trip Cock Activation

15.25.5 Other Prohibitions

Electronic equipment shall utilize stock components and shall function properly with the component manufacture's full range of tolerances such that after purchase screening or testing of components shall not be required.

Matching of components is permitted only if the components are normally available from the manufacturer in matched sets. Germanium semiconductors shall not be used.

15.26 Printed Circuit Board Standards

15.26.1 General

Printed circuit boards shall be designed, constructed and inspected to ANSI/IPC-D-275, latest revision, except where more stringent requirements are noted here. Within ANSI/IPC-D-275, printed circuit board classes are designated. Printed circuit boards supplied under this Specification shall be Class 2, minimum, with the exception of wayside computers that are not utilized in Locomotive operation. Class 3 requirements shall apply to all vital equipment.

Circuit board material shall be per NEMA Standard LI I, Type FR~4 (MIL-P-13949, Type GF), for boards which have no components whose power dissipation is greater than two watts and when said board is not mounted adjacent to components dissipating greater than two watts. Otherwise, circuit board material shall be per NEMA Standard LI 1, Type FR-5 (MIL-P-13949, Type GR).

Printed circuit boards shall have a minimum thickness of 1/16 inch (1.6 mm) base material. All conductor material shall be copper and shall be firmly attached to the board and shall be resistant to blistering and peeling when heated with a soldering iron.

All printed circuit boards shall be designed for ease of testability per ANSI/IPS-D-275, "Testability design check list".

Traces shall be made as wide as practical, with the minimum width being based on a 10°C temperature rise.

Components with pins shall be mounted only on one side. Connections shall be made to the, other side or internal layers via plated through holes. SMT devices may be mounted on both sides if part of an approved existing design.

All circuit boards shall be inherently stiff or shall be reinforced to prevent damage due to vibration or handling. Circuit boards larger than 100 in^2 (64,520 mm^2) shall be centrally stiffened unless otherwise approved.

All printed circuit boards with the same function shall be interchangeable between equipment groups without additional adjustment.

All printed circuit boards shall be of the "plug-in" type with positive support against vibration. Single board applications, where approved by PATH, may be of a "non-plug-in" type.
Printed circuit boards shall be designed for insertion and removal with power applied, except where power is removed by a switch adjacent to the card rack and except where the mechanical construction would generally prohibit removal and insertion with power applied. Where a switch is used, it shall be labeled with a warning regarding its proper use.

15.26.2 Marking

All circuit boards shall be labeled with a part number, serial number, and descriptive nomenclature. All components shall be labeled on the board with component drawing references and such other information as may be required to repair and troubleshoot the board. The component and wiring sides of the board shall each be marked to indicate capacitor and diode polarity, and at least two leads or one lead and a graphic symbol indicating orientation of all transistors and thyristors.

Integrated circuits and other multi-terminal devices shall have an index mark on the component side of the board, visible with the component inserted, to indicate proper keying and insertion; additionally the first pin on all IC packages shall be identified on the wiring side of the board. The labels used to identify components on the printed circuit board shall match those used in the schematic drawings for that particular component.

15.26.3 Component Mounting

Components shall be fastened to the board in such a manner as to withstand repeated exposure to shock and vibration. Large components shall be supported in addition to the solder connections. Power resistors shall be mounted on standoffs so that the resistor bodies do not contact the board, spaced far enough away from the board so that resistor produced heat will not discolor or damage the board.

15.26.4 IC and Device Sockets

IC and device sockets are prohibited except for components that must be removed *for* reprogramming or initial calibration procedures or devices that are available only in mounting in sockets. All socket applications are subject to PATH approval. All other components shall be soldered in place.

Where approved, IC sockets shall comply with approved standards such as MIL.-S-83502 and MIL-S- 83734, as is applicable for the device, and shall be made of the following materials:

- The bodies shall be molded from diallyl phthalate, PTFE Teflon, or PATH-approved equal.
- The contacts shall be fabricated from beryllium copper and shall be plated with a minimum of 0.000030 inch (0.76 I-UD) of gold over a minimum of 0.000050 inch (1.27 I-UD) of low stress nickel in the area of contact with IC pins.

15.26.5 Conformal Coating

Both sides of the assembled printed circuit boards shall be coated with a clear insulating and protective coating material conforming to MIL-I-46058 latest revision, or approved equal.

The coating shall be easily removed with a brush-applied solvent or penetrated by a hot soldering iron when a component must be unsoldered. The coating solvent shall not adversely affect board-mounted components. All IC sockets, connectors, and test points shall be masked when the coating is applied.

15.26.6 Keying

All printed-circuit boards shall be mechanically "keyed" to prevent insertion into the wrong slot or in the wrong orientation. Further, circuit boards in safety related control systems, such as friction brakes, cab signal, ATC, ATS, and systems which can cause damage or unsafe train operation if the Locomotive is operated with a card removed, shall be connected through a safety circuit to disable the Locomotive if a circuit board is removed.

15.26.7 Circuit Board Connectors

Printed circuit board connectors shall be heavy duty, high reliability, two-part type with a history of successful service in Locomotive applications and shall be approved by PATH prior to commencing design.

Connectors which comply with MIL-C-55302 or DIN 41612 Level 1 or 2, and which have plated contacts as described below, are considered to comply with the requirements of this section.

The connector contact area shall be plated with a minimum of 0.000030 inch (0. 76 um) of gold over a minimum of 0.000050 inch (1.27 1um) of low stress nickel.

Card edge connectors are prohibited.

15.26.8 Testing

Sufficient clearance shall be provided between components to allow testing, removal, and replacement without difficulty due to lack of space.

Test points shall be provided in appropriate locations on modules and printed circuit boards. A negative return test point shall also be provided. The test points for manual testing shall either accept and hold a standard 0.080 inch (2 mm) diameter tip plug or shall be a turret lug similar to Cambion No. 160-1026-01- OS, or approved equal, with sufficient clearance to permit it to accept a standard oscilloscope probe clip, and shall be identified by appropriate markings.

15.26.9 Extenders

Printed circuit board extenders (5 sets of each type) shall be provided by the Contractor for test purposes. The interfaces between extender and enclosure and PC board must be positive and secure and must prevent malfunction and falling out during testing. Mechanical locking means shall be considered on large PC boards.

15.27 Electrical Devices and Hardware

15.27.1 General

All electrical devices shall be railroad industry-proven.

15.27.2 Contactors and Relays

All contactors and relays shall meet or exceed the requirements of MIL-R-6106 and MIL.-R-5757 respectively with the following qualifications:

- Devices shall be tested for proper functioning in orientations up to 30 degrees from the orientation in which they are mounted in the Locomotive. in each of the three possible rotations: pitch. yaw, and roll.
- If adequate documentation exists demonstrating that during functional and operational testing of the Locomotive the contactors underwent normal duty cycle tests, it shall be considered as an acceptable alternative to a bum-in.
- In selected applications, contactors and relays shall comply with the requirements of MIL- R-6106 (for ratings of 1 0 amperes or greater) and MIL-R-5757 (for ratings of less than 10 amperes) but need not be qualified to these documents if all of the following requirements are met:
    1. The device is service proven in the exact same application.
    2. The device is service proven in railroad service.
    3. All other requirements of this Specification are met.
    4. PATH approves of this application.

All devices shall be constructed and utilized in a fail-safe manner; that is, all failures shall be in a direction so that neither the crew nor the equipment is placed in jeopardy.

All devices shall be installed so that they are fully accessible for inspection, repair-in-place, or removal and replacement. All contactor terminals shall be fully accessible for trouble shooting purposes. Contactors and relays shall incorporate means of visually determining whether they are picked up or dropped out Relays on printed circuit boards or within electronic assemblies may be exempted from the requirement for a visual indication, as approved by PATH.

There shall be a maximum of two wire terminations on anyone contact of the device.

The coils of all devices shall be suppressed to protect the low-voltage network from generated transients.

Under no circumstances shall either the main or auxiliary contact tips of the devices be placed in parallel for the purpose of carrying a current load at or above the manufacturers contact tip rating.

Contact tip ratings shall be stated for the worst condition of reduced surface contact, which may result from tip misalignment during normal operation of the device.

Contactor installation shall be such that the arc spray is directed by an arc chute away from ground and any other electrical devices proximate to the contactor.

Devices shall be constructed in a very heavy-duty fashion suitable for use in railroad service. PATH reserves the right to review and approve the design and selection of all contactors and relays. Contactor tip replacement shall not exceed 10 percent of the total number of tips at 90-day intervals.

All contactors shall be constructed so that the main contact tips make and break with a motion (wipe) that prevents deposits and pitting. All dc contactors shall be built with series-fed blowout coils. The Contractor shall demonstrate the ability of each contactor type to reliably interrupt current over the full design operating range.

All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit designation. No identifications shall be obscured, or partially obscured, by wire routing. The identification strip shall be mounted adjacent to the mounting of said device. Bifurcated contacts shall be used in low voltage applications, whenever necessary due to dry contacts or low current switching requirements.

All time delay relays shall be of the R-C delay or solid state type. No mechanical or pneumatic time delay devices will be permitted.

Where plug-in relays are approved, the relay shall be positively retained by means of a retaining clip or bar. This device shall be captive, of rugged construction and shall be easily positioned for relay installation and removal without the need for special tools. When the relay is removed, the retainer shall itself be retained so that it cannot come in contact with devices which may have exposed energized electrical circuits, and it shall not interfere with the operation of any other device when in this position.

Adequate gap and creepage distances shall be maintained from high voltage contactor tips and low voltage coil and auxiliary contacts to prevent entry of high voltage arcs or transients into the low voltage circuits. The same applies to grounded mounting surfaces.

Relays shall not be affected by the accumulation of airborne dust.

15.27.3 Switches

Unless approved by PATH on a case-by-case basis, poles of switches shall not be placed in parallel in order to carry currents in excess of the contact pole rating given by the manufacturer. Switches shall be provided with a "keying" feature so that after installation, the body of the switch is constrained from mechanical rotation.

All switches provided shall be of the highest quality procurable and shall be fully suitable for the rigors of PATH's service environment. All control switches which are subject to water splash, which is defined to mean any switches mounted near windows or doors, or mounted on the Train Operator's control stand, shall be environmentally sealed. Toggle and push button switches shall be per MIL-S-3950, MIL-S-8805, MIL-S-83 731, or equal. All safety-critical switches, such as those that can cause door openings, shall be designed to withstand a high potential test of 1500 volts for one second, in a clean, dry condition, without false conduction. The design and selection of all switches shall be subject to review and approval.

There shall be a maximum of two wires connected to each terminal of the device. Switches shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the switch to be replaced.

In addition to the above requirements, all switches and pushbuttons shall meet the following requirements:

- Contact resistance shall be less than 0.1 ohm at 3 Vdc and a 10 milliamp load.
- Open circuit resistance shall be 50 meg-ohms minimum.
- Resistance to case shall be 1000 meg-ohms minimum at 500 Vdc.
- Shock and vibration shall meet the requirement for IEC 61373 Railway applications - Rolling stock equipment - Shock and vibration tests.

15.27.4 Circuit Breakers

15.27.4.1 General

All circuit breakers provided shall be extremely rugged and fully suitable for the service intended.

They shall be of the highest quality procurable. Design and selection of all circuit breakers shall be subject to review and approval.

All circuit breakers of the same rating shall be of the same manufacture and model throughout the Locomotive.

The ON, OFF, and TRIPPED positions of all circuit breakers shall be permanently marked on the handle or the case of the circuit breaker. The circuit breaker, when tripped, shall assume a distinct position between the ON and OFF positions to permit determination of the fact that it has been tripped by either its excess current or shunt trip elements. All circuit breakers shall be mounted in the vertical direction with the ON position up.

Circuit breakers shall be individually replaceable without disconnecting or removing anything other than the mounting fasteners and electrical connections of the breaker to be replaced.

Electrical connections to circuit breakers shall either be threaded to accept machine screws or use a threaded stud. Wires to circuit breakers shall use ring terminals.

Circuit breaker terminals shall not be used as junction points.

Each and every input power circuit shall be protected by an individual circuit breaker. Separate circuit breakers shall be provided for major assemblies or functions. No circuit breaker shall protect more than one circuit, nor shall anyone circuit be protected by more than one circuit breaker.

All circuit breakers shall be sized by current rating and tripping time to protect both the associated equipment and the minimum size wire used for power distribution within the protected circuit without causing nuisance tripping.

High voltage circuit breaker poles may be connected in series if necessary to achieve the stated voltage interruption requirements.

Each circuit breaker pole shall be equipped with adequate means of arc extinction to prevent flashover.

The continuous current rating of thermal-magnetic trip circuit breakers shall be selected in accordance with ANSI C37.16 for the load and type of service specified.

All thermal-magnetic trip circuit breakers shall conform to the requirements of ANSI C37.13 and ANSI C37.14.

Circuit breaker current rating shall be clearly and permanently marked and shall be completely visible after installation. Electrically operated circuit breakers shall be arranged for operation from the low voltage dc supply.

15.27.4.2 High-Voltage Circuit Breakers

All high voltage circuit breakers shall be devices with not less than 3 poles connected in series.

All distribution-type, high voltage circuit breakers shall be Westinghouse Series C, FDB frame, Heinemann type GH, or PATH-approved equal.

The trip elements shall be thermal-magnetic, or magnetic, connected in series.

The circuit breaker handle shall protrude from the circuit breaker panel cover sufficiently to be manipulable in all positions.

15.27.4.3 Low-Voltage Circuit Breakers

Low voltage circuit breakers shall be either one-pole or two-pole devices depending on the

intended function. Trip elements shall be thermal-magnetic or magnetic, as is appropriate for the application. All low voltage circuit breakers shall be:

- General Use -Westinghouse Series C, Quicklag C frame, Heinemann Series AM or PATH-approved equal, front connection or approved access arrangement and approved labeling.

- Fast Operation -Airpax type IMLK, dust sealed, magnetic breaker, or Airpax type UP, hennetically sealed, magnetic breaker, or a PATH-approved equal.

15.27.5 Fuses

Fuses shall be used only where specifically called for in the Specification or where the use of circuit breakers is not technically feasible, and only with specific approval. Fuses may be considered in applications as follows;

- To protect solid state equipment from catastrophic damage, and
- Where current or voltage levels prohibit circuit breakers.

Fuses shall be permanently identified adjacent to the fuse. The rating of each fuse shall be permanently and clearly marked directly on each fuse. Fuses shall be readily accessible. All fuses mounted in exterior equipment boxes shall be accessible without going under the Locomotive.

Fuse holders shall contain fuse retention devices at both ends. Air gap and creepage distances shall be as approved.

High voltage fuses shall be mounted in totally enclosed, dead front fuse holders with no exposed high voltage connections. The fuse shall be extracted from the circuit when the fuse holder is opened and the exposed fuse shall be safely isolated from any circuit connection.
Where circuits use multiple fuses or fuses and circuit breakers, the coordination between the protective devices shall be discussed in design review.

15.27.6 Bus Bars

Bus bars are to be fabricated from OFE (Oxygen Free Electronic CDA C 10100) or ETP (Electrolytic Tough Pitch CDA C11000) copper. The bus bar conductivity shall be 100 percent IACS. All bus bar joints shall be silver or tin plated.

Current densities, other than at joints, shall not exceed 1,000 amperes per square inch (1.55 A/mm2), and in any case shall not exceed a value which would cause a bus bar temperature rise greater than 30°C. Current densities in joints shall not exceed 150 amperes per square inch (0.23 A/mm2).

Bus bars shall be properly brazed together at joints unless bolted connections are found to be absolutely necessary for maintenance purposes and are approved. The overlap at bus bar joints shall be no less than 10 times the thickness of the bus material. Bus bar connection bolts shall be torqued to obtain a uniform bus bar connection pressure of 200 psi (1.38 MPa). Bolting hardware shall be plated steel with cupp spring washers, as manufactured by Belleville, or PATH-approved equal to maintain connection pressure.

Except for connection areas, bus bars shall be safety-insulated, using a high-dielectric powder coating. heat shrink tubing or other approved means. Tape is not acceptable. Bus bars that are behind insulating panels are exempt from this requirement.

15.27.7 Capacitors and Resistors

Hermetically sealed, dry tantalum capacitors, in metal cases, shall be used in place of aluminum electrolytics, except for very high values which are not commercially practical or available, in which case long life grade aluminum electrolytics shall be used.

Commutating capacitors shall be a paper or plastic film type, shall incorporate a non-toxic impregnant and shall be chosen to give a service life of at least 20 years. Filter capacitors shall have high ripple current rating for long life.

Capacitors shall be derated 20 percent for voltage based on the nominal supply voltage and maximum case temperature. If filter capacitors are exposed to low ripple voltages, lesser values of derating may be accepted if it can be shown that reduced operating temperatures can be achieved due to lower dissipation; however, the sum of the dc and ac ripple voltages shall always be less than the capacitor's voltage rating at a maximum case temperature of 85°C.

All resistors, all resistors shall be derated 50 percent for power dissipation. Other power resistor applications may be submitted for approval of lower derating, on a case-by-case basis. If

15.27.8 Transformers and Inductors

Transformers and inductors shall be derated 10 percent for current. The following shall apply:

- The transformers shall have vacuum-impregnated windings.
- They transformers shall be rated to withstand at least twice the maximum peak-to-peak voltage that they shall be subjected to during operation.
- The transformers shall not emit audible noise in excess of 60 dB referenced to 20 micropascals at a distance of 2 feet (0.61 m) while operating at rated voltage and load. Be designed to minimize radiated and induced EMI.

- The location, orientation, mounting, cable connections and cable routing shall be in accordance to the overall EMI/EMC control plan for the Locomotive.

15.27.9 Switch, Circuit Breaker, and Fuse Panels

All switches, circuit breakers and fuse panels shall be dead front types mounted in the specified equipment enclosures, and shall conform to 49 CFR 229.85

Each switch and circuit breaker panel shall carry the necessary apparatus, arranged to be easily accessible to connections and designed to prevent operating or maintenance personnel from coming in contact with live parts when operating the switches or circuit breakers. Furthermore, all live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.

All switches, breakers, fuses, and indicating lights shall be provided with a nameplate of raised or recessed lettering on the dead front, clearly identifying the circuit which each controls arid its circuit designation. The dead front panel shall conform to NFPA 70, Article 384. The dead fronts shall be made of moisture-proof, electrically insulating, laminated phenolic or fiberglass, of approved quality suitable for switchboards. Asbestos shall not be used.

A wiring gutter shall be provided along the top, sides, and bottom, for the routing of high voltage leads to their designated circuit breakers.

The panel shall be secured by approved, captive fasteners and shall be configured for easy removal so that maintenance and repair action is not impeded.

Power distribution to circuit breakers and switches shall be from a bus bar or bus circuit. Distributing power by successive or "daisy-chained" connections between device terminals will not be permitted.

15.27.10 Battery Backup Circuits

Backup batteries are not permitted, unless specifically approved by PATH.

SECTION 16

16.0 SOFTWARE SYSTEMS

16.1 General

PATH adheres to NIST 800 53 r4, a review of PATH NIST based computing resources against the PATH Locomotive computing resources needs to take place to ensure compliance where applicable.

Some of the systems on the Locomotive will use processors and hence software. The application requirements for those systems are detailed in other portions of the Specification and the software must be treated as an integral part of the total system design. Even so, there are sufficient unique requirements to warrant a dedicated section, within this Technical Specification, for software requirements. See Attachment D, PATH LOCOMOTIVE SPECIFICATIONS INFORMATION TECHNOLOGY PROVISIONS.

Selected hardware requirements are also included within this section. Refer to Section 15 and to IEC 60571-2012 for related requirements.

All computer hardware and software for this Contract, whether resident within a microprocessor-controlled intelligent subsystem, provided as part of test equipment or for purposes such as post-download fault log processing, or incorporated within training technology, is subject to the same requirements, except as noted within this Specification.

If the Contractor supplies software for this Contract, then the Contractor shall also be considered a Supplier and shall be subject to the requirements of this section pertaining to Suppliers.

The entire system supplied by the Contractor and all Subcontractors shall correctly handle times and dates throughout the possible life expectancy of the Locomotive. This includes all Locomotive-borne software as well as PTEs. It includes, as a minimum, Operating Systems, documentation, software source, and files.

All systems provided under this Contract whether acting separately or in combination must properly process all times and dates within the required span of years from 1990 to 2100 inclusive. This includes issues related to the proper handling of times and dates in certain special cases.

The Contractor and Suppliers are required to provide robust designs and to establish, through both analysis and test, that the product shall process times and dates correctly through the required span of years.

Techniques, such as storing time as seconds past 1-1-1970, either will not be used or, if used, the methods will be extended to correctly process all required times and dates.

Proper time and date processing requirements must be included in the Software Requirements Specifications for all relevant systems or subsystems.

The systems must use robust designs including the following:

- The design must allow for setting of the time for the whole system or for any part of the system, forward or back, to any time in the required span of years, without incorrect operation or loss of data.

- All times and data produced by any of the software that includes dates shall use four digit years. Unless otherwise specified, any files, communications, display screens, or reports requiring a year field will include the full-digit year such as 1999, 2000, or 2001.

- The clocks shall not be used for other functions such as for internal timers.

- Time set operations shall be recorded in both the Event Recorder and the Monitoring and Diagnostic System as information to assist in the interpretation and tracing of time through other records.

To establish that the designs used are robust and to present an analysis of the impact of the design as it pertains to the correct processing of times, the Contractor shall submit for review and approval a report including the following:

- Identification of all clocks in the system both on the Locomotive and off and all modules within each subsystem that use times: This includes but is not limited to onboard systems, PTEs, Workstations, and operating systems. Both the hardware and the software to be used must be described. The storage techniques used must be identified. This must define the internal representation for the time and year as well as the algorithms used for operations on the time and year.

- An analysis that identifies any critical times requiring special processing, presents how those times will be processed so as to not cause errors, and identifies how tests should be performed to demonstrate the proper operation.

- Define the interfaces between subsystems or between modules within a subsystem that include times. The format, coding, and interpretation shall be given for each time passed. .
- A test procedure based on the above analysis and designed to demonstrate the correct handling of dates by the individual subsystems and by the complete system.

16.2 Supplier Qualifications

The Contractor and any subcontractor must have previous experience in programming and in configuring commercially available software for similar applications. The Contractor shall submit information on all previous software-related tasks, including dates, task, application, number of Locomotives, customers, etc. The Contractor, as systems and software integrator, and suppliers who are providing processor-based products shall have a mature software development process.

16.3 Design Process

The Contractor shall utilize a Software Quality Assurance Plan in accordance with ANSI/IEEE Standard 730. The plan shall describe a mechanism for orderly software development, using the

documents listed in Section 16.5.2. The Contractor shall be responsible for the overall design, the partitioning of the requirements to the subsystems, and the integration of the subsystems into the complete system. The overall System Functional Description, see section 19.3.1, shall define the partitioning of the system and the allocation of requirements (including derived requirements) to the subsystems. The Contractor Software Verification and Validation Plan (SVVP) shall describe the integration of the subsystems to cover the requirements of the entire system.

Since software is part of a total system design, it will be reviewed as part of each design review and any and all appropriate licenses for PATH's use of the software, including updates, shall be included.

16.4 Software Systems Functions and Features

16.4.1 Hardware Platform

Locomotive-borne and custom computer hardware shall be designed and constructed in accordance with the general electronic design principles of Section 15.2.7. The microprocessor-based systems shall be based on an established family of microprocessors in wide use in the control system industry. They shall be supported by a full range of software development languages and diagnostic programs. Any use of commercially available computer boards must be specifically approved by PATH. Such approval will be based upon a technical review of the product, product documentation, and a commercial assessment of product availability.

The control system shall be powered by dedicated transformer-isolated power supplies driven from the battery circuit.

All control system input and output signals shall be through isolation buffers. High voltage inputs and outputs shall be isolated external to the microcomputer card rack. Low voltage (battery and logic voltage level) inputs and outputs shall be isolated via buffer cards in or external to the microcomputer card rack. The isolation buffers shall:

- Protect and isolate the control system from damage due to over-voltage, under-voltage, transients, shorts, and opens.
- Perform necessary voltage translations.
- Remove noise and undesired signals.
- Limit, pre-process, discriminate and format those signals that would otherwise require excessive processor time.
- Consist of optical isolators, transformer isolators, and other circuits appropriate to the application. Voltage divider circuits will not be allowed unless approved by PATH on a case- by-case basis.

Program code and fixed data shall be stored in a form of PROM. All EPROM windows shall be covered with labels that are opaque at the UV erasing wavelengths. Flash PROM circuitry shall be configured so that reprogramming can be disabled via a semi-permanent hardware mechanism. After the software design has stabilized in service, flash PROM reprogramming shall be disabled such that an approved hardware "key" is required for future reprogramming. If a system does not disable flash PROM reprogramming in the equipment itself, then it is acceptable to a PTE where both a password and an approved hard key (dongle) are necessary for the PTE to download software. The hard key shall be approved by PATH. One hard key shall be provided for each PTE.

Other than the main Locomotive battery, batteries are restricted as follows: One battery for the purpose of maintaining a clock and calendar, one battery per Event Recorder System, and any others only with PATH approval. Rechargeable batteries shall be sized to retain data for at least six months without charging and shall be located such that leakage cannot damage any control system components. Battery life shall be no less than five years, regardless of type. The system shall annunciate the need for battery replacement such that the battery continues to perform its function until it can be replaced at the next periodic maintenance. Batteries shall not be connected by soldering. Upon detection of the loss of input power to non-battery backed systems, the processor system shall store all necessary RAM control data to non-volatile memory.

The hardware shall be designed -to allow program expansion without hardware modification. The memory needs of the installed software shall not utilize more than 70 percent of the installed memory. This requirement applies individually to each type of memory installed, whether it is EPROM, EEPROM, Flash PROM, RAM, or other type. Peak processing time demands shall not be greater than 50 percent of the available processor time, except as indicated below. The Contractor may petition for relief from the 50 percent requirement, based on product maturity and the lack of potential for expansion or modification. In no case may more than 75 percent of the peak processor time be utilized, and generally, more margins will be required. Simple singular functions performed by dedicated embedded processors may utilize up to 75 percent of the available processor time and do not have to provide spare I/O capability.

16.4.2 Operating Systems and Languages

Software may be written in a high or low level language although high level languages are preferred. The language, and its implementation for the selected microprocessor system, shall be commercially available in English. No proprietary languages or code generating systems are allowed. All languages and operating systems must have an acceptable installed base and be approved by PATH. All source code, including comments shall be in English. Source code must be well structured, modular, and clearly documented to allow easy comprehension and straightforward traceability to the Software Design Description documents. Software comments shall also include explanations of all significant memory addresses such as interrupt vectors, I/O addresses, and memory locations for RAM, ROM and other memory devices.

16.4.3 General Features

Software shall perform the following basic functions:

- Implement the desired control scheme such that the specified performance is achieved.

- Monitor all inputs for unsafe, erroneous, or unknown conditions or combinations of conditions and take appropriate actions to preserve proper functioning and capture appropriate information to facilitate root cause analysis and repair when necessary;

- Sample all input conditions at rates sufficient to detect and remedy all unsafe or damaging conditions in the shortest-possible time. Sampling rates and program execution times shall be such that the control system is not the limiting factor in response to unsafe or damaging conditions. All software shall be designed to ensure that the timing requirements for safety- related tasks are always met.

- Limit all output commands to safe levels regardless of any combination of input conditions.

- Perform self-diagnostic routines and respond promptly, safely, and predictably to detect faults. The self-diagnostics shall include tests for program corruption and integrity in read/write memories.

- Respond safely and predictably when powering up or recovering from power interruptions. All power interruptions likely to have corrupted temporary storage shall be detected and cause the system to re-initialize all affected routines and temporary data. Detection of power interruptions may be by hardware.

- Permit thorough interrogation of all input, output, and internal conditions by external-diagnostic equipment.

Programs shall be modular with separation of Operating/Executive Software from Application Software. Software version numbers shall be included within the code. Multi chip programs must self-test to assure that the correct complement of chips is installed. Software shall have verifiable version control based on a calculation cyclic redundancy check (CRC) polynomial published in the system documentation and verifiable using an approved utility. This utility shall be included in the Portable Test Units, Software Workstations, and the Monitoring and Diagnostic Logic System.

Processor system parameters shall be adjustable via PTE. Appropriate parameters shall be suggested by suppliers, in design review, for approval by PATH. User defined/changeable parameters shall be structured as tabled data. Allowable ranges of parameters shall be stated in the SRSs as requirements.

In the event that vital functions are performed in processor based systems, functionality shall be verified in accordance with IEEE Std. 1483-2000, IEEE Standard for the Verification of Vital Functions in Processor- Based Systems Used in Rail Transit Control.

16.4.4 Testability

All features and functions of software systems shall be testable on a systems level. Specific approval by PATH is required for any feature that is not testable on a systems level. For features that are only testable with special equipment, all such equipment shall be supplied by the Contractor as test equipment, and become the property of PATH. This equipment shall provide the logic, sequencing, and emulation necessary to verify that the software functions as intended. In lieu of separate equipment, appropriate test functions may be provided within the Portable Test Equipment.

Type tests of all processor systems shall verify the proper operation of all software features, including diagnostics.

All Test Plans and Procedures shall be submitted for approval prior to conducting the tests.

16.5 Software Documentation

16.5.1 General

It is the intention of this specification to be generally consistent with the evolving IEEE P1558 Standard for Software Documentation for Rail Equipment and Systems. Draft or released versions of that standard may be consulted, as they become available, for understanding of the desired direction for documentation standardization.

For non-commercially available software, thorough and accurate software documentation submittal and PATH approval is required. PATH shall be provided with sufficient documentation to fully comprehend and analyze the operation of the equipment in which the software is to be installed; and to enable PATH to maintain and modify the software to correct problems, adapt it to changing requirements, add features, and export it to a new hardware platform. The Contractor shall define a single software documentation methodology for the project and require all Subcontractors to comply with the same. The methodology shall be submitted for PATH approval. The Contractor shall provide descriptions to enable PATH's design reviewers to understand the documentation methodology. Software documentation training shall be included within the formal Training Program. Submissions also shall conform to the requirements of Attachment D.

Documentation for non-commercially available software shall fall into two categories. First, the documentation must include all form, fit, and function information for use by PATH for the Specification purpose as set forth in Attachment D . Second, documentation must include all implementation details as set forth in and for the use by PATH for the approved purposes as spelled out in Attachment D.

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16.5.2 Software, Specifically for Custom Applications

As described in Section 16.5.1, all software documentation from all suppliers shall be in a common format. This format shall use a consistent set of graphical and textual techniques to fully describe the software functionality and implementation.

System Functional Description (SFD) for each subsystem presenting the external interfaces, defining the processors in the subsystem, the Software Configuration items, and the internal interfaces within the subsystem shall be provided. It shall include a software summary table with a row for each software item in the system including proposed COTS items. Columns will give the software item name and ID. SRS name and ID, SDD name and ID, and section within the SFD where it is described. Each proposed COTS item must be described in the SFD. For programmable logic components such as FPGA's, CPLD's and other similar devices all specific hardware and programmed functions and the interfaces shall be defined in the SFD. The detailed design shall then be documented in the schematics or in an appropriate output of the software tool used to program the device. This description must include the requirements to be met by the item. This document shall be consistent with the overall System Functional Description required by Section 19.3.1.

All documents shall be submitted as separate documents, not as internal to other submittals such as the PDR or CDR documents. All documentation shall use names and acronyms consistent with those in the Technical Specification.

The Contractor shall assure that the documentation produced provides for the straightforward traceability of requirements of the Technical Specification throughout the design documentation and including the final tests. All documents submitted shall utilize revision bars in the margin and/or underline/strike through to highlight changes from one revision to the next.

After original approval, changes to the software shall be formally submitted for approval by PATH, prior to implementation of the changes in the source code. The Software documentation shall be revised concurrently with software changes. New versions of software must be accompanied by revised, reviewed and released software documentation.

16.5.2.1 Software Project Management Plan (SPMP)

The SPMP for both the Contractor and the Suppliers shall conform to IEEE Standard 1058, Software Project Management Plans. It shall include a schedule showing the key tasks defined for the project.

16.5.2.2 Software Documentation Templates

A template must be defined by the Contractor for each deliverable document. A common general format must be defined for the title page and the revision history. The title page must include the

Contractor or Supplier name. project name. document name, document ID, Sign-off names, signatures, and dates, the document version date, and the version number. The change history must show in a table the changes made for each version along with the source of the change such as a review issue, a change, or a meeting action item. Sufficient information must be provided to allow the reader to understand the changes and the reasons for the changes.

16.5.3 General Market Software

Some software supplied under this procurement may be commercially available to a wide variety of users. Examples include operating systems supplied by chip manufacturers. The Contractor shall submit a list of software that is commercially available to the general public. PATH shall determine which software will be classified as commercially available.

For commercially available software, software documentation requirements are limited to the original data storage/transfer media (CD-ROM or DVD), functional and usage details, all provider manuals, and licenses required for PATH site use. The Contractor shall incorporate training on how the software is to be used in the specific situation for which it was provided, as part of the Training Program. For all other software, as deemed by PATH, the documentation requirements of Section 16.5.2 apply.

16.5.4 Configuration Control

The Contractor shall develop and maintain a Software Configuration Control Plan for tracking software changes relative to the Locomotive and the PTE, on PATH property. This plan shall be submitted for approval by PATH. The Contractor shall include in the plan a data base system capable of maintaining the history of all software and status changes making it possible to determine which versions currently resides in which equipment. on which Locomotives, and also which versions were used in the past. The data base system shall be capable of generating various reports showing the configuration of a typical Locomotive system in terms of software history and status, and also a fleet configuration report capable of determining the exact software configuration of a particular operating unit on a Locomotive by Locomotive basis. The Contractor shall make these reports available to PATH.

The Software Configuration Control Plan (SCCP) shall be submitted for approval by PATH.

The Contractor shall submit a final software configuration for each Locomotive at the time of acceptance, or conditional acceptance, in an electronic format as approved by PATH.

All software shall be identified by a name and a version number. The name shall identify the equipment into which the software is installed. Every change to software shall be reflected in an update to the version number. Refer to Sections 16.4.3 and 16.6 for related requirements.

16.6 Software Maintenance and Related Tools

PATH retains the right to modify the performance of its equipment, at its own risk. Since this

involves software modifications, all software for the Locomotive shall be delivered to PATH on CD-ROM or DVD.

The Contractor shall provide software workstations in accordance with Section 20.3.2, including all of the software and software development tools used by the Suppliers. The complement of equipment shall include all compilers, assemblers, linkers, in-circuit emulators, and other such tools that are used for software development.

All associated manuals shall be provided. Development tools and software which are provided to PATH must be the same version as used by the Suppliers. The system shall allow software modifications and tests of all Locomotive related software on this Contract. The complete complement of software development/modification tools shall be delivered such that software modifications can, if desired, be made on- site during acceptance testing. PROM re-programming equipment shall allow re-programming of 16 PROMs per hour.

The Workstations shall include automated tools for the configuration management of software and associated hardware. The Contractor shall use this system throughout the Contract term so that configuration is controlled and PATH's configuration documentation remains current with the actual equipment configuration.

The workstation and software documentation equipment is to be delivered, demonstrated, and proven to perform its function prior to Acceptance of the first Locomotive. The demonstration shall consist of PATH personnel using the workstation, source code files, and written instructions to create program files that then must match the programs stored within the system's equipment.

16.7 Portable Test Equipment Software

For software that is resident in test computers, PATH shall be granted a license for its use and shall be furnished with all of the software documentation. The license and documentation furnished to PATH shall meet the requirements of Attachment D. The documentation furnished shall also comply with Section 16.5.

SECTION 17

17.0 COMPLIANCE PROGRAM

17.1 General

The Contract shall include a comprehensive compliance program to assist in assuring Specification compliance of Contractor furnished designs and equipment. The program shall include a Test Program as detailed within Section 17.2.

The Locomotive shall be thoroughly tested before delivery, after delivery, and prior to issuance of final acceptance by PATH. All tests shall be conducted to assure. 100% compliance with all Specifications and requirements stated in the Contract and Drawings.

Any defects in the equipment, its apparatus, material and workmanship, disclosed by any inspection or tests, including defects in performance, safety, reliability and maintainability shall be corrected at no additional expense to PATH. This shall include any re-shipping cost of the Locomotive or its components to and from the Contractor's plant for necessary corrective action.

The Contractor shall be responsible for furnishing all the necessary testing instruments and apparatus to conduct the required tests. All costs associated with the use of test instrumentation, apparatus, materials, labor, and facilities shall be borne by the Contractor.

The Contractor shall notify the Project Manager at least fifteen (15) working days in advance of the time when an item is ready to be tested. All tests shall be conducted in the presence of the Project Manager or his designee. Only the Project Manager may elect to waive PATH's right to witness any test.

All tests to be performed shall be documented by the Contractor. Documentation shall consist of the test's description, procedures, pass/fail criteria, instrument calibration certificates, and test data sheets. This documentation shall be submitted to the Project Manager for approval no later than thirty (30) working days prior to the start of the test. Within ten (10) working days after the conclusion of each test, the Contractor shall submit a complete test report to the Project Manager for approval.

In case of failure of any tests, the Contractor shall provide a failure analysis for the approval of the Project Manager that includes the cause of the failure and corrective actions to address the failure. Upon the Project Manager's approval of the failure analysis, the Contractor shall implement the approved corrective actions and repeat the subject test. Any subsequent failure of the test shall be handled in the same manner.

Tests not stipulated in this section or PATH's failure to conduct such tests shall not relieve the Contractor of any obligations specified under this Contract. The Contractor, its subcontractors and suppliers may perform additional testing to assure high-quality standards for all materials and parts of the Locomotive.

17.1.1 Not Used

17.1.2 First Locomotive Review

A First Locomotive Review will be performed at the Contractor’s facility, jointly by PATH and the Contractor, on a completely assembled Locomotive. The Contractor shall give at least thirty (30) calendar days, written notice to PATH prior to the schedule of the First Locomotive. Review the schedule shall be such that the Contractor has time to address all open items prior to the First Article Inspection (FAI).

17.2 Test Program

A comprehensive testing program shall be conducted on the Locomotive systems and subsystems to substantiate the design and performance requirements, to assure conformance to the Specifications, inclusive of reliability and maintainability requirements.

The Contractor and its subcontractors and suppliers may perform additional testing as deemed necessary, and shall perform additional quality control testing as necessary to assure Specification compliant, high-quality material and parts. Unless otherwise indicated, all costs associated with testing shall be borne by the Contractor. All instruments, personnel, and apparatus required for testing shall be provided by the Contractor.

If an item fails; a test, it shall be modified and retested at the Contractor's expense. If the design of an item is changed after a test is conducted, the Contractor shall perform a complete retest of the item to demonstrate Specification compliance.

The tests specified herein are considered to be an absolute minimum by the PATH. The Contractor shall furnish a comprehensive test plan as described in Section 17.4.1. The Contractor and its subcontractors may perform additional testing, as they deem necessary.

17.3 Classification of Tests

Tests are to be performed on the Locomotives, systems and components, and generally fall into the following test categories:

17.3.1 Qualification Test Definition

Qualification tests are typically one-time: tests conducted to demonstrate compliance with Specification design requirements at operating and environmental extremes. These tests shall be performed on the first Locomotive only and at the Contractor's plant.

17.3.2 Locomotive Pre-Shipment Test Definition

The Contractor shall complete these tests to demonstrate that all Locomotives have been

constructed in, accordance with Specification requirements, and is ready for shipment to PATH.

17.3.3 Conformance Test Definition

Conformance Tests are test conducted after delivery at PATH's property to demonstrate compliance with Specification design requirements at the operating and environmental extremes of PATH's fixed facilities. Conformance tests requirements may vary from inspection and functional demonstration for a simple component to a full system demonstration of the Locomotive. These tests shall be performed on the first Locomotive.

17.3.4 Acceptance Tests Definition

These tests shall be conducted after delivery on PATH property on all Locomotives, except the first Locomotive, as part of the Locomotive Acceptance Program.

17.3.5 Test Details

Item #	Test Description	Section Reference	Qualification Test, First Locomotive At Contractor Location	Pre Shipment Test All Locomotives at Contractor Location	Conformance Test First Locomotives at PATH Location	Acceptance Test, All Locomotives at PATH Location
1	Propulsion Test	17.5.1	X	X		
2	Engine Test	17.5.1.1.1 through 17.5.1.1.4	X			
3	Battery Test	17.5.1.2	X			
4	Traction Alternator Test	17.5.1.3	X			
5	Frictional Brake System	17.5.2	X	X		
6	Air Brake Equipment Test	17.5.2.1	X			
7	Reservoir Test	17.5.2.1.1	X			
8	Trip cock test	17.5.2.1.2	X			
9	Leakage	17.5.2.1.3	X			

Item #	Test Description	Section Reference	Qualification Test, First Locomotive At Contractor Location	Pre Shipment Test All Locomotives at Contractor Location	Conformance Test First Locomotives at PATH Location	Acceptance Test, All Locomotives at PATH Location
10	Park Brake Test	17.5.2.2	X		X	X
11	Wheel Load Test	17.5.3	X			
12	Camber Test	17.5.4	X			
13	Carbody Balance Test	17.5.5	X			
14	Carbody Underframe Radiographic Inspection Test	17.5.6	X			
15	Truck Radiographic Inspection Test	17.5.7	X			
16	Clearance Test	17.5.8	X		X	
17	Curving Test	17.5.9	X		X	
18	Coupler Test	17.5.10	X	X	X	X
19	Communication Test	17.5.11	X		X	X
20	HVAC Test	17.5.12	X		X	
21	Electrical Wiring Tests	17.5.13	X	X		
22	Insulation Resistance Test	17.5.13.1.1	X	X		
23	High Potential Test	17.5.13.2	X	X		
24	Continuity Test	17.5.13.3	X	X		
25	Short Circuit Test	17.5.13.4	X	X	X	
26	Light Test	17.5.15	X	X		

Item #	Test Description	Section Reference	Qualification Test, First Locomotive At Contractor Location	Pre Shipment Test All Locomotives at Contractor Location	Conformance Test First Locomotives at PATH Location	Acceptance Test, All Locomotives at PATH Location
27	Heated Windshield Test	17.5.16	X			
28	Horn Test	17.5.17	X			
29	Automatic Fire Suppression System	17.5.18	X	X		
30	Noise Level Test	17.5.19			X	
31	EMI Test	17.5.20			X	
32	Cab Water Leakage Test	17.5.21	X			
33	Safety Features Test	17.5.22	X	X	X	X
34	Independent Locomotive Heating & Battery Charging System	17.5.23	X	X	X	X
35	Maintainability Demonstration	17.5.24	X		X	
36	Visual Inspection Test	17.5.25	X	X	X	X
37	Functional Test	17.5.26	X	X	X	X
38	Truck Static Tests	17.5.27.1.1 through 17.5.27.1.4	X			
39	Carbody Structural Test	17.5.27.2.6 through 17.5.27.2.14	X			
40	Event Recorder test	17.5.27.2.15	X			X

Item #	Test Description	Section Reference	Qualification Test, First Locomotive At Contractor Location	Pre Shipment Test All Locomotives at Contractor Location	Conformance Test First Locomotives at PATH Location	Acceptance Test, All Locomotives at PATH Location
41	Monitoring and Diagnostic Test	17.5.27.2.16	X			
42	Propulsion Power Test	17.7.1.1			X	
43	Acceleration and Balance Speed Test	17.7.1.2			X	
44	Diesel Engine Exhaust Emissions Test	17.7.1.3			X	
45	Propulsion Multiple Unit Control Test	17.7.1.4		X	X	
46	Stopping Distance Test	17.7.2.1		X		
47	Pneumatic System Leakage Test	17.7.2.2		X	X	
48	Brake System Functional Test	17.7.2.4		X	X	
49	Performance Reliability Test	17.7.6				X

17.4 Test Plans, Procedures, and Reports

17.4.1 Test Plans

The Contractor shall submit to the PATH, for approval, a Master Test Plan covering all tests and adjustments listed in this Section and otherwise required in this Specification. The Test Plan shall identify all tests by reference to the appropriate number of the Section. The Test Plan shall contain a detailed schedule showing the time and place of each test to be performed. The Test Plan shall cover all suppliers' and subcontractors' tests to be completed at the suppliers' or subcontractors plants, all Contractor's tests to be completed at its plant prior to delivery, and all testing to be conducted by the Contractor on PATH property prior to the offer for acceptance.

The Locomotive Master Test Plan shall be submitted to PATH for review and approval no later than five months after the Contractor receives a Notice of Award.

17.4.2 Test Procedures

The Contractor shall prepare a detailed test procedure for each test described in this Section, and for any other tests conducted by the Contractor in connection with its own Quality Assurance Program. Each test procedure shall be submitted to PATH for review and approval. The Contractor shall submit, as part of each test procedure, forms to be used to record data accumulated in the performance of that test. Such forms shall also contain a step-by-step format for data reduction, formula used in deriving the format, criteria for acceptability, and justification for the criteria set forth.

Each procedure shall include the following items as applicable:

- System description and system drawings, schematics, and diagrams showing the main system functions and parameters, and location and connections of the measuring points. There should be a clear correlation between the text and the drawings,

- Test objective, including requirement to demonstrate that the equipment meets the safety requirements when operated in the environment in which it is to be used, description of the test set-up, drawings, schematics, diagrams, loading of the system or test specimen and the loading increments. There should be a clear understanding of the test set-up with system or specimen under the tests and a clear correlation between the text and the drawings,

- Typical log sheets, print-outs, forms for plotting data, and examples of any other data sheets which will be used during the test or in the final report,

- Table(s) showing the measuring points, their expected nominal, minimum and maximum values and conditions that cause the readings,

- Table(s) of predicted values at selected sensor or gauge locations. This table shall list the sensor or gauge number, predicted value (i.e. strain or stress) from the analysis (i.e. stress analysis), the location of the value (i.e. strain), a space to enter the actual value (i.e. strain or stress) and a space to enter the calculated percent difference, defined as:

$$Percent\ Difference = \frac{Actual - Predicted}{Actual}\ X\ 100\%$$

- Detailed list of the test instrumentation including data acquisition system, the instrumentation accuracy, the manufacturer description of the instrumentation, and current calibration certificates,

- Detailed list of the sensors and gauges including strain and deflection gauges, the manufacturer's description of the sensors and gauges, and current calibration certificates,

- Detailed start-up, shut-down and Emergency shut-down procedures.

Unless otherwise provided, each detailed test procedure shall be submitted to PATH in advance of the planned test date so as to provide at least 15 working days to review and approve the procedure.

17.4.3 Test Reports

The Contractor shall submit a written report of each test, including copies of all test data, to PATH for review and approval. In case of tests that are performed on all Locomotives, or all components, the reports of those tests shall be included in the appropriate Car History Book or equivalent database. In every case, the report shall include a description of the test, all raw data collected in the test, all data reduction forms, and a summary of the results in a manner that can be directly compared to the Specification without further calculations.

A final test report for each test shall be prepared documenting the results obtained and submitted for approval. The report shall be identified by a Contractor document number and shall refer to the Contractor part number and serial number of the test hardware. All pertinent test results (as well as a discussion of any deviations from the approval test procedure) shall be included. The test report shall also include any photographs and any additional data necessary to support the test results. Test data shall be presented as approved by PATH. Supplier test reports shall be approved by the Contractor prior to submittal to the PATH. Copies of the report shall be submitted for approval to the PATH within 15 working days after completion of testing.

Except as otherwise specified, all tests specified herein shall be performed by the Contractor and its subcontractors. When the Contractor can furnish a test report for a required qualification (design verification) test which has been performed on equipment identical to the equipment to be provided for this Contract, and when, in the PATH's judgment, the test report demonstrates that the requirements for this contract are met, the PATH may accept the prior test report in lieu of new testing.

Test reports for tests classified as commercial (quality assurance) tests shall not be submitted for approval but shall be made available to the PATH upon request.

17.4.4 Test Components

Items to be used for testing shall be production items. The items shall be manufactured according to the latest revision of manufacturing documentation and shall have been subjected to all prescribed quality control procedures. Any deviations from these requirements shall be subject to approval from the PATH.

17.4.5 Test Failure and Discrepancy Analysis

In the event that failures occur during any testing, a failure report shall be submitted to PATH. This report shall identify the Locomotive being tested, identify the cause(s) of failure, indicate what corrective action is necessary, and the extent of such action. Where the Contractor recommends that no change is made, justification for the recommendation shall be provided. When a failure occurs during a test, the test shall be suspended pending evaluation as to the bearing of the failure on the testing completed and as to the need of additional testing using new or reworked parts. Reports shall be submitted within 15 days of the reported failure.

17.4.6 Equipment Manufacturer's Representatives

Representatives of the manufacturers of equipment such as engines, traction alternators, traction motors, air brakes, and other equipment specialties shall be available at the site of each test of such equipment as the Contractor and/or the PATH may require.

17.4.7 Test Instrument Calibration

Calibration information for all test equipment utilized for any and all tests shall be traceable from each Test Report. Each Test Report shall contain a statement that all test equipment used was properly calibrated.

A copy of the Certificate of Calibration shall be supplied for each piece of test equipment utilized to obtain data pertinent to any and all of the tests performed. (It is understood that some equipment does not require calibration such as power supplies utilized strictly to provide source power for other equipment.) Additionally, test equipment shall be available for examination by PATH to allow for the inspection of calibration stickers and that calibration seals, where required, are intact and in place.

A list of all Calibration Standards shall be provided if the Contractor utilizes their in-house lab. Copies of the Calibration Certificates for all Calibration Standards in an in-house lab shall be provided to ensure traceability to the NIST (National Institute of Standards and Technology). If an outside lab performed any of the calibration on test equipment used, a copy of the lab's certification by the NIST shall be provided.

Where NIST is specified above, a higher international standards body may be substituted, where approved by PATH.

17.5 Qualification Tests

17.5.1 Propulsion Tests

A test shall be performed on the propulsion system, including the control system, engine, traction alternator, and traction motors to verify that the system meets the performance requirements of Section 2.5. Data such as control signals, engine output, traction alternator output, traction motor input, time, speed, acceleration, battery capacity test, etc. shall be recorded and a printout shall be included in the test report. Safety features shall be tested, by creating fault conditions for all safety criteria.

17.5.1.1 Engine Test

17.5.1.1.1 Horsepower Test

The Locomotive shall have its engine tested at rated rpm to verify that the horsepower developed is within the manufacturer's limits.

17.5.1.1.2 Heat Test

The Locomotive shall have its engine tested at full power to verify that the variation between the radiator air inlet and outlet temperatures and the radiator coolant inlet and outlet temperatures do not exceed the manufacturer's recommendations.

17.5.1.1.3 Back Pressure Test

The Locomotive shall have its exhaust system tested to verify that the maximum back pressure of the engine exhaust specified by the manufacturer is not exceeded.

17.5.1.1.4 Radiator Cooling Airflow and Engine Exhaust Velocity and Temperature Test

The Locomotive shall have its radiator cooling airflow and engine exhaust tested to verify the airflow velocity and temperature requirements of Sections 10.2 and 10.3. The test shall measure velocity and temperature at a distance of twelve (12) inches from the discharge opening at maximum propulsion power output once cooling and engine exhaust airflow temperatures have stabilized.

17.5.1.2 Battery

The battery shall be tested to establish that the batteries will meet the performance requirements of Section 10.7 and 10.7.1.

17.5.1.3 Traction Alternator Test

The traction alternator shall be given a routine test by the manufacturer to verify compliance with all aspects of the following for the nominal rotational input conditions from the diesel

engine:

- All output and control requirements
- Performance requirements
- Fault detection and annunciation requirements
- Insulation and isolation requirements. Insulation shall be tested as required in Section 17.5.13.1

17.5.2 Frictional Brake System

The friction brake system shall be functionally tested and adjusted on the Locomotive to meet the manufacturer's specification requirements.

17.5.2.1 Air Brake Equipment Testing

The air brake equipment shall be tested at the manufacturer's plant in accordance with approved test codes. The equipment shall then be tested after installation on the Locomotive. The following items shall be included:

17.5.2.1.1 Reservoir Test

The reservoirs shall be subjected to a hydrostatic test of 300 psi (2,067 kPa) and an air test of 160 psi (1,103 kPa) without leakage.

17.5.2.1.2 Trip Cock Test

The Contractor shall test the operation of each trip cock to verify compliance with Section 13.3.3

11.3.3. 17.5.2.1.3 Leakage Test

Upon completion of the Locomotive at the Contractor's plant, air brake system, including piping shall be tested to verify that it does not exceed leakage requirements of Section 11.4.2.

17.5.2.2 Park Brake Test

The park brake on the Ready-to-Run Locomotive shall be functionally tested to verify compliance with Section 11.3.10.

17.5.3 Wheel Load Test

Wheel load measurements shall be made by the Contractor on the first Ready-to-Run Locomotive to verify that the wheel load at every wheel is within the maximum permissible loads as specified in Section 2.3.2. The instrumentation for simultaneously measuring the wheel load under every wheel shall have an accuracy of 1 % and shall be coplanar within 1/16”(1.6

mm).

17.5.4 Camber Test

The camber shall be measured with a Ready-to-Run Locomotive to verify compliance with Section 3.2.2.

Under no circumstance should the carbody exhibit a negative camber. If the camber requirements are not met, then the Locomotive shall be subject to automatic rejection.

17.5.5 Carbody Balance Test

The Carbody Balance Test shall be performed to verify that the Locomotive meets the carbody balance requirements of Section 2.3.3.

17.5.6 Carbody Underframe Radiographic Inspection Test

The stripped Carbody underframe on the first Locomotive, including the end frame, bolster and any other primary structural member shall be tested by radiographic inspection of all welds. Areas where Radiographic inspection is difficult or cannot be used, Ultrasonic Inspection method can be used on a case-by-case basis with the approval of PATH.

Radiographs shall be made in accordance with AWS D 1.1 for welds. Inspection quality level shall be selected by the Contractor and approved by the Project Manager, but shall not be of lesser quality than that required by Section 6 of AWS D 1.1 for welds. Defects found shall be repaired and the underframe re-inspected. This process shall continue until the underframe passes the inspection. If major defects are found on the welds on the underframe of the first Locomotive then the underframe on the second Locomotive shall be tested. If major defects are found on the welds of the second Locomotive, then the underframe on all remaining Locomotives shall be tested.

Critical areas may be sectioned and etched to demonstrate weld soundness. In this case, there shall not be less than three etched sections at each critical area, and the location of each shall be approved by PATH.

17.5.7 Truck Radiographic Inspection Test

Both trucks on the first Locomotive, including the frame, bolster and any other primary structural member shall be checked by radiographic inspection of all critical welds. With PATH's approval, ultrasonic inspection can be applied to the requirement of this section instead of radiographic inspection. Critical welds shall be defined
as:

- All full penetration welds;
- All welds subject to tensile stresses in excess of 50 percent of the weld's rated fatigue

life;

- All non-redundant load path welds whose failure could cause truck failure or derailment; and
- All welds whose failure could impair brake performance.

Radiographs shall be made in accordance with AWS D 1.1 for welds. Inspection quality level shall be selected by the Contractor and approved by the Project Manager, but shall not be of lesser quality than that required by Section 6 of AWS D1.1 for welds. Any defects found shall be repaired and the truck re-inspected. This process shall continue until the truck passes the inspection. If major defects are found on the welds on the trucks of the first Locomotive, then both trucks on the second Locomotive shall be tested. If major defects are found on the welds of the second Locomotive, then all trucks on the remaining Locomotives shall be tested.

Critical areas may be sectioned and etched to demonstrate weld soundness. In this case, there shall not be less than three etched sections at each critical area, and the location of each shall be approved by PATH.

17.5.8 Clearance Test

The Locomotive shall be dimensionally checked to demonstrate that the carbody and trucks have been constructed to be within PATH's clearance requirements as per Section 2.1.3 and 2.1.4. for all operating conditions. After delivery to PATH, the Locomotive shall be tested on all or any part of the PATH System to verify compliance. The Locomotive shall be fitted with fixtures to simulate unit dynamic envelop. A list of critical dimensions to be verified shall be provided by the Contractor and approved by the Project Manager.

17.5.9 Curving Test.

The Locomotive shall be tested to verify that there is sufficient coupler swing when coupled to existing PATH cars when the Locomotive traverses the various restrictive curves on the PATH System. The restrictive curves include: a simple minimum radius curve, a reverse curve. and a minimum radius vertical curve, as specified in Section 2.2, with all possible maximum vertical and lateral movements and were taken into consideration.

During this test, clearances shall be checked between the truck/carbody to wayside, truck to carbody, and coupler to truck.

No interference is allowed between any parts of the carbody and truck or between the coupler and the carbody, including appurtenances such as pipe, hoses and clamps. Hoses shall not be kinked or stretched. The Contractor shall correct any interference. Kinked or stretched hoses shall be replaced with a longer hose, which will not be kinked or stretched under all curve conditions.

The contractor shall also conduct and supply the information regarding a computer modeled

curving performance tests to assess the susceptibility of the locomotive to low speed flange climb derailment under various conditions, including operation around curves with no lubrication, and curves where short distance changes in cross elevation (“warp” or “twist”) might occur.

17.5.10 Coupler Test

Each coupler shall be tested to demonstrate that it can be moved radially by applying a force of not more than 200 lb. (889.6 N) to the side of the coupler. The test shall be done by moving the coupler 3 times in both directions throughout its entire range of travel.

17.5.11 Communication Test

A functional test shall be performed to verify that the all features of the communication system, including the. buzzer, the headset intercom, and the 4 point trainline communication system, meet the requirements of Section 13.

17.5.12 HVAC Tests

HVAC tests shall be performed to verify that the system is designed to- comply with the requirements of Section 12.4.2. Safety features and requirements, such as those in Section 12.3.3 shall be tested to verify proper safety protection.

17.5.13 Electrical Wiring Tests

All wires shall conform to applicable AAR, ICEA, and NEC specifications. All cross-linked polyolefin irradiated insulation shall be tested in accordance with the requirements specified in Section 15.14.3.1. However, in lieu of certain requirements, certifications from the manufacturer(s) may be provided for the Project Manager's approval.

17.5.13.1 Insulation, Continuity and Short Circuit Testing

The integrity of the electrical insulation and continuity of the cables and wiring shall be confirmed where specified below by performing megger insulation resistance tests and high potential tests on individual devices, systems, and apparatus.

The intent of these tests is to detect insulation damage, such as pin holes, tears, open or short circuited wires, thinning of wire or cable during the installation in all trainlines, conduits, raceways or during dressing harnesses into boxes, cabinets or other enclosures.

All wiring and cable tests within any sub-assembly, equipment, or smaller devices, which are supplied by and tested by manufacturers or suppliers other than the Contractor, may be waived, pending PATH approval of the testing certification provided by these manufacturers or suppliers.

17.5.13.1.1 Insulation Resistance, Tests

Insulation resistance tests shall be conducted on all circuits within a device or system apparatus. Insulation resistance tests shall be conducted before high potential tests are conducted. Tests shall be conducted to verify the state of the insulation to the equipment case, between wiring of different voltage classes, and between the input and output circuit of high voltage line switches and circuit breakers. Semiconductor devices may be protected against the test voltage by means of shorting jumpers if they are not inherently protected by the circuit in which they are used.

On items with double insulation, each set of insulation shall be individually tested; i.e., resistors to frame and frame to Carbody.

The following insulation resistance limits shall apply when all circuits on the Locomotive of a given voltage class are connected in parallel under all environmental conditions including high humidity:

Nominal Circuit Voltage Volts dc or ac rms	Minimum Insulation Resistance
Below 90 volts except battery assembly	2 megohms at 500 Vdc
90 to 300 volts	4 megohms at 1,000 Vdc
Above 300 volts	5 megohms at 1,000 Vdc

The test limits for individual devices or apparatus shall be higher than the above listed limits, as is appropriate for that hardware, so that the limits for the completed vehicle can be met.

17.5.13.1.2 High Potential Tests

A high potential test shall be conducted after the insulation resistance test is completed and passed. The high potential test shall be conducted on all circuits within a device *or* system. Tests shall. be conducted to verify the state of the insulation to the equipment case, between wiring of different voltage classes, and between the input and output circuit of high voltage line switches and circuit breakers. Semiconductor devices and lighting inverter ballasts may be protected against the test voltage by means of shorting jumpers if they are not inherently protected by the circuit in which they are used.

All components and systems shall be in place when the high potential tests are being performed. The Contractor shall jumper together the various wires in a system to ensure that all parts of a system are tested, and to prevent capacitive currents or fault currents from passing through and damaging low voltage devices.
On items with double insulation, such as grid resistors mounted by insulators to a frame insulated from Carbody, each set of insulation shall be individually tested; (i.e., resistors to frame and frame to Carbody.)

The test shall be conducted by applying the test voltage, as listed below, for a period of I minute, across the insulation being tested, the test is passed if there is no insulation breakdown or excessive leakage current The test voltage shall be at a frequency of *60* Hz with a sinusoidal waveform. V, in the formula below, shall be the nominal system voltage for a circuit

Nominal Circuit Voltage Volts dc or ac rms	Test Voltage. ac rms
Below 300 Volts	(2) (V) + 1,000 volts
Equal to or above 300 Volts	(2.25) (V) + 2,000 volts

Standard apparatus may be production tested for I second at a test voltage 20 percent higher than the above listed 1-minute test voltage.

17.5.13.2 Continuity Test

All circuits shall be tested to ensure continuity and correct polarity of equipment and devices. All frame grounds and terminal connections shall be checked for tightness.

17.5.13.3 Short Circuit Test

The Contractor shall test-to ensure that each wire in cable conduits, raceways, *or* harnesses shall not be short- circuited to carbody ground or to any other wire.

17.5.14

Not used.

17.5.15 Lighting Test

The control and operation of all lights: and indicating lamps shall be tested to verify compliance with the requirements of Section 14.

17.5.16 Heated Windshield/Windows Test

The heated windshield shall be tested to illustrate compliance with the requirements of Section 6.3.1. The overheat protection requirements shall also be verified.

- The Cab Doors and Cab Windows are closed for the duration of the humidification period and the demisting period.
- 100% of the internal surface of the windshield and windows shall be allowed to fog.
- The windshield and windows are then energized while the cab heater is turned on.

17.5.17 Horn Test

The horn shall be tested for compliance to the requirements of Section 11.3.12.

17.5.18 Automatic Fire Suppression System Test

A functional test recommended by the manufacturer of the system shall be conducted to verify that the system meets the manufacturer's specification.

17.5.19 Noise and Vibration Tests

Noise and Vibration tests shall be performed to confirm compliance with the requirements of Section 2.8.

17.5.20 EMI Test

The Contractor shall. conduct tests to verify compliance with the EMC and EMI requirements specified in Section 2.7.

The Contractor shall prepare an EMC Design Report prior to Final Design Review (FDR), and subsequently update it when and if design changes occur as a result of testing.

17.5.21 Cab Water Leakage Test

For the cab, all areas of the cab walls and roof. including doors and windows shall be given a complete test for water-tightness. The tests shall be made before installation of sound deadening material, thermal insulation, and interior finish. Water shall be sprayed from nozzles that are a distance of 46 inches (1163 mm) to 84 inches (2123 mm) from the carbody, and aimed directly at. the surface being tested. Not less than 0.182 gallons per minute (7.43 L/min/m^2) shall be delivered to each square foot of surface being tested. and the nozzle velocity of the water shall be 77 to 90.2 feet per second (23.5 m/sec to 27.5 m/sec).

All spray applications shall run for 10 minutes before the inspection for leaks begins, and shall run continuously during the inspection. Exterior equipment enclosures and interior equipment enclosures exposed to the outside shall be water-tightness tested as indicated in this Section. If leaks are detected, then repairs shall be made and test shall be repeated. The water test area shall be suitably heated to prevent icing of spray water in cold weather and testing shall be of duration to demonstrate water tightness to the Project Manager.

17.5.22 Safety Features Test

A test shall be performed to verify that all safety features operate as designed. Functional tests to verify that the emergency brake will apply when activated by the conductor's handles, the deadman, and a brake pipe rupture, shall be included in this test.

17.5.23 Independent Locomotive Heating & Battery Charging System

The Contractor shall conduct tests to verify that the Independent Locomotive Heating & Battery Charging System is operating in accordance with the manufacturer's specification and in compliance with the requirements specified in Section 10.15.

17.5.24 Maintainability Demonstration

A demonstration shall be performed to verify that a sampling of equipment, as determined by the Project Manager, is designed to permit quick and convenient access for inspection and maintenance (including removal and installation). The removal and reinstallation of the power plant, mounted on a removable platform per Section 10.2, is one of the demonstration items to be performed.

17.5.25 Visual Inspection Test

The Locomotive will be carefully inspected by PATH inspectors for good workmanship as required in Section 15 and for any potential safety hazards, as required in Section 18.5.4. The Contractor shall correct any defects or unsafe conditions as determined by the Project Manager. The decision of the Project Manager is final.

17.5.26 Functional Tests

Functional tests shall be performed on equipment for which specific tests are not required to verify proper operation.

17.5.27 Strength Tests

17.5.27.1 Truck Test

The Contractor shall perform all truck tests such as static load, dynamic, primary suspension, equalization, fatigue, radiographic inspection, etc. to comply with the minimum requirements of Sections 4.1.4 and 4.1.5.

The manufacture shall demonstrate either at its facility or as a part of acceptance testing that the locomotive when occupying a circuited section of track will cause a change in the circuit that will register occupancy by means of a “downgrade” in the aspect of the signal governing entrance to that occupied section of track. The “shunting ability” of the locomotive will be demonstrated on both dry and wet rail, when the locomotive is stationary, when it is moving, and when sand is being applied to the locomotive wheels.

17.5.27.1.1 Static Tests

The truck shall be subjected to load combinations specified under this Section. Individual loads and loads in each combination shall be applied in at least five (5) increments, and removed in reverse order.

Maximum stress in any portion of the truck structure under the maximum load shall not exceed the criteria specified in this Section. Strain gages /rosettes shall be located at all high stress areas on the approved stress analysis. They shall verify the calculated stresses. The readings of each gage at each load level shall be recorded. The stress analysis shall be c:ompleted prior to the static test.

17.5.27.1.2 Static Loads

The static test load shall be:

a. Vertical Dead Load -Completely Equipped Carbody and truck
Vertical Live Load -Maximum crew, equipment and fuel load

b. An allowance for vertical impact or 30% of the total vertical load consisting of loading (a.) above.

c. An allowance for dynamic motor loads as given below shall be applied at the motor center of gravity.

ALLOWANCE FOR DYNAMIC MOTOR LOADS

	Vertical	Transverse (T)	Longitudinal (L)
c (1) Low	+ 5.5g	+ 5.5g	+3.5g
c (2) Maximum	+ 10.5g	+ 10g	+5.5g

d. A force of 0.50g caused by running on a sharp curve without super "elevation at a speed sufficient to throw the entire weight of the equipped Locomotive, including trucks, on the four wheels on the outside rail.

e. A transverse load of 20% of the weight of an equipped carbody and live load applied at the truck center plate.

f. Forces caused by the maximum longitudinal acceleration resulting from a 25% coefficient of adhesion.

g. Forces caused by the maximum longitudinal deceleration resulting from a 25% coefficient of adhesion and a brake shoe force of 10,000 pounds (44.5 kN) per brake shoe.

17.5.27.1.3 Static Load Combinations

The stresses under the first set of test load combinations specified below shall be determined by superposition of stresses obtained from the application of individual loads. A total of four design load combinations from the second and third sets specified below, as, approved by the Project Manager, shall be used with all loads in each combination multiplied by a factor of 1.2. These four (4) combinations shall be arrived at by establishing a test matrix derived by superposition of the stresses obtained under the individual specified loads in combination and by selecting, with considered engineering judgment, those three (3) combinations which cause the highest stresses at a representative number of locations.
First Set of Load Combinations:

(a) a+ b
(b) a + (c(I)V or c(I)T or c (l)L)
(c) a+e
(d)a+f
(e) a + g

Second Set of Load Combinations:

(a) a + b + c(2)V + c(1)T + c(1)L + e + (f or g)
(b) a + b + c(1)V + c(2)T + c(1)L + e + (f or g)
(c) a+ b+ c(1)V + c(1)T+ c(2)L + e + (for g)

Third Set of Load Combinations:

a + c(1)V + c(1)L + d

The dynamic motor loads indicated shall be applied to one motor and simultaneously, the c(l) loads shall be applied to the other motor.

All components of the above specified loads shall be included the following:

- Static loads shall be applied individually and in the three (3) test load combinations specified above.

- Individual loads and loads in each combination shall be applied in at least five equal increments and removed in reverse order.

- The physical load tests shall cause no observable permanent deformation and no fractures or cracks, as determined by magnetic particle and dye penetrant inspections.

17.5.27.1.4 Static Loading Criteria

The trucks shall meet each of the following static loading criteria:

1. Under each combination from the first set of load combinations, determined by superposition of stresses obtained from the application of individual loads, no stress shall be in excess of 1/3 of the specified minimum yield stress of the material except as permitted in 2 below.

2. Under each combination from the second and third sets of load combinations determined by superposition of stresses obtained from the application of individual loads, no stress shall exceed 2/3 of the specified minimum yield stress of the material. If, however, under these load combinations, the stress at any point does not exceed 1/2 of yield, then the stresses in 1 above, shall be permitted to exceed 1/3 of yield but shall not exceed 1/2 of yield.

3. Under each of the four (4) load test combinations from the second and third sets including the factor of ½ as defined under "Static Load Combinations" above, no stress shall be in excess of 4/5 of the specified minimum yield stress of the material.

17.5.27.2 Carbody Structural Tests

Structural testing, including all reports, shall be designed and developed to confirm that the analyses of the Locomotive Carbody structure requirements of Sections 3.3 and 3.4. The test reports shall be sufficient for 10ng-teTOl use as part of the permanent information to be used to maintain, repair and modify the car throughout its life.

17.5.27.2.1 General

The first Carbody shall be tested by the Contractor to verify that the critical portions of the Carbody structure comply with this Specification. The teats shall not begin until the Carbody stress analysis has been approved.

The test specimen shall be completely inspected and all non-conformances corrected. A II inspection, test, and corrective action reports shall be available for review.
The test shells shall be structurally complete, but excluding such items as exterior and interior trim, windows, doors (except those used in the vertical load test), seats, lights, interior lining, insulation, or other parts that would obscure any structural member from view or that would interfere with the performance of the test. Underfloor equipment shall be simulated by equivalent weights at their respective locations. All structural tests shall be conducted on the same specimen.

The Carbody shall be weighed and the weight recorded prior to installation of any test equipment. For the tests, the Carbody be supported on the trucks or equivalent supports to allow longitudinal movement.

All gauges and instruments shall be in current calibration. The method of calibration and time period for re-calibration shall be in accordance with the test laboratory's national standard or ISO. The laboratory shall have on file a current certification of calibration traceable to the laboratory's national standard.

The Contractor may conduct preliminary tests, but all critical dimensions must be verified after the Contractor tests and before the official test begins. The official test (test of record) shall be witnessed by PATH. A copy of all recorded data shall be given to the PATH witness at the conclusion of each test.

Where practical, all gauges shall have all electric output suitable for recording on electronic (magnetic) media. A data acquisition system shall be provided to permanently record all gauge output at each load step. At the end of each load step, a printout of all strain gauge readings in proper engineering units (microstrains) and a plot of load vs. gauge reading for critical gauge locations shall be given to the PATH representative for review. The Contractor shall obtain

approval from the PATH representative after every load step before proceeding with the next step. The Contractor shall not break down the test fixtures until the PATH representative has reviewed all the data.

The Contractor shall prepare a color photographic record of the test. This record shall include photographs of the Locomotive in the several test fixtures, installation of critical strain gauges, repairs or modifications, deviations from the drawings and any areas that were found to be non-compliant.

17.5.27.2.2 Test Procedure

A test procedure shall be prepared for each test. The procedure shall include a description of the test, the purpose, how and with what equipment the specimen is to be loaded and in what load increments, the type and location of strain gauges, the location of deflection gauges, complete description of all instruments and gauges, and details of the data acquisition system. Annotated copies of catalogue cuts may be used to provide some of this description. An explanation of the accuracy of the instrumentation shall be provided. Drawings and sketches shall be included to clarify the text. The test procedure shall be a step by step instruction describing how load is applied, the load at each step, when to record data, and the place where authorization to proceed is to be obtained from the PATH representative. Test procedures shall be submitted not less than 90 days in advance of the test date, and approvals of the test procedure and stress analysis are necessary prerequisites for testing.

The test procedure shall include a copy of the current certification for every instrument and gauge to be used during the test. Typical logging sheets, Print-outs, plotting forms, and examples of any other data sheets which will be used during the test or in the final report shall be submitted as part of the test procedure.

Tables shall be included which show the maximum allowable gauge reading for each gauge and loading condition. Other tables shall be included which show the requirements for all other test criteria.

Each test procedure shall contain a table of predicted strain (or stress) at selected strain gauge locations. This table shall list the strain gauge number, predicted strain (or stress) from the stress analysis, the location of the strain, a space to enter the actual strain (or stress) and a space to enter the calculated percent difference, defined
as:

$$Percent\ Difference = \frac{Actual - Predicted}{Actual} \text{ X } 100\%$$

17.5.27.2.3 Strain Gauges

A minimum of 200 strain gauges shall be applied to the Locomotive Carbody structure for the compression tests. A minimum of 200 strain gauges shall be applied to the car structure for the

vertical tests. A minimum of 200 strain gauges shall be applied to the car structure for the diagonal jacking tests. Some of the gauges may be used for more than one test if their location on the structure is appropriate for both tests, but readings from at least 200 strain gauges in locations where the stress may be critical shall be obtained for each test. The location of the strain gauges shall be based on the Contractor's experience, the stress analysis, and PATH recommendations. Drawings and sketches showing the location of every strain gauge shall be prepared by the Contractor and submitted as part of the test procedure. These drawings shall dimension the location of every gauge showing the distance from edges, connections, and bends. The location on the upper or lower, inner or outer surface shall be noted on these drawings.

The strain gauges shall be bonded resistance (SR-4) type or other approved gauges suitable for the application. The gauges shall- be calibrated in accordance with the manufacturer's instructions for the material being measured. The gauges shall be compensated for temperature. For the post load test, there shall be a minimum of 100 strain gauges applied to the post and car structure. Some of the gauges may be used for more than one test if their location on the structure is appropriate for both tests, but readings from at least 100 strain gauges in locations where the stress may be critical shall be obtained for each test.

17.5.1.7.1.4 Deflection Gages

Vertical deflection of the Carbody shall be measured along the side sill during all tests. At least 11 gauges shall be used per side; Gauges shall be located at the end sills, at the bolsters, and half-way between the bolsters. The remaining gauges shall be evenly spaced between the five locations. Measurements shall be taken to the nearest 0.0 1 inch (0.25 mm), and the deflections shall be considered as the average of the readings recorded on both sides of the car.

To measure the longitudinal deflection of the car during compression testing, additional longitudinal deflection gauges shall be applied at the end sills, near the ram and at the opposite end sill, near the reaction.

For the diagonal jacking test, an additional vertical deflection gauge shall be applied at the jack which is lowered or raised to measure the vertical movement at this point.

The deflection gauges shall have an electric output compatible with the data logging apparatus used with the strain gauges. All deflections shall be recorded simultaneously with the strain gauge recordings.

In addition to the above electronic recordings, five dial indicators of sufficient stroke shall be employed to measure the vertical deflection at the center of both side sills, the longitudinal deflection at the anti-climber next to the ram and next to the reaction at the opposite end of the Locomotive. The fifth indicator shall be located next to the lowering jack during the diagonal jacking test. These dial indicators shall be read and manually recorded at every load step.

To measure the bending of the collision posts during the post tests, deflection gauges shall be applied to the post at a minimum of four places on each post being tested: top, bottom, middle,

and load application point. These gauges shall be mounted to measure the motion of the post in the direction of the applied force. In addition, a dial indicator shall be mounted at the middle of the post, to measure the motion perpendicular to both the axis of the post and the direction of loading, in each test.

17.5.27.2.5 Load Cells

In order to verify the accuracy of the applied vertica1 and compressive loads, load cells shall be provided at the appropriate location for each test Each load cell shall be calibrated to 1- percent accuracy and certified within two months before commencement of these tests over the full range of 1.5 times the maximum load to which the load cell will be subjected during these tests.

The load cells shall have electric output compatible with the data logging apparatus used with the strain gauges. All loads shall be recorded simultaneously with the strain gauge recordings. Hydraulic load cells are not permitted.

A single load cell shall be placed at the end of the ram for the compression test A load cell shall be placed at each secondary spring location for the vertical test. A load cell shall be placed at each jack location for the diagonal-jacking test. A load cell shall be placed under each wheel for the wheel load test Load cell readings shall be taken and recorded at each step of the vertical, compression, and diagonal jacking load application and removal process.

17.5.27.2.6 Vertical Load Test

17.5.27.2.6.1 Test Description

The Carbody specimen supported on trucks or a simulation shall be subjected to a vertical load test. A test load equal to the static vertical operating load specified in Section 3.3.3.1 shall be applied to the specimen. The load shall be applied in four approximately equal increments resulting in a total of five vertical load readings. One of these increments shall be equivalent to a Ready-to-Run Locomotive Carbody weight, including a full crew load. The test load may be applied by means of weights or jacks, but shall be distributed in proportion to the distribution of weight in the finished Locomotive. The specimen shall be unloaded in the increments that it was loaded, in reverse order. Strain gauge and deflection readings shall be taken at each load increment.

During the vertical load test, a measurement of Carbody vertical deflection shall be made along both Carbody side sills at each test load applied.

17.5.27.2.6.2 Test Criteria

The car will be compliant with this Specification if all of the following are met:

- Stresses are in accordance with the requirements of Section 3.3.3.1.

- Vertical deflection reading plotted against load do not vary by more than +/-5 percent from a
- straight line (linear) deflection curve, with one end point at the origin (no load) and the other near that point which represent the measured deflection for maximum vertical load.

- Strain readings plotted against load do not vary by more than +/-5 percent from a straight-line (linear) curve, with one end point at the origin (no load) and the other near the point, which represents the measured strain at maximum load.

- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Recorded residual vertical deflection between bolsters following removal of the maximum vertical test loading does not exceed 0.04 inch (1.0 mm).

- Recorded residual car transverse width and/or opening diagonal dimensions following removal of the maximum vertical test load do not exceed 0.04 inch (1.0 mm).

- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.

    - There are no permanent deformations, fractures, cracks, or separations in the car structure. Broken. welds shall be jointly inspected by the Contractor and PATH to determine if the failure is the result of weld quality or stress.

17.5.27.2.7 Compression Load Test at the End Sill

17.5.27.2.7.1 Test Description

The ability of the Carbody structure to resist the end sill compression loads specified in Section 3.3.3.2 shall be tested.

During the compression test, the Carbody shall be supported on trucks or a simulation thereof to allow free longitudinal movement. The empty Carbody shall be loaded with sufficient dead weight to bring the total body weight (of test specimen) up to that of, a fully loaded Locomotive, including full crew. This loading shall be distributed in proportion to the distribution of weight in the- finished Locomotive.

The test load shall be applied to the anti-climber. The load shall be distributed over an area not to exceed the height of the anti-climber by 12 inches (305 mm) in width.

The compression test load shall be applied by means of a controlled hydraulic ram, and the force

measured by a means independent of those producing the force. Cushioning means, such as lead sheets, shall be provided to assure uniform bearing. The test load shall be applied horizontally on the car longitudinal centerline. The load shall be applied in increments of 25, 50, 75, 87.5, and 100 percent of full load. After each load increment is applied, the load shall be reduced to not more than 2 percent of full load. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load. The ram shall be supported at the Carbody end but shall remain free to move longitudinally with respect to the Carbody end.

17.5.27.2.7.2 Test Criteria

The Locomotive will be compliant with this Specification if all of the following are met:

- Stresses are in accordance with the requirements of Section 3.3.3.2.
- The vertical deflection of t:ach side of the test structure shall be within +/- 10 percent of the value determined by the analysis.
- Vertical deflection reading plotted against load do not vary by more than +/-5 percent from a straight line (linear) deflection curve, with one end point at the origin (no load) and the other near the point which represents the measured deflection at maximum load.
- Strain readings plotted against load do not vary by more than +/- 5 percent from a straight line (linear) curve, with one end point at the origin (no load) and the other near the point, which represents the measured strain, at maximum load.
- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.
- Recorded residual vertical deflection between bolsters following removal of the maximum vertical test load does not exceed 0.04 inch (1.0 mm).
- Recorded residual horizontal deflection between ends following removal of the maximum test load does not exceed 0.04 inch (1.0 mm).
- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.
- There are no permanent deformations, fractures, cracks, or separations in the Locomotive Carbody structure. Broken welds shall be jointly inspected by the Contractor and PATH to determine if the failure is the result of weld quality or stress.

17.5.27.2.8 Compression Load Test at the Coupler

17.5.27.2.8.1 Test Description

The ability of the Locomotive Carbody structure to resist the coupler compression loads specified in Section 3.3.3.3 shall be tested.

During the compression test, the empty Locomotive Carbody shall be supported on trucks or a simulation thereof to allow free longitudinal movement. The empty Locomotive Carbody shall be loaded with sufficient dead weight to bring the total body weight (of test specimen) up to that of a fully-loaded Locomotive, including full crew. This loading shall be distributed in proportion to the distribution of weight in the finished Locomotive.

The compression test load shall be applied by means of a Controlled hydraulic ram, and the *force* measured by a means independent of those producing the force. Cushioning means, such as lead sheets. shall be provided to assure uniform bearing. The test load shall be applied horizontally on the car longitudinal centerline. The load shall be applied in increments of 25, 50, 75, 87.5. and 100 percent of full load. After each load increment is applied, the load shall be reduced to not more than 2 percent of full load. Strain gauge and deflection readings shall be taken at each load increment and at each relaxation of load. The ram shall be supported at the Carbody end but shall remain free to move longitudinally with respect to the Carbody end.

17.5.27.2.8.2 Test Criteria

The car will be compliant with this Specification if all of the following are met:

- Stresses are in accordance with the requirements of Section 3.3.3.3.

- The vertical deflection of each side of the test structure shall be within +/- 10 percent of the value
- determined by the analysis.

- Vertical deflection reading plotted against load do not vary by more than +/- 5 percent from a straight line (linear) deflection curve. with one end point at the origin (no load) and the other near the point which represents the measured deflection at maximum load.

- Strain readings plotted against load do not vary by more than +/- 5 percent from a straight line (linear) curve, with one end point at the origin (no load) and the other near the point, which represents the measured strain at maximum load.

- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Recorded residual vertical deflection between bolsters following removal of the maximum vertical test load does not exceed 0.04 inch (1.0 mm).

- Recorded residual horizontal deflection between ends following removal of the maximum load does not exceed 0.04 inch (1.0 mm).

- Indicated residual strains a1: strain gauges on principal structural elements following removal of the maximum vertical loading do not exceed the maximum error resulting from the accuracy of the instrumentation.

- There are no permanent deformations, fractures, cracks, or separations in the car structure. Broken welds shall be jointly inspected by the Contractor and PATH to determine if the failure is the result of weld quality or stress.

- The flatness and straightness of structural members meet the requirements of Section 3.3.3.4.

17.5.27.2.9 Collision Post Load Tests

The ability of the Locomotive to resist the collision post loads shall be tested to verify compliance with Section 3.3.3.5. During the primary collision post load tests, the car shell shall be supported on trucks or a simulation thereof to allow free longitudinal movement. The empty Locomotive Carbody shall be loaded with sufficient dead weight to bring the total Locomotive Carbody weight (of test specimen) up to that of a fully loaded Locomotive, including full crew. This loading shall be distributed in proportion to the distribution of weight in the finished Locomotive.

The specimen shall be instrumented as required for the car and collision post in Section 17.5.27.2.3, Section 17.5.27.2.4 and Section 17.5.27.2.5.
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The test load shall be applied by means of a controlled hydraulic ram, and the force measured by a means independent of that producing the force. A fixture and cushioning means, such as load sheets, shall be provided to assure uniform bearing and prevent cripping around the area of force application. This fixture and cushion shall not be attached to the post. The test load shall be applied horizontally parallel to the Locomotive's longitudinal centerline. The load shall be applied in increments of 25. 50. 75. 87.5 and 100 percent of full load. The load shall be reduced to not more than 2 percent of full load after each step. Strain gauge and deflection readings shall be taken at each location increment and at each relaxation of load. The ram shall be supported at the Carbody end but shall remain free to move longitudinally with respect to the Carbody end.

17.5.27.2.9.1 Test Criteria

The car will be compliant with this Specification if all of the following are met:

- Deflection readings plotted against load do not vary by more than, +/- 5 percent from a straight line (linear) deflection curve, with one end point at the origin (no load) and the

other near the point which represents the measured deflection at maximum load.

- Strain readings plotted against load do not vary by more than +/- 5 percent from a straight line (linear) curve, with one e:nd point at the origin (no load) and the other near the point which represents the measured strain at maximum load.

- Maximum stresses calculated from strain readings in any structural element do not exceed the allowable stresses approved prior to starting the test program as part of the stress analysis.

- Indicated residual strains at strain gauges on principal structural elements following removal of the maximum loading do not exceed the maximum error resulting from the accuracy of the instrumentation.

- There is no permanent deformation, fractures, cracks, or separations in the car structure. Broken welds shall be jointly inspected by the Contractor and PATH to determine if the failure is the result of weld quality or stress.

17.5.27.2.10 Compression Test Anti-Climber Load

The anti-climber and Carbody structure shall be tested under the loads of Specification Section 3.3.3.6. There shall be two tests; one a test of the anti-climber and its attachment to the end sill, and the other a test to permit, by superposition and extrapolation, validation of the anti-climber combined load case analysis.

A loading test of the anti-climber and its attachment to the end sill shall be performed by the Contractor. The test shall be performed on an actual production anti-climber, which may be mounted in a special test fixture, as long as the method of attachment to the test fixture is the same as production, so that the connection will be subjected to the test loads in a realistic manner.

In addition, as part of the vertical load testing required by Specification Section 17.5.27.2.6, a test shall be performed on the Carbody structural test article to permit validation of the analysis of the anti-climber combined load case of Specification Section 3.3.3.6. At a convenient time during the vertical load testing, the test article shall be loaded by placing a jack under the cab end sill with an intervening load cell. The jack shall be raised until the test article is supported on the jack and the truck at the far end of the test article, and strain deflection data shall be recorded relative to the normal vertical load condition, or other appropriate condition which will permit the test data to be referenced to zero load for the test support condition. The contractor shall propose a test method for this purpose in detail in its test procedure, including procedures for data extrapolation and superposition to produce data which can be compared with the analytical results for the corresponding anti-climber combined load case.

17.5.27.2.11 Diagonal Jacking Test

17.5.27.2.11.1 Test Description

The Locomotive Carbody shall be loaded to its fully loaded condition, including a full crew, with all trucks (or an equivalent weight) hanging from the body bolsters. The Carbody shall be supported symmetrically at the jack pads at the four corners of the Car1body. One of the jacks shall be lowered in five equal increments until the load on the jack is 10 percent of its original load. All gauges shall be recorded at each increment of jack position. The procedure shall be reversed until the load on the jack is returned to its original level.

17.5.27.2.11.2 Test Criteria

The Locomotive will be compliant with this Specification if all of the following are met:

- Maximum stresses calculated from strain readings in any structural element do not exceed the
- allowable stresses approved prior to the start of the test program as part of the stress analysis.

- Strain readings plotted against load do not vary by more than +/- 5 percent from a straight line (linear) curve, with one end point at the origin (no load) and the other near the point which represents the measured strain at maximum load.

- Indicated residual strains at strain gauges following return to original level do not exceed the maximum error resulting from the accuracy of the instrumentation.

- There shall be no permanent deformation, fractures, cracks or separations in the Carbody structure. Broken welds shall be jointly inspected by the Contractor and PATH to determine if the failure is the result of weld quality or stress.

17.5.27.2.12 Structural Changes

Any structural changes or modifications: made during any failed test or during construction and assembly shall be subjected to the entire test series. All Locomotives constructed prior to and subsequent to these tests shall incorporate these structural changes or modifications. These tests and modifications shall be at the expense of the Contractor.

17.5.27.2.13 Test Report

The Contractor shall prepare and submit a final test report within 30 days after successful completion of the structural tests. Approval of the test report constitutes acceptance of the Locomotive structural tests. The test report shall include:

- A table of contents.

- The test procedure (with all its appendices).
- A narrative describing the conduct of the test.
- Tables showing stresses and deflections which were 80 percent or more of the allowable.
- Description and explanation of any value that exceeded the test criteria.
- Appendices containing all data i.e. output from each gauge for each load step. These data shall be clearly identified and include the date that they were recorded.
- The record photographs shall be mounted on pages the same size as the report pages.
- Side sill deflection curve for each load step.
- Stress (or strain) vs. load c:urves for the 10 greatest tension stress locations and the 10 greatest compressive stress locations for each test series.
- Tables comparing the stresses computed in the analyses with stresses determined from the strain gauge readings for each test. These tables shall be annotated to explain differences between the predicted and test values.

17.5.27.2.14 Equipment Support Test

The strength of equipment supports subject to stress analysis as required by Section 3.3.2.1 shall be tested. The three heaviest items of equipment, and a fourth selected by PATH shall be subjected to the required tests.

Each item of equipment required to be tested shall be subjected to loading in both senses on all three principal axes in accordance with the requirements of Section 3.3.3.9 with all supports active. The tests shall then be repeated with one less than the total number of supports in accordance with the requirements of Section 3.3.3.9.

The test shall be considered successful if the failure criterions of Section 3.3.3.9 are met.

17.5.27.2.15 Event Recorder Test

Each Event Recorder System shall be tested and certified as being compliant with 49 CFR Part 229.

A functional system test shall be conducted to verify proper installation, operation, and interface of the Event Recorder System on each locomotive This shall include an end-to-end verification of each event recorder channel, which means that all signals shall be measured, at their source

and before pickup sensor, with an independent calibrated instrument, and the end reading on the Event Recorder shall be verified as accurately recording the monitored parameter through its full range of operation.

Each Crash Harden Memory Module (CHMM) shall have a certified marking applied per FRA 49 CFR Part 229.

17.5.27.2.16 Monitoring and Diagnostic System (MDS)
A functional system test shall be conducted to verify proper operation of the Monitoring and Diagnostic System in each Locomotive.

17.6 Locomotive Pre-Shipment Tests

The following tests shall be performed on all Locomotives other than the first Locomotive.

- Propulsion Test (17.5.1.1)
- Frictional Brake System (17.5.2)
- Carbody Underframe Radiographic Inspection Test (if required after performing test on first
- Heated Windshield/Windows test, Section 17.5.16)
- Truck Radiographic Inspection Test (if required after performing test on first Locomotive, Section 17.5.7)
- Coupler Test (17.5.10)
- Electrical Wiring Tests (17.5.13)
- Lighting Test (17.5.15)
- Automatic Fire Suppression System Test (17.5.18)
- Safety Features Test (17.5.22)
- Visual Inspection (17.5.25)

A functional test shall also be conducted for these Locomotives as required per Section 17.5.26. However, the pre-shipment functional tests shall be conducted for systems for which qualification tests are not required.

17.7 Conformance Tests

Conformance tests shall be satisfactorily completed by the Contractor as one of the conditions of Acceptance. All tests shall be performed on the first Locomotive. The Contractor shall provide all test equipment necessary to perform this testing.

After delivery of the first Locomotive and before it is operated, it shall be jointly inspected by the PATH and the Contractor. The Contractor shall make any reassembly, adjustment, or repair as required for proper operation before conformance testing is begun. Contractor shall provide the PATH with evidence that any inadequacies have been corrected prior to shipment of additional Locomotives.

Successful completion of all of the Contractor's acceptance tests shall be required before delivery of additional Locomotives to PATH.

17.7.1 Propulsion System

17.7.1.1 Propulsion Power Test

A test shall be performed to verify that the propulsion system is designed to pull the loads on grades as specified in Section 2.5.

17.7.1.2 Acceleration and Balance Speed Test

A balance speed and acceleration test shall be performed. The Locomotive will be by itself and be coupled to existing PATH work cars and tested on level tangent track. It will also be tested by itself. The Locomotive consist will start from standstill and the propulsion controller will be moved to the full power position. Various parameters, including speed, distance and acceleration will be recorded. When the Locomotive consist attains its balance speed, the test will be completed. Five runs will be performed for this test in both directions. The acceleration rate for the consist will be calculated from the speed and distance data collected.

17.7.1.3 Diesel Engine Exhaust Emissions Test

The Locomotive shall be tested at a site in the PATH underground System, to be determined by the Project Manager, to measure Nitric Oxide (NOx), Nitrogen Dioxide (NO2*)*, Carbon Monoxide (CO), and Aldehydes exposure levels at various locations in and around the Locomotive. The specific locations (sensor locations) at which measurements will be taken shall be representative of locations in which PATH personnel will be present during Locomotive operation, and will be approved by PATH.

A total of at least four (4) 8-hr sample:) will be collected for Nitric Oxide. A total of at least four (4) 8-hr samples will be collected for Aldehydes. A total of at least sixty-four (64) 15-minute samples will be collected for Nitrogen Dioxide. A total of at least sixty-four (64) 15-minute samples will be collected for Aldehydes.

17.7.1.4 Propulsion Multiple Unit Control Tests

The multiple unit operation will be tested by connecting the twelve point trainline to another PATH Locomotive to verify that the new Locomotive can control the PATH Locomotive, and that the PATH Locomotive can control the new Locomotive.

17.7.1.5 Propulsion Function Tests

The propulsion system will be functionally tested to verify that all features are operating in accordance with the manufacturer's specification.

17.7.2 Brake System Tests

17.7.2.1 Stopping Distance Tests

A stopping distance test shall be performed. The Locomotive will be coupled to existing PATH work cars and tested on level tangent track. The Locomotive will also be tested by itself. The Locomotive consist will be brought to speeds of 5, 10, 15, 20 and 25 mph and the emergency brakes will be applied via a trip stop mounted on the track, activating the trip cock. Various parameters, including speed, distance, brake pipe pressure, brake cylinder pressure, and equalizing reservoir pressure will be recorded. The deceleration rate for the Locomotive consist will be calculated from the speed and distance data collected.

Stopping distance tests. These tests also need to be conducted when making a service application of the brakes (full service), to confirm that the locomotive can meet PATH’s required rate of deceleration without the necessity of an emergency application of the brakes. The supplier shall provide a Stopping Distance test procedure for PATH to approve. The tests shall be conducted on both wet and dry rail. In addition, if PATH opts to include dynamic braking, then the locomotive must be able to reach zero velocity within the signal design distance when the dynamic brake is not operative.

17.7.2.2 Pneumatic System Leakage Test

A brake system leakage test shall be performed after the reassembly of the brake system, including hoses, to meet the leakage requirements of Section 11.4.2.

17.7.2.3 Park Brake Test

The park brake shall be demonstrated to be effective in holding a completely equipped Locomotive, including fuel (full), full crew on the maximum grade for one hour.

17.7.2.4 Brake System Function Tests

The brake system shall be functionally tested to verify that all features are operating in accordance with the manufacturer's specification, including all emergency brake application features.

17.7.3 Curve Tests

The Locomotive shall be coupled to the appropriate adjacent cars and checked for proper truck, drawbar, coupler, cable and hose clearance with the consist on PATH's 100' +/- 5' radius curve and 110' +/- 5' radius reverse curve. The Locomotive and adjacent car ends shall be checked for proper inter-car clearance. The couplers shall be checked for proper vertical and horizontal swing and for clearance from the truck, under car components, anti-climber and ground (top of rail). All

truck, trainline, and coupler cables and hoses shall be checked for clearance and to verify that there is no stretching and chafing of cables and hoses.

17.7.4 Clearance Test

The first Locomotive shall be operated through a representative section of PATH, as selected by the PATH, to ensure clearances with the existing wayside facilities.

17.7.5 Function Test

A complete, orderly and comprehensive test of each and every system shall be made to verify proper operation. The Portable Test Units (PTUs) shall be used for these tests to the maximum extent possible. Whenever possible, the tests shall be conducted to verify that all features are operating in accordance with the manufacturer's specification. They shall include, but not be limited to the following systems:

- Cab Control Stand Controls
- HVAC
- Communications
- Lights
- Safety Features
- Four Point Communication Line
- Event Recorder
- Monitoring and Diagnostic (MDS)

17.7.6 Performance Reliability Test

A thirty- (30) day performance reliability test of actual operation shall be conducted prior to acceptance. Reliability shall be measured and reported daily over a period of 30 days, and no day should have less than 99% availability. This test shall be conducted only after having successfully completed all other Conformance tests required in this Section. During the test, the Locomotive shall operate in its normal duty cycle to verify that the Locomotive shall operate safely and reliably. It is assumed that during this reliability test, PATH personnel, as required by the approved interim manuals, will perform normal routine maintenance and inspection with the assistance of the Contractor's representative.

Any design or two quality failures will result in a failed test and must be restarted from day one. Design failures are those which require a re-design in a component, system or subsystem to resolve a failure. Quality failures are those in which a component, system or subsystem is replaced in-kind. The Contractor must provide a failure analysis report for all failures, including the cause of the failure and how die recommended resolution addresses the failure. The failure analysis report will be reviewed and must be approved by PATH. The decision of the PATH shall be final.

17.8 Locomotive Acceptance Tests

Acceptance tests shall be conducted by the Contractor for each Locomotive after it has arrived on PATH property. The Contractor, as one of the conditions of Acceptance, shall satisfactorily complete the tests. The Contractor shall provide all test equipment necessary to perform the testing. After receipt of each Locomotive at the PATH property and before it is operated, it shall be jointly inspected by PATH and the Contractor. The Contractor shall reassemble, make adjustments or repairs as required to prepare the Locomotive Ready-to-Run before acceptance testing is begun. If defects are found during inspection, the Contractor shall provide PATH with evidence that the system, subsystem, or component has been repaired, or remedied, and is functioning properly after this defect(s) is corrected and prior to shipment of additional Locomotives.

Where such agreement calls for the work to be done at PATH shops by the employees of PATH, the Contractor shall pay PATH the cost of labor, materials, plant facilities and equipment involved in the work in accordance with PATH "Schedule of Rates for Services Rendered to Outside Parties" in effect at the time of such work. Current rate schedules for Contractors are available at PATH. Any defects disclosed by any inspection or tests in the equipment, its apparatus, material or workmanship, shall be corrected at the Contractor's expense.

The Acceptance Tests shall include the following:

- Propulsion Function Test (Section 17.7.1.5)
- Pneumatic System Leakage Test (Section 17.7.2.2)
- Brake System Function Test, including emergency brake applications (Section 17.7.2.4)
- Park brake Function Test (17.7.2.3)
- Coupler Swing Test (Section 17.5.10)
- Propulsion Multiple Control Unit Test (see Section 17.7.1.4). The multiple unit operation will be tested by connecting the twelve point trainline to another Locomotive to verify that one Locomotive can control the other Locomotive, and vice versa.
- Event Recorder function test (See section 17.5.7.27.2.15)
- Monitoring and Diagnostic System (MDS) Function test (see section 17.5.7.27.2.16)
- Function Test (Section 17.7.5), which includes:
    - Cab Control Stand Controls
    - HVAC
    - Communications

- Lights
- Safety Features
- Four Point Communication Line

SECTION 18

18.0 SYSTEM ASSURANCE

This Section establishes criteria for the development and implementation of a system assurance program to optimize the quality, reliability and maintainability characteristics and safety aspects of the PATH's system elements and of the completed Locomotive. The Locomotive shall be designed to provide a high degree of safety and reliability, and to minimize downtime during preventive and corrective maintenance activities. Designs shall assure that the Locomotive performs as required without excessive failures, delays, interrupted service, or hazards to the crew.

18.1 Quality Assurance Requirements

18.1.1 General Requirements

At the PDR, the Contractor shall plan and implement a Quality Assurance (QA) Program to assure delivery of a quality product to the PATH under the terms of this Contract. The elements of the program shall be imposed on the Contractor's entire organization and all manufacturers, subcontractors, and suppliers that perform contract work. The QA Program shall assure that all aspects, of the Contract are in conformance with the design materials and workmanship requirements provided in this Specification and that those requirements shall be provided in a timely manner. The program shall also require the Contractor to document inspection of the design and manufacturing operations.

The Contractor shall be solely responsible for all of the quality assurance functions required by this Contract. The Contractor shall ensure Contract compliance by subcontractors and suppliers. Surveillance of I subcontractors shall include sampling and review of products, records, procedures, processes, manufacturing operations, and Quality Control methods.

The Contractor's quality assurance efforts shall be in compliance with the requirements of ISO 9000 or ANSI/ASQC Q9000-1, latest revision. The Contractor need not be registered under ISO 9000 or ANSI/ASQC Q9000-1 to obtain compliance.

18.1.2 Quality of Work

The following domestic standards and specifications define materials for this contract: Federal or Military Specifications or Standards, the Specifications of the Aluminum Association of America, AAR, ANSI, ASME, ASTM, FRA, IEEE, and additional requirements, as specified herein.

All equipment shall comply with applicable codes, standards, and regulations cited in these Specifications. Where conflicts exist between standards, the more restrictive, as determined by the PATH, shall apply. Should however any discrepancy appear or any misunderstanding arise as to the import of anything contained in either, the explanation or decision of the Project Manager shall be final.

Deviations from, and substitutions of, specified standards shall be made only if approved by PATH. Contractor shall submit a detailed comparison of the alternative criteria, the rationale for the alternative, and whether the proposed code or standard meets or exceeds the existing standard.

18.1.3 Assessment of Quality Assurance Program

PATH shall have the right to visit facilities of the Contractor and subcontractors to assess their quality assurance programs. This assessment will determine if the quality assurance programs will assure product compliance with the Specification requirements. During assessment, PATH may inspect production facilities, examine operations in progress, and review documentation. If deficiencies are noted, the Contractor shall ensure that corrective action is accomplished and approved. Corrective measures and their documentation are a condition for PATHs acceptance of the Quality Assurance Program Plan.

After Notice of Award, PATH shall have free access to shops of the Contractor and subcontractors. PATH will perform quality assurance inspections during the Contractor's execution of the Contract to ensure that the Contractor is meeting all of its Quality Assurance Program requirements. The inspections will be performed independent of and in addition to the Contractor's quality assurance function. These monitoring functions will confirm that all deliverables under the Contract, and PATH -approved Contractor drawings and documentation conform to the Specification. PATHs quality assurance activities will in no way replace, negate, override, or lessen the Contractor's quality assurance and other obligations.

Quality assurance responsibilities required by this Specification include planning, establishing and maintaining a quality assurance program; performing all work required by the quality assurance program; and conducting regular QA program audits.

18.1.4 Quality Assurance Program Plan

Within 60 days after the Notice of Award, the Contractor shall submit a work specific Quality Assurance Program Plan to PATH for approval. As a minimum, the Contractor shall submit all procedures identified in this Section for PATH disposition. This Quality Assurance Program Plan shall regulate procedures, methods and processes to ensure compliance with all Contract requirements. As a condition of having the Plan approved, the Contractor shall incorporate written procedures defining methods to implement and maintain its QA program. All engineering, procurement, manufacturing, inspection and test plans and procedures shall be developed using the methods and procedures found in the referenced Quality Assurance Manual. It shall clearly define the authority of the Quality Assurance Department and the responsibilities

of every department for quality. An organization chart shall be included to show the reporting relationships of all management staff. The Plan shall clearly indicate that Quality Assurance personnel shall have sufficient authority and organizational freedom to ensure that a nonconforming or discrepant product or service will not be delivered to the PATH.

The responsibility for the quality assurance function shall be so placed in the Contractor's own organization that meeting schedule and cost projections will not compromise the quality of products or services delivered under the terms of the Contract The Plan shall also contain or refer to a comprehensive collection of forms for documentation of quality control activities.

18.1.4.1 Quality Assurance Manual

The Contractor's and major subcontractor's Quality Assurance Manual shall be submitted for reference.

18.1.5 PATH Inspections

18.1.5.1 First Article Inspections

A First Article Inspection (FAI) will be performed jointly, by PATH and the Contractor, on the major subassemblies and the first fully assembled Locomotive.

First Article Inspection will evaluate the design of the component and system, for which it was intended, as well as their maintainability, including the use of the PTE. FAI will only be performed on a component built using approved production processes and tooling, and shall establish the quality of workmanship for the balance of like components. The level shall be established jointly by the PATH and the Contractor.

First Article Inspection will not be conducted until the design drawings of the article have been conditionally approved. If conditionally approved drawings are used, the PATHs conditions *for* approval shall be satisfied at the FAI and represented by the inspection article.
As a minimum, First Article inspections will be performed on the following items and these items do not have to be retained for the duration of the manufacturing phase, photographs and/or videotapes shall be used and retained by the Contractor:

- Power Plant, including Engine and Alternator,
- Propulsion Control System,
- Cab Construction and Interior,
- Cab Controls,
- Above Deck Equipment Arrangement and Installation

- Electrical Wiring Layout, including Raceway and Conduit Layout and Installation,

- Brake System Installation, including Piping Layout,

- Interior Equipment Installation, and

- Underfloor Equipment Layout and Installation.

The requirements below shall apply to each FAI:

- FAI package submitted to PATH in advance of the FAI that provides the following detail:
    - Schedule and Agenda
    - Component List with Latest Drawing Status
    - All Material & Component Certifications
    - Carbuilder Inspection Plan

- A complete set of approved or conditionally approved drawings and software documentation (with the PATH's comments) for the item to be inspected shall be available;

- Completed Contractor in process and final inspection reports;

- Completed test documents that indicate applicable tests have been passed be available;

- The inspection work space shall provide the proper environment for inspection of piece part,
- subassembly or locomotive final assembly;

- Proper tools and labor to take mechanical or electrical measurements shall be provided; Tools and labor for disassembly and removal of covers shall be provided; and

- Conformance testing shall be performed.

18.1.5.2 Work In-Process and Final Inspections

Inspection shall be in accordance with the Contractor's quality control program. All inspections and tests shall be performed to verify that work in its shops is performed in compliance with the approved design drawings. The Contractor shall provide a qualified supervisor to accompany the PATH during the inspections to assure that proper corrective action is taken. The Contractor shall provide labor and appropriate tools to remove or open and reapply covers and doors during final inspection, all systems shall be operational with use of approved types of special equipment or power supplies.

18.1.6 Qualification of Personnel

Contractor personnel performing work, inspections or tests shall be qualified for such activity by virtue of prior experience and training, and verified by testing where applicable. Records of personnel certification and qualifications shall be maintained and available for PATH review.

18.1.7 Failed Parts Handling

Parts of the Locomotive that may fail in their normal course of operation, maintenance, or inspection thereof. during the Contract warranty period, shall be removed and replaced by the Contractor, with an equal or better Contractor-supplied spare part. The Contractor shall be responsible for transporting the failed part(s) to the Contractor's preferred yet domestically located failure analysis laboratory. The part(s) shall remain in their "as-removed" condition until they are examined at the laboratory. Failed Parts examinations shall be witnessed by authorized representatives of the Project Manager, the Contractor and the part’s’ manufacturer.

The Contractor shall be responsible for promptly furnishing a complete and conclusive failure analysis report on the failed part to the Project Manager. If a definitive failure analysis cannot be made in the Contractor's chosen failure analysis laboratory, the failed part may be submitted to the manufacturer for further analysis at a location of the manufacturer's choice. A report shall be prepared for each failure analysis performed. The report shall include complete details of the failure, the failed part's service history, and proposed corrective actions to eliminate the failure mode. Upon the Project Manager's approval of a proposed corrective action, the Contractor shall implement the corrective measure on the equipment in question and in accordance with a Contractor proposed, Project Manager-approved schedule.

18.1.8 Quality Assurance Audits

The PATH will audit the Contractor's quality assurance activities to determine compliance with the approved Quality Assurance Program Plan. During the initial audit of the Contractor's quality assurance functions, the PATH shall reserve the right to audit the quality assurance programs of subcontractors. Audits shall be performed to approved checklists by personnel other than those who performed the work.

The PATH will notify the Contractor of noncompliance found during audits. The Contractor shall correct noncompliance promptly and request approval by the PATH. Noncompliance with any part of the approved Quality Assurance Program Plan shall be cause for rejection of Contract work. If the Contractor is responsible, work on the Contract shall be rejected. If a subcontractor is responsible, work by that subcontractor shall be rejected.

After corrective action of the noncompliance has been verified, the Contractor will be notified; Contract work may be resumed. Schedule delays caused by non-compliance with the approved Quality Assurance Program Plan shall not justify an extension of time under the Contract. Audits shall report on the degree of compliance with approved Quality Assurance Program Plan in Section 18.1.4.

18.2 Reliability

All components, assemblies, subsystems and systems shall be designed for a heavy freight locomotive, switcher locomotive or passenger car, unless otherwise approved by PATH. These items shall be service proven in similar applications unless otherwise approved by PATH. At a minimum, the Mean Distance Between Failure (MDBF) at the system level shall be 160,000 miles. The MDBF shall be finalized by PDR and subjected to PATH approval.

A 30-day reliability test will be performed on the first locomotive in PATH per Section 17.

18.3 Maintainability

18.3.1 General

The Locomotive shall incorporate designs that minimize the cost and time for maintenance and improves the maintainability of the Locomotive. Maintainability of the locomotive and associated items shall be given prime consideration by the Contractor in the design and manufacture of the car, and by the Contractor's vendors in the design of the individual Systems, Subsystems, Assemblies, and Components. This particular aspect of construction shall be reviewed and approved by the Railroad as the design progresses.

18.3.2 Maintenance Plan

The Contractor shall develop and submit for Railroad approval, 30 days prior to PDR, a Maintainability Program Plan (MPP) to ensure that the Locomotive will be designed to facilitate maintenance and meet the specified maintainability requirements in a cost-effective manner. The Contractor's maintainability program shall include a detailed plan outlining all schedules and activities for the Locomotive's corrective and preventive maintenance. This plan shall be reviewed and approved by the Project Manager prior to the delivery of the first Locomotive. The plan shall outline each maintenance task, time schedules, recommended tools, personnel, and skill levels required. These recommendations shall be based upon those of the Contractor and of the equipment suppliers. Wherever practicable, the Contractor shall schedule inspection and maintenance tasks to coincide with PATH's existing locomotive shop inspection and maintenance cycles – daily pre-trip inspection, 92-day, 6-month, 1 year and air brake system overhaul every 3 years. The approved procedures shall be incorporated into the inspection and maintenance manuals.

18.3.3 Maintainability Demonstration

During the FAI, the Project Manager may request the Contractor to perform a maintainability demonstration, consisting of the removal and replacement of a component, system or subsystem. It may also consist of performing an inspection or any other procedure as required in the manuals or as required for a similar type of item. These items may be chosen by the Project Manager or his representative(s) because in their opinion, the item may not be readily maintainable. Special

attention shall be given to the design to provide easy access to the installation and removal of control apparatus. Stacking of components shall be minimized to improve maintenance.

18.4 Regulatory Requirements

18.4.1 General

The Locomotive shall be designed and constructed to be safe to the operating crew, persons near the Locomotive, passengers standing on the platform of a passing Locomotive, and employees, both under normal operating conditions and in the event of equipment failure. The Contractor shall ensure that all systems' safety aspects are considered for each individual system and for systems as integrated to complete the Locomotive design.

Conflicts between performance and safety requirements will be addressed on a case-by-case basis. The guidelines for resolution of conflicts will be as follows:

- Applications, which in accordance with the requirements of this section are determined to have a significant impact on crew safety, will conform to applicable safety requirements. Requirements for other material characteristics or properties will conform to that of materials typically used for the application that are available at the time of award of contract. Typical examples of this application are materials used in the interior of the cab.

- Applications which do not meet the criteria described in the previous paragraph will require conformance to all operational, performance, service, and maintenance requirements.

18.4.1.1 Industry Codes and Standards

All equipment shall comply with applicable codes, standards, and regulations cited in Section 15.1.2 and elsewhere in this Specification. Where conflicts exist between standards. the more restrictive, as determined by PATH, shall apply.

Deviations from, and substitutions of, specified standards shall be made only if previously approved by PATH. Contractor shall submit a detailed comparison of the alternative criteria, the rationale for the alternative, and whether the proposed code or standard meets or exceeds the existing standard.

18.5 Hazard Analysis

18.5.1 General

A hazard analysis (per MIL-sm-882 as a guideline) shall be performed by the Contractor to qualitatively address the safety concerns associated with the Locomotive's component. subsystem and system failure modes, back-up" contingencies, and probabilities of failure mode

occurrence and their corresponding levels of, criticality. The analysis shall be developed in the earliest phases of the Contract and shall be continuously maintained throughout as design and construction evolves. The analysis shall cover, but not limited to, failures of the following systems:

- Propulsion System
- Air Brake System
- Control Circuits
- Lighting
- Horns

18.5.2 General Design Requirements

The general safety design requirements of Paragraph 4.3 in MlL-STD-882, and the guidelines listed below, shall be incorporated into the design of all Locomotive systems affecting safety:

- Only components with high reliability and which have been proven in conditions similar to the projected service shall be utilized.
- All devices not guaranteed fail-safe shall be assumed capable of failing in permissive modes.
- All electronic circuits and software shall be assumed capable of failing in permissive modes.
- Systems shall be based on closed-circuit principles in which energized circuits result in permissive conditions, while interrupted or de-energized circuits result in restrictive conditions.
- All vital circuits not wholly within the system apparatus enclosure shall be double-wire, and double-break, with the exception of connections to non-vital circuits, which may be single-wire, and single-break.
- Any component or wire becoming grounded shall not cause a permissive condition. Safety circuits shall be kept free of any combination of grounds that will permit a flow of current equal to, or in excess of, 75 percent of the release value of any safety device in the circuit.
- Circuit impedances, signal encoding, shielding, layout, and isolation shall be selected to minimize the effects of interference to the extent that safety is maintained under all

conditions.

- Commands that result in permissive conditions shall be propagated by no less than two independent signals, both of which must be present before the permissive condition can occur. The lack of either signal shall be interpreted as a restrictive command.

- Systems controlled by variable level signals shall be arranged such that zero signal level results in the most restrictive condition. At least one enabling signal, however, independent from the variable control signal, shall be present before the control signal can modulate the system to a more permissive level.

- Circuit breakers and fuses shall be guaranteed by the manufacturer to successfully interrupt rated currents. Circuit breakers and fuses shall be applied such that the maximum circuit fault currents cannot exceed the manufacturer's guaranteed operating ranges.

- Systems that rely on structural integrity for safety shall have sufficient safety factors such that failures are not possible within the life -of the Locomotive under all possible conditions.

- Systems subject to wear shall not wear to permissive states within a period no less than three times the overhaul period under the worst-case combination of duty cycle, environment, and all other influences. Such devices shall be clearly indicated as SAFETY CRITICAL in the maintenance manuals.

- Mechanical systems, which apply force to achieve safe states; shall not depend upon the application of fluid pressure or electrical energy, unless specifically approved.

- All locks, catches, and similar devices affecting safety shall be either self-engaging without application of power, or, if engaged by application of power, shall remain fully and safely engaged in the absence of power.

- All systems shall function safely under all combinations of supply voltages, fluid pressures, shock, vibration, dirt accumulation, and PATH's environment.

- All safety related systems, and devices within those systems, shall be clearly identified as SAFETY CRITICAL in all maintenance manuals, procedures, and training materials.

18.5.3 Failure-Induced Hazards

Locomotive equipment and systems shall be designed and constructed to revert to safe modes under failure conditions. The Contractor shall employ high quality components, proven systems, redundancy, checking devices, and other techniques to accomplish this goal.

The Locomotive systems whose failure could result in hazards of Category I or n severity shall conform to both of the following design principals, and shall be validated during the acceptance testing:

- The failure of a single device shall not result in a permissive condition, and

- An undetected failure of any device shall not permit a subsequent device failure to result in a permissive condition.

The term "failure" includes both the initial device failure and all consequential device failures caused by the initial failure.

The term "device" includes any component, subsystem, or system, whether electrical or mechanical.

The terms "restrictive" and "permissive" relate to potential system responses, which result in either a more-safe or less-safe condition, respectively, such as: stop vs. proceed, a lower speed vs. a higher speed, deceleration vs. acceleration, brakes applied vs. brakes released, actuation of alarm vs. no actuation of alarm. Systems shall conform to the safety design principals by one or both of the following methods:

- The utilization of fail-safe devices, that is, devices with known, guaranteed-by-the-manufacturer failure modes, such as signal-grade relays, and

- Independent channels with independent checking of each channel. All channels shall indicate a permissive state in order that the controlled system achieves a permissive state. Failure in any channel shall not affect any other channel, or force the system into a permissive state. Lack of correspondence between channels shall be alarmed and shall force a restrictive state on the system. Checking equipment invariably requires devices conforming to this method.

Failures in equipment that result in an indication of danger, whether or not actual danger exists, shall be considered to have occurred in a safe manner. Conversely, a failure, which results in an indication of safety, when in fact a dangerous condition may exist, shall not be considered safe.

18.5.4 Safety Under Normal Operating Conditions

The Locomotive shall present a safe, hazard-free environment to the operating and maintenance personnel.

Operators and other crewmembers shall not be exposed to tripping hazards, sharp points and edges, lethal or injurious voltages, toxic materials, abrupt or unexpected accelerations, or similar hazards. Location, illumination levels, colors, graphics, and surface finishes shall be selected to maximize visibility of step edges, controls, and other objects with which the operator and crew

must interface.

Normal and emergency equipment and controls which the operator and crewmembers may operate shall be clearly identified, and operating procedures shall be presented in both printed and graphic formats. Exposure of maintenance personnel to lethal or injurious voltages shall be minimized through compartmentalization, interlocks, and similar measures. All equipment shall be free from sharp points and edges. All equipment enclosures containing hazardous materials, lethal or injurious voltages, or other risks shall be clearly labeled on both the outside and inside of the equipment enclosures.

18.5.5 Human Error and Other External Influences

The Contractor may wish to use MIL-STD-882 and MIL-STD- 782 as guides. All systems shall minimize unsafe conditions resulting from human error. No sequence of standard operations, or the simultaneous activation of any controls, shall result in unsafe conditions. Where conflicting commands are requested, the more restrictive shall result.

Maintenance of safety-related equipment shall be arranged such that the effects of errors are minimized. Methods such as limitation of adjustment ranges, unalterable software, non-interchangeable parts, and visible wear indicators shall be employed.

18.5.6 Hazard Identification

Contractor shall identify all failure-induced and normal operating (non-failure condition) hazards falling into severity Categories I or II and fit Hazards shall be compiled into lists and submitted for approval to PATH.

As required by MIL-STD-882, hazard lists shall be organized into a Preliminary Hazard List (PHL), Subsystem Hazard List (SSHL), and System Hazard List (SHL,) as described in Tasks 201, 203, and 204, respectively.

In addition to those hazards identified by the Contractor, the following hazards shall be included in the listings and shall be considered hazards of Category I or II severity:

- Emergency brake fails to apply when requested,
- Service brakes fail to apply when requested,
- Propulsion fails to cease when requested,
- Excessive currents or overheated equipment cause fire hazard,
- Locomotive moves in wrong direction.

- Locomotive speed and track curvature combines in such a manner as to cause a train to derail or a vehicle to overturn.

- On board equipment causing EMI affecting wayside signaling system or other onboard systems.
- Wayside equipment causing EMI affecting wayside signaling system through vehicle or on board
- systems.

- Uncoupled train assumed to be coupled.

- Service brake fails to provide requested braking rate.

18.5.7 Hazard Analyses

Contractor shall perform hazard analyses on all hazards identified in the hazard lists developed in Section 18.5.6. Per-hour failure rates shall be established for each Category of hazard severity. Analyses shall demonstrate that the Locomotive conforms to the requirements of this Specification and that all identified hazards are either eliminated, or reduced to levels of risk acceptable to PATH.

All hazard analyses shall be adjusted or amended as the Locomotive design and construction progresses.

The analysis methods shall be selected by the Contractor as appropriate for the system under evaluation and the Category of hazard severity. Hazards of Category I and II severity shall receive analyses sufficiently rigorous to demonstrate that the hazard cannot occur under any reasonable conditions. The Contractor shall be prepared to demonstrate by test the validity of any portion of all analyses of Category I or II severity hazards. Failure rate for Category I and II hazards must be less than 10^{-7} per hour of operation. Failure rate for Category II hazard must be less than 10^{-5} per hour of operation.

Standard failure and safety analysis methods, and published failure rates for components shall be utilized wherever possible. All electrical circuit failure mode analyses shall include a sneak circuit analysis. All methods shall be submitted for review and approval to the PATH.
Existing hazard analyses of subsystems may be submitted provided the analyzed subsystem is identical in all respects to that proposed, including the operating environment, and the analysis method is sufficiently rigorous. Analyses or tests required by other Sections of this Specification, such as structural analyses or fire penetration tests, may also be submitted for consideration by PATH where appropriate.

Analyses shall examine the Locomotive in all possible configurations.
Analyses shall identify all maintenance errors that could result in unsafe conditions, such as incorrect adjustment of sensors. Analyses shall also include design errors that could produce

unsafe conditions, such as improper breaker type or rating and temperature or environmental dependence on proper operation for use in checking designs.

18.6 Equipment Protection, Access and Maintainability Requirements

All equipment furnished and installed on the Locomotive shall be designed for maximum protection against dust, dirt and moisture entry. All items of equipment and the parts thereof shall be constructed of high quality modular units allowing for fast, easy and efficient removal and replacement of said units and parts thereof. All covers, doors, access panels, etc. on equipment that is opened for regular periodic inspection and maintenance shall be held captive and designed to permit quick and convenient access for inspection and maintenance. Also, they shall be designed so that for all positions, they remain within the car clearance envelope and do not come into physical contact with other components. Covers, doors, access panels, etc. which cannot be designed so that for all positions they remain within the car clearance envelope, shall have safety locks as approved by the Project Manager. Generally, all covers shall be hinged at the top unless approved by the Project Manager. Heavy equipment, which cannot be removed by hand. shall be designed for quick and easy removal using PATH's standard lifting equipment. Such equipment shall include a detailed procedure for removal and installation.

18.7 Inspection, Maintenance, Overhaul and Maintainability

The Contractor must include a maintainability philosophy for the ease of inspection and maintenance for all systems, subsystems and parts of the Locomotive during its design. The designer must envision the inspection and maintenance process so that sufficient room will be provided for access, including any room to use tools and special equipment required for the inspection, maintenance, removal and replacement of all parts such as an adjustment, removal and replacement of a belt.

Access to and/or removal/replacement of consumables, such as filters and fluid filler ports must be unobstructed, and shall not require any movement or removal of any other equipment. Access to other similar items such as belts and hoses shall also be "maintenance friendly" as practical.

18.8 Lockout / Tagout Policy

The Contractor shall comply with, as a minimum, the requirements of OSHA General Industry Regulations 29 CFR 1910.147 -the control of hazardous energy (lockout/tagout). A lockout/tagout policy is required by PATH, in order to ensure a safe working environment and eliminate personnel injury during operation and maintenance of the Locomotive. Lockout/tagout applies to the servicing and maintenance of Locomotive equipment in which the unexpected energization or start-up of the equipment, or release of stored energy could cause injury to authorized employees. This section establishes minimum performance requirements for the control of such hazardous energy.

Lockout is the placement of a lockout device on an energy isolating device, in accordance with a Contractor- established procedure as approved by PATH, ensuring that the energy isolating

device and the equipment being controlled cannot be operated until the lockout device is removed.

The Contractor must provide a means to ensure that all equipment powered by energy source(s) such as electric, mechanical, pneumatic, hydraulic, thermal, or other energy on the Locomotive can be disabled or de-energized when maintenance is being performed. This requirement will enable each authorized employee to verify that lockout and tagout devices are applied to forbid unauthorized operation or removal of energy isolating devices, thus preventing another employee from inadvertently activating the system being serviced until maintenance is completed and the lockout tagout device is removed.

The Contractor shall identify all Locomotive equipment that requires lockout/tagout during servicing. All such equipment aboard the Locomotive shall be equipped to accommodate the required lockout tagout device. Locomotive equipment that requires lockout/tagout during servicing shall include, but not be limited to the following:

- Batteries
- Compressors
- Reservoirs
- Capacitors
- Brake rigging

PATH shall approve lockout devices to be used for each type of equipment that may need to be serviced.

Lockout/tagout does not apply to work on cord and plug connected electric equipment for which exposure to the hazards of unexpected energization or startup of the equipment is controlled by the unplugging of the equipment from the energy source and by the plug being under the exclusive control of the authorized employee performing the service. Also, lockout/tagout does not apply to minor tool changes and adjustments, and other minor servicing activities, which take place during normal maintenance operations, if they are routine, repetitive, and integral to the use of the equipment, provided that the work is performed using alternative measures which provide effective protection.

An energy isolating device will be considered to be capable of being locked out either if it is designed with a hasp or other attachment or integral part to which, or through which, a lock can be affixed, or if it has a locking mechanism built into it. Other energy isolating devices will also be considered to be capable of being locked out, if lockout can be achieved without the need to dismantle, rebuild, or replace the energy isolating device or permanently alter its energy control capability.

An energy isolating device is a mechanical device that physically prevents the transmission or release of energy, including but not limited to the following:

- A manually operated electrical circuit breaker; a disconnect switch; a manually operated switch by which the conductors and, in addition, no pole can be operated independently; a slide gate; a slip blind; a line valve; a block; and any similar device used to block or isolate energy. The term does not include a push button, selector switch, and other control circuit type devices.

The Contractor shall provide lockout devices that utilize a positive means such as a lock, either key or combination type, or other hardware as approved by PATH for isolating, securing or blocking of equipment from energy sources to hold the energy isolating device in the safe position and prevent the energizing of the equipment. PATH shall approve lockout devices to be used for each type of equipment that may need to be serviced.

Lockout devices shall be singularly identified; shall be the only device(s) used for controlling energy; and shall not be used for other purposes. Devices must meet the following criteria:

- Lockout devices shall be capable of withstanding the environment to which they are exposed for the maximum period of time that exposure is expected.

- Lockout devices shall be standardized in at least one of the following criteria: color, shape, or size.

- Lockout devices shall be substantial enough to prevent removal without the use of excessive force or unusual techniques such as with the use of bolt cutters or other metal cutting tools.

When more than one individual, such as a crew, craft, department or other group is required to lockout equipment, a multiple lockout device (hasp) shall be provided if an energy locking device cannot accept multiple locks.

A lockout/tagout procedures shall be provided in a separate section of the Maintenance Manual and shall also, describe the required employee training.

SECTION 19

19.0 CONTRACT MANAGEMENT

19.1 Management

19.1.1 General

This Section specifies the requirements for contract management. The management shall be sufficiently comprehensive to enable PATH to ascertain, with a high degree of confidence, that the Contractor will meet the requirements of this Specification, and to enable PATH to monitor the contractual effort.

19.1.2 Project Manager/Director

The Contractor shall assign an individual on a full-time basis, fluent in English, and approved by PATH, to serve as Project Manager/Director for this Program. This individual shall have prior experience in management of locomotive procurements and be familiar with design, subcontractor equipment procurement, construction, test, communications, and inspection of locomotives. This individual shall be granted full authority to render decisions on behalf of the Contractor pertaining to technical and commercial decisions on the Program. The Program Manager shall serve as the Contractor's representative in all meetings with PATH and/or their duly appointed representatives. No substitution of the Program Manager will be permitted without PATH's prior approval. The Program Manager/Director shall have staff capable of performing a liaison engineering function.

19.1.3 Project Management Responsibilities

The office of the Project Manager/Director shall represent the Contractor during progress meetings, design review meetings, warranty, contract change negotiations, and open item meetings with PATH and, with the Program Manager's supporting staff, be capable of addressing all issues on the agenda for each scheduled meeting. The Program Manager shall arrange to have supporting staff members available for participation in these meetings, as required.

19.1.4 Management Program

19.1.4.1 General

The Contractor shall establish an organization to properly manage this procurement program. The organization shall be highly responsive to the needs of PATH as required in this Specification.

19.1.4.2 Management Plan

The Contractor shall develop and submit to PATH for approval a Management Plan. The Management

Plan shall be submitted within 30 days after Notice of Award to the Contractor and updated via monthly progress reports.

The Management Plan shall show all design reviews and audits required by this Section and elsewhere in this Specification, and shall include, but shall not necessarily be limited to:

- An organization chart including names and a definition of the responsibilities and qualifications of all personnel therein, for the Contractor and major suppliers.

- The internal methods, communications, correspondence coding system, and correspondence control to be used to monitor, oversee. and manage the Program Schedule, technical performance" program changes. subcontracts, purchase orders, material procurement, in-service support, warranty. systems assurance analysis, tests. and demonstrations.

- A Master Program Schedule in Critical Path Method (CPM) format showing key milestones and events. The schedule shall be updated by the Contractor to reflect the changes in the schedules whenever they occur.

- A list of drawings to be submitted during the design review phase of the program and a schedule for the submittal of these drawings.

- An updated and expanded Contract Data Requirements List (CDRL) based on the information in each Section of this Specification within 60 days after Contractor Notice of Award. The CDRL shall contain the consolidated listing of all required data including specific format, quantity, frequency, and paragraph reference of submittal as required by the Technical Requirements. Submittals include, but are not limited to, schedules, plans, procedures, reports, certificates, samples, certifications, test results, and as-built drawings.

  The CDRL list shall be in accordance with the following column headings:

  - Item No: Numeric identifier
  - Title: CDRL item
  - Reference Section: Location of requirement within the Contract Documents
  - Description: Brief description of required due dates and frequency
  - Quantity: Number of documents, Locomotives, or copies required

19.1.5 Monthly Progress Reports

After initial approval of the Master Program Schedule and monthly thereafter, the Contractor shall submit to PATH a copy of the updated Master Program Schedule containing data as of the end of each month. The purpose of the monthly progress reports is the joint review and agreement on job progress. Job progress shall specifically include:

- All items listed in the Management Plan;

- Actual completion dates; for activities completed during the report period; .Actual start dates for activities started during the report period;

- Estimated remaining durations for activities in progress;
- Estimated start dates for activities scheduled to start during the six weeks following the report period;
- Changes in the durations of activities and minor logic changes;
- Workarounds needed to make up for schedule slippage, as necessary;
- Activities not previously included in the master program schedule; and
- Status of correspondence including open items.

The Contractor shall also provide a narrative which shall state the work actually completed and reflect the progress in terms of days ahead of or behind the specified dates for each of the work items, as well as percent completed. During the manufacturing, assembly, and testing phases, Contractor shall supplement the narrative with five (5) or more color photographs to show the status and/or problem areas of the work in progress. PATH may request supplemental detailed reports and/or photographs if the monthly progress report is determined to be adequate.

19.1.6 Master Program Schedule Updating

The Contractor shall update the Master Program Schedule in the following manner:

- Initial schedule shall remain the same for each update;
- Actual progress shall be shown using different colored lines or lines of a different pattern from those used when preparing the initial schedule. Actual progress shall be shown directly under the activity with the percentage complete indicated as of the date prepared;
- Date of the updates shall be provided;
- Actual start/finish dates shall be shown for activities in progress.

19.1.7 Progress Review Meetings

Progress Review Meetings (PRMs) will be held monthly. The monthly PRMs will be held alternately, one month at a PATH location and the following month by teleconference. Based on the activities of the Contract. PATH may elect to increase or decrease the frequency of these meetings. Depending on the subject matter to be covered in the Progress Review Meetings, PATH may opt to conduct certain meetings at the Locomotive construction facilities or facilities of the Contractor's subcontractors. PATH will make this known to the Contractor at least five (5) days prior to the meetings.

The Contractor shall prepare and distribute an agenda to all participants expected to attend the meetings three days prior to the scheduled meeting date.

The appropriate Contractor personnel, based upon anticipated agenda. shall attend.

As a minimum. the following topics shall be discussed:

- Introduce new attendees and areas of responsibility;
- Review minutes of previous meetings, amend minutes if necessary, and accept minutes;
- Review of the updated Master Program Schedule;
- Analyze work accomplished since previous meetings, including: design status, fabrication problems, product delivery problems, schedule slippages, problems arising from proposed changes, and other circumstances which might affect progress of the work;
- Discuss sequence of critical work and schedule of manufacturing using the Contract Schedule and Monthly Progress Reports;
- Discuss engineering, manufacturing, and quality control;
- Discuss changed conditions and time extensions;
- Discuss corrective measures to maintain Progress Schedule when necessary;
- Discuss work to be done in the next six weeks.

Each of the inquiries, reports, and requests for solution of problems presented during such meetings shall be answered, when possible, during the: meeting; those not answered during the meeting shall be solved and the resolution documented and delivered in person or mailed to PATH's designee, within three working days of the close of the meeting, or longer time frame if mutually acceptable. Program Review meeting minutes shall be prepared by the Contractor and submitted to PATH for review and approval within five (5) working days after the meeting.

19.1.8 Contractor Representatives

The Contractor, and its sub-suppliers, shall provide qualified technical and administrative support on PATH's property commencing with the arrival of the first Locomotive and concluding with the completion of the warranty program. The Contractor Representatives shall be fluent in English and fully qualified for the on-site tasks. Included among the personnel shall be a full range of engineering skills, until such time as all Locomotives are accepted. All necessary specialized Contractor and sub-Contractor support shall be available, on short notice, to assist the

on-site personnel in the investigation and resolution of Locomotive and equipment malfunctions.

Contractor Representatives must be identified by the Contractor and display appropriate identification while on PATH property. Contractor's on-site personnel must undergo PATH's safety training prior to access to PATH facilities and adhere to all PATH Rules and Regulations, which are available on PATH's website at http://www.panynj.gov/path/rules-regs.html.

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19.1.9 Project Executive Steering Committee

During the course of this Contract, both the Contactor and PATH may be required to assign senior level personnel who shall form an "Executive Steering Committee". If required, the Executive Steering Committee shall serve to reach resolution on any technical issue which the project managers have not been able to resolve after due consideration. The Superintendent Car Equipment shall be the single point of authority for all technical issues brought before the Executive Steering Committee.

19.2 Design Approvals, Contractor's Drawings, Documentation and Data Requirements

19.2.1 Review Procedures for Drawings, Documents and Data

The Contractor shall submit four copies, and one electronic copy, of all documents, data. assembly and installation drawings required to convey concept, design, dimensions, maintenance, operation, and overall assembly aspects and interfaces for review. The required electronic copy shall be created and submitted using a software package and release approved by PATH. All documents submitted by the Contractor shall be in English.
The Contractor shall submit drawings in accordance with the Contractor's Management Plan. This Plan is based on the Contractor's Drawing Submittal List and Schedule. Subassembly drawings shall also be submitted for information to facilitate the review of assembly and installation drawings. Drawings shall be accompanied by material specifications, process specifications, and flammability and smoke emissions data required to permit review of the drawings. PATH reserves the right to request additional drawings, documents, or data. or any combination of documents, drawings, or data to support the review process. When submitting drawings of structural parts or assemblies for the Locomotive carbody structure or equipment supports, the Contractor shall also submit, for review and approval, stress analyses for these parts or assemblies in summary form. Other contract deliverables including material sample test plans, test procedures, and analyses as required by this Specification shall be submitted in the quantities specified. Review of Contractor submittals shall be secured before manufacturing any parts.

Except as provided below, or as defined in the Review Plan, PATH will return submittals approved, or with comments noted, within 30 calendar days after receipt by PATH. PATH will make good faith efforts to review, disposition, and return Contractor submittals (other than manuals and catalogues identified in Section 20.1, Training and Manuals) within 21 calendar

days or less, except when Contractor submittals exceed the submittal maximum of 100 drawings in a 30 day period. PATH will disposition all manuals and catalogs identified in Section 20.1, Training and Manuals, within 90 calendar days after receipt by PATH. PATH will respond to the Contractor at an address designated by the Contractor.

To prevent grouping of drawings into large packages submitted to PATH, PATH will not be obligated to review more than l00 drawings and technical documents, within a 30-day period. In the event that more than l00 drawings are submitted for review in a 30-day period, PATH will make every effort to review them within the 30 days, except, if specifically identified elsewhere in the Specification. If this is not possible, PATH will review them in accordance with priorities as mutually agreed to between the Contractor and PATH.

As submitted by the Contractor, the drawings, documents and data shall be accompanied by a letter of transmittal listing drawing and document titles, numbers, and revisions. If more than one drawing or document is submitted at a time, the drawings and documents shall be listed in the transmittal in numerical sequence.

No extension of Contract time will be allowed for revision of Contractor's drawings or documents which have been either "disapproved" or "approved with comments noted". Such drawings and documents shall be resubmitted and will be reviewed and! returned to the Contractor within the same time intervals as would be allotted to the drawings and documents when initially submitted. Drawings shall be submitted in an orderly and logical sequence to enable PATH to readily determine and review the interface relationships between all major structural elements and their subassemblies and also between the structural elements and the attached apparatus, equipment, wiring, piping and hardware.

The Contractor shall maintain a record of Contractor and Subcontractor drawing and document status. This shall include drawing and document numbers, revision letter, drawing title, date submitted, transmittal document, disposition, and the document number identifying the disposition. This status shall be updated not less than monthly and submitted to PATH as part of the Monthly Progress Report (reference Section 19.1.5).

19.2.2 Requirements for Drawings, Documents and Data

The Contractor shall provide a wire list, the wire list shall be in an electronic format that is searchable/filterable by wire code, origin and destination.

All drawings shall be produced electronically utilizing computer-aided design software. Manual revisions to drawings shall not be permitted. All dimensions shall be expressed in the English system (feet and inches); all wording shall be in the English language. All terminology used shall be conventional to the U.S. railroad industries. Drawings shall be made to tile third-angle projection system.
All Record Drawings submitted by the Contractor shall be in the format as required by PATH
The Contractor shall provide to PATH a searchable drawing list, the list will contain the number and description of all electrical, mechanical, and pneumatic drawings. Drawings must be detailed

enough to make new parts from them. The parts list shall include the manufacturer’s name and part number.

Drawings shall be submitted as full-size plots, unless specifically allowed otherwise by PATH. A revision block shall be provided for an documents, drawings, and data. The revision block shall identify the revision letter, date of revision, initials of the engineer authorizing the revision, a description of the change and a summary of the change, the location of the change on the drawing and the reason for making the change.

The full description of the change and the reason for making the change shall be shown on a change sheet or similar document accompanying the drawing and appropriately referenced in the revision block. Subsequent to document, drawing, and ,data approval by PATH, engineering change requests (ECR) must be submitted to PATH for approval before incorporation of any document, drawing, and data revisions. Upon receipt of ECR approval, the document, drawing, and data shall be revised and the document, drawing, and data, with the accompanying approved ECR, shall be submitted for approval. No additional revisions to an approved documents, drawings, and data shall be made without an approved ECR.

All structural drawings shall be of sufficient scale and size to clearly delineate the shape and size of all assemblies, members and components. The drawings shall be completely dimensioned. Buildup of materials shall be shown and identified (thicknesses dimensioned). Full and complete information regarding location, type, size, and extent of all welds shall be clearly shown on the drawings. All joints and connections shall be detailed, with. all dimensions, showing the size of the fasteners, and complete AWS, or equivalent, weld symbols (including size and process). The list of materials shall include the material's specification with grade, temper, thickness, and nominal size.

All drawings shall be zoned to make it easier to locate details. The zones shall be approximately 3 inches by 3 inches in size. The vertical divisions shall be designated by letter and the horizontal divisions designated by number. Whenever a cut, section or detail is referenced on a drawing, its location, by sheet and zone, where it can be found shall be given. Wherever the cut, section, or detail is shown, the location by sheet number and zone from whence it came shall be given.
All drawings supplied by the Contractor shall be delineated in a manner that permits the wiring, piping, and mechanical interface relationships between components furnished by the Contractor and its subcontractors to be clearly identifiable.

Whenever reference is made on a drawing to a material or process by the Contractor's own specification number, the drawing shall also give the commercial equivalent. If there is no commercial equivalent, the Contractor shall provide copies of its specification.

Totally integrated Locomotive schematics relating to all electrical and pneumatic systems shall include component identification, component values, waveforms, voltages, currents, resistance values, wire identification, connector identification, and connector pin numbers. All components on PC boards shall be individually shown in the schematics. Schematics shall be comprehensive in nature and thoroughly detailed to permit use by PATH shop, electricians and air brake

specialists to troubleshoot and repair Locomotive systems.

Schematic location (page number. for example) of the energization portion of each device (such as the coil in a relay) shall be noted adjacent to the operating portions (such as relay interlocks) of the device.

A set of device tables shall be located in a single section at the rear of the schematic book. This table shall be arranged in logical fashion by system device type. This table shall include data for all system and subsystem components including but not limited to:

- Electrical control and Power components (groups, Panels, PC cards, contactors, relays, circuit breakers, capaci1tors, inductors, resistors, specialized modules, rectifiers. thyristors, diodes, fuses, and other components, as appropriate)

- Electrical machinery (rotating equipment, reactors, transformers, pumps, fans, compressors, switchgear, and other machinery)

- Pneumatic control and power devices (valves, chokes, strainers, reducers, and other components)

- Pneumatic machinery (compressors, air cylinders, air motors, air latches, and other
- machinery)

At a minimum, device listings shall include the following:

Location in schematic and schematic designation,
- Type, model. and part number,
- Location on Locomotive
- Function,
- Schematic symbol,
- Appropriate ratings data and
- Interface information, as appropriate.

The integrated schematic drawings shall be formatted by subsystem, using identical device symbols and wire and pipe designators for each subsystem. All interfaces, from page to page, and subsystem to subsystem, shall be clearly delineated. The integrated schematic and narrative shall be designed, drafted, assembled, and published by the Contractor, or by a single subcontractor placed under contract for that express purpose. It will not be acceptable to assemble a collection of subcontractor drawings, independently produced, into a single, Locomotive integrated schematic. To ensure clarity, the Contractor shall select lettering and detail size to be legible for a schematic page reduced to a size of 8-1/2 inches x 11 inches; however, the schematic shall be submitted in a page format as specified by PATH.

Wiring diagrams shall be integrated connection diagrams and a wire list in book form based on

the integrated schematic. The diagrams shall show all wiring, raceways, conduits, and connections.

The wire list shall include each individual wire segment in the Locomotive, listed separately, whether the wire is used for the transfer of power or information.

As a minimum, the following information shall be provided for each wire segment:

- Wire code (schematic designation),
- Origin (FROM device/terminal),
- Destination (TO device/terminal),
- Wire size,
- Voltage rating,
- Length,
- Appropriate specification,
- Jacket color, and
- Harness designation.

Instructional drawings shall be prepared in accordance with the requirements of Air Transport Association of America (ATA) Specification No. 100 "Specification for Manufacturer's Technical Data" and shall be prepared so that reduction can be made to 8-1/2 inch by 11-inch dimensions.

The following ANSI standard for the preparation of drawings shall apply: VI.I, Abbreviations for Use on Drawings; V32.2, Graphics Symbols for Electrical and Electronic Diagrams; and Y32.l4, Graphic Symbols for Logic Diagrams. The requirements for AT A and ANSI standard graphic symbols and abbreviations may be waived by PATH provided a system of standard abbreviations and symbols for all drawings submitted is used and the Contractor provides PATH with five (5) copies of a bound booklet in a format which contains a legend cross-referencing all abbreviations and graphic symbols used on drawings to those required by the ATA and ANSI standards.

19.2.3 Working Drawings

Working drawings prepared by the Contractor shall show in detail all dimensions with tolerances, kind and quality of material required herein, and as may be required to permit construction, furnishing, delivering. installation of equipment by the Contractor and inspection, operation, maintenance and repair of the Locomotive by PATH. These drawings may be provided in the Contractor's format as approved by PATH.

The working drawings shall be fully cross-referenced and four (4) prints of each shall be submitted to the Project Manager. All working drawings shall be folded to letter size. Drawings whose proper review depends on the availability of other ,drawings and equipment shall be submitted accompanied by or following such other drawings, with sufficient engineering information for the referenced equipment. Every drawing, unless otherwise approved, shall

reference the next higher level drawing, which shows how its subassembly is incorporated to a higher level assembly. The prints will be reviewed by the . Project Manager and comments, will be brought to the Contractor's attention in writing. No work specified in the working drawings shall commence until twenty (20) working days from the date of the Project Manager's receipt of such submittal so as to permit the Project Manager to make any such comments, but nothing herein shall prevent the Project Manager from making the comments at any later date, if he deems them appropriate (PATH will respond to the drawing submittals as quickly as possible, provided the Contractor does not submit an excessive number of drawings at the same time. A mutually agreeable drawing processing procedure will be established).

When a drawing is revised, the date arid all changes shall be listed by descriptions in the block for that revision. The Contractor shall promptly, resubmit the required number of prints of each drawing revision, whether in response to the Project Manager's comments or otherwise. The Contractor shall furnish the Project Manager such number of prints of all working drawings used in connection with the work as may be reasonably requested.

The Project Manager's review and comment on working drawings or other documents shall not relieve the Contractor of his sole responsibility for the proper completion of the work, including the design, arrangement, construction or satisfactory operation of the Locomotive to meet the requirements specified herein, nor shall it impair any of the Contractor's warranty obligations.

Prior to or simultaneously with the submission of the working drawings, the Contractor shall assure the Project Manager in writing that the submitted drawings were reviewed and approved by the Contractor's safety engineer with regard to the safety of PATH's operating and maintenance personnel in operating, inspecting and maintaining the Locomotive.

Before the delivery of the Locomotive the Contractor shall submit a complete set of working drawings incorporating all the modifications and comments. The Project Manager will review and approve printing them as record drawings.

19.2.4 Not Used

19.2.5 Drawings Requiring Approval

Drawings to be furnished by the Contractor for approval by PATH shall include but not limited to those listed below. PATH reserves the right to request additional drawings as required to clarify and amplify the intent of drawings furnished.

- General:
    - Exterior elevations of both sides of Locomotive
    - Exterior elevations of both ends of Locomotive
    - Floor plan, including Cab
    - Reflected ceiling plan, including Cab
    - Roof plan, including Cab
    - Interior, longitudinal sections of both sides of Locomotive

- Interior elevations of both ends of Locomotive
- Layout of cab control stand
- Interior elevations of cab layout
- Reflected plan, undercar equipment layout
- Reflected plan, conduit and cable layouts
- Reflected plan, piping layout
- Side elevation, undercar equipment layout
- Car Body and wayside clearance drawings

· Sections: Transverse sections to show all variations in cross section such as through various cab and power plant equipment.
  - Transverse section to show extreme movements of Locomotive (including yaw) permitted by Locomotive suspension and running gear.
  - Transverse and longitudinal sections to show physical relationship of major Undercar components.
  - Transverse sections to show vertical and lateral undercar equipment clearances to rail and roadbed.

· Framing and Miscellaneous Drawings:
  - Anti-climbers - plan, elevations, and sections
  - Cab frame - plan, elevations, and sections
  - Power Plant Enclosure frame - plan, elevations, and sections

· Propulsion Equipment:
  - Power Plant Components, including engine, alternator, traction motors - details
  - Controls-details
  - Assembly and installation details

· Equipment Boxes, Compartments and Lockers:
  - Plan, elevation, sections
  - Hardware details

· Cab Equipment
  - Control Stand -plan, elevation, details
  - Controls -plan, elevation, details
  - Equipment -plan, elevation, details

· Cab Construction:
  - Floor -details, sections and installation
  - Wall and Ceiling paneling and trim

· Auxiliary Electric Equipment:
  - Battery -Assembly and installation details
  - Circuit breaker panels details

    - Main switches - Assembly and installation details
    - High speed circuit breaker -Assembly and installation details

- Brake System:
    - Air supply Locomotive -Assembly and Installation details
    - Pneumatic control Locomotives -Assembly and Installation details
    - Park Brake -Assembly and Installation details

- Handrails and Grab Bars:
    - Plan, elevations, details

- General Arrangement
    - Trucks
    - Couplers

- Electrical Drawings:
    - Schematic wiring diagram -high voltage
    - Schematic wiring diagram -nominal 37.5 Vdc equipment

- Pneumatic Diagram:
    - Schematic piping diagram -air brake equipment

19.2.6 Documents Requiring Approval

Design test documents to be furnished by the Contractor for approval by PATH shall include, but not be limited to, those listed below. PATH reserves the right to request additional documents, as required, to clarify and amplify the intent of the Locomotive design.

- Weight analysis
- FMEA analysis
- Structural and equipment hanging bucket analysis
- All test procedures and reports .Grounding scheme
- Test and inspection (QA/QC) plans
- Welding and brazing procedures
- Smoke and flammability information for all combustible materials
- Hazard Analysis

19.2.7 Review of Contractor Documents, Drawings and Data

All drawings, technical data, test procedures, test schedules, test results, test reports, progress schedules and reports, drawing lists, samples, and other data submitted by the Contractor and requiring review by PATH will be handled in accordance with the above provisions.

Approval does not relieve the Contractor of the obligation to meet all of the requirements of the

Contract. Approval of a document, drawing, and data, which contain deviations from, or violation of, the Specification does not constitute authority for that deviation or violation. Such deviations must be specifically requested and granted. Should the Contractor proceed without PATH approval of submittals, it shall be at the Contractor's own risk.

19.3 Design Review Requirements

19.3.1 Design Review Meetings

At the start of the Design Review phase, the Contractor shall submit a System Functional Description that:

- Clearly defines the sub-systems that constitute the overall system.
- Describes and graphically depicts each interface between the subsystems.
- Shows how the requirements of the Technical Specification are allocated to the subsystems. This will include descriptions of how single requirements, including control and timing requirements, will be decomposed into several requirements allocated to separate subsystems.
- Defines names for subsystems and the interfaces between them to assure consistent terminology used by all suppliers.
- Define each system's line replacement Locomotive.

The descriptions of the subsystems, as presented in the design review documentation and presentations will need to match this overall system description in function, interfaces, and terminology. This document shall be updated as the design progresses and be resubmitted to PATH for review and approval.

Design review meetings as scheduled in the approved Management Plan will be held in which the Contractor conducts a presentation in accordance with a previously approved agenda. In its presentation, the Contractor shall address design approaches, concepts, and design details for the Locomotive, its system and subsystem. During these design review meetings, action items will be identified, with each action item assigned to an individual for disposition by a pre-determined response date. A design review action item log will be maintained by PATH.

Ten working days prior to a design review meeting, the Contractor shall submit three (3) copies of the agenda and a data package covering information to be addressed in the meeting. Design Review meetings shall be held in New York or at locations as mutually agreed and shall include sites of the Contractor and any of its subcontractors or suppliers. Design review meeting minutes shall be prepared by the Contractor and submitted to PATH for review and approval within five working days after the meeting.

Attendance at design review meeting will include representatives of the Contractor and appropriate subcontractors and suppliers and PATH or its representative.

19.3.1.1 Specification Review

Within two weeks after Notice of Award, the Contractor's Program Manager, the Contractor's technical specialists and PATH shall perform a detailed review of these Specifications. During this meeting the Contractor will be asked to provide an explanation of the approach planned in response to each Specification requirement. PATH will answer any questions that the Contractor may have regarding Specification requirements.

19.3.1.2 Preliminary Design Review

Upon reaching agreement with regard to the design concepts, the Contractor shall prepare conceptual design drawings for review by PATH. Drawings shall be submitted for review and comment. Two weeks subsequent to receipt of conceptual design drawings, a Preliminary Design Review Meeting (PDR), as scheduled in the approved Management Plan. shall be held at PATH.

19.3.1.4 Critical Design Review

The Critical Design Review (CDR) will take place when the design is essentially complete. All PDR issues must be resolved prior to scheduling and commencing the CDR activity. The CDR is to provide the opportunity to review, revise, and agree on the details of the final design prior to release of the designs for manufacture. Any open engineering items and related program management issues must be discussed and resolved during the CDR to consider the CDR closed.

19.3.1.5 First Article Inspections

First Article Inspections, as detailed in Section 18.1.5.1 and as defined within Section 1.6.1 - Definitions, shall be performed as part of the design review process.

19.4 Additional Drawings, Documents and Data to Be Furnished by Contractor

Within 120 days after Contractor Notice of Award, the Contractor shall submit a schedule for submittal of the following drawings, documentation, and data to PATH for its review, in accordance with the Master Program Schedule:

- Dynamic outline of the Locomotive showing clearance diagrams which reflect all undercar, side or roof mounted equipment under conditions which consider the maximum truck lateral, vertical, and roll suspension limits and maximum wheel wear.

- Single line control schematic and functional block diagrams for each subsystem, showing all values, operations, and control components.

- General control circuit interface data such as type of signal, range, circuit loading and impedance, type of transducer or pickup, and mechanical requirements.

- Graphs and curves showing response and functional characteristics of major subsystems

and components.

- Documentation of analyses conducted by the Contractor, as specifically called for in these Specifications.

- Propulsion System Technical Data shall be submitted as follows:
    - Capability curves of tractive effort versus command signal and speed for both acceleration and dynamic braking mode;
    - Single line diagram of power circuits and functional diagrams of the control loop including input and output signals;
    - Number and connection of power semiconductors used in propulsion circuits together with current and voltage rating of each;
    - Propulsion motor torque characteristics

- Auxiliary Electrical System Technical Data shall be submitted as follows:
    - Operating characteristics of low voltage system power supply (alternator);
    - Low-voltage power supply/battery charger operating characteristics;
    - Battery discharge curves and charging requirements; and
    - Tabulation of all low voltage dc loads, giving:

        - Maximum and average current,
        - Circuit breaker ratings, and
        - Continuous or intermittent load.

- Flammability and Smoke Emission Data for all combustible materials in accordance with Section 15.22.,

- The Contractor shall implement a comprehensive program to control car weight and weight distribution. Prior to the first design review, the Contractor shall submit:
    - A proposed weight data record format;
    - Initial weight and balance estimates; and
    - A proposed procedure for ensuring control of new Locomotive parts, systems and subsystems.

These data shall be updated and revised monthly throughout the car design and manufacturing phases as more precise estimates and actual weight data become available, and shall be submitted to PATH.

The submission shall include the most recent weights for the Locomotive less trucks, each truck and the complete Locomotive. It shall also include a list of weights for every system on the Locomotive, and indication of percentage of the estimated weight that the system contributes to the total estimated weight. As equipment scale weights become available, they shall replace the estimated weights in these reports.

19.5 As-Built Drawings to Be Furnished by Contractor

All technical information contained on the final approved working drawings of an As-built Locomotive shall be submitted as As-built Record Drawings. Within thirty (30) working days after the delivery of First Locomotive, the Contractor shall furnish one set of As-built Record Drawings in accordance with the latest revision of PATH Engineering standard.

After approval of the As-built Record Drawings by PATH and no later than thirty (30) days after Acceptance of the last Locomotive, the Contractor shall furnish one set of As-built Record Drawings on Transparency (hereafter Mylars) for PATH approval as detailed in Section 19.5. At the same time, the Contractor shall supply four (4) sets of CD-ROMs of all approved As-built Record Drawings and Index on the latest version of AutoCAD format and three (3) sets of the latest version of AutoCAD software with licenses. The Drawing CD-ROMs shall include an indexing system to facilitate a search for drawings by entering PATH drawing title or number.

The As-built Record Drawings shall show sufficient details and information for PATH to maintain the Locomotive, including ordering, manufacturing, and assembling all parts. These drawings shall show parts as furnished and delivered. All assembly and system drawings shall also be included in the Parts Catalog.

Any equipment modifications performed during the warranty period shall be reflected in a new set of As- built Record Drawing Mylars and AutoCAD drawings. After approval of As-built Record Drawing for said modifications. the Contractor shall submit Mylars and AutoCAD drawings within thirty (30) working days. Sixty (60) working days prior to the end of warranty of the last Locomotive, the Contractor shall supply four (4) sets of CD-ROMS of all as-built record drawings in AutoCAD format reflecting all modifications performed during the Warranty period.

19.5.1 Time and Scope of Submittals

As-built drawings shall comply with PATH Engineering Standards: Engineering Record Drawings except as indicated below. Within thirty (30) days following the delivery of the first Locomotive, the Contractor shall supply As-built Drawings for the following items:

- All Contractor's and suppliers' drawings details, bills of material, and catalog cuts that are required by PATH for future installation. maintenance and repair purposes;
- All electrical schematics, electronic circuits, and wiring diagrams;
- All pneumatic and air conditioning schematic piping diagrams;
- All interface control drawings down to all line replaceable Locomotives;
- All assemblies, subassemblies, and arrangements of the Locomotive;

- All items which are special purpose or fabricated by the Contractor, such as tooling; and

- All materials furnished by the Contractor and by its suppliers, down to and including the module and circuit board level. In every case, outline drawings shall not be considered acceptable.

All information required above shall also be supplied in a single electronic format usable by PATH. The preferred format is AutoCad latest version.

19.5.2 Transparency Quality Standards

The transparencies shall be produced on clear polyester film. The printing shall be on the front face and a matte surface shall be provided on the front or both faces of the reproducible. Printing shall be black and of "wash-off' consistency. Reproductions shall be the same size as the original drawings. The archival quality of the completed and approved as-built mylar drawings shall last at least eighty (80) years. The Contractor shall submit for PATH's approval, certification that the proposed transparencies will meet these drawing requirements.

19.5.3 Revision to be Included

The transparencies shall include all revisions made during construction and be in as-built configuration.

19.5.4 Title Block and Other Data

In the processing of the reproducible of the Contractor's Drawings, the Contractor's title block shall be obliterated or as a minimum reduced to 1/4 scale and located on the lower left hand comer of the drawing. The drawing number and the drawing title shall be incorporated in PATH's title block for identification purposes. The Bill of Material shall be left on the reproducible. The title block change applies only to the Contractor's drawings and does not apply to Subcontractor drawings of proprietary equipment such as, motors, control components or brake components.

19.5.5 Material Identification Lists

Reproducible Material Identification Lists including a Contractor Number, a supplier number, and provision for PATH's Stores Number shall also be furnished by the Contractor in a single format. This data shall provide PATH with all the information required for procurement of materials used in the construction of all parts of the Locomotive. These lists shall take the form of reproducible Bills of Materials suitable for loose-leaf binding and shall be cross-referenced to the related drawings and the Bill of Materials.

19.5.6 List of Transparencies

The Contractor shall provide PATH with a complete list of transparencies to be delivered.

19.6 Changes

Changes to the documents, drawings, or data shall be controlled by the processing of engineering change requests (ECRs). An engineering change to any part, assembly, or equipment item of the Locomotive shall be designated as a Class I change when form, fit, function, or interchangeability is affected. All Class I ECR's must address the following:

- Delivered manuals,
- Delivered product (retrofit),
- Electromagnetic interference characteristics, Reliability or maintainability,
- Safety,
- Schedules of deliveries,
- Source or repairable items (source control drawing), or
- Weight or balance.

All other changes shall be designated as Class II changes.

All Class I ECR's together with documentation and cost information, shall be submitted to PATH for review prior to implementation. Time for review and schedule relief shall be considered by PATH in its review. Class II ECRs shall be submitted to PATH for information, approval of Class II ECRs will only be required if the changes deviate from the Technical Specification requirements. The Contractor shall maintain an Engineering Change Status Report which shall list all approved changes, all Class II changes, their status and completion dates. The status shall be included with the monthly progress report. Implementation of an ECR shall require incorporation in all Locomotives unless approved by PATH as an effective point change.

19.7 Car History Books

The Contractor shall provide PATH an up-to-date Car History Book, as a hard copy and in an PATH approved electronic media, for each Locomotive within two weeks after Acceptance. The Car History Book shall provide a record of tests, measurements, analysis and procedures performed on that specific Locomotive as well as the origin and identity of major components. As such, forms and records included in the book should contain signatures and certifications where appropriate.

Each Locomotive's Car History Book shall accompany the Locomotive through manufacture and Acceptance. The contents of the book shall be originals.

The book cover/binder and all external labels shall be waterproof, The cover/binding shall reasonably match the thickness of its contents. Pages must be arranged so that graphic copies can be accomplished without compromising the integrity of the binding.

Each Car History Book shall contain the following general information:
A title page with the name of the Project Managers of the Contractor and PATH; in addition to key managerial personnel of both the Contractor and PATH,

- A signature key page with designated blocks for printed name, signature, company affiliation, and identification number (if any) for each person given authority to sign any certifications (test, measurements, releases, etc.) in the books.

- A table of contents (Pre-shipments and post-shipments sections shall be separate from any other sections).

Each Car History Book shall contain, but is not limited to, the following car-specific information:

- Certified weight, including scale tickets;
    - Weights shall include independent weight of each equipped truck as well as the entire Locomotive.

- Description of modifications and completion dates of incorporation;

- List of defects noted during manufacture and testing and the disposition of each;

- List of serial-numbered apparatus and their serial numbers;

- List of software configuration of the Locomotive at the time of acceptance;
    - The list shall include the name of the software, a brief description of the programs purpose (e.g. propulsion fault monitoring), the system(s) the software operates on/controls, the software author or provider, software version and last revision date.

- Provisions for recording inspection, servicing and major overhaul events;

- Shipping documents;
    - The release to ship certification, including a signature of the Contractor's inspector verifying that all documentation in the Car History Book is complete, with affixed signatures & certificates, as required.

- Summary detail of each test and formal inspection performed on the complete Locomotive or any part thereof with signatures where appropriate. This documentation shall include tests, measurements and inspections performed during manufacture, acceptance and warranty;

- While the Technical Specification does not allow the use of hazardous material, if it .is determined that potential hazardous material has been incorporated into the Locomotive,

a record of such material and its location shall be maintained in the car history book, including a record of any subsequent removal;

- A record of any abnormalities that occurred during the manufacture of the car or its subsystems (including assemblies such as the engine or HVAC system, etc.), including their authorized repair procedures and quality control approval of work performed; and

- Acceptance for service The acceptance (conditional) certification shall include a clause stipulating that PATH signatories accepting the car have verified that all documentation in the Car History Book is complete with affixed signatures and certifications, as required.

The Contractor shall also furnish PATH, for inclusion in the Car History Book, documentation recording changes made during the warranty period.

SECTION 20

20.0 IN-SERVICE SUPPORT

20.1 Training and Manuals

20.1.1 Deliverable Documentation

The Contractor shall furnish manuals and catalogs for use by Locomotive operators and maintenance personnel in accordance with the requirements of this Specification. In addition to hard copies, the Contractor shall provide five (5) copies of each manual and catalog on CD-ROM disks in the latest version of IBM compatible Adobe FrameMaker™ format or PATHapproved equal. Illustrations shall be stored in a format (e.g., TIFF) that is readable and editable using the latest version of Adobe™ PhotoShop™ software or PATH–approved equal. Three (3) copies of the commercially available software used to create the manuals, and catalogs shall be provided, with site licenses and original documentation.

Manuals to be supplied as part of this Contract are as follows:

· Operator's Manual	10 copies
· Road Car Inspector's Troubleshooting Manual	10 copies
· Inspection and Maintenance Manual	5 copies
· Illustrated Parts Catalog	5 copies
· Overhaul Manual	5 copies
· Special Tools and Test Equipment	5 copies
· Manual of instruction for event recorder download and analysis of data	5 copies

All manuals, shall clearly identify all hazardous materials and equipment. All maintenance procedures involving hazards shall contain clear identification of the hazard and instructions to minimize or eliminate the hazards during the procedure. Maintenance manuals, procedures, and training shall indicate the proper handling, storage, and disposal of hazardous materials.

The Contractor shall submit for PATH review and approval all the manuals, as specified in Section 20.1.2, two (2) months prior to delivery of the first Locomotive for PATH review and approval.

The initial submittal of all manuals shall be as complete and detailed as possible given the state of the Locomotive and system design at that point. The Contractor shall review all materials for technical accuracy before submittal to PATH.

The Contractor shall maintain and update the manuals, as specified within Section 20.1.2, to reflect changes in Locomotive design during the term of this Contract up to and including the completion of the warranty requirements of the Contract.

20.1.1.1 Operator's Manual

The Operator's Manual shall contain all information needed for the optimum safe operation of the Locomotive. It shall include general Locomotive familiarization material, such as:

- Location, function and operation of controls, gauges, indicators and switches;
- Basic theory of operation of the Locomotive, including systems which the Operator may not be in a position to control or adjust; but of which the Operator should have some basic knowledge;
- Emergency procedures;
- Trouble symptoms and diagnosis methods; and
- Operator corrective action, if any.

The manual shall be logically organized with systems and elements considered in descending order of importance. Care shall be taken that all statements are clear, positive, and accurate, with no possibility of incorrect implications or inferences.

20.1.1.2 Road Car Inspector's Troubleshooting Manual

The Road Car Inspector's Troubleshooting Manual shall contain all information needed to troubleshoot and repair the Locomotive when it experiences failures during service. The purpose of the manual is to provide information required to return the Locomotive to service or to remove it from service and relocate it to a PATH maintenance shop to obtain further maintenance. The content and organization shall be similar to the Operator's Manual, with troubleshooting and corrective action extending beyond what Operators are expected to perform, but falling within the Road Car Inspectors' duties.

Sections of the Operator's Manual may duplicated and expanded where appropriate.

20.1.1.3 Inspection and Maintenance Manual

The Inspection and Maintenance Manual shall enable the maintenance staff to have access to all information needed for periodic shop inspection and servicing requirements, including lubrication, inspection and adjustment of all apparatus. It shall also have maintenance procedures, including preventive maintenance inspections, on-Locomotive running maintenance and adjustments, and on-line trouble diagnosis of each system, troubleshooting guides, equipment specifications and schematics for the Locomotive and each of its systems.

Information on how to use the special tools or test equipment for troubleshooting or repairing the Locomotives shall be found in the appropriate manuals where the equipment is needed.

This manual shall contain instructions for using portable test units for maintenance, adjustment, test, and troubleshooting functions. This manual must note references to the Special Tools and Test Equipment Manuals.

20.1.1.4 Overhaul Manual

The Overhaul Manuals shall contain a detailed analysis of each component of the Locomotive so that the maintenance staff can effectively service, inspect, maintain, adjust, troubleshoot, repair, replace, and overhaul. The Overhaul Manuals shall include instructions for using portable test equipment, bench testers, and shop test stands for maintenance, adjustment, test, and troubleshooting functions as they apply to overhaul.

The Overhaul Manuals shall also include detailed electronic repair information needed by Electronics Lab personnel.

20.1.1.5 Illustrated Parts Catalog

The Illustrated Parts Catalog (IPC) shall enumerate and describe every component with its related parts for the Locomotives, PTEs and special tools, including the supplier's name and part number, the commercial equivalents, and PATH's stock number. This also includes Printed Circuit Boards.

Drawings showing cutaway and exploded views of subassemblies and components shall be used to permit identification of all parts. Each part or component shall be identified as being part of the next higher assembly.

20.1.1.6 Special Tools and Test Equipment Manuals

Operation and maintenance manuals for each special device identified in Sections 20.2.2 and 20.3 shall be presented in the appropriate Manual (i.e., Operator's, Road Car Inspector's, Inspection and Maintenance, etc.), and as specified in Section 20.1.2. The information shall include setup and calibration procedures for each test device, as well as maintenance, troubleshooting and repair information and schematics for servicing and repairing the device.

Information on how to use the special tools or test equipment for troubleshooting or repairing the Locomotives shall be found in the appropriate manuals where the equipment is needed.

Two complete sets of gauges and special tools (Section 20.2.2) and test and inspection equipment (Section 20.3) shall be provided to support the training program.

20.1.1. Format and Organization

The organization of the manuals shall treat the Locomotive as an integrated system and not as a grouping of disassociated parts. The manuals shall highlight the precautions to be taken by

operating and service personnel to assure their safety while operating Locomotives and performing maintenance and servicing operations.

Manuals furnished under this Contract shall be complete, modem, thoroughly organized, and authentic with no extraneous or irrelevant information. The material in the inspection, maintenance manuals and parts catalogs shall be similarly organized and indexed, with a standard numbering system. The numbering of the sections shall be consistent from one type of manual to another to allow easy cross-referencing among different manuals.

Each section of the maintenance manual shall be subdivided, to the extent required by the subject matter, into the same chapters, to facilitate looking up specific topics or tasks. Coverage of the chapters shall include the following topics:

General subsystems description and operation, including how the system fits into the Locomotive and interfaces with other systems and subsystems;

- Block diagrams;
- Signal flow diagrams;
- Functional schematics;
- Functional wiring and/or piping diagrams;
- Troubleshooting techniques;
- Microprocessor software;
- Lubrication and cleaning, including frequency, methods and trade identifications of recommended materials, component location and description;
- Inspection and maintenance s:tandards including wear limits, settings, and tolerances;
- Installation and removal;
- Test and evaluation procedures.

The format of all data contained in the maintenance and parts manuals shall be consistent from section to section.

Manuals with alternate format and organization, which are standard to the Contractor, will be considered by PATH.

Upon PATH's approval of the Contractor's manual submittals, the manuals shall be considered as "Interim Manuals." Following the issue of each Interim Manual, the Contractor shall provide revised pages covering any changes, whether required by change of design or procedures or due to error, and these revisions shall be kept current during the term of this Contract up to and including the completion of the warranty requirements of the Contract. Manual and catalog revisions shall be supplied to PATH before or coincidental with the arrival of the altered parts or components.

A new status sheet listing the effective dates of each page shall be included for each manual at the time updates are forwarded to PATH. Each updated page shall be annotated with a vertical bar in the margin to indicate where material has been added, deleted or revised. Cross references and a Table of Contents shall be provided in each volume.

All covers shall be resistant to oil, moisture, and wear, to a high degree commensurate with their intended uses. Diagrams and illustrations shall not be loose or in pockets. All printed material shall be clearly reproducible by dry copying machines. Line drawings, including exploded isometrics and three dimensional outline drawings are required.

20.1.3 Training

20.1.3.1 General

The Contractor shall provide an educational program based on a "Train the Trainer" approach for the specified number of PATH's designated Instructors, Supervisors, and Engineering personnel. The training shall be of a quality and depth sufficient to permit PATH's instructors to train Operating and Maintenance personnel to safely and satisfactorily operate, service, and maintain the Locomotives and all carborne equipment.

All courses shall consist of a combination of classroom and hands-on instruction. For most practical subjects, the expected portion of training time to be spent on hands-on activities is fifty (50) percent. The classroom and hands-on training should be integrated so that the hands-on training reinforces the topics covered in the classroom. The Contractor may employ additional suitable training methods necessary to properly develop the skills of PATH’s trainees. Training shall include classroom and hands-on instruction through the use of actual equipment, with additional support through the use of computer simulators, models, manuals, diagrams, and parts catalogs.

The Contractor shall assume no knowledge of the features of the Locomotives on the part of the designated personnel, and shall design the training program to bring the level of student knowledge to one fully adequate for the objective. The Contractor may assume that all personnel possess the basic qualifications of their positions. The Contractor's approach to this effort shall be based on the assumption that the Contractor's own interests, immediate and ultimate, are best served by a satisfactory program. All courses of instruction shall be presented in the English language.

Prior to the initiation of classroom instruction, all instructors to be utilized by the Contractor shall attend a one-day orientation at PATH (see PATH- On Track Safety Training: "Roadway Worker Protection" requirements below) to become familiar with PATH's safety regulations and facilities, and to be advised of student qualifications and expectations.

20.1.3.2 Instructor Qualifications

All of the instructors provided by the Contractor shall be fully capable of transmitting in-depth technical information that can be understood by participants.

PATH will recognize the instructor as qualified when the individual:

- Can communicate, in English, in a manner that allows the participants to understand;
- Has an in-depth knowledge of the system under discussion, how it interfaces with other systems or subsystems, the procedures for isolating faults and troubleshooting, and is able to communicate that information to students in an effective manner; and
- Has an in-depth knowledge of PATH Policies and Procedures concerning Locomotive operation.

20.1.3.3 Training Schedules and Class Size

Class size will be from five (5) to ten (10) people, depending on the nature of the course being taught. The duration and types of individuals to be trained by the Contractor are as follows:

- Operator's Course - 24 hours per course, 72 hours total (within 30 days after delivery of 1st Locomotive)
- Inspection and Maintenance Course - 40 hours per course, 120 hours total (within 60 days after delivery of 1st Locomotive)
- Road Car Inspector's Course - 40 hours per course, 120 hours total (within 90 days after delivery of 1st Locomotive)
- Electronic Repair Course - 16 hours per course, 32 hours total (within 120 days after delivery of 1st Locomotive)

The Contractor shall supervise all classes. Classes will generally run from Monday through Friday, eight (8) hours per day, beginning and ending at times consistent with PATH's regular daytime operations.

The Contractor shall ensure that the necessary training equipment is available for use. PATH will furnish suitable classroom furniture (desks, chairs, and tables).

Classroom instruction for maintenance courses shall include not only the details and functioning of parts under discussion, but the essentials of their routine care, including lubrication schedules, materials, Contractor's recommendations for test frequency, tolerance limits, and methods for testing, including instruments required, when applicable. When methods of access, removal, dismantling, or application are not self-evident, the instruction shall cover these matters.

20.1.3.4 Training Classes

20.1.3.4.1 Operator Training

Topics to be covered in the operations training program shall include, but not be limited to the following:

Locomotive specifications, controls and indicators;
Locomotive systems *(i.e.,* propulsion, friction brake, electrical, environmental, lighting and communications);
Locomotive operations *(i.e.,* actual operation of the Locomotive in PATH Maintenance Yards and on the main tracks);
troubleshooting procedures; and
recovery operations, as detailed in the corresponding manuals.

The Contractor's instructor shall be accompanied at all times by PATH's qualified instructor or supervisor to ensure that all PATH's rules and procedures are respected.

20.1.3.4.2 Road Car Inspector Training

Topics to be covered in the Road Car Inspector training program shall include, but not be limited to the following:

Locomotive specifications:
Locomotive description and layout;
Locomotive systems, system schematic diagrams, controls and indicators;
emergency equipment procedures;
troubleshooting procedures; and
recovery operations, as detailed in the corresponding manuals.

20.1.3.4.3 Inspection and Maintenance Training

Inspection and maintenance training shall provide adequate training for PATH's car inspectors and maintainers to maintain the equipment during the warranty period. The Inspection and Maintenance Program shall consist of theory of operation, system and component description, inspection procedures, troubleshooting procedures and use of (PTE), and removal and replacement procedures to the LRU level. An Inspection Checklist shall be developed and provided in the Inspection and Maintenance manual.

PATH's employees shall be exposed to the depth of detail that is necessary for the performance of all preventive (scheduled) and corrective (unscheduled) maintenance operations for all aspects

for the Locomotives. Students shall be afforded the opportunity to perform the more complex maintenance functions on the Locomotive and in the shop, in addition to troubleshooting systems with faults artificially introduced in the equipment while using the appropriate subsystem test devices.

Classroom instruction for maintenance courses shall include not only the details and functioning of parts under discussion, but the essentials of their routine care, including lubrication schedules, materials, Contractor's recommendations for test frequency, tolerance limits, and methods for testing, including instruments required, when applicable. When methods of access, removal, dismantling, or application are not self-evident, the instruction shall cover these matters.

The course shall also provide instructions for performing heavy maintenance repair and overhauling selected components.

20.1.3.4.4 Electronic Repair Course

A course shall be provided which summarizes the repair of electronic equipment and boards performed at the PATH Car Equipment Division (CED) Electronic Shop.

20.1.3.4.5 PATH -On Track Safety Training: "Roadway Worker Protection"

The Contractor, and its employees who may be assigned to this project must be certified when working on or near the tracks through PATH's "On Track Safety Program" in compliance with the Rules and Regulations set forth in Federal Railroad Administration (FRA) Regulation, 49 CFR Part 214, Subpart C, entitled "Roadway Worker Protection". PATH will certify Supervisory personnel only in a four (4) hour mandatory class, which includes a certification test. Contractor Supervisory staff will then be responsible for training and certifying all additional workers who may be assigned to the project. A letter, and the original test certifying these additional workers shall be filed with PATH's Training Coordinator, 201-216-6212, The Port Authority Trans-Hudson Corporation, One PATH Plaza, 10th Floor, Jersey City, NJ 07306, within 48 hours of the training. The letter shall state that / these individuals fully understand, and will comply with the FRA Regulation stated above for "Roadway Worker Protection". Contractor employees not named, will not be permitted to enter the "Working Limits" of the project until they have been certified.

The manuals shall be accurate, complete, of professional quality, and shall have been approved by PATH. Drawings shall be the most recent version reviewed by PATH.

The program shall be conducted at PATH's facilities in Harrison New Jersey, and include classroom and hands-on instruction. The Contractor shall provide an adequate supply of high quality, professionally prepared material on paper, video recordings and such other training aids

as may be necessary to impart the essential knowledge to the people involved and leave them with authoritative: and up-to-date reference material. The video recordings shall demonstrate the assembly and mounting of all equipment and maintenance procedure of all the tasks for the Locomotive. At least ten (10) copies of such recordings shall be provided in DVD format to PATH. The program shall include steps to determine the proficiency of the students.
The training shall provide in-depth instruction covering all subjects and systems, and their location, removal, replacement and interfaces with other systems and parts of the Locomotives.

The Contractor shall submit a training outline three (3) months prior to delivery of the first Locomotive for PATH review and approval. The training outline shall identify each module of instruction and the general topics to be taught and indicate the order in which modules will be presented.

All training materials, such as training aids and lesson plans, shall be approved by PATH, and shall become the property of PATH at the completion of the training program. The Contractor shall be responsible for the condition of these materials for the duration of the training program, and shall replace all damaged materials unless the damage results from PATH negligence. Lesson plans shall be updated as required during the course of instruction.

The training sessions will be recorded on DVD by the Contractor and the videos shall become the property of PATH.

20.2 Parts and Tools

20.2.1 Recommended Spare Parts

The Contractor shall furnish a list of recommended consumable and replacement parts necessary to maintain the Locomotives for an entire overhaul cycle, consistent with the Contractor's recommended maintenance practices. The list must be forwarded no later than ninety (90) days prior to the scheduled delivery of the first Locomotive. This list is to remain current and must be resubmitted at the end of the warranty period.

The list of recommended consumable parts shall be predicated on Contractor and subcontractor experience with the equipment in service on other properties and on the maintenance requirements of PATH.

For the Contract, the following Spare Parts shall be delivered and service-ready immediately following the delivery of the second and third Locomotives, and prior to the delivery of any subsequent Locomotive.

Spare Parts to be supplied as part of this Contract:

DESCRIPTION	QUANTITY
#1 & #2 Trucks (Fully equipped pairs)	2
Traction Motors	4
Main Alternator	2
Air Compressor	2
Propulsion Control Package (1 set)	2
Additional Spare Printed Circuit Boards	
for Propulsion Control Package (1 set)	2
Diesel Engine	1
Low Voltage Power Supply	2
Batteries	2
Air Conditioner	2
Gear Unit	1

20.2.2 Gauges and Special Tool

The Contractor shall furnish two (2) sets of gauges and special tools. Special tools include but are not limited to any jigs, fixtures, equipment, hand tools, power tools, or other tools and equipment necessary to inspect, calibrate, adjust, maintain, repair, assemble, and disassemble the Locomotive or subsystems, that are not commonly available from commercial tool suppliers. PC board extenders required by Section 15.26.9 are also considered special tools.

Documentation and drawings related to gauges and special tools to be furnished for each system shall be included in the Contractor's Critical Design Review Document(s), and shall be reviewed as part of the CDR. In addition, the documentation and drawings related to gauges shall include the condemning limits.

The Contractor shall have their own gauges and special tools necessary to perform their contractually required duties. Gauges and special tools furnished to PATH will not be available for the Contractor's use. In addition, the two (2) sets of gauges and special tools that are used for the Contractor provided training (Section 20.1.1.6) shall be delivered to PATH upon the completion of training, and shall be included as part of the five (5) sets of manuals to be provided, as set forth in Section 20.1.1.

All gauges or special tools, other than the PTEs that are required to maintain the Locomotive shall be supplied along with complete manuals explaining the use of the gauge or tool and its care and maintenance. In addition adequate information, inclusive of manufacturing drawings and parts lists, shall be furnished by the Contractor; to enable PATH to have additional gauges and special tools manufactured, beyond those Contract-required quantities furnished by the Contractor.

20.3 Test and Inspection Equipment

The Contractor shall provide all test and inspection and diagnostic equipment specialized for Locomotive maintenance, troubleshooting, testing, repairing, calibrating and inspecting equipment on the Locomotive. This includes, but is not limited to, inspection and test equipment that the Contractor refers to in the inspection and maintenance manuals that are not commonly available from commercial suppliers. This shall include equipment for the support of back shop repair activities, and for on-board inspection and test of equipment. Automatic Bench Test Equipment (BTE) shall be provided for each Locomotive's propulsion control system, the MDS, and the LVPS if supplied).

Documentation and drawings related to test and inspection equipment to be furnished for each system shall be included in the Contractor's Critical Design Review Document(s), and shall be reviewed as part of the CDR.

For laptop PCs required within Section 20.3.1, the standards for a high performance PC for the expected time of delivery cannot be determined at this time due to continual advances in

technology. At a minimum, the laptop PC shall meet the requirements for workstation computer in Section 20.3.3. Six (6) months prior to system delivery, the Contractor and PATH will determine the final specifications for the laptop. The delivered systems shall conform to the then current industry standard to ensure that it is capable of running the then current software packages. This equipment shall be approved by PATH.

20.3.1 Portable Test Equipment (PTE)

20.3.1.1 General

PTE shall be supplied for all on-board systems, to aid the maintenance staff in maintaining, troubleshooting, and repairing the Locomotive equipment.

Seven sets of PTEs, software (including licenses) and accessories shall be provided.

Complete parts lists and schematic diagrams of the PTE and instructions concerning how to use them for their intended purpose shall be included in the appropriate manuals described in Section 20.1.1.

For each applicable system, there shall be system specific software to be utilized by a common PTE laptop. The Contractor shall provide all software modules, master copy and licenses for each PTE program. Cabling shall be standardized to perform testing for all carborne systems. Drawings of all non-off-the-shelf cables shall be provided with sufficient information to manufacture the cable.

All test functions required in any section of this document shall be performed by laptop PTE or other PTE. The same PTE will be used to monitor and diagnose the engine control and other systems i.e. braking, battery charging and lighting. Software shall be subject to the requirements of Section 16.

The carborne equipment design shall make use of multi-pin connectors to establish all the connections required for utilization of the PTEs. Power required for operation of the PTEs shall be supplied by the Locomotive's 37.5 Vdc power supply, as is appropriate for the function. There shall be no high-voltage connections allowed between the Locomotive and PTE. It shall not be necessary to remove, dislodge, dismount, or disconnect any component, card, wire, chassis, terminal, or cable in order to perform periodic calibration, or trouble diagnosis while using the PTEs.

The PTEs shall include all cables, industrial grade connectors and associated equipment to interface with the test points.

20.3.1.2 Functional Requirement

The function of the PTEs shall be to produce all of the operating commands and other input

signals necessary to fully exercise all functions and components of the particular system or subsystem under test, and to measure or indicate all of the signals, responses and outputs produced by a system by means of indicators such as lamps, meters, oscilloscopes, or gages. It will be acceptable to require a visual check for system response such as closure of a contactor, provided that the responding item of equipment does not require removal of other equipment or use of hand tools to permit observation of response, and does not require the maintenance technician to move more than 15 feet (4.6 m) to make the required observation. When used according to the instructions supplied by the Contractor, each PTE shall enable the maintenance technician to fully check and calibrate the system or subsystem under test and to locate and replace any removable component which has fully or partially failed. Response indicators and input-signal generators shall be built into the PTEs to the maximum extent possible, and shall have accuracy commensurate with the alignment tolerances specified.

The Contractor shall develop a general PTE interface specification that is consistent with the details below and all relevant sections of the Technical Specification. This specification shall be used to ensure a common "look I and feel" for all PTE applications regardless of supplier, and shall be submitted to PATH for approval as part of Preliminary Design Review.

System status and functional information shall be provided in a graphical format, superimposed over a system diagrammatic or schematic. When a graphic presentation is not feasible, system status and functional information shall be provided in English language statements and relevant engineering units, and shall be formatted for easy readability. In no case shall the use of a PTE require "look-up" tables or other references to translate various codes into human comprehensible text.

Laptop based PTEs shall operate under the Microsoft Windows environment. All user interaction with the software shall be consistent with established Windows conventions.

The specification shall standardize details including, but not limited to the following:

- Graphical symbols used for common electrical, electronic, electro-mechanical and mechanical components such as contactors, relays, circuit-breakers, valves, motors, etc.

- Color codes for the status of the above items.

- Terminology for the status of the above items shall be consistent, and shall be in plain English language, not logical status. For example, valves are open or closed, contactors are on or off.

- Engineering units used for data presentation.

20.3.1.3 Physical Requirements

The PTE shall perform under the environmental conditions imposed by the activities of the

Locomotive inspection and repair shop. The test equipment shall be portable and suitable for industrial service for use on the shop floor, pit locations, and use in the yard. The test equipment shall be self-protected in the event of an overload or short circuit condition. All PTEs that will enable reprogramming of control software shall be provided with a single "mechanical key" (dummy plug with internal jumpers) that will need to be engaged to enable reprogramming. The laptop PC PTEs shall be a state-of-the-art, high performance notebook computer. The PC shall comply with all software and hardware requirements of section 20.3.3. The hard storage shall be capable of storing all system and subsystem test software and fault log downloads from an entire work shift. (see Section 16.4.1 for minimum spare storage requirements). The laptop shall come with a PATH approved operating system and all software applications required to view or run all the downloaded information from any system or subsystem.

For PTEs, which do not consist of laptop PCs, response and output indicators and input signal generators shall be of an industrial grade. Each PTE shall be housed in an aluminum or fiberglass suitcase-type enclosure with a removable cover suitable for use in a shop environment, as approved by PATH. All meters supplied as part of the PTEs shall be of a variety capable of withstanding industrial service.

The weight for any PTE shall not exceed 10 lbs. (4.5 kg) without the prior approval of PATH.

20.3.1.4 Interface Connections

Connection of the PTE to the equipment shall be through a test plug (Local connector) on the equipment, conveniently located on the Locomotive so that the maintenance technician is able to observe the functioning of the specific system under test.

Connectors used in the interface between the PTE and the system under test shall have recessed pins to prevent bending and breakage during frequent use, All connections shall be hand operated, robust, weather tight, quick disconnect, multi-pin connectors meeting the requirements of Section 15.

One way air coupling, manufactured by ARO, or PATH-approved equal , with quick disconnects shall be used for all pressure test fittings

20.3.1.5 Cables and Hoses

External hook-up multi-conductor cables shall be furnished to connect the Locomotive system with the PTE. A minimum number of cable connection shall be used to connect the test equipment to the systems under test. Cables shall be flexible, abrasion resistant, and oil resistant. The connecting cables and hoses shall be stored within the PTE case.

The Contractor shall not require connection of external apparatus to the PTEs without the prior written approval of PATH. In such cases, terminals shall be provided to allow connection of the required apparatus to the PTEs. However, such apparatus shall be considered part of the PTEs and shall be supplied with it on a one-to-one basis.

20.3.2 Bench Test Equipment

20.3.2.1 General

Automated bench test equipment shall be supplied by the Contractor to support back shop repair and maintenance activities. The bench test equipment (BTE) shall be designed for the purpose of testing, troubleshooting, and calibrating the Locomotive propulsion and other intelligent and non-intelligent system. Commercially-available test equipment approved by PATH may be used for printed circuit board level testing, fault detection and isolation. The BTE shall be delivered with the delivery of the third Locomotive. The bench test equipment shall be designed to enable a technician to perform rapid testing, troubleshooting to the printed circuit board level repair, and calibration of equipment. Capability shall include, but not limited to each and every type of electronic circuit board, including mother boards.

Each BTE shall have a large Emergency Shutdown button for BTEs which operate with voltages of 120 Volts and higher, which, when activated by pushing, shall remove all power from the equipment under test (EUT) and shall prevent further damage to the BTE.

Each piece of bench test equipment shall be supplied with an instructional manual in electronic format that describes how to use the tester. Detailed step-by-step procedures shall be provided along with expected results. The bench test equipment, when used in accordance with instructions supplied by the Contractor, shall test and calibrate the Locomotive equipment to a quality level equal to that performed by the original supplier.

Complete details for troubleshooting and repairing the bench test equipment shall be provided, including complete parts lists and schematic diagrams of the bench test equipment. The bench test equipment shall conform to the materials and workmanship, and documentation requirements of this Specification.

PATH shops are equipped with 120 volt single phase and 480 volt three phase AC, 60Hz electrical power. The Contractor supplied bench test equipment must be designed to operate in this environment. Other necessary operating voltages shall be produced by the bench test equipment The bench test equipment shall include provisions for varying the electric input power as may be appropriate for the unit under test over the full operating range. The bench test equipment shall be suitably buffered to protect against failure of the bench test equipment when testing and troubleshooting defective parts.

Additionally, the supplied BTE shall be a rack mounted equipment of maximum height 76”, mounted on lockable casters. It shall include all required test instruments (i.e., oscilloscope, function generator, power supplies (programmable, if the application calls for it), wiring harnesses, Interface Test Adapters, etc)., storage cabinet(s) for ITAs, rugged work table (preferably attached to the BTE rack) and a chair, a printer, a bar code reader, and a warning strobe light on top of the BTE Rack that illuminates when high voltage is present in the unit. The BTE shall have newly calibrated instruments on the date of BTE Commissioning. Cable entry

(power and signal) into the BTE Rack shall employ cable glands and be at least 24” above the bottom of the Rack. The BTE shall incorporate a cable management scheme such that no cable(s) or wiring between adjacent modules of the BTE shall be laid on the ground.

20.3.2.2 Bench Test Equipment -Acceptance Procedure

Qualification testing of the bench test equipment shall be performed in accordance with PATH’s Test Program. All necessary procedures shall be repeated after delivery and installation in PATH's shops as an acceptance test.

20.3.3 Workstation Equipment

Workstations capable of supporting software and hardware shall be provided. The workstations shall be delivered prior to delivery of the first Locomotive. At a minimum, the computer performance of all workstations shall meet or exceed the equivalent of the year 2015 benchmark processor suitable to perform all required functions, comprised of 4 cores, clocking at 3.4 GHz or higher with support of up to 16 GB of DDR3 RAM, and at least 1 GB of integrated HD graphics memory. At least 8 GB of RAM and 500 GB of hard disk drive shall be installed. The motherboard shall have a Gigabit Ethernet Network Interface. If the video memory requirements provided by the Central Processor Unit (CPU) is not enough, a dedicated Graphics Processor Unit (GPU) shall be installed to fulfill the demand. The memory needs (RAM and hard drive) of the installed software shall not utilize more than 70 percent of the installed memory. A 101-key keyboard and a 3-button mouse shall be provided. A high speed DVD RW internal drive capable of handling a write speed of 24X shall come installed. The monitor shall be a 19" LED Backlit LCD, capable of producing 16.7 million colors at a resolution of 1440 x 900. The response time shall be 5ms and refresh rate of 60 Hz The monitor shall come with an anti-glare coating to minimize screen glare and promote readability in bright light. Additionally, a high-speed (27 ppm) multi-function (print, scan, fax, copy) color printer, shall be included for making hard copies. The systems shall come with a PATH-approved operating system and all software, required or used by supplier during development, to run the applications on the system, including the latest version of the office suite. All required media and software and the associated licenses to support the applications or re-initialize the workstation shall be provided.

The PC, monitor and all external components must be supplied by a PATH-approved manufacturer. Appropriate disks, cables, and accessory software shall be provided for all ancillary equipment.

20.3.4 Software Workstation

Two (2) sets of computer-controlled workstation equipment shall be supplied by the Contractor to support the software maintenance of Locomotives.

END OF ATTACHMENT

ATTACHMENT D

PATH LOCOMOTIVE SPECIFICATIONS

INFORMATION TECHNOLOGY PROVISIONS

1 – AUTHORITY'S RIGHTS IN PROPERTY

A. Technology License

1. The Contractor hereby grants to the Authority on the Contractor's behalf, and on behalf of its Subcontractors, Suppliers and Manufacturers (as to whom the Contractor represents and warrants that it has the power and authority to grant such sublicense), an irrevocable, perpetual, royalty-free, nonexclusive license and sublicense ("Technology License") to use, itself or through its employees, consultants, and contractors, for the Approved Purposes described in paragraph A.2 of this Section: all patented, copyrighted and unpatented technology, know-how, trade secrets and other proprietary rights, and documentation thereof except Manufacturing Detailed Drawings, which are included in the Locomotives, including but not limited to all Systems, Subsystems, assemblies, subassemblies, components, and interface systems and controls which are necessary for the maintenance and repair, modification and upgrading, overhaul and/or remanufacture of the Locomotives, and for the manufacture of parts which are unavailable for purchase, as defined below (other than Software, which is separately defined at and licensed pursuant to paragraph B of this section), all of which shall be designated the "Licensed Technology".

2. The Authority's rights under this Technology License shall be limited to its use for the following PATH purposes:

   i. evaluation and qualification for the purposes of future Locomotive procurements of Systems, Subsystems and components of Subsystems on the Locomotives to be delivered under this Contract;

   ii. preparation of specifications for future production orders of Locomotives employing some or all of the Licensed Technology (the "Specification Purpose");

   iii. maintenance and repair of the Locomotives;

   iv. modification and upgrading of the Locomotives;

   v. overhaul and/or remanufacture of the Locomotives;

   vi. manufacture of parts for the Locomotives which become unavailable for purchase. The term "unavailable for purchase" means that a part is no longer being manufactured; or an inventory of the part in sufficient quantities to meet the Authority's needs is not available for purchase; or no supplier will sell a part to the Authority or cannot supply the part according to a delivery schedule that meets the Authority's needs; or that no supplier will offer the parts at a commercially reasonable price as determined by PATH. Before using licensed property for the Approved Purpose described in paragraph A.2 (vi), the Authority shall first solicit a proposal from the Licensor.

3. The Authority shall not have the right under this Technology License either to use the Licensed Technology to manufacture itself, or to have manufactured for it by a third party as a sublicensee of the Authority, either the Locomotives, Systems, Subsystems or components thereof, except as specified in the foregoing subparagraph (vi). The purposes described in the foregoing subparagraphs (i) through (vi) as limited by the immediately preceding sentence are referred to in this paragraph as the "Approved Purposes."

B. Software License

1. The Contractor hereby grants to the Authority on the Contractor's behalf, and on behalf of its Subcontractors, Suppliers and Manufacturers (as to whom the Contractor represents and warrants that it has or will have the power and authority to grant such sublicense), an irrevocable, perpetual, royalty-free, nonexclusive license and sublicense ("Software License") to use, itself or through its employees, consultants and contractors, , for the Approved Purposes set forth in paragraphs B.2 and B.3 of this section) which is included in the Locomotives, and in all Systems, Subsystems, assemblies, subassemblies and components thereof, all interface systems and controls with respect to all of the above, all diagnostic and testing systems, and all other microprocessor-based systems and software necessary to permit the Authority to implement the Approved Purposes, including all such systems and software which are necessary for the maintenance and repair, modification and upgrading, overhaul and/or remanufacture of the Locomotives and for the manufacture of parts which become obsolete or otherwise unavailable for purchase, all of which shall be designated the "Licensed Software".

2. The term "Software" shall mean any and all computer application programs which are incorporated as part of any System, Subsystem, assembly, subassembly or components thereof, or any interface system control between or among the Systems, Subsystems, assemblies, subassemblies, or component thereof, in the Locomotives, or which are used in connection with a system (which use involves microprocessors, controllers, drivers, or other electronic data processing elements) or which are used in connection with any related diagnostic or testing equipment (if any), together with all related Documentation, including without limitation the object code, source code and pseudo-code versions of such assemblies, subassemblies, programs, firmware containing such programs, know-how protocols, listings, instruction sets, indices and other intellectual property necessary for the Authority's use of the Software for the Approved Purposes in the form prepared by the Contractor, Subcontractor, Supplier or Manufacturer in the regular course of its business, or to the extent that the Technical Specification requires a different form, then in the form required by the Technical Specification.

3. The term "Documentation," except as applicable to commercially available software, includes all user manuals, systems manuals, training materials, guides, logic diagrams, programmer's notes, flow-charts, algorithms, development tools and development platforms, including Input/Output Documentation [defined in paragraph B.5 of this section] and other materials necessary for the Authority's understanding and use of the Software for the Approved Purposes in the form prepared by the Contractor, Subcontractor, Supplier or Manufacturer in the regular course of its business, or, to the extent that the Technical Specification requires a different form, then in the form required by the Technical Specification.

4. For all Software determined by the Project Manager to be commercially available software, the term "Documentation" includes all user manuals, systems manuals, training manuals, guides and all other materials made available by the software developer to users of its software, including Contractor.

5. The Contractor shall provide the Authority with full documentation, in the form(s) required by the Technical Specification, as to all input/output protocols and operating parameters for microprocessor-based control systems installed in the Locomotives, provided, however, that the Authority's right to disclose or use such information shall be limited to the Approved Purposes. The term "Input/Output Documentation" shall mean a complete listing of all commands and operating parameters generated by electronic input devices, such as manual controls, sensors and test equipment used with the system, and responses generated by the controller to such devices, directives and responses sent between controllers and the output to the controlled system. Input/Output Documentation shall also include complete specifications for all communication interfaces, external device drivers and analog/digital converters used by the control system, the addresses, parameters, priority and functions of all operating routines and the locations, structure and functions of all data stores.

C. Form, Fit and Function License

To the extent not otherwise licensed to the Authority under this paragraph, the Authority shall have an irrevocable, perpetual, royalty-free, nonexclusive license to copy, modify and disseminate for the Approved Purposes all documents, information and data relating to the form, fit and function of any System, Subsystem, assembly, subassembly, or component thereof included in the Locomotives ("Form, Fit and Function Data License"). Form, Fit and Function Data shall include: data relating to items, components, or processes that are sufficient to enable physical and functional interchangeability, as well as data identifying source, size, configuration, mating and attachment characteristics, and performance requirements; for computer software, it shall include data identifying source, functional characteristics, performance requirements, and methodology for validation of the aforementioned data, all of which shall be designated the Licensed Form, Fit and Function Data.

D. Software Standards

In its design of the Locomotives, the Contractor shall insure that all Software (i) conforms to those standard industry interfaces and protocols specified by the Authority to permit interchangeability of Systems and Subsystems, (ii) is capable of maintenance, modification and upgrades in accordance with conventional software standards and practices, (iii) utilizes conventional command sequence and structure, and (iv) in all respects meets the software standards requirements of the Technical Specification.

E. Use of Copyrighted Material

The Licenses granted herein each shall entitle the Authority to copy, modify and disseminate, solely for the Approved Purposes, all copyrighted material included in the Licensed Technology, the Licensed Software, and the Licensed Form, Fit and Function Data, including (without limitation) manuals, drawings, diagrams, schematics, data bases, Form, Fit and Function Data, and all materials furnished pursuant to paragraph I.B.5 and I.G.

F. Tangible Materials

The tangible copies of all drawings, schematics, parts lists, diagrams, manuals, Software, Documentation and other data and documents, regardless of the media or form of its storage or use, furnished to the Authority in connection with this Contract shall become the property of the Authority; provided, however, the use, storage, reproduction, handling, disclosure and dissemination of any such materials shall be subject to this paragraph.

G. Deliverables

With respect to all of the Licensed Technology, Licensed Software, and Licensed Form, Fit and Function Data, the Contractor shall furnish to the Authority, in the form(s) required by the Technical Specification, as-built drawings, parts lists, schematics, diagrams, manuals, other data, documents and information, including all Software and Documentation, of the Locomotives, including but not limited to all Systems, Subsystems, assemblies, subassemblies, components and interface systems and controls required by the Technical Specification and needed by the Authority for its use for the Approved Purposes, as well as Form, Fit and Function Data sufficient for the Specification Purpose. The Contractor, and each Subcontractor, Supplier and Manufacturer, shall prepare all such materials in such manner as not to include any confidential information that is protected under paragraph II provided, however, if confidential information must be furnished in respect of certain Systems, Subsystems, assemblies, subassemblies, or components thereof, in order to permit use by the Authority for the Approved Purposes (other than the Specification Purpose), those materials containing confidential information, if any, shall be identified amd presented to the Authority. The parties shall agree on procedures for verifying the completeness of each delivery, and at the time of the first delivery and each delivery thereafter, the Authority and Contractor shall jointly verify the deliverables in accordance with agreed upon procedures.

H. Delivery Schedule

In furtherance of the grant of the Licenses granted in this paragraph, the Contractor covenants that it shall verify the receipt by the Contractor of all deliverables under paragraph.G no later than the time that the Contractor delivers the first Locomotive. The Contractor further covenants that it will deliver to the Authority complete and current copies of all of the Licensed Technology, Licensed Software, and Licensed Form, Fit and Function Data as described in paragraph.G six months prior to the date of expiration of the General Warranty on the first Locomotive. The Contractor shall provide for inspection, after delivery of the first Locomotive, when requested by PATH, of all of the Licensed Technology, Licensed Software, and Licensed Form, Fit and Function Data as described in paragraph.G. The initial set of deliverables will be replaced with a final set, which will include all corrections, modifications and upgrades that have been incorporated into the Locomotives. The Contractor shall deliver the final set of deliverables with delivery of the fourth Locomotive. . With this final delivery, the Contractor shall certify that the Authority has received all Licensed Technology, Licensed Software, and Licensed Form, Fit and Function Data representing the "as built" Locomotives.

I. Use of Contractors and Consultants

The Authority may employ Contractors and Consultants for the Approved Purposes, as needed, and may sublicense its rights to use the Licensed Technology, the Licensed Software, and the Licensed Form, Fit and Function Data to such Contractors and Consultants for the Approved Purposes; provided, however, that each such Contractor or Consultant (i) shall receive such sublicense only pursuant to a written agreement subjecting the Contractor or Consultant to the same restrictions on use and disclosure of the licensed property as the Authority; and (ii) the Contractor or Consultant shall have no right to sublicense the licensed property, and (iii) except with respect to the Approved Purposes set forth in paragraph.A.2 (vi), the Contractor or Consultant shall not be a direct competitor of the Licensor.

J. Escrow Agreement

The Contractor shall maintain an escrow account with a Port Authority approved and independent third party company in the business of providing escrow services. The Contractor shall deposit the latest source code along will all necessary documentation, test programs, specifications, instructions for maintaining or modifying the licensed software and notify the Port Authority of the deposit date. The deposit shall contain all libraries and the platform operating system to allow the application to be recreated if so needed.

K. Tooling Rights

1. The Contractor, its Subcontractors, Suppliers and Manufacturers shall not sell destroy, or otherwise dispose of their rights to the use of, the castings, patterns, and forming or extrusion dies after their use in the production of the Locomotives without first offering them to the Authority, with reasonable costs associated with the transfer to be borne by the Authority, or, in the case of a proposed sale to another, without first offering them for sale to the Authority at a fair market price. The Contractor shall be liable to the Authority to the extent that the failure of the Contractor, its Subcontractor, Supplier or Manufacturer to comply with this paragraph.K. causes the Authority to incur costs to have the tooling replicated.

2. For purposes of this paragraph.K., the terms "sell" and "sale" shall not include transfer of these assets to a successor corporation or other entity which assumes the business and obligations of any Contractor, Subcontractor, Supplier or Manufacturer herein, including obligations arising under this Contract.

3. Upon Contractor's offer of any of the materials described in paragraph K.1. above and the Authority's refusal, Contractor's obligation under this paragraph.K, as it relates to the materials offered and refused, shall cease.

II PATENTS, COPYRIGHTS, ETC., INFRINGEMENT CLAIMS

A. Right and Remedies of the Authority

1. The Contractor warrants that, at the time that the Contractor shall deliver the Locomotives to the Authority, each Subcontractor, Supplier or Manufacturer of any System, Subsystem, assembly, subassembly or component thereof shall not be party to any litigation which it has not disclosed to the Authority involving allegations of infringement of patents, copyrights, mask works, trademarks, trade secrets, antitrust or other trade regulation relating to any of the Licensed Technology, Licensed Software, Licensed Form, Fit and Function Data, any System, Subsystem assembly, subassembly or any component thereof, or any drawing, document, information, equipment or other material to be delivered to the Authority, and shall not be subject of any injunction, order, award or judgment which may prohibit or restrict it under certain circumstances from supplying or licensing any System, Subsystem, assembly, subassembly or component thereof to be used or delivered under the Contract or any of the Licensed Technology, Licensed Software, Licensed Form, Fit and Function Data, incorporated in the Locomotives. If a party to such litigation is a Subcontractor, Supplier or Manufacturer to the Contractor under this Contract, it shall be at the Contractor's risk, and in all events, neither the Contractor- nor the Authority will undertake to determine the merits of such litigation. The Contracting Party and the Authority reserve the right to reject anything which is the subject of such litigation, injunction, order, award or judgment if in their judgment use of it as a result of such circumstance would delay the Work or be unlawful.

2. The Contractor and each Subcontractor, Supplier, or Manufacturer supplying any System, Subsystem, assembly, subassembly, or component thereof, shall indemnify, defend and hold harmless the Authority against all damages, liabilities, charges and expenses (including reasonable attorney's fees) arising out of or related to any claim of infringement of any patent, trademark, copyright or mask work or misappropriation or misuse of any trade name, trade secret or other unpatented technology based upon (i) the Contractor, or such Subcontractor, Supplier, or Manufacturer supplying any System, Subsystem, assembly, subassembly, or component thereof, or any tools, equipment, test materials or process to be delivered to the Authority under the Contract, (ii) the Authority's operation of the Locomotives, or (iii) the Authority's use of any System, Subsystem, assembly, subassembly or component thereof.

3. Promptly following the Authority's receipt of notice of any alleged claim or liability asserted against it which may constitute an indemnified claim or liability asserted under paragraph II.A., the Authority shall give notice to the indemnifying party. The Authority shall proceed to resist and dispose of such liability in such manner as it deems appropriate; provided, however, that the indemnifying party or its insurer shall have the right to assume the defense thereof, including the employment of legal counsel reasonably acceptable to the Authority and payment of all expenses in connection therewith.

4. If the indemnifying party elects to assume the defense of any such action, the Authority shall cooperate with the indemnifying party in its defense of such claim. In addition, the Authority shall have the right to employ separate legal counsel in any such action and participate in the defense thereof, but the fees and expenses of such other counsel shall be at the expense of the Authority and not subject to indemnification under this paragraph II.

5. The indemnifying party, in the defense of any such claim or litigation, shall not, except with the prior written consent of the Authority, which consent shall not be unreasonably withheld or delayed, consent to the entry of any judgment or enter into any settlement which does not include the release by the claimant or plaintiff of the Authority from all liability in respect to such claim or litigation. The Authority shall not consent to the entry of any judgment or enter into any settlement without the prior written consent of the indemnifying party, which consent shall not be unreasonably withheld.

6. The Authority agrees that if operation of the Locomotives becomes, or is likely to become, the subject of a claim within the scope of this paragraph II, the Authority will permit the Contractor, at its option and expense, either to secure the right for the Authority to continue to use the Licensed Technology, Licensed Software and Licensed Form, Fit and Function Data and operate the Locomotives or to replace or modify the technology or software so that it becomes noninfringing, yet still meets all functional and operational standards of the article replaced.

7. If the Contractor has not alleviated any claim pursuant to the provisions of this paragraph and as a result the Authority is enjoined from using a portion of the Work as to which the Contractor is to indemnify the Authority under this paragraph, during the pendency of any such injunction against the Contractor the Authority may, at its option and without limiting any of the rights it otherwise may have under this Contract or at law or in equity, require the Contractor to supply at its own expense a replacement for the infringing item which shall not be subject to such injunction and shall not infringe any patent, copyright or mask work or misuse or misappropriate any trade secret or other proprietary right. If the Contractor shall fail to provide such a replacement or cannot do so, the Contractor, at its own expense, shall take such steps as may be necessary to ensure compliance by the Authority with such injunction, while preserving the Authority's right to continue to use the Licensed Technology, Licensed Software and Licensed Form, Fit and Function Data and to operate the Locomotives.

8. Any invention, idea, design, method, System, Subsystem, assembly, subassembly, component, design or document which the Authority provides to the Contractor, or directs the Contractor to use, shall be excluded from the Contractor's indemnity under this paragraph, but the Contractor shall notify the Authority if the Contractor is aware of any claim of infringement, or threatened claim of infringement, relating to the same.

9. Subject to the limitations provided elsewhere in this Contract, the rights and remedies to be provided to the Authority under this paragraph shall be exclusive for any claim within the scope of paragraph.A.

B. Authority's Obligations with Respect to Licensed Technology, Licensed Software and Licensed Form, Fit and Function Data

1. The Authority shall implement the Policy and Procedure of its Escrow Agent as set forth in paragraph J.and generally shall employ good business practices no less diligent than those used for its own confidential information to hold in confidence the Licensed Technology, Software, Documentation, Form, Fit and Function Data, drawings, schematics, manuals, data and other information and materials provided by the Contractor pursuant to the Contract, which contain proprietary or confidential nonpublic information and which bears appropriate notices and legends to afford notice of the confidential character of the item.

2. The duty of confidence shall not apply to any information that (i) is or becomes publicly available without restriction through no act or fault of the Authority; (ii) is received from a third party free of any restriction for the benefit of Contractor and without any breach of duty of secrecy, nondisclosure or nonuse due the Contractor; or (iii) is known to the Authority prior to its delivery by the Contractor, free of any restriction for the Contractor's benefit. Notwithstanding the above, the Contractor acknowledges that the Port Authority's obligations under this Agreement are subject to the provisions of the Port Authority Freedom of Information Code and Procedure adopted by the Port Authority's Board of Commissioners on October 22, 2014, as it may be amended from time-to-time, and any disclosure made pursuant thereto is not a violation of this Agreement. The Port Authority Freedom of Information Code can be found at https://www.panynj.gov/corporate-information/pdf/foi-code.pdf, and is incorporated herein.

3. The duty of confidence shall not prevent the Authority from disclosing to its Contractors and

Consultants any confidential information (including the Software and Documentation) for use for the Approved Purposes specified herein.

4. The Authority shall advise the Contractor if the Authority learns or has reason to believe that any unauthorized person has had access to any part of the Contractor's confidential information, or that any person who has had access to such confidential information has violated or intends to violate the terms of this Contract regarding protection of such confidential information. The Authority shall reasonably cooperate with the Contractor, at the Contractor's expense, in seeking equitable relief in the name of the Authority or the Contractor against any such person.

5. The Authority shall reasonably cooperate with the Contractor, at the Contractor's expense, in seeking equitable relief in the name of the Contractor or the Authority against any individual or entity who fails to comply with the provisions of this paragraph II.

C. Contractor's Obligations with Respect to its Confidential Information

1. The Contractor and each Subcontractor, Supplier, and Manufacturer shall use reasonable efforts to place copyright notices and patent notices on all documents, drawings, schematics, manuals, Software, Documentation, etc., to which such notices are applicable (whether or not such notices are required by statute) in a manner reasonably calculated to give notice to the Authority of the same.

2. The Contractor, and each Subcontractor, Supplier, and Manufacturer, shall restrict the use of confidentiality legends to those documents, drawings, schematics, manuals, Software, Documentation, etc., and other materials and information furnished to the Authority which contain proprietary trade secrets. If requested by the Authority (for example, as may be needed for the Specification Purpose described in paragraph herein), the Contractor, and each Subcontractor, Supplier and Manufacturer, shall use its or their reasonable efforts to prepare separate versions of each drawing, document, diagram, schematic, manual, etc., containing confidential information, so that one version will not contain any confidential information (and hence will not be legended) and the other version will contain the confidential information (and hence will be legended).

3. Nothing in this paragraph II shall prevent the Authority from disclosing confidential information of the Contractor, or any Subcontractor, Supplier, or Manufacturer under order of a court or governmental agency having jurisdiction, but only after having given the other party, if legally permissible, timely notice and affording it full opportunity to appeal such order, seek a protective order or take other action for protection of its confidential information as it deems appropriate.

D. Remedies for Breach of paragraphs I or II

1. The Contractor agrees that, in the event of a breach by the Contractor of any provision of this paragraph II, the Authority would be irreparably damaged by such breach and that, in the event of any such breach or threatened breach of any such agreement, in addition to any remedy for damages available to the Authority, at law or in equity, the Authority shall be entitled to injunctive relief prohibiting future breaches or violations of, or other non-compliance with, the terms of paragraph II, or to prevent any threatened breach.

2. The Contractor agrees that, in view of the Authority's public character, in the event of a breach by the Authority of any provision of paragraph II.B., the Contractor shall have as its sole remedy against the Authority a claim for money damages and prospective equitable relief to prohibit further wrongful use or disclosure by the Authority; in all events the Contractor shall have no right to terminate the Technology License, the Software License, or the Form, Fit and Function Data License.

3. During the resolution of any dispute between the Contractor and the Authority relating to a claimed breach of an obligation under paragraph II.B., the parties shall continue to perform their respective obligations under this Contract in good faith and neither to exercise any remedy of self-help nor to suspend performance pending determination of the dispute resolution.

ATTACHMENT E

CONTRACT SPECIFIC TERMS AND CONDITIONS

TABLE OF CONTENTS

1. General Agreement 2
2. Order of Precedence 2
3. Specific Definitions 2
4. Delivery Requirements 3
5. Delivery Schedule 4
6. Progress Schedule 4
7. Time is of the Essence 5
8. Bill of Sale 5
9. Title to Materials 5
10. Invoices 6
11. Payment 6
12. Default – Delays ..... **Error! Bookmark not defined.**
13. Equipment Warranty 7
14. Insurance Procured by the Contractor 8
15. Materials and Workmanship 10
16. Inspection and Acceptance 10
17. Errors and Omissions 11
18. Approval by the Project Manager 11
19. Changes 11
20. Variations in Quantity 11

CONTRACT SPECIFIC TERMS AND CONDITIONS

1. General Agreement

Subject to all of the terms and conditions of this Contract, the undersigned (hereinafter called the "Contractor") hereby offers and agrees to manufacture and deliver four (4) Locomotives and associated spare parts, and all other things necessary to perform the Work required by this Contract as specified in the Request for Proposal (RFP), and fully set forth in the Specifications, at the location(s) listed in RFP and fully set forth in the Specifications, and do all other things necessary or proper therefor or incidental thereto, all in strict accordance with the provisions of the Contract Documents and any future changes therein; and the Contractor further agrees to assume and perform all other duties and obligations imposed upon it by this Contract.

In addition, all things not expressly mentioned in the Specifications but involved in the carrying out of their intent and in the complete and proper execution of the matters referred to in and required by this Contract are required by the Specifications, and the Contractor shall perform the same as though they were specifically delineated, described and mentioned therein.

2. Order of Precedence

Anything to the contrary herein notwithstanding, all Contract Specific Terms and Conditions shall be deemed to control in the event of a conflict with the Standard Terms and Conditions contained in this Contract.

3. Specific Definitions

To avoid undue repetition, the following terms, as used in this Contract, shall be construed as follows:

Government, United States Government, Federal or words of like import shall mean the United States of America.

UMTA or FTA - shall mean the United States Department of Transportation, Federal Transit Administration (formerly known as the Urban Mass Transportation Administration).

DOT - shall mean the United States Department of Transportation.

DCAA - shall mean the Defense Contract Audit Agency.

The Port Authority or Authority - shall mean The Port Authority of New York and New Jersey.

PATH - shall mean the Port Authority Trans-Hudson Corporation.

Director - means the Director/General Manager of PATH acting either personally or through his duly authorized representatives acting within the scope of the particular authority vested in them.

Project Manager – means the Project Manager assigned by PATH to manage this contract, acting either personally or through his duly authorized representatives acting within the scope of the particular authority vested in them.

"Contractor" shall mean the Proposer to whom this Contract is awarded, its successors and assignees. For convenience the Contractor is hereinafter referred to as if the Contractor were an individual. The word "he" shall, as the sense may require include: "she," "it" and "they"; the word "him" shall include "her," "it" and "them;" and the word "his" shall include "her," "its" and "their"

"Contract-" "Contract Documents" or "Agreement" shall mean the ATTACHMENTS, APPENDICES, CONTRACT SPECIFIC CONTRACT TERMS AND CONDITIONS, STANDARD TERMS AND CONDITIONS, SCHEDULES (if any), TECHNICAL SPECIFICATIONS (if any), CONTRACT DRAWINGS (if any), PURCHASE ORDER NUMBER, and the Notice of Award.

Investigation - Any inquiries made by any federal, state or local criminal prosecuting agency and any inquiries concerning civil anti-trust investigations made by any federal, state or local governmental agency. Except for inquiries concerning civil anti-trust investigations, the term does not include inquiries made by any civil government agency concerning compliance with any regulation, the nature of which does not carry criminal penalties, nor does it include any background investigations for employment, or Federal, State, and local inquiries into tax returns.

Item(s) – shall mean the goods, merchandise, supplies, equipment, services or articles specified.

Manufacturer – shall mean the person or entity who will actually build the specific Item to be provided as described herein.

Satisfactory Delivery - shall mean the delivery to PATH of equipment and other Items meeting the requirements of this Contract and shall include passing such tests and inspections at PATH's facility as are required under this Contract.

4. Delivery Requirements

Delivery shall be FOB Destination, and the Contractor shall bear all cost of freight and insurance for delivery and unloading of the Locomotives to the Port Authority. Delivery locations shall be coordinated with Edward Perara, the Project Manager at 201-216-6021. All deliveries shall be made between the hours of 8:00 am and 2:00 pm, unless otherwise noted in the Specifications or agreed upon by the parties, in writing. The Contractor shall follow the instructions for the proper method of making deliveries. Failure to do so may result in delayed payments.

A. All deliveries must be accompanied by an original packing slip, which shall always contain:

1. The Port Authority Purchase Order Number.
2. A description of each Item.
3. The quantity shipped of each Item.
4. The Contractor's packing slip/invoice number.

B. Shipping cartons shall not contain loose and/or unmarked Item(s).

5. Delivery Schedule

The Contractor shall complete delivery of the Locomotives under this Contract as follows:

Complete the Satisfactory Delivery of the Locomotives, delivery of all other equipment, and the performance of all other obligations by the Contractor under this Contract no later than **800 days** after the issuance of a Notice of Award.

6. Progress Schedule

Within **ten (10)** business days after receipt of a Notice of Award, the Contractor shall prepare a detailed delivery schedule, based on the schedule below and the additional Items listed in Part V of this Contract, for the approval of the Project Manager. The delivery schedule shall show the date for the commencement and completion of the different portions of the Contract.

After the approval of the schedule, no changes shall be made thereto without the written approval of the Project Manager. Approval of any delivery schedule shall not relieve the Contractor of its obligation to complete the Contract by the time required in the Contract or as otherwise agreed to by the parties, nor shall it constitute a representation by the Authority that the Contractor will be able to proceed or complete in accordance with the schedule.

Progress Schedule:

The Contractor shall meet the following milestones:

1. Within **100** calendar days after receipt of a Notice of Award, Contractor must submit for approval, the Configuration, Dimensional, Working and Shop drawings.
2. Within **650** calendar days after receipt of a Notice of Award, the Contractor shall secure PATH's approval of the inspection of the first

Locomotive at the Contractor's plant and then every thirty (30) calendar days inspection of the 2nd, 3th and 4th Locomotive.

3. Within **680** calendar days after receipt of a Notice of Award, delivery of the first Locomotive to PATH and then every thirty (30) calendar days, delivery of the 2nd, 3th and 4th Locomotive.
4. Within **710** calendar days after receipt of a Notice of Award, PATH and the Contractor to perform clearance, test runs and place the Locomotive into service and then every thirty (30) calendar days perform clearance, test runs and place into service the 2nd, 3th and 4th Locomotive.
5. Within **800** calendar days after receipt of a Notice of Award, deliver all the required spare parts.

7. Time is of the Essence

The Contractor's obligation for the performance within the time provided for this Contract is of the essence of this Contract. The Contractor guarantees that it can and will complete such fabrication, supply, delivery, factory and field testing, and on-site training within the time herein stipulated.

The delivery times shall be extended (subject, however, to the provisions of this numbered clause) only if requested in writing and approved by the Project Manager. Further, the Contractor shall be entitled to an extension of time to the extent that delay in its performance results from floods, earthquakes, storms, lightning, fire, epidemic, strike, force majeure, civil disturbance or any other cause which is beyond the reasonable control of the Contractor as determined by the Project Manager.

Any reference herein to the Contractor shall be deemed to include suppliers and others performing on behalf of the Contractor, whether or not in privity of contract with the Contractor, and employees and others will be considered as agents of the Contractor.

8. Bill of Sale

The Contractor warrants that the Locomotives and all spare parts are free of liens and other encumbrances. The Contractor shall promptly furnish to the Port Authority such bills of sale and other instruments as may be required by it, properly executed, acknowledged and delivered, assuring to it title to the Locomotives and all spare parts, free of liens and other encumbrances, upon delivery of such merchandise to the Port Authority.

9. Title to Materials

All manufactured equipment, drawings, specifications, spare parts, training programs/ materials, provided to the Port Authority shall be and become the property of the Authority upon successful completion of commissioning and acceptance testing by PATH. All equipment stored by the Contractor shall be individually marked and identified in a conspicuous manner "Property of the Port Authority of New York and

New Jersey – RFP # 45178" Contractor shall arrange for the Project Manager to have access to the storage site for inspection of equipment stored as requested. The Contractor shall have risk of loss for any equipment stored until their delivery and acceptance by PATH at the Project site. As a prerequisite to the Port Authority or PATH making any payments under this Contract, the Contractor shall furnish whatever documents evidencing transfer of title of equipment to the Authority that the Project Manager requires, including bills of sale and affidavits of title in forms acceptable to the Project Manager.

10. Invoices

An invoice with a unique invoice number and the backup delivery receipts with Contract number shall be submitted to the Port Authority before payment can be made. The Contractor's invoice shall state the starting and ending dates of the delivery. All invoices shall be mailed to the address depicted on the Contract.

11. Payment

Subject to the provisions of this Contract, the Port Authority agrees to pay to the Contractor and the Contractor agrees to accept from the Port Authority as full and complete consideration for the performance of all its obligations under this Contract and as sole compensation for the Items(s) and/or service(s) provided by the Contractor hereunder, a compensation calculated from the respective prices inserted by the Contractor in the Pricing Sheet(s) for actual services and goods performed/provided, forming a part of this Contract. The manner of submission of all bills for payment to the Contractor for Service(s) and/or Item(s) provided under this Contract shall be subject to the approval of the Port Authority in all respects, including, but not limited to, format, breakdown of Items presented and verifying records. All computations made by the Contractor and all billing and billing procedures shall be done in conformance with the clause entitled "Invoices" and the following procedures:

a. Upon full acceptance of each Locomotive, payment for each such Locomotive will be made in accordance with the Pricing Sheets.

b. No payment will be made to the Contractor until the first Locomotive OR the first lot of spare parts is delivered to PATH and completely accepted.

c. Upon full acceptance of each lot of spare parts, the Contractor shall be paid as set forth in the Pricing Sheets.

d. No certificate, payment, acceptance of any Item(s) or any other act or omission of any representative of the Port Authority shall operate to release the Contractor from any obligation under or upon this Contract, or to estop the Port Authority from showing at any time that such certificate, payment, acceptance, act or omission was incorrect or to preclude the Port Authority from recovering any monies paid in excess of those lawfully due and any damage sustained by the Port Authority.

e. In the event an audit of received invoices should indicate that the correct sum due the Contractor for the relevant billing period is less than the amount actually paid by the Port Authority, the Contractor shall pay to the Port Authority the

difference promptly upon receipt of the Port Authority's statement thereof. The Port Authority may, however, in its discretion elect to deduct said sum or sums from any subsequent payments payable to the Contractor hereunder.

f. "Final Payment", as the term is used throughout this Contract, shall mean the final payment made for the supply, delivery and acceptance of all Item(s) required under this Contract. The Contractor's acceptance of Final Payment shall act as a full and complete release to the Port Authority of all claims of and of all liability to the Contractor for all Item(s) furnished in connection with this Contract and for every act and neglect of the Port Authority and others relating to or arising out of this Contract, including claims arising out of breach of contract and claims based on claims of third persons. No payment, however, final or otherwise shall operate to release the Contractor from any obligations in connection with this Contract.

12. Equipment Warranty

Notwithstanding the Specifications forming a part of this Contract, any inspection or approval of the Item(s) by the Port Authority or the existence of any patent or trade name, the Contractor nevertheless unconditionally warrants that the Item(s) specified herein shall be of the best quality and shall be fully fit for the purpose for which it is to be used. The Contractor unconditionally warrants all equipment furnished against defects or failures of any kind, including defects or failures in design, workmanship and materials, failure to operate satisfactorily for any reason, excepting such defects or failures which the Contractor demonstrates to the satisfaction of the Project Manager have arisen solely from accident, abuse or fault of the Port Authority occurring after acceptance by the Port Authority and not due to fault on the Contractor's part for the warranty period(s) described below. In the event of defects or failures in said equipment, then upon receipt of notice thereof from the Project Manager, the Contractor shall correct such defects or failures by immediately reconstructing, repairing or making such alterations or replacement of said Item(s) as may be necessary or desirable in the sole opinion of the Project Manager to comply with the above warranty at no cost to the Port Authority.

The foregoing warranty shall not, however, be a limitation on any rights which the Authority would have, either expressed or implied, in connection with this Contract in the absence of such warranty, said warranty being given only for the greater assurance of the Port Authority. In addition, the Contractor shall provide the following specific warranties to the Port Authority:

- All equipment shall be warranted for two (2) years from date of acceptance.

Contractor agrees that it will make available to PATH replacement equipment, parts and service of equipment either under the warranty set forth above, or through separate purchase, after the warranty period, for five (5) years from the date of acceptance. If the Contractor discontinues manufacturing or support of any product supplied, Contractor shall provide PATH with the latest drawings, and parts lists and PATH shall have the

right to have the product or services manufactured or provided by any other source at PATH's discretion, without any additional payment to the Contractor.

13. Insurance Procured by the Contractor

The Contractor shall take out, maintain, and pay the premiums on Commercial General Liability Insurance, including but not limited to premises-operations, products-completed operations, and independent contractors coverage, with contractual liability language covering the obligations assumed by the Contractor under this Contract and, if vehicles are to be used to carry out the performance of this Contract, then the Contractor shall also take out, maintain, and pay the premiums on Automobile Liability Insurance covering owned, non-owned, and hired autos in the following minimum limits:

Commercial General Liability Insurance - $2 million combined single Limit per occurrence for bodily injury and property damage liability.

Automobile Liability Insurance - $2 million combined single limit per accident for bodily injury and property damage liability.

Railroad Protective Liability Insurance:

$5 million combined single limit per occurrence for bodily injury and property damage. If Work is to be performed on or within 50 feet of railroad property, then the contractual liability coverage shall contain an endorsement deleting any railroad exclusion.

In addition, the liability policy (ies) shall name The Port Authority of New York & New Jersey, its related entities, their commissioners, directors, officers, partners, employees and agents as additional insured, including but not limited to premises-operations, products-completed operations on the Commercial General Liability Policy. Moreover, the Commercial General Liability Policy shall not contain any provisions for exclusions from liability other than provisions for exclusion from liability forming part of the most up to date ISO form or its equivalent unendorsed Commercial General Liability Policy. The liability policy (ies) and certificate of insurance shall contain separation of insured conditions and severability of interests clauses for all policies. These insurance requirements shall be in effect for the duration of the contract to include any warrantee /guarantee period and any maintenance period . An act or omission of one of the insureds shall not reduce or void coverage to the other insureds. Furthermore, the Contractor's insurance shall be primary insurance as respects to the above additional insureds. Any insurance or self-insurance maintained by the above additional insureds shall not contribute to any loss or claim

The certificate of insurance and liability policy (ies) must contain the following endorsement for the above liability coverages:

"The insurer(s) shall not, without obtaining the express advance written permission from the General Counsel of the Port Authority, raise any defense involving in any way the jurisdiction of the Tribunal over the person of the Port Authority, the immunity of the Port Authority, its Commissioners, officers, agents or employees, the governmental nature of the Port Authority, or the provisions of any statutes respecting suits against the Port Authority."

The Contractor shall also take out, maintain, and pay premiums on Workers' Compensation Insurance in accordance with the requirements of law in the state(s) where work will take place, and Employer's Liability Insurance with limits of not less than $1 million each accident.

Each policy above shall contain a provision that the policy may not be canceled, terminated, or modified without thirty (30) days' prior written notice to the Port Authority of NY and NJ, Att: Facility Contract Administrator, at the location where the work will take place and to the General Manager, Risk Financing.

The Port Authority may at any time during the term of this agreement change or modify the limits and coverages of insurance. Should the modification or change results in an additional premium, The General Manager, Risk Financing for the Port Authority may consider such cost as an out-of-pocket expense.

Within five (5) days after the award of this Contract and prior to the start of work, the Contractor must submit an original certificate of insurance, to the Port Authority of NY and NJ, Facility Contract Administrator, at the location where the work will take place. This certificate of insurance MUST show evidence of the above insurance policy (ies), stating the agreement/contract number prior to the start of work. The General Manager, Risk Financing must approve the certificate(s) of insurance before any work can begin. Upon request by the Port Authority, the Contractor shall furnish to the General Manager, Risk Financing, a certified copy of each policy, including the premiums.

If at any time the above liability insurance should be canceled, terminated, or modified so that the insurance is not in effect as above required, then, if the Manager shall so direct, the Contractor shall suspend performance of the contract at the premises. If the contract is so suspended, no extension of time shall be due on account thereof. If the contract is not suspended (whether or not because of omission of the Manager to order suspension), then the Authority may, at its option, obtain insurance affording coverage equal to the above required, the cost of such insurance to be payable by the Contractor to the Port Authority.

Renewal certificates of insurance or policies shall be delivered to the Facility Contractor Administrator, Port Authority at least fifteen (15) days prior to the expiration date of each expiring policy. The General Manager, Risk Financing must approve the renewal certificate(s) of insurance before work can resume on the facility. If at any time any of

the certificates or policies shall become unsatisfactory to the Port Authority, the Contractor shall promptly obtain a new and satisfactory certificate and policy.

The requirements for insurance procured by the Contractor shall not in any way be construed as a limitation on the nature or extent of the contractual obligations assumed by the Contractor under this contract. The insurance requirements are not a representation by the Authority as to the adequacy of the insurance to protect the Contractor against the obligations imposed on them by law or by this or any other Contract. [CITS#4526N]

14. Materials and Workmanship

All Item(s) shall be manufactured and/or provided in accordance with the best current practice in the industry and free from defects. All Item(s) shall at all time and places be subject to the inspection of the Project Manager. Should any Item(s) fail to meet the Project Manager's approval, they shall be forthwith made good, replaced or corrected, as the case may be, by the Contractor, at its own expense. All Item(s) shall be new Item(s).

15. Inspection and Acceptance

Inspection and acceptance will be conducted at the destination, unless otherwise provided and agreed upon by the Port Authority and the Contractor. Any risk of loss will be the Contractor's responsibility until such delivery, inspection and acceptance is made, unless loss results from negligence of the Port Authority.

The Contractor shall provide a written detailed description of its testing procedures; this shall be submitted for approval along with the shop drawings, within two (2) weeks after acceptance of its Proposal by issuance of a Notice of Award.

After delivery, a final inspection of each Locomotive will be made by the Project Manager. If any parts have been damaged or for any reason do not comply with the requirements hereof, the Contractor will be notified in writing within ten (10) calendar days and it shall replace the parts at its own expense even though the Locomotive may have been inspected and approved for shipment. After such satisfactory replacement, if any is required, the entire Locomotive (and any required replacement parts) will be approved as satisfactory and payment therefore will be made as provided in the clause hereof entitled "Payment".

The Contractor shall notify PATH at least two weeks (14 calendar days) in advance of the date when the Contractor wishes to perform Factory Production Tests and Inspection.

This notice shall be given in writing to the following:
The Port Authority of New York & New Jersey
One PATH Plaza, 6th Floor
Jersey City, NJ 07306
Attention: Mr. Edward Perara, Tel. No. (201) 216-6021

A representative of the Authority or PATH may attend the tests and inspections.

16. Errors and Omissions

If the Contractor discovers any errors or omissions in the Specifications or in the Work undertaken and executed by it, it shall immediately notify the Project Manager and the Project Manager shall promptly verify the same. If, with the knowledge of such error or omission and prior to the correction thereof, the Contractor proceeds with any work affected thereby, it shall do so at its own risk, and the work so done shall not be considered as work done under and in performance of this Contract.

17. Approval by the Project Manager

The approval by the Project Manager of any Item(s) shall be construed merely to mean that at that time the Project Manager knows of no good reason for objecting thereto and no such approval shall release the Contractor from its full responsibility for the satisfactory construction and operation of the Item(s). The decision of the Project Manager shall be conclusive, final and binding on the parties as to all questions arising out of, under, or in connection with this Contract (including questions of breach of Contract).

18. Changes

The Port Authority may at any time, by a written order, make changes within the general scope of this Contract in any one or more of the following: (a) drawings, designs, or specifications; (b) method of shipment; and (c) place of delivery, and (d) schedule. If any such change causes an increase or decrease in the cost of, or the time required for, performance of this Contract, a mutual equitable adjustment shall be made to the Contract price or delivery schedule, or both, and the Contract shall be modified in writing accordingly. Any claim by the Contractor for adjustment under this section must be asserted within thirty (30) days from the date of receipt by the Contractor of a notification of change: provided, however, that nothing in this section, “Changes,” shall excuse the Contractor from proceeding with the Contract as changed. Except as otherwise provided herein no payment for Changes shall be made, unless the Changes have been authorized in writing by the Authority.

19. Variations in Quantity

The quantities set forth in the Price Schedule are estimates; actual total quantity purchased may be greater or lower. The Port Authority reserves the right to increase or decrease the quantity of Items called for under this Contract at the Unit Prices specified. The Port Authority may exercise the option to vary the quantity by written notice to the Contractor. Delivery of the additional quantity of Items shall continue at the same rate as the like Items called for under the Contract, unless the parties otherwise agree. All Items to be added shall be set forth in a Change Order, in accordance with section 18 above.

ATTACHMENT F
DISADVANTAGED BUSINESS ENTERPRISE (DBE) PROGRAM

The Port Authority has established a Disadvantaged Business Enterprise (DBE) program in accordance with applicable United States Department of Transportation (USDOT) regulations in 49 CFR Part 26. The Port Authority receives Federal financial assistance from the Department of Transportation, and as a condition of receiving this assistance, the Port Authority has signed an assurance that it will comply with these regulations. It is the policy of the Port Authority to ensure that DBEs, as defined in 49 CFR Part 26, have an equal opportunity to receive and participate in USDOT-assisted contracts. It is also Port Authority policy: *To ensure nondiscrimination in the award and administration of USDOT-assisted contracts;*

1. *To create a level playing field on which DBEs can compete fairly for USDOT-assisted contracts;*

2. *To ensure that the DBE program is narrowly tailored in accordance with 49 CFR Part 26;*

3. *To ensure that only firms that fully meet regulatory eligibility standards as outlined in 49 CFR Part 26 are permitted to participate as DBEs;*

4. *To help remove barriers to the participation of DBEs in USDOT-assisted contracts; and,*

5. *To assist the development of firms that can compete successfully in the market place outside the DBE program.*

The Director of OBDCR has been delegated as the DBE Liaison Officer. In that capacity, the Director of OBDCR is responsible for implementing all aspects of the DBE program. Implementation of the DBE program is accorded the same priority as compliance with all other legal obligations incurred by the Port Authority in its financial assistance agreements with the USDOT.

The Port Authority has disseminated this policy statement to the Board of Commissioners and all the components of our organization. We have disseminated this statement to DBE and non-DBE business communities that perform work for us on USDOT-assisted contracts through posting on the OBDCR website: http://www.panynj.gov/business-opportunities/supplierdiversity.html

B. DBE OBLIGATION

The proposer agrees to take all necessary and reasonable steps to ensure that DBEs have the opportunity to compete for and perform work under this Contract, if awarded. (Note: If the total contract price is increased as a result of change orders, the Contractor shall make a good faith effort to achieve a commensurate increase in DBE participation). Submission of the proposal constitutes a certification and representation by the proposer that good faith efforts will be made to satisfy the DBE goal requirement in paragraph B during contract performance.

Furthermore, the Proposer will ensure that the following clause is placed in every contract or subcontract resulting from this Contract:

> "The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, creed/religion, sex, age or handicap/disability, in the performance of this contract. The

Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of USDOT-assisted contracts. Failure by the Contractor or subcontractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the PANYNJ deems appropriate."

C. SUBMISSION OF DBE UTILIZATION PLAN

By submitting a bid or proposal for this Contract, the proposer assures the Authority that it will meet the foregoing goal and shall submit the DBE Goals Statement form (Appendix A1) with its Proposal. If the proposer determines it cannot make this assurance, it may nevertheless submit a bid or proposal, but in such event, it shall note on the DBE Goals Statement form the percentage of DBE participation it anticipates, including documentation supporting the good faith efforts made to achieve the goals set forth in the Contract.

The proposer shall submit, with its Proposal, the DBE Participation Plan and Affirmation Statement (Appendix A2) for each DBE firm it intends to use on this Contract. The DBE Participation Plan and Affirmation Statement shall provide the name and address of each DBE firm, a description of the work to be performed, the dollar value of each DBE subcontract and the signature affirmation from each DBE firm participating in this Contract.

The bidder shall submit with its Proposal the completed Information on Solicited Firms form (Appendix A3), listing every firm that provided a quotation to the bidder for any subcontract to be performed under this Contract, whether the firms are DBE certified and whether the firms' quotes were included in the final Proposal.

Bidders who are utilizing trucking firms to meet their DBE goal are directed to complete the "Pre-Award DBE Trucking Commitment Form" (Appendix A4) and submit the form with their Proposals for each DBE used on this Contract.

Bidders who are utilizing materials suppliers to meet their DBE goal are directed to complete the "DBE Regular Dealer Verification Form" (Appendix A5) and submit the form with their Proposals for each DBE used on this Contract.

1. By listing a firm on its DBE Participation Plan and Affirmation Statement (Appendix A2) the proposer is representing the following:

   a. It intends to use the firm for the work specified in the DBE Participation Plan and Affirmation Statement (Appendix A2) to perform the work specified.

   b. The firm is a certified DBE in the states of either New York or New Jersey and is technically and financially qualified to perform the work specified and that the firm is available to perform the work.

   c. If it is awarded the contract, it will enter into a subcontract with such DBE (or an approved substitute), subject to the terms and conditions of this contract, for the work described and at the price set forth in the DBE Participation Plan and Affirmation Statement (Appendix A2).

d. It will not substitute a DBE firm listed in its DBE Participation Plan and Affirmation Statement (Appendix A2) unless the Port Authority provides prior written approval in accordance with Paragraph J, below.

D. PROMPT PAYMENT AND RETAINAGE PROVISION

The Contractor agrees to pay each subcontractor under this prime contract for the satisfactory performance of its contract, no later than ten (10) days from the receipt of each payment the Contractor receives from the Authority. The Contractor agrees further to return all retainage, if any, owed to a subcontractor within ten

(10) days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time-frame may occur only for good cause following written approval from the

Port Authority. This clause applies to both DBE and non-DBE subcontractors. Failure to comply with this

section may constitute a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any other available remedy.

E. CREDIT TOWARD DBE GOAL

No credit toward meeting the DBE goal will be allowed unless OBDCR or a NYSUCP or NJUCP Certifying Partner has certified the DBE firm as eligible. Only the value of the work actually performed by the DBE will be counted toward the DBE goal. The DBE shall verify payments on the DBE Payment Request Certification Form attached to all invoices. The Authority will use the following guidelines to determine the amount to be counted toward the DBE goal:

1. OBDCR will credit the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a USDOT-assisted contract, toward DBE goals, provided OBDCR determines the fee to be reasonable and not excessive as compared with fees customarily allowed for similar services.

2. When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a certified DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

3. Joint ventures between DBEs and non-DBEs may be counted toward the DBE goal in proportion to the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE performs with its own forces. Please contact the Office of Business Diversity and Civil Rights at (201) 395-3958 for more information about requirements for such joint ventures.

4. OBDCR will credit expenditures to a DBE subcontractor toward DBE goals, only if the DBE is performing a commercially useful function on the contract.

5. Commercially Useful Function

A. A DBE is considered to perform a commercially useful function when it is responsible for the execution of a distinct element of work on a contract and carries out its responsibilities by actually performing, managing and supervising the work involved in accordance with normal industry practice. Regardless of whether an arrangement between the Contractor and the DBE represents standard industry practice, if the arrangement erodes the ownership, control or independence of the DBE or in any other way does not meet the commercially useful function requirement, that firm shall not be included in determining whether the DBE goal is met and shall not be included in DBE reports. If this occurs with respect to a firm identified as a DBE, the Contractor shall receive no credit toward the DBE goal and may be required to backfill the participation. A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction or contract through which funds are passed in order to obtain the appearance of DBE participation. A DBE may rebut a determination by the Authority that the DBE is not performing a commercially useful function to the United States Department of Transportation (USDOT) funding agency (for example, FAA, FTA or FHWA).

B. Work Force. The DBE must employ a work force (including administrative and clerical staff) separate and apart from that employed by the Contractor, other subcontractors or their affiliates. This does not preclude the employment by the DBE of an individual that has been previously employed by another firm involved in the Contract, provided that the individual was independently recruited by the DBE in accordance with customary industry practice. The routine transfer of work crews from another employer to the DBE shall not be allowed.

C. Supervision. All Work performed by the DBE must be controlled and supervised by the DBE without duplication of supervisory personnel from the Contractor, their affiliates and other subcontractors performing Work on the Contract. This does not preclude routine communication between the supervisory personnel of the DBE and other supervisors necessary to coordinate the Work.

D. Equipment. DBE subcontractors may supplement their equipment by renting or leasing additional equipment in accordance with customary industry practice. If the DBE obtains equipment from the Contractor, other contractors or their affiliates, the DBE shall provide documentation to the Authority demonstrating that similar equipment and terms could not be obtained at a lower cost from other customary sources of equipment. The required documentation shall include copies of the rental or leasing agreements, and the names, addresses, and terms quoted by other sources of equipment.

E. If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of its contract with its own work force, or the DBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work involved, OBDCR will presume that it is not performing a commercially useful function.

6. <u>Counting DBE Participation</u>

When a certified DBE firm is awarded the Contract, the DBE goals shall be deemed to have been met.

The value of the Work performed by a DBE, including that of a DBE prime contractor, with its own equipment, with its own forces, and under its own supervision, will be counted toward the DBE goal, provided the utilization is a commercially useful function. Work performed by DBEs will be counted as set forth below. If the Authority determines that some or all of the DBE's work does not constitute a commercially useful function, only the portion of the work considered to be a commercially useful function will be credited toward the DBE goal.

A. Subcontractors. 100 percent of the value of the Work to be performed by a DBE subcontractor will be counted toward the DBE goal. The value of such Work includes the cost of materials and supplies purchased by the DBE, except the cost of supplies or equipment leased from the Contractor, other subcontractors or their affiliates will not be counted. When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

B. Manufacturers/Fabricators. 100 percent of the expenditure to a DBE manufacturer or fabricator will be counted towards the DBE goal.

C. Material Suppliers. 60 percent of the expenditure to a DBE material supplier will be counted toward the DBE goal. Packagers, brokers, manufacturer's representatives, or other persons who arrange or expedite transactions are not material suppliers within the meaning of this paragraph.

D. Brokers/Manufacturer's Representatives. 100 percent of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees for transportation charges for the delivery of materials or supplies provided by a DBE broker/manufacturer's representative will be counted toward the DBE goal, provided they are determined by the Authority to be reasonable and not excessive as compared with fees customarily allowed for similar services. The cost of the materials and supplies themselves will not be counted.

E. Services. 100 percent of fees or commissions charged by a DBE for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of the Work will be counted toward the DBE goal, provided the fee is reasonable and not excessive as compared with fees customarily allowed for similar services.

F. Trucking Operations. The DBE trucking firm of record is the firm that is listed on the DBE Participation Plan. The DBE trucking firm shall own and operate at least one registered, insured and fully operational truck used for the performance of the Work and shall be responsible for the management and supervision of the entire trucking operation on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting the DBE goal. The DBE trucking firm of record shall control the day-to-day DBE trucking operations for performance of the Work, and shall be responsible for (1) negotiating and executing rental/leasing agreements; (2) hiring and terminating the work force; (3) coordinating the daily trucking needs with the Contractor; and (4) scheduling and dispatching trucks.

    1. DBE Owned/Leased Trucks. 100% of the value of the trucking operations the DBE provides for the performance of the work using trucks it owns and trucks that are registered, insured and operated by the DBE using drivers it employs, will be counted toward the DBE goal.

2. DBE Leased Trucks. The DBE may lease trucks from another DBE, including an owner/operator who is certified as a DBE. 100% of the value of the trucking operations that the lessee DBE provides will be counted toward the DBE goal.

3. Non-DBE Trucks. The DBE may lease trucks from non-DBE firms and owner-operators. The value of these trucking services will be counted toward the DBE goal up to the value of services performed by the DBE trucks used on the Contract. DBE participation can be counted for the value of the services of non- DBE trucks that exceed the value of the services performed by DBE trucks only in the amount of the fee or commission a DBE receives as a result of the lease agreement.

G. Joint Venture Joint ventures between DBEs and non-DBEs will be counted toward the DBE goal in proportion to the total dollar value of the Contract equal to the distinct, clearly defined portion of the Work of the Contract that the DBE performs with its own forces. The joint venture agreement is therefore subject to review by OBDCR, a copy of which is to be furnished by the firm to be awarded the Contract before execution of the Contract.

7. If a firm is not currently certified as a DBE in accordance with 49 CFR Part 26 at the time of the execution of the Contract, OBDCR will not credit the firm's participation toward any DBE goals, except as provided for in 49 CFR Section 26.87(i).

8. When a firm loses its DBE certification, OBDCR will follow the applicable regulations in 49 CFR Section 26.87(j).

   a. If a contract or subcontract has not been executed with the firm prior to notification of its ineligibility, any participation by the ineligible firm will not be counted toward the contract or overall goal. OBDCR will direct the Contractor to meet the contract goal with an eligible DBE firm or demonstrate good faith efforts to do so.

   b. If a contract or subcontract has been executed with the firm prior to notification of its ineligibility, the Contractor may continue to receive credit toward its DBE goal for the firm's work.

9. OBDCR will not credit toward the DBE goal the participation of a DBE subcontractor until the amount being counted toward the goal has actually been paid to the DBE, as evidenced by submission of the Statement of Payments to .DBE Subcontractors / Lessors / Suppliers and the DBE Payment Request Certification Form.

J. <u>CONTRACT AWARD</u>

1. Only proposers who submit proposals that meet the DBE goal or who demonstrate good faith efforts to meet the DBE goal, as herein provided will be eligible for award of the Contract.

2. If the successful proposer does not reach the DBE goal, the proposer shall nevertheless remain eligible for award of the contract if it can demonstrate to the satisfaction of OBDCR that it has made a good faith effort to meet the DBE goal. In making such a determination, OBDCR shall consider, among other things, the criteria set out in subparagraph 3 below.

3. Demonstration of Good Faith Efforts

To demonstrate a good faith effort to meet the DBE contract goal, a proposer shall submit with the DBE Goals Statement form (Appendix A1) a list of the steps it has taken to obtain DBE participation, together with documentation supporting those steps. Such efforts may be demonstrated by showing the following:

a. That the proposer attended any pre-solicitation or pre-bid meetings that were scheduled by the Port Authority to inform DBEs of contracting and subcontracting opportunities;

b. That the proposer advertised in general circulation, trade association, and minority-focus media, at least 15 days before proposal due date, to request DBE subcontract performance on the specific project;

c. That the proposer provided written notice to a reasonable number of specific DBEs that their interest in the contract was being solicited, in sufficient time to allow the DBEs to participate effectively;

d. That the proposer followed up initial solicitations of interest by contacting DBEs to determine with certainty whether the DBEs were interested in participating in the project;

e. That the proposer selected portions of the work to be performed by DBEs in order to increase the likelihood of meeting the DBE goal (including where appropriate, breaking down contracts into economically feasible units to facilitate DBE participation);

f. That the proposer provided interested DBEs with adequate information about the plans, specifications and requirements of the contract;

g. That the proposer negotiated in good faith with interested DBEs, not rejecting DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities. Documented efforts of negotiations with DBEs must include at a minimum:

1. The names, addresses and telephone numbers of DBEs that were considered;

2. A description of the information provided to DBEs regarding the plans and specifications for portions of the work to be performed;

3. A statement explaining why agreements with the DBEs could not be reached.

h. That the proposer made efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance required by the Port Authority or Consultant;

i. That the proposer made efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services; and

j. That the proposer effectively used the services of available minority/women community organizations; minority/women contractor's groups; local, state and federal minority/women business assistance offices; and other organizations that provide assistance in the recruitment and placement of DBEs.

4. Reconsideration of Good Faith Efforts Determination

In determining whether a proposer has demonstrated good faith efforts, the Port Authority will look at all efforts that the proposer has made. If OBDCR determines that the successful proposer has failed to make good faith efforts to meet the DBE goal, that firm's submission may be deemed non-responsive. The non- responsive firm will have an opportunity for administrative reconsideration, in accordance with the Port Authority's Protest Procedures. In accordance with the Protest Procedures, as part of this reconsideration,

the proposer will have the opportunity to provide written documentation or argument concerning the issue of whether it met the goal or made adequate good faith efforts to do so. In accordance with the Protest

Procedures, a written decision will be sent to the proposer explaining the basis for finding that the proposer did or did not meet the goal or make adequate good faith efforts to do so.

K. DBE MODIFICATIONS

In the event that a proposer wishes to modify its DBE Participation Plan and Affirmation Statement (Appendix A2) after its submission or after a contract is awarded, then the proposer must request approval for the modification from OBDCR in writing. A proposer may not, without OBDCR's prior consent, terminate a DBE subcontractor approved under this contract and then perform the work of the contract with its own forces or those of an affiliate. A modification includes any change to items of work, material, services, subcontract value or DBE firms, which differ from those identified on the approved DBE Participation Plan and Affirmation Statement (Appendix A2). When a DBE subcontractor is terminated or fails to complete its work for any reason, the Contractor must make good faith efforts to find another DBE subcontractor to substitute for the original DBE. These good faith efforts must be directed at finding other DBEs to perform at least the same amount of work under the contract as the former DBE to the extent needed to meet the contract goal. The Contractor must provide OBDCR with any and all documents and information as may be requested with respect to the modification. If OBDCR determines that the Contractor failed to make good faith efforts, the Port Authority may consider such failure a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any and all other available remedies.

L. EEO/NON-DISCRIMINATION

During the performance of this Contract, the Contractor hereby agrees that no person on the ground of race, color, national origin, creed/religion, sex, age or handicap/disability shall be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the furnishing of goods or services or in the selection and retention of subcontractors and/or vendors under this Contract. Contractor shall also ascertain and comply with all applicable federal, state and local laws, ordinances, rules, regulations, and orders that pertain to equal employment opportunity, affirmative action, and non-discrimination in employment, including 49 CFR Part 26.

M. OFFICE OF THE INSPECTOR GENERAL

The Port Authority Office of Inspector General (OIG) is responsible for investigating fraud and misconduct by Port Authority contractors, subcontractors, consultants, suppliers and others, including the DBE Program.

Depending upon the dollar value of the construction project, and regulatory requirements, the OIG might engage the services of an Integrity Monitor who reports to the OIG and assists in monitoring compliance governing the DBE program.

The OIG and its Integrity Monitors may perform on-site investigations and payment verifications, review relevant consultant, contractor, subcontractor and supplier documents, including but not limited to financial records, certificates and licenses, certified payroll reports, and employee sign-in sheets. They may also interview officers and employees of these firms either on-site, at their offices, or at any other location the OIG determines is in the best interest of the Port Authority.

All consultants, contractors, subcontractors, suppliers and others who are participating in the DBE Program in any manner, shall cooperate fully with the Port Authority OIG and shall provide all requested documents immediately upon request. The failure to cooperate may be considered a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any other available remedy.

1. Disadvantaged Business Enterprise Program (DBE)

DISADVANTAGED BUSINESS ENTERPRISE PROGRAM (DBE)

A. POLICY

It is the policy of The Port Authority of New York and New Jersey (the "Port Authority" or the "Authority") and its related entities, including Port Authority Trans-Hudson Corporation ("PATH") that Disadvantaged Business Enterprises ("DBEs") are provided the opportunity to participate in the performance of this Contract. Each proposer shall take all necessary and reasonable steps to ensure that its proposal includes DBE participation and performance of work on this Contract, when awarded. This Contract is subject to the United States Department of Transportation ("USDOT") regulations on "DBEs" contained in Part 26 of Title 49 of the Code of Federal Regulations.

The Proposer shall not discriminate on the basis of race, color, national origin, creed/religion, sex, age or handicap/disability in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of USDOT-assisted contracts. Failure by the Contractor or subcontractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the PANYNJ deems appropriate.

B. GOAL

The Port Authority Office of Business Diversity and Civil Rights ("OBDCR") has established a goal for DBE participation on this Contract, which the proposer will be

required to show how it will meet, if awarded this Contract. This goal, expressed as a percentage of the total contract price, including change orders issued pursuant to the changes provision of the contract, is:

DBE Participation Goal: _1__ **%**

for firms owned and controlled by socially and economically disadvantaged individuals (as defined in C.5 below) and certified as DBEs by the Authority. Eligible DBE firms are listed on the following Uniform Certification Programs ("UCPs") websites:

New York UCP – http://www.nysucp.net/

New Jersey UCP – http://www.njucp.net/

In the event the successful proposer's proposed level of DBE participation is less than this prescribed level of DBE participation, to remain eligible for contract award, the successful proposer must satisfy the good faith efforts requirements set forth in paragraph I.3 below

OBDCR is responsible for determining compliance by the proposer with DBE Program requirements established for this solicitation and in this Contract. The proposer shall make all DBE Program submissions required by this solicitation to the Port Authority Procurement Department contact with a copy to OBDCR. Once awarded, the successful proposer (Contractor) will make all DBE Program submissions to OBDCR at the following address and email address:

Contract Number:

Name: Jacqueline Carroll

Email: jacarroll@panynj.gov

Telephone No.: (201) 395-3958

Address: The Port Authority of NY & NJ
2 Montgomery Street, 2nd Fl.
Jersey City, NJ 07302

C. DEFINITIONS

1. To avoid undue repetition, the following terms, as used in this Agreement, shall be construed as follows: **Bidder or Proposer** can be used interchangeably and **Consultant or Contractor** can be used interchangeably.
2. **Certification** means the process by which a business demonstrates to OBDCR or to a New York State Unified Certification Program Certifying Partner ("NYSUCP") or to a New Jersey Unified Certification Certifying Partner ("NJUCP") that it meets the requirements to be a DBE under USDOT regulations set forth in 49 C.F.R. Part 26.

3. **Disadvantaged Business Enterprise or DBE** is a for-profit small business concern (a) that is at least 51% owned by one or more individuals who are both socially and economically disadvantaged or, in the case of a corporation, in which at least 51% of the stock is owned by one or more such individuals; and (b) whose management and daily business operations are controlled by one or more of the socially and economically disadvantaged individuals who own it.

4. **New York State Unified Certification Program Certifying Partners** include the Port Authority of New York & New Jersey, Metropolitan Transportation Authority, the Niagara Frontier Transportation Authority and the New York State Department of Transportation.

5. **New Jersey Unified Certification Program Certifying Partners** include the Port Authority of New York & New Jersey, New Jersey Transit and the New Jersey State Department of Transportation.

6. **Socially and economically disadvantaged individual** means any individual who is a citizen (or lawfully admitted permanent resident) of the United States and who is:

   a. Any individual OBDCR or a NYSUCP or NJUCP Certifying Partner finds to be a socially and economically disadvantaged individual on a case-by-case basis.

   b. Any individual in the following groups, members of which are rebuttably presumed to be socially and economically disadvantaged:

      1. Black Americans which includes persons having origins in any of the Black racial groups of Africa;

      2. Hispanic Americans which includes persons of Mexican, Puerto Rican, Cuban, Dominican, Central or South America or other Spanish or Portuguese culture or origin, regardless of race;

      3. Native Americans which includes persons who are American Indians, Eskimos, Aleuts or Native Hawaiians;

      4. Asian-Pacific Americans which includes persons whose origins are from Japan, China, Taiwan, Korea, Burma (Myanmar), Vietnam, Laos, Cambodia (Kampuchea), Thailand, Malaysia, Indonesia, the Philippines, Brunei, Samoa, Guam, the U.S. Trust Territories of the Pacific Islands (Republic of Palau), the Commonwealth of the Northern Marianas Islands, Macao, Fiji, Tonga, Kiribati, Juvalu, Nauru, Federated States of Micronesia, or Hong Kong;

      5. Subcontinent Asian Americans which includes persons whose origins are from India, Pakistan, Bangladesh, Bhutan, the Maldives Islands, Nepal or Sri Lanka;

      6. Women; and

7. Any additional groups whose members are designated as socially and economically disadvantaged by the Small Business Administration ("SBA"), at such time as the SBA designation becomes effective.

D. THE DBE PROGRAM

The Port Authority has established a Disadvantaged Business Enterprise (DBE) program in accordance with applicable United States Department of Transportation (USDOT) regulations in 49 CFR Part 26. The Port Authority receives Federal financial assistance from the Department of Transportation, and as a condition of receiving this assistance, the Port Authority has signed an assurance that it will comply with these regulations. It is the policy of the Port Authority to ensure that DBEs, as defined in 49 CFR Part 26, have an equal opportunity to receive and participate in USDOT-assisted contracts. It is also Port Authority policy:

1. *To ensure nondiscrimination in the award and administration of USDOT-assisted contracts;*

2. *To create a level playing field on which DBEs can compete fairly for USDOT-assisted contracts;*

3. *To ensure that the DBE program is narrowly tailored in accordance with 49 CFR Part 26;*

4. *To ensure that only firms that fully meet regulatory eligibility standards as outlined in 49 CFR Part 26 are permitted to participate as DBEs;*

5. *To help remove barriers to the participation of DBEs in USDOT-assisted contracts; and,*

6. *To assist the development of firms that can compete successfully in the market place outside the DBE program.*

The Director of OBDCR has been delegated as the DBE Liaison Officer. In that capacity, the Director of OBDCR is responsible for implementing all aspects of the DBE program. Implementation of the DBE program is accorded the same priority as compliance with all other legal obligations incurred by the Port Authority in its financial assistance agreements with the USDOT.

The Port Authority has disseminated this policy statement to the Board of Commissioners and all the components of our organization. We have disseminated this statement to DBE and non-DBE business communities that perform work for us on USDOT-assisted contracts through posting on the OBDCR website: http://www.panynj.gov/business-opportunities/supplierdiversity.html

E. DBE OBLIGATION

The proposer agrees to take all necessary and reasonable steps to ensure that DBEs have the opportunity to compete for and perform work under this Contract, if awarded. (Note: If the total contract price is increased as a result of change orders, the Contractor shall make a good faith effort to achieve a commensurate increase in DBE participation). Submission of the proposal constitutes a certification and representation by the proposer that good faith efforts will be made to satisfy the DBE goal requirement in paragraph B during contract performance.

Furthermore, the Proposer will ensure that the following clause is placed in every contract or subcontract resulting from this Contract:

> "The Contractor or subcontractor shall not discriminate on the basis of race, color, national origin, creed/religion, sex, age or handicap/disability, in the performance of this contract. The Contractor shall carry out applicable requirements of 49 CFR Part 26 in the award and administration of USDOT-assisted contracts. Failure by the Contractor or subcontractor to carry out these requirements is a material breach of this contract, which may result in the termination of this contract or such other remedy as the PANYNJ deems appropriate."

F. SUBMISSION OF DBE UTILIZATION PLAN

By submitting a bid or proposal for this Contract, the proposer assures the Authority that it will meet the foregoing goal and shall submit the DBE Goals Statement form (Appendix A1) with its Proposal. If the proposer determines it cannot make this assurance, it may nevertheless submit a bid or proposal, but in such event, it shall note on the DBE Goals Statement form the percentage of DBE participation it anticipates, including documentation supporting the good faith efforts made to achieve the goals set forth in the Contract.

The proposer shall submit, with its Proposal, the DBE Participation Plan and Affirmation Statement (Appendix A2) for each DBE firm it intends to use on this Contract. The DBE Participation Plan and Affirmation Statement shall provide the name and address of each DBE firm, a description of the work to be performed, the dollar value of each DBE subcontract and the signature affirmation from each DBE firm participating in this Contract.

The bidder shall submit with its Proposal the completed Information on Solicited Firms form (Appendix A3), listing every firm that provided a quotation to the bidder for any subcontract to be performed under this Contract, whether the firms are DBE certified and whether the firms' quotes were included in the final Proposal.

Bidders who are utilizing trucking firms to meet their DBE goal are directed to complete the "Pre-Award DBE Trucking Commitment Form" (Appendix A4) and submit the form with their Proposals for each DBE used on this Contract.

Bidders who are utilizing materials suppliers to meet their DBE goal are directed to complete the "DBE Regular Dealer Verification Form" (Appendix A5) and submit the form with their Proposals for each DBE used on this Contract.

1. By listing a firm on its DBE Participation Plan and Affirmation Statement (Appendix A2) the proposer is representing the following:

   a. It intends to use the firm for the work specified in the DBE Participation Plan and Affirmation Statement (Appendix A2) to perform the work specified.

   b. The firm is a certified DBE in the states of either New York or New Jersey and is technically and financially qualified to perform the work specified and that the firm is available to perform the work.

   c. If it is awarded the contract, it will enter into a subcontract with such DBE

(or an approved substitute), subject to the terms and conditions of this contract, for the work described and at the price set forth in the DBE Participation Plan and Affirmation Statement (Appendix A2).

d. It will not substitute a DBE firm listed in its DBE Participation Plan and Affirmation Statement (Appendix A2) unless the Port Authority provides prior written approval in accordance with Paragraph below.

G. PROMPT PAYMENT AND RETAINAGE PROVISION

The Contractor agrees to pay each subcontractor under this prime contract for the satisfactory performance of its contract, no later than ten (10) days from the receipt of each payment the Contractor receives from the Authority. The Contractor agrees further to return all retainage, if any, owed to a subcontractor within ten (10) days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above referenced time-frame may occur only for good cause following written approval from the Port Authority. This clause applies to both DBE and non-DBE subcontractors. Failure to comply with this section may constitute a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any other available remedy.

H. CREDIT TOWARD DBE GOAL

No credit toward meeting the DBE goal will be allowed unless OBDCR or a NYSUCP or NJUCP Certifying Partner has certified the DBE firm as eligible. Only the value of the work actually performed by the DBE will be counted toward the DBE goal. The DBE shall verify payments on the DBE Payment Request Certification Form attached to all invoices. The Authority will use the following guidelines to determine the amount to be counted toward the DBE goal:

1. OBDCR will credit the entire amount of fees or commissions charged by a DBE firm for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of a USDOT-assisted contract, toward DBE goals, provided OBDCR determines the fee to be reasonable and not excessive as compared with fees customarily allowed for similar services.

2. When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a certified DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

3. Joint ventures between DBEs and non-DBEs may be counted toward the DBE goal in proportion to the total dollar value of the contract equal to the distinct, clearly defined portion of the work of the contract that the DBE performs with its own forces. Please contact the Office of Business Diversity and Civil Rights at (201) 395-3958 for more information about requirements for such joint ventures.

4. OBDCR will credit expenditures to a DBE subcontractor toward DBE goals, only if the DBE is performing a commercially useful function on the contract.

5. Commercially Useful Function

A. A DBE is considered to perform a commercially useful function when it is responsible for the execution of a distinct element of work on a contract and carries out its responsibilities by actually performing, managing and supervising the work involved in accordance with normal industry practice. Regardless of whether an arrangement between the Contractor and the DBE represents standard industry practice, if the arrangement erodes the ownership, control or independence of the DBE or in any other way does not meet the commercially useful function requirement, that firm shall not be included in determining whether the DBE goal is met and shall not be included in DBE reports. If this occurs with respect to a firm identified as a DBE, the Contractor shall receive no credit toward the DBE goal and may be required to backfill the participation. A DBE does not perform a commercially useful function if its role is limited to that of an extra participant in a transaction or contract through which funds are passed in order to obtain the appearance of DBE participation. A DBE may rebut a determination by the Authority that the DBE is not performing a commercially useful function to the United States Department of Transportation (USDOT) funding agency (for example, FAA, FTA or FHWA).

B. Work Force. The DBE must employ a work force (including administrative and clerical staff) separate and apart from that employed by the Contractor, other subcontractors or their affiliates. This does not preclude the employment by the DBE of an individual that has been previously employed by another firm involved in the Contract, provided that the individual was independently recruited by the DBE in accordance with customary industry practice. The routine transfer of work crews from another employer to the DBE shall not be allowed.

C. Supervision. All Work performed by the DBE must be controlled and supervised by the DBE without duplication of supervisory personnel from the Contractor, their affiliates and other subcontractors performing Work on the Contract. This does not preclude routine communication between the supervisory personnel of the DBE and other supervisors necessary to coordinate the Work.

D. Equipment. DBE subcontractors may supplement their equipment by renting or leasing additional equipment in accordance with customary industry practice. If the DBE obtains equipment from the Contractor, other contractors or their affiliates, the DBE shall provide documentation to the Authority demonstrating that similar equipment and terms could not be obtained at a lower cost from other customary sources of equipment. The required documentation shall include copies of the rental or leasing agreements, and the names, addresses, and terms quoted by other sources of equipment.

E. If a DBE does not perform or exercise responsibility for at least 30 percent of the total cost of its contract with its own work force, or the DBE subcontracts a greater portion of the work of a contract than would be expected on the basis of normal industry practice for the type of work involved, OBDCR will presume that it is not performing a commercially useful function.

6. Counting DBE Participation

When a certified DBE firm is awarded the Contract, the DBE goals shall be deemed to have been met.

The value of the Work performed by a DBE, including that of a DBE prime contractor, with its own equipment, with its own forces, and under its own supervision, will be counted toward the DBE goal, provided the utilization is a commercially useful function. Work performed by DBEs will be counted as set forth below. If the Authority determines that some or all of the DBE's work does not constitute a commercially useful function, only the portion of the work considered to be a commercially useful function will be credited toward the DBE goal.

A. Subcontractors. 100 percent of the value of the Work to be performed by a DBE subcontractor will be counted toward the DBE goal. The value of such Work includes the cost of materials and supplies purchased by the DBE, except the cost of supplies or equipment leased from the Contractor, other subcontractors or their affiliates will not be counted. When a DBE subcontracts part of the work of its contract to another firm, the value of the subcontracted work may be counted toward DBE goals only if the DBE's subcontractor is itself a DBE. Work that a DBE subcontracts to a non-DBE firm does not count toward DBE goals.

B. Manufacturers/Fabricators. 100 percent of the expenditure to a DBE manufacturer or fabricator will be counted towards the DBE goal.

C. Material Suppliers. 60 percent of the expenditure to a DBE material supplier will be counted toward the DBE goal. Packagers, brokers, manufacturer's representatives, or other persons who arrange or expedite transactions are not material suppliers within the meaning of this paragraph.

D. Brokers/Manufacturer's Representatives. 100 percent of fees or commissions charged for assistance in the procurement of the materials and supplies, or fees for transportation charges for the delivery of materials or supplies provided by a DBE broker/manufacturer's representative will be counted toward the DBE goal, provided they are determined by the Authority to be reasonable and not excessive as compared with fees customarily allowed for similar services. The cost of the materials and supplies themselves will not be counted.

E. Services. 100 percent of fees or commissions charged by a DBE for providing a bona fide service, such as professional, technical, consultant, or managerial services, or for providing bonds or insurance specifically required for the performance of the Work will be counted toward the DBE goal, provided the fee is reasonable and not excessive as compared with fees customarily allowed for similar services.

F. Trucking Operations. The DBE trucking firm of record is the firm that is listed on the DBE Participation Plan. The DBE trucking firm shall own and operate at least one registered, insured and fully operational truck used for the performance of the Work and shall be responsible for the management and supervision of the entire trucking operation on a particular contract, and there cannot be a contrived arrangement for the purpose of meeting the DBE goal. The DBE trucking firm of record shall control the day-to-day DBE trucking operations for performance of the Work, and shall be responsible for (1) negotiating and executing rental/leasing agreements; (2) hiring and terminating the work force; (3) coordinating the daily trucking needs with the Contractor; and (4) scheduling and dispatching trucks.

1. DBE Owned/Leased Trucks. 100% of the value of the trucking operations the DBE provides for the performance of the work using trucks it owns and trucks that are registered, insured and operated by the DBE using drivers it employs, will be counted toward the DBE goal.

2. DBE Leased Trucks. The DBE may lease trucks from another DBE, including an owner/operator who is certified as a DBE. 100% of the value of the trucking operations that the lessee DBE provides will be counted toward the DBE goal.

3. Non-DBE Trucks. The DBE may lease trucks from non-DBE firms and owner-operators. The value of these trucking services will be counted toward the DBE goal up to the value of services performed by the DBE trucks used on the Contract. DBE participation can be counted for the value of the services of non- DBE trucks that exceed the value of the services performed by DBE trucks only in the amount of the fee or commission a DBE receives as a result of the lease agreement.

G. Joint Venture. Joint ventures between DBEs and non-DBEs will be counted toward the DBE goal in proportion to the total dollar value of the Contract equal to the distinct, clearly defined portion of the Work of the Contract that the DBE performs with its own forces. The joint venture agreement is therefore subject to review by OBDCR, a copy of which is to be furnished by the firm to be awarded the Contract before execution of the Contract.

7. If a firm is not currently certified as a DBE in accordance with 49 CFR Part 26 at the time of the execution of the Contract, OBDCR will not credit the firm's participation toward any DBE goals, except as provided for in 49 CFR Section 26.87(i).

8. When a firm loses its DBE certification, OBDCR will follow the applicable regulations in 49 CFR Section 26.87(j).

a. If a contract or subcontract has not been executed with the firm prior to notification of its ineligibility, any participation by the ineligible firm will not be counted toward the contract or overall goal. OBDCR will direct the Contractor to meet the contract goal with an eligible DBE firm or demonstrate good faith efforts to do so.

b. If a contract or subcontract has been executed with the firm prior to notification of its ineligibility, the Contractor may continue to receive credit toward its DBE goal for the firm's work.

9. OBDCR will not credit toward the DBE goal the participation of a DBE subcontractor until the amount being counted toward the goal has actually been paid to the DBE, as evidenced by submission of the Statement of Payments to .DBE Subcontractors / Lessors / Suppliers and the DBE Payment Request Certification Form.

I. CONTRACT AWARD

1. Only proposers who submit proposals that meet the DBE goal or who demonstrate good faith efforts to meet the DBE goal, as herein provided will be eligible for award of the Contract.

2. If the successful proposer does not reach the DBE goal, the proposer shall nevertheless remain eligible for award of the contract if it can demonstrate to the satisfaction of OBDCR that it has made a good faith effort to meet the DBE goal. In making such a determination, OBDCR shall consider, among other things, the criteria set out in subparagraph 3 below.

3. Demonstration of Good Faith Efforts

   To demonstrate a good faith effort to meet the DBE contract goal, a proposer shall submit with the DBE Goals Statement form (Appendix A1) a list of the steps it has taken to obtain DBE participation, together with documentation supporting those steps. Such efforts may be demonstrated by showing the following:

   a. That the proposer attended any pre-solicitation or pre-bid meetings that were scheduled by the Port Authority to inform DBEs of contracting and subcontracting opportunities;

   b. That the proposer advertised in general circulation, trade association, and minority-focus media, at least 15 days before proposal due date, to request DBE subcontract performance on the specific project;

   c. That the proposer provided written notice to a reasonable number of specific DBEs that their interest in the contract was being solicited, in sufficient time to allow the DBEs to participate effectively;

   d. That the proposer followed up initial solicitations of interest by contacting DBEs to determine with certainty whether the DBEs were interested in participating in the project;

   e. That the proposer selected portions of the work to be performed by DBEs in order to increase the likelihood of meeting the DBE goal (including where appropriate, breaking down contracts into economically feasible units to facilitate DBE participation);

   f. That the proposer provided interested DBEs with adequate information about the plans, specifications and requirements of the contract;

   g. That the proposer negotiated in good faith with interested DBEs, not rejecting DBEs as unqualified without sound reasons based on a thorough investigation of their capabilities. Documented efforts of negotiations with DBEs must include at a minimum:

      1. The names, addresses and telephone numbers of DBEs that were considered;

      2. A description of the information provided to DBEs regarding the plans and specifications for portions of the work to be performed;

3. A statement explaining why agreements with the DBEs could not be reached.

h. That the proposer made efforts to assist interested DBEs in obtaining bonding, lines of credit, or insurance required by the Port Authority or Consultant;

i. That the proposer made efforts to assist interested DBEs in obtaining necessary equipment, supplies, materials, or related assistance or services; and

j. That the proposer effectively used the services of available minority/women community organizations; minority/women contractor's groups; local, state and federal minority/women business assistance offices; and other organizations that provide assistance in the recruitment and placement of DBEs.

4. Reconsideration of Good Faith Efforts Determination

In determining whether a proposer has demonstrated good faith efforts, the Port Authority will look at all efforts that the proposer has made. If OBDCR determines that the successful proposer has failed to make good faith efforts to meet the DBE goal, that firm's submission may be deemed non-responsive. The non-responsive firm will have an opportunity for administrative reconsideration, in accordance with the Port Authority's Protest Procedures. In accordance with the Protest Procedures, as part of this reconsideration, the proposer will have the opportunity to provide written documentation or argument concerning the issue of whether it met the goal or made adequate good faith efforts to do so. In accordance with the Protest Procedures, a written decision will be sent to the proposer explaining the basis for finding that the proposer did or did not meet the goal or make adequate good faith efforts to do so.

J. DBE MODIFICATIONS

In the event that a proposer wishes to modify its DBE Participation Plan and Affirmation Statement (Appendix A2) after its submission or after a contract is awarded, then the proposer must request approval for the modification from OBDCR in writing. A proposer may not, without OBDCR's prior consent, terminate a DBE subcontractor approved under this contract and then perform the work of the contract with its own forces or those of an affiliate. A modification includes any change to items of work, material, services, subcontract value or DBE firms, which differ from those identified on the approved DBE Participation Plan and Affirmation Statement (Appendix A2). When a DBE subcontractor is terminated or fails to complete its work for any reason, the Contractor must make good faith efforts to find another DBE subcontractor to substitute for the original DBE. These good faith efforts must be directed at finding other DBEs to perform at least the same amount of work under the contract as the former DBE to the extent needed to meet the contract goal. The Contractor must provide OBDCR with any and all documents and information as may be requested with respect to the modification. If OBDCR determines that the Contractor failed to make good faith efforts, the Port Authority may consider such failure a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any and all other available remedies.

K. EEO/NON-DISCRIMINATION

During the performance of this Contract, the Contractor hereby agrees that no person on the ground of race, color, national origin, creed/religion, sex, age or handicap/disability shall be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the furnishing of goods or services or in the selection and retention of subcontractors and/or vendors under this Contract. Contractor shall also ascertain and comply with all applicable federal, state and local laws, ordinances, rules, regulations, and orders that pertain to equal employment opportunity, affirmative action, and non-discrimination in employment, including 49 CFR Part 26.

L. OFFICE OF THE INSPECTOR GENERAL

The Port Authority Office of Inspector General (OIG) is responsible for investigating fraud and misconduct by Port Authority contractors, subcontractors, consultants, suppliers and others, including the DBE Program. Depending upon the dollar value of the construction project, and regulatory requirements, the OIG might engage the services of an Integrity Monitor who reports to the OIG and assists in monitoring compliance governing the DBE program.

The OIG and its Integrity Monitors may perform on-site investigations and payment verifications, review relevant consultant, contractor, subcontractor and supplier documents, including but not limited to financial records, certificates and licenses, certified payroll reports, and employee sign-in sheets. They may also interview officers and employees of these firms either on-site, at their offices, or at any other location the OIG determines is in the best interest of the Port Authority.

All consultants, contractors, subcontractors, suppliers and others who are participating in the DBE Program in any manner, shall cooperate fully with the Port Authority OIG and shall provide all requested documents immediately upon request. The failure to cooperate may be considered a breach of contract, entitling the Port Authority to remedies provided herein, in addition to any other available remedy.

2. Exhibit A – Federal Transit Administration Requirements

3. Exhibit B – Standard Contract Terms and Conditions

ATTACHMENT G - Certified Environmentally Preferable Products/Practices

Proposer Name: _____Date: _____

In line with the Port Authority's efforts to promote products and practices which reduce our impact on the environment and human health, Proposers are encouraged to provide information regarding their environmentally preferable/sustainable business practices as they relate to this contract wherever possible. Proposers **must** complete this form and submit it with their response, if appropriate. Proposers **must** submit appropriate documentation to support the items for which the Proposer indicates a "Yes" and present this documentation in the proper sequence of this Attachment.

1. <u>Packaging</u>

Has the Proposer implemented any of the following environmental initiatives? **(A checkmark indicates "Yes")**

____ Use of corrugated materials that exceed the EPA recommended post-consumer recycled content

____ Use of other packaging materials that contain recycled content and are recyclable in most local programs

____ Promotes waste prevention and source reduction by reducing the extent of the packaging and/or offering
packaging take-back services, or shipping carton return

____ Reduces or eliminates materials which have been bleached with chlorine or chlorine derivatives

____ Eliminates any packaging that may contain polyvinyl chloride (PVC), or polystyrene or heavy metals

If yes, a description of the practices being followed must be included with the submission.

2. <u>Business Practices / Operations / Manufacturing</u>

Does the Proposer engage in practices that serve to reduce or minimize an impact to the environment, including, but not necessarily limited to, the following items? **(A checkmark indicates "Yes")**

____ Recycles materials in the warehouse or other operations

____ Use of alternative fuel vehicles or vehicles equipped with diesel emission control devices for delivery or transportation purposes

____ Use of energy efficient office equipment or signage or the incorporation of green building design elements

____ Use of recycled paper (that meets federal specifications) in their marketing and/or resource materials

____ Other sustainable initiative

If yes, a description of the practices being followed must be included with the submission.

3. <u>Training and Education</u>

Does the Proposer conduct/offer a program to train or inform customers and employees of the environmental benefits of the products to be offered under this contract, and/or does the Proposer conduct environmental training of its own staff?

☐ Yes ☐ No If yes, Proposer must attach a description of the training offered and the specific criteria targeted by the training.

4. <u>Certifications</u>

Has the Proposer or any of its manufacturers and/or subcontractors obtained any of the following product / industry certifications? **(A checkmark indicates "Yes")**

____ ISO 14000 or adopted some other equivalent environmental management system

____ Other industry environmental standards (where applicable), such as the CERES principles, LEED Certification, C2C Protocol, Responsible Care Codes of Practice or other similar standards

____ Third Party product certifications such as Green Seal, Scientific Certification Systems, Smartwood, etc.

If yes, Proposers must attach copies of the certificates obtained.

5. <u>Other Environmental Criteria</u>

Proposers are encouraged to respond to criteria specifically indicated in this RFP as “Management Approach” (and attach the appropriate documentation) to receive consideration in the evaluation.

I hereby certify, under penalty of the law that the above statements are true and correct.

_____Name **_____Date**

EXHIBIT A
FEDERAL TRANSIT ADMINISTRATION
REQUIRED CONTRACT PROVISIONS

Contents

FEDERAL TRANSIT ADMINISTRATION REQUIRED CONTRACT PROVISIONS....1

1. DEFINITIONS 2
2. INCORPORATION OF FEDERAL TRANSIT ADMINISTRATION TERMS....2
3. FEDERAL CHANGES 2
4. NO FEDERAL GOVERNMENT OBLIGATIONS TO THIRD PARTIES 3
5. ORGANIZATIONAL CONFLICT OF INTEREST 3
6. CERTIFICATION - DEBARMENT AND SUSPENSION....4
7. LOBBYING 5
8. CIVIL RIGHTS....6
9. CARGO PREFERENCE - USE OF UNITED STATES FLAG VESSELS 8
10. DAVIS-BACON AND COPELAND ANTI-KICKBACK ACTS....8
11. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT 17
12. VETERANS EMPLOYMENT....18
13. SEISMIC SAFETY 18
14. ENERGY CONSERVATION....19
15. CLEAN WATER REQUIREMENTS....19
16. CLEAN AIR REQUIREMENTS....19
17. FLY AMERICA 20
18. RECYCLED PRODUCTS 20
19. PROGRAM FRAUD AND FALSE OR FRAUDULENT STATEMENTS OR RELATED ACTS 21
20. TRANSIT EMPLOYEE PROTECTIVE REQUIREMENTS....21
21. ADA ACCESS REQUIREMENTS 22
22. BUY AMERICA....23
23. TERMINATION FOR CAUSE OR CONVENIENCE 23
24. AUTHORITY OF CHIEF ENGINEER - BREACHES AND DISPUTE RESOLUTION 23

CERTIFICATION REGARDING LOBBYING PURSUANT TO 31 U.S.C. 1352 25

STANDARD FORM LLL - DISCLOSURE OF LOBBYING ACTIVITIES....28

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES....30

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTIONS 32

BY SIGNATURE OF AUTHORIZED OFFICIAL....32

INSTRUCTIONS FOR COMPLETION OF CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTIONS 33

END OF FTA CONTRACT PROVISIONS....34

1. DEFINITIONS

As used herein, the term "Agreement" shall mean "Contract". This Agreement is anticipated to be funded in whole or in part by the United States Department of Transportation's Federal Transit Administration (FTA).

As used herein, "Contractor" and "Subcontractor" shall have the same meanings as "Consultant" and "Subconsultant", respectively.

2. INCORPORATION OF FEDERAL TRANSIT ADMINISTRATION TERMS

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The following provisions include, in part, certain Standard Terms and Conditions required by the United States Department of Transportation (DOT), whether or not expressly set forth in the following contract provisions. All contractual provisions required by DOT, as set forth in the FTA Circular 4220.1F are hereby incorporated by reference. Anything to the contrary herein notwithstanding, all FTA mandated terms shall be deemed to control in the event of a conflict with other provisions contained in this Contract. The Contractor shall not perform any act, fail to perform any act, or refuse to comply with any Authority requests that would cause the Authority to be in violation of the FTA terms and conditions.

Each and every provision required by the FTA to be inserted in this Contract shall be deemed to be inserted herein and the Contract shall be read and enforced as though it were included herein. If any provision of this Contract shall be such as to effect non-compliance with any FTA requirement, such provision shall not be deemed to form part hereof, but the balance of this Contract shall remain in full force and effect.

3. FEDERAL CHANGES

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Contractor shall at all times comply with all applicable FTA regulations, policies, procedures and directives, including without limitation those listed directly or by reference in the Master Agreement between the Authority and the FTA, as they may be amended or promulgated from time to time during the term of this Contract. Contractor's failure to so comply shall constitute a material breach of this Contract. The most recent Federal laws, regulations, policies, and administrative practices apply to this Contract at any particular time, unless FTA issues a written determination otherwise. All standards or limits within this document are minimum requirements, unless modified by the FTA or subagency thereof. The requirements of this section apply to each applicable changed requirement.

4. NO FEDERAL GOVERNMENT OBLIGATIONS TO THIRD PARTIES –

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Authority and the Contractor acknowledge and agree that, notwithstanding any concurrence by the Federal Government in or approval of the solicitation or award of the underlying contract, absent the express written consent by the Federal Government, the Federal Government is not a party to this Contract and shall not be subject to any obligations or liabilities to the Authority, Contractor, or any other party (whether or not a party to that contract) pertaining to any matter resulting from the underlying contract.

The Contractor agrees to include the above clause in each subcontract financed in whole or in part with Federal Assistance provided by the FTA. It is further agreed that the clause shall not be modified, except to identify the subcontractor who will be subject to its provisions.

5. ORGANIZATIONAL CONFLICT OF INTEREST

This Contract may give rise to a potential for an organizational conflict of interest. An organizational conflict of interest exists when the nature of the work to be performed under the contract may, without some form of restriction on future activities; result in an unfair competitive advantage to the Contractor.

1.) The Contractor shall have access to confidential and/or sensitive Authority information in the course of contract performance. Additionally, the Contractor may be provided access to proprietary information obtained from other contracted entities during contract performance. The Contractor agrees to protect all such information from disclosure unless so authorized, in writing, by the Authority and to refrain from using such information for any purpose other than that for which it was furnished.

2.) To the extent that the Contractor either (a) uses confidential and/or sensitive Authority information or proprietary information obtained from other Authority contractors to develop any form of document, report, or plan that is determined by the Authority to be the basis, in whole or in part, of any subsequent solicitation issued by the Authority or (b) develops written specifications that are used in any subsequent solicitation issued by the Authority, the Contractor agrees that it shall not be eligible to compete for such subsequent solicitation(s) as a prime or principal contractor or as part of any teaming arrangement unless the Authority provides, in writing, a specific waiver of this restriction. The duration of any restriction imposed under this subparagraph shall not exceed the length of the initial performance period of

any subsequently awarded contract for which the Contractor was ineligible to compete.

The Contractor, by submitting its bid or proposal, agrees to the above stated conditions and terms and further agrees to perform all duties under the contract and, in doing so, not to enter into contractual agreements with Authority prime contractors and first-tier subcontractors in such a way as to create an organizational conflict of interest.

If the Authority determines that the Contractor has violated any term of this numbered clause, the Authority may take any appropriate action available under the law or regulations to obtain redress to include, but not be limited to, requiring the Contractor to terminate any affiliation or contractual arrangement with an Authority prime contractor or first-tier subcontractor at no cost to the Authority; determining the Contractor ineligible to compete for or be awarded any subsequent or "follow-on" contracts that may be based upon the Contractor's actions under this Contract or violations of this numbered clause, or terminating this Contract, in whole or inpart.

6. CERTIFICATION - DEBARMENT AND SUSPENSION

Applies to all contracts and subcontracts at any level expected to equal or exceed $25,000 as well as any contract or subcontract (at any level) for federally required auditing services.

This Contract is a covered transaction for purposes of 2 CFR Parts 180 and 1200. As such, the Contractor is required to verify that none of the Contractor, its principals, as defined at 2 CFR 180.995, or affiliates, as defined 2 CFR 180.905, are excluded or disqualified as defined at 2 CFR 180.935 and 180.940.

The Contractor is required to comply with 2 CFR 180, Subpart C and must include the requirement to comply with 2 CFR 180, Subpart C in any lower tier covered transaction it enters into.

By signing and submitting its bid or proposal, the proposer certifies as follows:

The certification in this clause is a material representation of fact relied upon by the Port Authority of New York and New Jersey. If it is later determined that the proposer knowingly rendered an erroneous certification, in addition to remedies available to the Port Authority of New York and New Jersey, the Federal Government may pursue available remedies, including but not limited to suspension and/or debarment. The proposer agrees to comply with the requirements of 49 CFR 29, Subpart C while this offer is valid and throughout the period of any contract that may arise from this offer. The proposer further agrees to include a provision requiring such compliance in its lower tier covered transactions.

FTA requires that each potential Contractor, for major third party contracts, complete a certification entitled "Certification Regarding Debarment, Suspension, Ineligibility, and

Voluntary Exclusion" for itself and its principals and requires each Subcontractor or Supplier (for Subcontracts and Supplier agreements expected to equal or exceed $25,000) to complete a certification entitled "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion – Lower Tiered Covered Transactions" for itself and its principals. Copies of the required Certification forms and accompanying instructions are set forth following the clause herein entitled "Integrity Monitor".

In the event that the Contractor has certified prior to award that it is not proposed for debarment, debarred, suspended, or voluntarily excluded from covered transactions by any Federal Department or agency and such certification is found to be false, this Contract may be canceled, terminated or suspended by the Authority and the Contractor will be liable for any and all damages incurred by the Authority because of such cancellation, termination or suspension because of such false certification.

The Contractor shall obtain certifications from all known potential Subcontractors and Suppliers (for which payments are expected to equal or exceed $25,000) and submit such certifications to the address set forth in E below.

Prior to the award of any Subcontracts or Supplier agreements expected to equal or exceed $25,000, regardless of tier, any prospective Subcontractor or Supplier who has not previously submitted a certification for this Contract must execute and submit to the Contractor a certification in the form set forth following the clause herein entitled "Integrity Monitor" which will be deemed a part of the resulting Subcontract and Supplier agreement.

The originals of any Certifications or correspondence relating hereto shall be sent by the Contractor to the Contracts Specialist listed in the solicitation document.

The Contractor shall not knowingly enter into any Subcontracts or Supplier agreements with a person that is proposed for debarment, debarred, suspended, declared ineligible or voluntarily excluded from covered transactions.

As required by FTA, the Contractor and its Subcontractors or Suppliers required to file the certification have a continuing duty to disclose, and shall provide immediate written notice to the Authority if, at any time, it learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

7. LOBBYING

Applies to construction/architectural and engineering/acquisition of rolling stock/professional service contract/operational service contract/turnkey contracts. Does not apply to micro-purchases ($3,000 or less, except for construction contracts over

$2,000).

Byrd Anti-Lobbying Amendment, 31 USC 1352 as amended by the Lobbying Disclosure Act of 1995—"Byrd Anti-Lobbying Amendment (31 U.S.C. 1352)—Contractors who apply or bidfor an award of $100,000 or more shall file the certification required by 49 CFR part 20, ''New Restrictions on Lobbying.'' Each tier certifies to the tier above that it will not and has notused Federal appropriated funds to pay any person or organization for influencing or attemptingto influence an officer or employee of any agency, a member of Congress, officer or employeeof Congress, or an employee of a member of Congress in connection with obtaining anyFederal contract, grant or any other award covered by 31 U.S.C. 1352. Each tier shall also discloseany lobbying with non-Federal funds that takes place in connection with obtaining anyFederal award. Such disclosures are forwarded from tier to tier up to the recipient. Access toRecords and Reports

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Contractor agrees to provide the Authority, the FTA Administrator, the Comptroller General of the United States or any of their authorized representatives access to and the right to examine and inspect any books, documents, papers and records of the Contractor which are directly pertinent to this Contract for the purposes of making audits, examinations, excerpts and transcriptions. The Contractor also agrees, pursuant to 49 CFR 633.15 to provide the FTA Administrator or authorized representatives thereto including any Project Management Oversight (PMO) Contractor access to the Contractor's records and construction sites pertaining to the project.

The Contractor shall make available records related to the contract to the Authority, the Secretary of Transportation and the Comptroller General or any authorized officer or employee of any of them for the purposes of conducting an audit and inspection.

The Contractor agrees to permit any of the foregoing parties to reproduce by any means whatsoever or to copy excerpts and transcriptions as reasonablyneeded.

The Contractor agrees to maintain all books, records, accounts and reports required underthis Contract for a period from the beginning of the Project, and through the course of the Project, until three years after the Recipient has submitted its final expenditure report and other pending matters are closed. Project closeout does not alter the record retention requirements of the Master Agreement, §9.

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This requirement is independent of the Authority's requirements for record retentioncontained elsewhere in the contract documents. The FTA does not require the inclusion of these requirements in subcontracts.

8. CIVIL RIGHTS

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

Nondiscrimination - In accordance with Title VI of the Civil Rights Act, as amended, 42 U.S.C. § 2000d, section 303 of the Age Discrimination Act of 1975, as amended, 42 U.S.C. § 6102, and section 202 of the Americans with Disabilities Act of 1990, 42 U.S.C. § 12132, the Contractor agrees that it will not discriminate against any employee or applicant for employment because of race, color, creed, national origin, sex, age, or disability. In addition, the Contractor agrees to comply with applicable Federal implementing regulations and other implementing requirements FTA may issue.

Equal Employment Opportunity - The following equal employment opportunity requirements apply to the underlying contract:

1.) Race, Color, Creed, National Origin, Sex - In accordance with Title VII of the Civil Rights Act, as amended, 42 U.S.C. § 2000e, and Federal transit laws at 49 U.S.C. § 5332, the Contractor agrees to comply with all applicable equal employment opportunity requirements of U.S. Department of Labor (U.S. DOL) regulations, "Office of Federal Contract Compliance Programs, Equal Employment Opportunity, Department of Labor," 41 C.F.R. Parts 60 *et seq*., (which implement Executive Order No. 11246, "Equal Employment Opportunity," as amended by Executive Order No. 11375, "Amending Executive Order 11246 Relating to Equal Employment Opportunity," 42 U.S.C. § 2000e note), and with any applicable Federal statutes, executive orders, regulations, and Federal policies that may in the future affect construction activities undertaken in the course of the Project. The Contractor agrees to take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, creed, national origin, sex, or age. Such action shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruitment or recruitment advertising, layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. In addition, the Contractor agrees to comply with any implementing requirements FTA may issue.

2.) Age - In accordance with section 4 of the Age Discrimination in Employment Act of 1967, as amended, 29 U.S.C. § 623, the Contractor agrees to refrain from discrimination against present and prospective employees for reason of age. In addition, the Contractor agrees to comply with any implementing requirements FTA may issue.

3.) Disabilities - In accordance with section 102 of the Americans with Disabilities Act, as amended, 42 U.S.C. § 12112, the Contractor agrees that it will comply with the requirements of U.S. Equal Employment Opportunity Commission, "Regulations to Implement the Equal Employment Provisions of the Americans with Disabilities Act," 29 C.F.R. Part 1630, pertaining to

employment of persons with disabilities. In addition, the Contractor agrees to comply with any implementing requirements FTA mayissue.

The Contractor shall be responsible for ensuring that lower tier contractors and subcontractors and subagreements are in compliance with these requirements.

9. CARGO PREFERENCE - USE OF UNITED STATES FLAG VESSELS

Applies to contracts involving equipment, materials or commodities which may be transported by ocean vessels. These requirements do not apply to micro-purchases ($3,000 or less, except for construction contracts over $2,000).

If this Contract involves equipment, materials, or commodities that may be transported by ocean vessels, the Contractor herein agrees:

To utilize privately owned United States-flag commercial vessels to ship at least fifty percent (50%) of the gross tonnage (computed separately for dry bulk carriers, dry cargo liners, and tankers) involved, whenever shipping any equipment, material, or commodities pursuant to this Contract, to the extent such vessels are available at fair and reasonable rates for United States-flag commercial vessels.

To furnish within twenty (20) working days following the date of loading for shipments originating within the United States or within thirty (30) working days following the date of loading for shipments originating outside the United States, a legible copy of a rated, "on-board" commercial ocean bill-of-lading in English for each shipment of cargo described in paragraph (A) above to the FTA Administrator and grantee (through the contractor in the case of subcontractor bills-of-lading) and to the Division of National Cargo, Office of Market Development, Maritime Administration, Washington, DC 20230.

To include these requirements in all subcontracts issued pursuant to this Contract when the subcontract may involve the transport of equipment, material, or commodities by ocean vessel.

10. DAVIS-BACON AND COPELAND ANTI-KICKBACK ACTS

Applies to Construction contracts and subcontracts exceeding $2,000.

The Davis-Bacon and Copeland Acts are codified at 40 USC 3141, *et seq.* and 18 USC 874. The Acts apply to grantee construction contracts and subcontracts that "at least partly are financed by a loan or grant from the Federal Government." 40 USC 3145(a), 29 CFR

5.2(h), 49 CFR 18.36(i)(5). The Acts apply to any construction contract over $2,000. 40 USC 3142(a), 29 CFR 5.5(a). 'Construction,' for purposes of the Acts, includes "actual construction, alteration and/or repair, including painting and decorating." 29 CFR 5.5(a). The requirements of both Acts are incorporated into a single clause (*see* 29 CFR 3.11) enumerated at 29 CFR 5.5(a) and reproduced below and are applicable if this Contract is a construction contract (as delineated above) over $2000.

A. Minimum Wages

1.) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which, if applicable, is attached hereto and made a part hereof (the attachment is the most current determination), regardless of any contractual relationship which may be alleged to exist between the Contractor and such laborers and mechanics. Determinations may change during the term of the Contract, and the wages and fringe benefits required by the most recent determination of the Secretary of Labor are those to be used.
Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (A)(4) of this Section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classifications and wage rates conformed under paragraph (A)(2) of this Section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the Contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

2.)

a. The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(i) Except with respect to helpers as defined as 29 CFR 5.2(n)(4), the work to be performed by the classification requested is not performed by a classification in the wage determination;
(ii) The classification is utilized in the area by the construction industry;
(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination; and
(iv) With respect to helpers as defined in 29 CFR 5.2(n)(4), such a classification prevails in the area in which the work is performed.

b. If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

c. In the event the Contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

d. The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs A (2)(ii) (b) or (c) of this Section, shall be paid to all workers performing work in the classification under this Contract from the first day on which work is performed in the classification.

3.) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the Contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

4.) If the Contractor does not make payments to a trustee or other third person, the Contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the Contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the Contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

5.)

a. The contracting officer shall require that any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefor only when the following criteria have been met:

(i) The work to be performed by the classification requested is not performed by a classification in the wage determination;

(ii) The classification is utilized in the area by the construction industry; and

(iii) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

b. If the Contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

c. In the event the Contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination with 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs A (2)(ii)(b) or (c) of this Section, shall be paid to all workers performing work in the classification under this Contract from the first day on which work is performed in the classification. The FTA does not require the inclusion of these requirements in subcontracts.

B. Withholding

The Authority shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the Contractor under this Contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the Contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), all or part of the wages required by the contract, the Authority may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

C. Payrolls and Basic Records

1.) Payrolls and basic records relating thereto shall be maintained by the Contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash

equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the Contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

2.)

a. The Contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the Authority for transmission to the Federal Transit Administration. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under section 5.5(a)(3)(i) of Regulations, 29 CFR part 5. This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of Documents (Federal Stock Number 029-005-00014-1), U.S. Government Printing Office, Washington, DC 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors.

b. Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the Contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(i) That the payroll for the payroll period contains the information required to be maintained under section 5.5(a)(3)(i) of Regulations, 29 CFR part 5 and that such information is correct and complete;

(ii) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(iii) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash eqequivalents for the

classification of work performed, as specified in the applicable wage determination incorporated into the contract.

c. The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph C(2)(b) of this Section.

d. The falsification of any of the above certifications may subject the Contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

3.) The Contractor or subcontractor shall make the records required under paragraph C(1) of this Section available for inspection, copying, or transcription by authorized representatives of the Federal Transit Administration or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the Contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the Contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

D. Apprentices and Trainees

1.) Apprentices - Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the Contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice

performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a Contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the Contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator of the Wage and Hour Division of the U.S. Department of Labor determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the Contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

2.) Trainees - Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the

Employment and Training Administration withdraws approval of a training program, the Contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

3.) Equal employment opportunity - The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR Part 30.

E. Compliance with Copeland Act Requirements

The Contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this Contract.

F. Subcontracts

The Contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the Federal Transit Administration may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

G. Contract Termination: Debarment

A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

H. Compliance with Davis-Bacon and Related Act Requirements

All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this Contract.

I. Disputes Concerning Labor Standards

Disputes arising out of the labor standards provisions of this Contract shall not be subject to the general disputes clause of this Contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the Contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

J. Certification of Eligibility –

1.) By entering into this Contract, the Contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the Contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

2.) No part of this Contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

3.) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

11. CONTRACT WORK HOURS AND SAFETY STANDARDS ACT

Applies to grantee contracts and subcontracts under 40 USC 3701(b)(1)(B)(iii) and (b)(2), 29 CFR 5.2(h), 49 CFR 18.36(i)(6) for contracts for construction, and non-construction projects that employ "laborers or mechanics on a public work, where the contract amount is greater than $100,000.

A. Overtime Requirements
No Contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

B. Violation; liability for unpaid wages; liquidated damages
In the event of any violation of the clause set forth in paragraph A of this Section the Contractor and any subcontractor responsible therefor shall be liable for the unpaid wages. In addition, such Contractor and subcontractor shall be liable to the United States for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph A of this Section, in the sum of $10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph A of this Section.

C. Withholding for unpaid wages and liquidated damages

The Authority shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the Contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph B of this Section.

D. Subcontracts

The Contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraphs A through D of this Section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs A through D of this Section.The FTA does not require the inclusion of these requirements in subcontracts.

12. VETERANS EMPLOYMENT

Contractors working on a capital project funded using such assistance agree to give a hiring preference, to the extent practicable, to veterans (as defined in 5 U.S.C. 2108) who have the requisite skills and abilities to perform the construction work required under the contract. This subsection shall not be understood, construed or enforced in any manner that would require an employer to give a preference to any veteran over any equally qualified applicant who is a member of any racial or ethnic minority, female, an individual with a disability, or a former employee. The Contractor shall ensure that its hiring practices reflect the requirements of this section and shall, upon request, provide to the Authority personnel data which reflects compliance with the terms contained herein.

13. SEISMIC SAFETY

Applies only to the Construction of new buildings or additions to existing buildings. These requirements do not apply to micro-purchases ($3,000 or less, except for construction contracts over $2,000).

If this is a contract for the construction of new buildings or additions to existing buildings, the Contractor agrees that any new building or addition to an existing building will be constructed in accordance with standards for Seismic Safety required in Department of Transportation Seismic Safety Regulations 49 CFR Part 41 and will certify compliance to the extent required by the regulation. The Contractor also agrees to ensure that all work performed under this Contract including work performed by a subcontractor is in compliance with the standards required by the Seismic Safety Regulations and the certification of compliance. The completed certification of

compliance is to be submitted to the Port Authority's Project Manager. The seismic safety standards applicable to this Contract are contained in Section 2312 ICBO Uniform Building Code (UBC), as modified by the Appendix to Title 27, Chapter 1 (Volume 7), of the Administrative Code and Charter of the City of New York at RS 9-6 Earthquake Loads.

14. ENERGY CONSERVATION

Applies to All Contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Contractor agrees to comply with the mandatory energy efficiency standards and policies within the applicable State energy conservation plans issued in compliance with the Energy Policy and Conservation Act, 42 U.S.C. §6321 et seq and the National Environmental Policy Act, 42 U.S.C. §4321 et seq. Accordingly, the Contractor agrees that the construction of any new building, or any addition, alteration or renovation of any existing building which materially increases the heating or cooling requirements for the building will comply with mandatory standards and policies relating to energy efficiency which are contained in 42 USC §6321 et seq., Article 11 of the New York State Energy Law and in Parts 7810 to7815 of Title 9, Subtitle BB of the New York Codes, Rules and Regulations. The Contractor shall be responsible for ensuring that lower tier contractors and subcontractors and subagreements are in compliance with these requirements.

15. CLEAN WATER REQUIREMENTS

Applies to each contract and subcontract which exceeds $100,000.

The Contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Federal Water Pollution Control Act, as amended, 33 USC §1251 et seq. The Contractor agrees to report each violation to the Authority and understands and agrees that the Authority will, in turn, report each violation as required to assure notification to FTA and the appropriate EPA Regional Office.

The Contractor also agrees to include the requirements of this Article in all subcontracts exceeding $100,000 issued pursuant to this Contract.

16. CLEAN AIR REQUIREMENTS

Applies to all contracts over $100,000, including indefinite quantities where the amount is expected to exceed $100,000 in any year.

The Contractor agrees to comply with all applicable standards, orders or regulations issued pursuant to the Clean Air Act, as amended, 42 USC §7401 et seq. The Contractor agrees to report each violation to the Authority and understands and agrees that the Authority will, in turn, report each violation as required to assure notification to FTA and the appropriate EPA Regional Office.

The Contractor also agrees to include the requirements of this Clause in all subcontracts exceeding $100,000 issued pursuant to this Contract.

17. FLY AMERICA

Applies to certain contracts involving international transportation of persons or property, by air when the FTA will participate in the costs of such air transportation. These requirements do not apply to micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Contractor agrees to comply with 49 U.S.C. 40118 (the "Fly America" Act) in accordance with the General Services Administration's regulations at 41 CFR Part 301-10, which provide that recipients and subrecipients of Federal funds and their contractors are required to use U.S. Flag air carriers for U.S Government-financed international air travel and transportation of their personal effects or property, to the extent such service is available, unless travel by foreign air carrier is a matter of necessity, as defined by the Fly America Act. The Contractor shall submit, if a foreign air carrier was used, an appropriate certification or memorandum adequately explaining why service by a U.S. flag air carrier was not available or why it was necessary to use a foreign air carrier and shall, in any event, provide a certificate of compliance with the Fly America requirements. The Contractor agrees to include the requirements of this section in all subcontracts that may involve international air transportation. The Contractor shall include the requirements of this section in all first tier subcontracts that may involve international air transportation and shall be responsible for ensuring that lower tier contractors and subcontractors are in compliance with these requirements.

1. RECYCLED PRODUCTS

Applies to all contracts for items designated by the EPA, when the Port Authority or contractor procures $10,000 of more of one of these items during the fiscal year or when the cost of such items purchased during the previous fiscal year was $10,000.

The Contractor agrees to comply with all the requirements of Section 6002 of the Resource Conservation and Recovery Act (RCRA), as amended (42 U.S.C. 6962), including but not limited to the regulatory provisions of 40 CFR Part 247, and Executive Order 12873, as they apply to the procurement of the items designated in Subpart B of 40 CFR Part 247. The Contractor also agrees to include the requirements of this Clause in all subcontracts exceeding $10,000 for items designated by the Environmental Protection Agency (EPA) and issued pursuant to this Contract. The Contractor shall be responsible for ensuring that lower tier contractors and subcontractors are in compliance with these requirements.
with these requirements.

2. PROGRAM FRAUD AND FALSE OR FRAUDULENT STATEMENTS OR RELATED ACTS

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000).

The Contractor acknowledges that the provisions of the Program Fraud Civil Remedies Act of 1986, as amended, 31 U.S.C. § 3801 *et seq*. and U.S. DOT regulations, "Program Fraud Civil Remedies," 49 CFR Part 31, apply to its actions pertaining to this Project. The Contractor certifies or affirms the truthfulness and accuracy of any statement it has made, it makes, it may make, or causes to be made, pertaining to the contract or project. In addition to other penalties that may be applicable, the Contractor further acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification, the Federal Government reserves the right to impose the penalties of the Program Fraud Civil Remedies Act of 1986 on the Contractor to the extent the Federal Government deems appropriate.

The Contractor also acknowledges that if it makes, or causes to be made, a false, fictitious, or fraudulent claim, statement, submission, or certification to the Federal Government under this Contract, financed in whole or in part with Federal assistance, the Federal Government reserves the right to impose the penalties of 49 U.S.C. § 5323(l), 18 U.S.C. § 1001, or other applicable Federal law to the extent the Federal Government deems appropriate.

The Contractor agrees to include the above two clauses in each subcontract related to this Contract. It is further agreed that the clauses shall not be modified, except to identify the subcontractor who will be subject to the provisions.

3. TRANSIT EMPLOYEE PROTECTIVE REQUIREMENTS

Applies to all contracts except micro-purchases ($3,000 or less, except for construction contracts over $2,000). The Contractor Agrees to comply with the applicable transit employee protective requirements as follows:

1. The Contractor agrees to comply with plicable transit employee protective requirements as follows:

a. General Transit Employee Protective Requirements-To the extent that FTA determines that transit operations are involved, the Contractor agrees to carry out the transit operations work on the underlying contract in compliance with terms and conditions determined by the U.S. Secretary of Labor to be fair and equitable to protect the interests of employees employed under this Contract and to meet the employee protective requirements of 49 U.S.C. A 5333(b), and U.S. DOL guidelines at 29 C.F.R. Part 215, and any amendments thereto. These terms and conditions are identified in the letter of certification from the U.S. DOL to FTA

applicable to the FTA Recipient's project from which Federal assistance is provided to support work on the underlying contract. The Contractor agrees to carry out that work in compliance with the conditions stated in that U.S. DOL letter. The requirements of this subsection (1), however, do not apply to any contract financed with Federal assistance provided by FTA either for projects for elderly individuals and individuals with disabilities authorized by 49 U.S.C. § 5310(a)(2), or for projects for non-urbanized areas authorized by 49 U.S.C. § 5311. Alternate provisions for those projects are set forth in subsections (b) and (c) of this clause.

b. Transit Employee Protective Requirements for Transit Employee Protective Requirements for Projects Authorized by 49 U.S.C.§ 5310(a)(2) for Elderly Individuals and Individuals with Disabilities-If the contract involves transit operations financed in whole or in part with Federal assistance authorized by 49 U.S.C. § 5310(a)(2), and if the U.S. Secretary of Transportation has determined or determines in the future that the employee protective requirements of 49 U.S.C. § 5333(b) are necessary or appropriate for the state and the public body subrecipient for which work is performed on the underlying contract, the Contractor agrees to carry out the Project in compliance with the terms and conditions determined by the U.S. Secretary of Labor to meet the requirements of 49 U.S.C. § 5333(b), U.S. DOL guidelines at 29 C.F.R. Part 215, and any amendments thereto. These terms and conditions are identified in the U.S. DOL's letter of certification to FTA, the date of which is set forth Grant Agreement or Cooperative Agreement with the state. The Contractor agrees to perform transit operations in connection with the underlying contract in compliance with the conditions stated in that U.S. DOLletter.

c. Transit Employee Protective Requirements for Projects Authorized by 49 U.S.C.§ 5311 in Nonurbanized Areas - If the contract involves transit operations financed in whole or in part with Federal assistance authorized by 49 U.S.C. § 5311, the Contractor agrees to comply with the terms and conditions of the Special Warranty for the Nonurbanized Area Program agreed to by the U.S. Secretaries of Transportation and Labor, dated May 31, 1979, and the procedures implemented by U.S. DOL or any revision thereto.

2. The Contractor also agrees to include the any applicable requirements in each subcontract involving transit operations financed in whole or in part with Federal assistance provided by FTA.

21. ADA ACCESS REQUIREMENTS

Facilities to be used in public transportation service must comply with 42 U.S.C. Sections 12101 *et seq*. and DOT regulations, "Transportation Services for Individuals with Disabilities (ADA),"

49 CFR Part 37; and Joint ATBCB/DOT regulations, "Americans with Disabilities (ADAAccessibility Specifications for Transportation Vehicles," 36 CFR Part 1192 and 49 CFR Part 38.

22. BUY AMERICA

Applies to Construction Contracts and Acquisition of Goods or Rolling Stock (valued at morethan $100,000).

The contractor agrees to comply with 49 U.S.C. 5323(j) and 49 C.F.R. Part 661, which provide that Federal funds may not be obligated unless steel, iron, and manufactured products used in FTA-funded projects are produced in the United States, unless a waiver has been granted by FTA or the product is subject to a general waiver. General waivers are listed in 49 C.F.R. 661.7, and include final assembly in the United States for 15 passenger vans and 15 passenger wagons produced by Chrysler Corporation, and microcomputer equipment and software. Separate requirements for rolling stock are set out at 49 U.S.C. 5323(j)(2)(C) and 49 C.F.R. 661.11. Rolling stock must be assembled in the United States and have a 60 percent domestic content. The Contractor shall be responsible for ensuring that lower tier contractors and subcontractors are in compliance with these requirements. Subcontracts in any amount are subject to Buy America.

A bidder or offeror must submit to the FTA recipient the appropriate Buy America Certification with all bids or offers on FTA-funded contracts, except those subject to a general waiver. Bids or offers that are not accompanied by a completed Buy America Certification must be rejected as non-responsive. This certification requirement does not apply to lower- tier subcontractors.

23. TERMINATION FOR CAUSE OR CONVENIENCE

Notwithstanding anything to the contrary elsewhere within this Contract, the Authority may terminate this contract, in whole or in part, at any time by written notice to the Contractor for cause or when it is in the Authority's best interest, pursuant to 49 C.F.R. 13.36 (i)(2) and as set forth in the "Standard Contract Terms and Conditions," Part II, Section 14, Termination Provisions (for cause or convenience). In the event of termination for convenience, the Contractor shall be paid its costs, including contract close-out costs, as so provided for in the Contract, on work performed up to the time of termination for convenience. See the "Standard Contract Terms and Conditions," Part II, Section 14(f).

24. AUTHORITY OF CHIEF ENGINEER - BREACHES AND DISPUTE RESOLUTION

Inasmuch as the public interest requires that the project to which this Contract relates shall be performed in the manner which PATH, acting through the Chief Engineer (or his/her designee), deems best, the (or his/her designee) shall have absolute authority to determine what is or is not necessary or proper for or incidental to the portion thereof, and the Contract Drawings and Specifications shall be deemed merely his present determination on this point.

In the exercise of this authority, he/she shall have power to alter the Contract Drawings and Specifications; to require the performance of Work not required by them in their present form, even though of a totally different character from that now required; and to vary, increase and diminish the character, quantity and quality of, or to countermand, any Work now or hereafter required. Such variation, increase, diminution or countermanding need not be based on necessity but may be based on convenience.

If at any time it shall be, from the viewpoint of PATH, impracticable or undesirable in the judgment of the Chief Engineer (or his/her designee) to proceed with or continue the performance of the Contract or any part thereof, whether or not for reasons beyond the control of PATH, he/she shall have authority to suspend performance of any part or all of the Contract until such time as he may deem it practicable or desirable to proceed. Moreover, if at any time it shall be, from the viewpoint of PATH impracticable or undesirable in the judgment of the Chief Engineer (or his/her designee) to proceed with or continue the performance of the Contract or any part thereof whether or not for reasons beyond the control of PATH, he shall have authority to cancel this Contract as to any or all portions not yet performed and as to any materials not yet installed even though delivered. Such cancellation shall be without prejudice to the rights and obligations of the parties arising out of portions already performed, but no allowance shall be made for anticipated profits.

To resolve all disputes and to prevent litigation the parties to this Contract authorize the Chief Engineer (or his/her designee) to decide all questions of any nature whatsoever arising out of, under, or in connection with, or in any way related to or on account of, this Contract (including claims in the nature of breach of Contract or fraud or misrepresentation before or subsequent to acceptance of the Contractor's Bid or Proposal and claims of a type which are barred by the provisions of this Contract) and his/her decision shall be conclusive, final and binding on the parties. His/her decision may be based on such assistance as he/she may find desirable. The effect of his/her decision shall not be impaired or waived by any negotiations or settlement offers in connection with the question decided, whether or not he participated therein himself, or by any prior decision of the Engineer or others, which prior decisions shall be deemed subject to review, or by any termination or cancellation of this Contract provided, however, that notwithstanding the decision reached by the Chief Engineer (or his/her designee) in a review of determinations by the Chief of Construction or Engineer of Construction or Engineer that a particular item of Work is not a Change that is subject to the provisions of the clause hereof entitled “Changes,” the Contractor shall be compensated therefor as provided in written orders of the Chief of Construction or Engineer of Construction or Engineer expressly and unmistakably indicating his/her intention to treat Work described therein as Changes issued in accordance with the Changes clause for amounts not in excess of $250,000.

All such questions shall be submitted in writing by the Contractor to the Chief Engineer (or his/her designee) for his decision, together with all evidence and other pertinent information in regard to such questions, in order that a fair and impartial decision may be made. In any action against PATH relating to any such question the Contractor must allege in his complaint and prove such submission, which shall be a condition precedent to any such action. No evidence or information shall be introduced or relied upon in such an action that has not been so presented to the Chief Engineer (or his/her designee).

This numbered clause shall be governed by and construed in accordance with the law of the State of New York, without giving effect to its choice of law provisions.

i. Performance During Dispute – Unless otherwise directed by the Port Authority, the Contractor shall continue performance under this Contract while matters in dispute are being resolved.

ii. Claims for Damages – Should either party to the Contract suffer injury or damage to person or property because of any act or omission of the party or of any of his employees, agents or others for whose acts he is legally liable, a claim for damages therefor shall be made in writing to such other party within five (5) days after the claim arises.

iii. Rights and Remedies –The duties and obligations imposed by the Contract Documents and the rights and remedies available thereunder shall be in addition to and not a limitation of any duties, obligations, rights and remedies otherwise imposed or available by law. No action or failure to act by the AGENCY or CONTRACTOR shall constitute a waiver of any right or duty afforded any of them under the Contract, nor shall any such action or failure to act constitute an approval of or acquiescence in any breach thereunder, except as may be specifically agreed in writing.

CERTIFICATION REGARDING LOBBYING PURSUANT TO 31 U.S.C. 1352
(TO BE SUBMITTED WITH EACH BID OR OFFER EXCEEDING $100,000.)

The undersigned

_____
(name of authorized officer)

certifies, to the best of my knowledge and belief, that:

- No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.

- If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form LLL, "Disclosure of Lobbying, Activities" in accordance with its instructions.

- The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify and disclose accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite formaking or entering into this transaction imposed by, 31, U.S. C. § 1352 (as amended by the Lobbying Disclosure Act of 1995). Any person who fails to file the required certification shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.

Note: Pursuant to 31 U.S.C § 1352(c)(I)-(2)(A), any person who makes a prohibited expenditure or fails to file or amend a required certification or disclosure form shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such expenditure or failure.

The Contractor certifies or affirms the truthfulness and accuracy of each statement of its certification and disclosure, if any. In addition, the Contractor understands and agrees that the provisions of 31 U.S.C. § 3801, et seq., apply to this certification and disclosure, if any.

Executed this day_____of_____, 201___
By:_____
Signature of Authorized Official

_____
Official Name and Title of Authorized Official

STANDARD FORM LLL - DISCLOSURE OF LOBBYING ACTIVITIES

Complete this form to disclose lobbying activities pursuant to 31 U.S.C. 1352

1. Type of Federal Action: ____a. contract ____b. grant ____c. cooperative agreement ____d. loan ____e. loan guarantee ____f. loan insurance	**2. Status of Federal Action:** _____a. bid/offer/application _____b. initial award ____ c. post award	**3. Report Type:** _____a. initial filing _____b. material change **For material change only:** Year_____quarter_____ Date of last report_____
4. Name and Address of Reporting Entity: ____Prime _____Subawardee Tier_____, if Known:	**5. If Reporting Entity in No. 4 is Subawardee,** Enter Name and Address of Prime: **Congressional District,** *if known*:	
6. Federal Department/Agency:	**7. Federal Program Name/Description:** CFDA Number, *if applicable*: _____	
8. Federal Action Number, *if known:*	**9. Award Amount**, *if known:* **$**	
10. a. Name and Address of Lobbying Registrant *(if individual, last name, first name, MI):*	**b. Individuals Performing Services** *(including address if different from No. 10a)* *(last name, first name, MI):*	
11. Information requested through this form is authorized by title 31 U.S.C. Section 1352. This disclosure of lobbying activities is a material representation of fact upon which reliance was placed by the tier above when this transaction was made or entered into. This disclosure is required pursuant to 31 U.S.C. 1352. This information will be reported	**Print Name:** _____ **Title:** _____	

to the Congress semi-annually and will be available for public inspection. Any person who fails to file the required disclosure shall be subject to a civil penalty of not less than $10,000 and not more than $100,000 for each such failure.	**Telephone No.:_____Date: _____**
Federal Use Only	**Authorized for Local Reproduction** **Standard Form - LLL (Rev. 7-97)**

INSTRUCTIONS FOR COMPLETION OF SF-LLL, DISCLOSURE OF LOBBYING ACTIVITIES

This disclosure form shall be completed by the reporting entity, whether subawardee or prime Federal recipient, at the initiation or receipt of a covered Federal action, or a material change to a previous filing, pursuant to title 31 U.S.C. Section 1352. The filing of a form is required for each payment or agreement to make payment to any lobbying entity for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with a covered Federal action. Complete all items that apply for both the initial filing and material change report. Refer to the implementing guidance published by the Office of Management and Budget for additional information.

1. Identify the type of covered Federal action for which lobbying activity is and/or has been secured to influence the outcome of a covered Federal action.
2. Identify the status of the covered Federal action.
3. Identify the appropriate classification of this report. If this is a followup report caused by a material change to the information previously reported, enter the year and quarter in which the change occurred. Enter the date of the last previously submitted report by this reporting entity for this covered Federal action.
4. Enter the full name, address, city, State and zip code of the reporting entity. Include Congressional District, if known. Check the appropriate classification of the reporting entity that designates if it is, or expects to be, a prime or subaward recipient. Identify the tier of the subawardee, e.g., the first subawardee of the prime is the 1st tier. Subawards include but are not limited to subcontracts, subgrants and contract awards under grants.
5. If the organization filing the report in item 4 checks "Subawardee," then enter the full name, address, city, State and zip code of the prime Federal recipient. Include Congressional District, if known.
6. Enter the name of the federal agency making the award or loan commitment. Include at least one organizational level below agency name, if known. For example, Department of Transportation, United States Coast Guard.
7. Enter the Federal program name or description for the covered Federal action (item 1). If known, enter the full Catalog of Federal Domestic Assistance (CFDA) number for grants, cooperative agreements, loans, and loan commitments.
8. Enter the most appropriate Federal identifying number available for the Federal action identified in item 1 (e.g., Request for Proposal (RFP) number; Invitations for Bid (IFB) number; grant announcement number; the contract, grant, or loan award number; the application/proposal control number assigned by the Federal agency). Included prefixes, e.g., "RFP-DE-90-001."
9. For a covered Federal action where there has been an award or loan commitment by the Federal agency, enter the Federal amount of the award/loan commitment for the prime entity identified in item 4 or 5.

10. (a) Enter the full name, address, city, State and zip code of the lobbying registrant under the Lobbying Disclosure Act of 1995 engaged by the reporting entity identified in item 4 to influence the covered Federal action.

    (b) Enter the full names of the individual(s) performing services, and include full address if different from 10(a). Enter Last Name, First Name, and Middle Initial(MI).

11. The certifying official shall sign and date the form, print his/her name, title, and telephone number.

According to the Paperwork Reduction Act, as amended, no persons are required to respond to a collection of information unless it displays a valid OMB control Number. The valid OMB control number for this information collection is OMB No. 0348-0046. Public reporting burden for this collection of information is estimated to average 10 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0046), Washington, DC 20503

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTIONS

1. The prospective lower tier participant,

_____, certifies by submission of this bid or proposal, that neither it nor its principals are presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department oragency.

2. Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

3. The prospective lower tier participant shall provide immediate written notice to the Authority (and the Contractor, if applicable) if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

Executed this day_____of_____, 201_____.

_____

BY SIGNATURE OF AUTHORIZED OFFICIAL

_____

NAME AND TITLE OF AUTHORIZED OFFICIAL

INSTRUCTIONS FOR COMPLETION OF CERTIFICATION REGARDING DEBARMENT, SUSPENSION, INELIGIBILITY AND VOLUNTARY EXCLUSION - LOWER TIER COVERED TRANSACTIONS

1. By signing and submitting this Proposal, the prospective lower tier participant is providingthe signed certification set out on the previous page.

2. This certification is a material representation of fact upon which reliance was placed whenthis transaction was entered into. If it is later determined that the prospective lower tier participant knowingly rendered an erroneous certification, in addition to other remedies available to the Federal Government, the Authority may pursue available remedies, including suspension and/or debarment.

3. The prospective lower tier participant shall provide immediate written notice to the Authority if at any time the prospective lower tier participant learns that its certification was erroneous when submitted or has become erroneous by reason of changed circumstances.

4. The terms "covered transaction," "debarred," "suspended," "ineligible," "lower tier covered transaction," "participant," "persons," "lower tier covered transaction," "principal," "proposal," and "voluntarily excluded," as used in this clause, have the meanings set out in the Definitions and Coverage sections of rules implementing Executive Order 12549 [49 CFR Part 29]. The Proposer may contact the Procurement Representative for assistance in obtaining a copy ofthose regulations.

5. The prospective lower tier participant agrees by submitting this proposal that, should the proposed covered transaction be entered into, it shall not knowingly enter into any lower tier covered transaction with a person who is debarred, suspended, declared ineligible, or voluntarily excluded from participation in this covered transaction, unless authorized in writing bythe Authority.

6. The prospective lower tier participant further agrees by submitting this proposal that it will include the "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions.

7. A participant in a covered transaction may rely upon a certification of a prospective participant in a lower tier covered transaction that it is not debarred, suspended, ineligible, or voluntarily excluded from the covered transaction, unless it knows that the certification is erroneous. A participant may decide the method and frequency by which it determines the eligibility of its principals. Each participant may, but is not required to, check the Nonprocurement List issued by U.S. General Service Administration.

8. Nothing contained in the foregoing shall be construed to require establishment of system of records in order to render in good faith the certification required by this clause. The knowledge and information of a participant is not required to exceed that which is normally possessed bya prudent person in the ordinary course of business dealings.

9. Except for transactions authorized under sub-paragraph 5 of these instructions, if a participant in a covered transaction knowingly enters into a lower tier covered transaction with a person who is suspended, debarred, ineligible, or voluntarily excluded from participation in this transaction, in addition to all remedies available to the Federal Government, the Authority may pursue available remedies including suspension and/or debarment.

END OF FTA CONTRACT PROVISIONS

APPENDIX A1: DBE GOALS STATEMENT

The undersigned Proposer has satisfied the requirements of the Contract in the following manner (Complete the appropriate spaces and check one box):

☐ The Proposer is committed to meeting the DBE goal set forth in this Contract.

OR

☐ The Proposer is unable to meet the DBE goal set forth in this Contract, but is committed to a minimum of % DBE utilization on this Contract and submits the attached narrative and documentation demonstrating good faith efforts consistent with Appendix A of 49 CFR 26 to meet the DBE utilization goal set forth in this Contract. Attach as many pages as necessary to provide a full and complete narrative and supporting documentation of good faith efforts made. This narrative shall be submitted on company letterhead and signed.

It is the present intent of the Proposer to utilize the specific DBE firms identified in Appendix A2 in the performance of the Work under this Contract. If for any reason, one or more of the DBE firms identified in Appendix A2 are unable or unwilling to participate, the Proposer will make good faith efforts to replace the DBE firm with another DBE firm in accordance with the Information For Proposers clause entitled "Disadvantaged Business Enterprise Program (DBE)".

I_____(print name), an officer of _____ (company name), certify that I have read the Appendix A1 – DBE Goals Statement and the information contained in it is true. I fully understand that any false statement within this submittal may prevent the company and/or the undersigned from being found to be responsible bidders/proposers in connection with future agreements. In addition, any false statement within this submittal may subject the company and/or the undersigned to criminal charges in the state and federal courts of New York and New Jersey.

Signature_____Title_____Date _____

Officer must have ACKNOWLEDGEMENT BY NOTARY PUBLIC completed on the reverse side.

ACKNOWLEDGEMENT BY NOTARY PUBLIC

APPENDIX A1 - DBE GOALS STATEMENT (reverse)

ACKNOWLEDGEMENT
of

STATE OF_____)
S.S.:
COUNTY OF_____)

On this_____day of_____, before me personally came and appeared_____to be known, who being by me duly sworn, did depose and say that he/she resides at_____, that he/she is the _____of_____company, that the seal affixed to said Certification is such corporate seal, that it was so affixed by order of the directors of said corporation, and that he/she signed his/her name thereto by like order.

(Notary's Seal or Stamp)

_____
Notary Public
My commission expires:

APPENDIX A2: DBE PARTICIPATION PLAN AND AFFIRMATION STATEMENT PA 3752B / 12-15

Instructions: Submit one DBE PARTICIPATION PLAN AND AFFIRMATION STATEMENT form for each DBE firm used on this Contract.

CONTRACT NUMBER AND TITLE: _____

PROPOSER:
Name of Firm: _____

Address:_____Telephone: _____

Email Address: _____

DBE:
Name of Firm: _____

Address:_____Telephone: _____

Description of work to be performed by DBE: _____

Calculation (supply only): _____

The Proposer is committed to utilizing the above-named DBE for the work described above. The estimated dollar value of this work is $_____
or
____% of the total contract amount of $_____. The anticipated start date is_____and the anticipated completion date is __

AFFIRMATION of DBE

The above-named DBE affirms that it will perform the portion of the Contract for the estimated dollar value as stated above.

By: _____ Date: _____
Signature of Principal or Officer of DBE - Print Name and Title

If the Proposer does not receive award of the Contract, any and all representations in this DBE Participation Plan and Affirmation Statement shall be null and void.

I_____(print name), an officer of_____(company name), certify that I have read the Appendix A2 – DBE Participation Plan and Affirmation Statement and the information contained in it is true. I fully understand that any false statement within this submittal may prevent the company and/or the undersigned from being found to be responsible Bidders/Proposers in connection with future agreements. In addition, any false statement within this submittal may subject the company and/or the undersigned to criminal charges in the state and federal courts of New York and New Jersey.

Signature of Proposer_____Title_____Date _____

Please Note: Only 60% of the expenditure to a DBE material supplier will be counted toward the DBE goal. Please show calculation above. Example: $100,000 x 60% = $60,000 estimated DBE dollar value of work. Plan cannot be accepted without calculation.

Officer of the Proposer must have ACKNOWLEDGEMENT BY NOTARY PUBLIC completed on the reverse side.

ACKNOWLEDGEMENT BY NOTARY PUBLIC

APPENDIX A2
DBE PARTICIPATION PLAN AND AFFIRMATION STATEMENT (reverse)

ACKNOWLEDGEMENT
of

STATE OF_____)
S.S.:
COUNTY OF_____)

On this_____day of_____, before me personally came and appeared _____to be known, who being by me duly sworn, did depose and say that he/she resides at _____ , that he/she is the_____of _____company, that the seal affixed to said Certification is such corporate seal, that it was so affixed by order of the directors of said corporation, and that he/she signed his/her name thereto by like order.

(Notary's Seal or Stamp)

_____
Notary Public
My commission expires:

APPENDIX A3: INFORMATION ON SOLICITED FIRMS PA 3752C / 12-15

The proposer must complete this form for itself and for all firms which gave the proposer a quotation for any work planned to be subcontracted regardless of whether they are ultimately chosen to participate in the Contract. Provide the information required below for every firm that provided a bid or a quote for a subcontract – even if the bid or quote from the firm is not used in the preparation of the final Proposal.

Name of Firm	Address of Firm	Phone Number	Contact Person	Firm Age	Annual Gross Revenue Range NOTE: See Footnote Below	DBE Certified (Yes/No)

Footnote: Annual Gross Revenue Ranges: Less than $500,000; $500,000 - $1 Million; $1 - $2 Million; $2 - $5 Million; Over $5 Million - Select the category that best identifies the annual gross revenue of the solicited firm.

I_____(print name), an officer of_____(company name), certify that I have read the Appendix A3 – **INFORMATION ON SOLICITED FIRMS** and the information contained in it is true. I fully understand that any false statement within this submittal may prevent the company and/or the undersigned from being found to be responsible Proposers/Proposers in connection with future agreements. In addition, any false statement within this submittal may subject the company and/or the undersigned to criminal charges in the state and federal courts of New York and New Jersey.

Signature_____Title_____Date _____

Officer must have ACKNOWLEDGEMENT BY NOTARY PUBLIC completed on the reverse side.

ACKNOWLEDGEMENT BY NOTARY PUBLIC

APPENDIX A3
INFORMATION ON SOLICITED FIRMS (reverse)

ACKNOWLEDGEMENT
of

STATE OF_____)
S.S.:
COUNTY OF_____)

On this_____day of_____, before me personally came and appeared _____to be known, who being by me duly sworn, did depose and say that he/she resides at _____, that he/she is the_____of _____company, that the seal affixed to said Certification is such corporate seal, that it was so affixed by order of the directors of said corporation, and that he/she signed his/her name thereto by like order.

(Notary's Seal or Stamp)

_____
Notary Public
My commission expires:

EXHIBIT B

STANDARD CONTRACT TERMS AND CONDITIONS

PART I GENERAL DEFINITIONS 3

PART II GENERAL PROVISIONS 4

1. Facility Rules and Regulations of PATH 4
2. Contractor Not An Agent 4
3. Contractor's Warranties 4
4. Personal Non-Liability 5
5. Non-Discrimination Requirements 5
6. Rights and Remedies of PATH 5
7. Rights and Remedies of the Contractor 6
8. Submission To Jurisdiction 6
9. Harmony 6
10. Claims of Third Persons 7
11. No Third Party Rights 7
12. Provisions of Law Deemed Inserted 7
13. Costs Assumed By The Contractor 7
14. Termination Provisions (for cause or convenience) 8
15. Sales or Compensating Use Taxes 10
16. No Estoppel or Waiver 11
17. Records and Reports 11
18. General Obligations 12
19. Assignments and Subcontracting 13
20. Indemnification and Risks Assumed By The Contractor 13
21. Approval of Methods 14
22. Safety and Cleanliness 15
23. Accident Reports 15
24. Trash Removal 15
25. Lost and Found Property 15
26. Property of the Contractor 15
27. Modification of Contract 16
28. Invalid Clauses 16
29. Approval of Materials, Supplies and Equipment 16
30. Intellectual Property 16
31. Contract Records and Documents – Passwords and Codes 17
32. Designated Secure Areas 17
33. Notification of Security Requirements 17
34. Construction In Progress 20
35. Permit-Required Confined Space Work 20
36. Signs 20
37. Vending Machines, Food Preparation 20
38. Confidential Information/Non-Publication 20
39. Time is of the Essence 21
40. Holidays 21
41. Personnel Standards 21
42. General Uniform Requirements for Contractor's Personnel 22

43. Contractor's Vehicles – Parking - Licenses 22
44. Superintendent/Manager's Authority 22

PART III CONTRACTOR'S INTEGRITY PROVISIONS 23
1. Certification of No Investigation (criminal or civil anti-trust), Indictment, Conviction, Debarment, Suspension, Disqualification and Disclosure of Other Information 23
2. Non-Collusive Bidding, and Code of Ethics Certification, Certification of No Solicitation Based On Commission, Percentage, Brokerage, Contingent or Other Fees 24
3. Bidder Eligibility for Award of Contracts - Determination by an Agency of the State of New York or New Jersey Concerning Eligibility to Receive Public Contracts 25
4. Contractor Responsibility, Suspension of Work and Termination 26
5. No Gifts, Gratuities, Offers of Employment, Etc 26
6. Conflict of Interest 27
7. Definitions 27

STANDARD CONTRACT TERMS AND CONDITIONS

PART I GENERAL DEFINITIONS

To avoid undue repetition, the following terms, as used in this Agreement, shall be construed as follows:

Authority or Port Authority - shall mean the Port Authority of New York and New Jersey.

PATH – shall mean the Port Authority Trans-HudsonCorporation.

Contract, Document or Agreement - shall mean the writings setting forth the scope, terms, conditions and Specifications for the procurement of Goods and/or Services, as defined hereunder and shall include, but not be limited to: Invitation for Bid (IFB), Request for Quotation (RFQ), Request for Proposal (RFP), Purchase Order (PO), Cover Sheet, executed Signature Sheet, AND PRICING SHEETS with Contract prices inserted," "STANDARD CONTRACT TERMS AND CONDITIONS," and, if included, attachments, endorsements, schedules, exhibits, or drawings, the Authority's acceptance and any written addenda issued over the name of the Authority's Manager, Purchasing Services Division.

Days or Calendar Days - shall mean consecutive calendar days, Saturdays, Sundays, and holidays, included.

Week - unless otherwise specified, shall mean seven (7) consecutive calendar days, Saturdays, Sundays, and holidays.

Month – unless otherwise specified, shall mean a calendarmonth.

Director/General Manager – shall mean the Director/General Manager of PATH which operates the facility of PATH at which the services hereunder are to be performed, for the time being, or his/her successor in duties for the purpose of this Contract, or one of his/her authorized representatives for the purpose of this Contract.

Superintendent/Manager – shall mean the Superintendent/Manager of the PATH Division responsible for operating the said Facility for the time being, or his/her successor in duties for the purpose of this Contract, or his/her duly authorized representative for the purpose of this Contract.

No person shall be deemed a representative of the Director/General Manager or Superintendent/Manager except to the extent specifically authorized in an express written notice to the Contractor signed by the Director/General Manager or Superintendent/Manager as the case may be. Further, no person shall be deemed a successor in duties of the Director/General Manager unless the Contractor is so notified in writing signed by the Authority's, Assistant Director, Commodities & Services Division, Procurement Department. No person shall be deemed a successor in duties of the Superintendent/Manager unless the Contractor is so notified in a writing signed by the Director/General Manager.

Site of the Work - or words of similar import shall mean the Facility and all buildings and properties associated therewith as described in thisContract.

Subcontractor - shall mean anyone who performs work (other than or in addition to the furnishing of materials, plant or equipment) in connection with the services to be provided hereunder, directly or indirectly for or on behalf of the Contractor (and whether or not in privity of contract with the Contractor), but shall not include any person who furnished merely his own personal labor or his own personal services. "Subcontractor", however, shall exclude the Contractor or any subsidiary or parent of the Contractor or any person, firm or corporation which has a substantial interest in the Contractor or in which the Contractor or the parent or the subsidiary of the Contractor, or an officer or principal of the Contractor or of the parent of the subsidiary of the Contractor has a substantial interest, provided, however, that for the purpose of the clause hereof entitled "Assignments and Subcontracts" the exclusion in this paragraph shall not apply to anyone but the Contractor itself.

Work - shall mean all services, equipment and materials (including materials and equipment, if any, furnished by the Authority) and other facilities and all other things necessary or proper for, or incidental to the services to be performed or goods to be furnished in connection with the service to be providedhereunder.

PART II GENERAL PROVISIONS

1. Facility Rules and Regulations of PATH

a. The Contractor shall observe and obey (and compel its officers, employees, guests, invitees, and those doing business with it, to observe and obey) the facility Rules and Regulations of PATH now in effect, and such further reasonable Rules and Regulations which may from time to time during the term of this Agreement be promulgated by PATH for reasons of safety, health, preservation of property or maintenance of a good and orderly appearance and efficient operation of the Facility. PATH agrees that, except in case of emergency, it shall give notice to the Contractor of every Rule and Regulation hereafter adopted by it at least five days before the Contractor shall be required to comply therewith.

b. A copy of the facility Rules and Regulations of PATH shall be available for review by the Contractor at the Office of the Director/General Manager of PATH.

2. Contractor Not An Agent

This Agreement does not constitute the Contractor the agent or representative of PATH or the Port Authority, for any purpose whatsoever except as may be specifically provided in this Agreement. It is hereby specifically acknowledged and understood that the Contractor, in performing its services hereunder, is and shall be at all times an independent Contractor and the officers, agents and employees ofthe Contractor shall not be or be deemed to be agents, servants or employees of PATH or the Port Authority.

3. Contractor's Warranties

The Contractor represents andwarrants:

a. That it is financially solvent, that it is experienced in and competent to perform the requirements of this Contract, that the facts stated or shown in any papers submitted or referred to in connection with the solicitation are true, and, if the Contractor be a corporation, that it is authorized to perform this Contract;

b. That it has carefully examined and analyzed the provisions and requirements of this Contract, and that from its own investigations it has satisfied itself as to the nature of all things needed for the performance of this Contract, the general and local conditions and all other matters which in any way affect this Contract or its performance, and that the time available to it for such examination, analysis, inspection and investigation was adequate;

c. That the Contract is feasible of performance in accordance with all its provisions and requirements and that it can and will perform it in strict accordance with such provisions andrequirements;

d. That no Director, officer, agent or employee of PATH is personally interested directly or indirectly in this Contract or the compensation to be paid hereunder and that no Commissioner, officer, agent or employee of the Port Authority is personally interested directly or indirectly in this Contract or the compensation to be paid hereunder;

e. That, except only for those representations, statements or promises expressly contained in this Contract, no representation, statement or promise, oral or in writing, of any kind whatsoever by thePort Authority, PATH, their Directors, Commissioners, officers, agents, employees or consultants has induced the Contractor to enter into this Contract or has been relied upon by the Contractor, including any with reference to: (1) the meaning, correctness, suitability, or completeness of any provisions or requirements of this Contract; (2) the nature, quantity, quality or size of the materials, equipment, labor and other facilities needed for the performance of this Contract; (3) the general or local conditions which may in any way affect this Contract or its performance; (4) the price of the Contract; or (5) any other matters, whether similar to or different from those referred to in (1) through (4) immediately above, affecting or having any connection with this Contract, the bidding thereon, any discussions thereof, the performance thereof or those employed therein or connected or concerned therewith.

Moreover, the Contractor accepts the conditions at the Site of the Work as they may eventually be found to

exist and warrants and represents that it can and will perform the Contract under such conditions and that all materials, equipment, labor and other facilities required because of any unforeseen conditions (physical or otherwise) shall be wholly at its own cost and expense, anything in this Contract to the contrary notwithstanding.

Nothing in the Specifications or any other part of the Contract is intended as or shall constitute a representation by PATH as to the feasibility of performance of this Contract or any part thereof.

The Contractor further represents and warrants that it was given ample opportunity and time and by means of this paragraph was requested by the Port Authority and PATH to review thoroughly all documents forming this Contract prior to opening of Bids on this Contract in order that it might request inclusion in this Contract of any statement, representation, promise or provision which it desired or on which it wished to place reliance; that it did so review said documents, that either every such statement, representation, promise or provision has been included in this Contract or else, if omitted, that it expressly relinquishes the benefit of any such omitted statement, representation, promise or provision and is willing to perform this Contract without claiming reliance thereon or making any other claim on account of such omission.

The Contractor further recognizes that the provisions of this numbered clause (though not only such provisions) are essential to PATH's consent to enter into this Contract and that without such provisions, PATH would not have entered into this Contract.

4. Personal Non-Liability

Neither the Directors of PATH, the Commissioners of the Port Authority nor any of them, nor any officer, agent or employee of PATH or the Port Authority, shall be charged personally by the Contractor with any liability, or held personally liable to the Contractor under any term or provision of this Agreement, or because of its execution or attempted execution, or because of any breach, or attempted or alleged breach, thereof.

5. Non-Discrimination Requirements

The Contractor shall take all necessary and reasonable steps to ensure non-discrimination in the performance and administration of all aspects of this Contract.

A. Contractor hereby agrees that no person on the ground of race, color, national origin, creed/religion, sex, age or handicap/disability shall be excluded from participation in, denied the benefits of, or be otherwise subjected to discrimination in the furnishing of goods or services or in the selection and retention of subcontractors and/or vendors under this Contract. Contractor shall also ascertain and comply with all applicable federal, state and local laws, ordinances, rules, regulations, and orders that pertain to equal employment opportunity, affirmative action, and non-discrimination in employment.

B. Contractor agrees that these "Non-Discrimination Requirements" are a binding part of this Contract. Without limiting the generality of any other term or provision of this Contract, in the event the Authority, or a state or federal agency finds that the Contractor or any of its subcontractors or vendors has not complied with these "Non-Discrimination Requirements", the Authority maycancel, terminate or suspend this Contract in accordance with Section 14 of these Standard Terms and Conditions entitled "Termination Provisions."

C. Contractor agrees to cooperate fully with the Authority's investigation of allegations of discrimination. Cooperation includes, but is not limited to, allowing the Authority to question employees during the investigation of allegations of discrimination, and complying with directives that the Authority or the State or Federal government deem essential to ensure compliance with these "Non-Discrimination Requirements."

6. Rights and Remedies of PATH

PATH shall have the following rights in the event the Contractor is deemed guilty of a breach of any term whatsoever of this Contract:

a. The right to take over and complete the Work or any part thereof as agent for and at the expense of the Contractor, either directly or through others.

b. The right to cancel this Contract as to any or all of the Work yet to be performed.

c. The right to specific performance, an injunction or any appropriate equitableremedy.

d. The right to money damages.

For the purpose of this Contract, breach shall include but not be limited to the following, whether or not the time has yet arrived for performance of an obligation under this Contract: a statement by the Contractor to any representative of PATH indicating that the Contractor cannot or will not perform any one or more of its obligations under this Contract; any act or omission of the Contractor or any other occurrence which makes it improbable at the time that it will be able to perform any one or more ofits obligations under this Contract; any suspension of or failure to proceed with any part of the Work by the Contractor which makes it improbable at the time that it will be able to perform any one or more ofits obligations under this Contract.

The enumeration in this numbered clause or elsewhere in this Contract of specific rights and remedies of PATH shall not be deemed to limit any other rights or remedies which PATH would have in the absence of such enumeration; and no exercise by PATH of any right or remedy shall operate as a waiver of any other of its rights or remedies not inconsistent therewith or to estop it from exercising such other rights or remedies.

7. Rights and Remedies of the Contractor

Inasmuch as the Contractor can be adequately compensated by money damages for any breach of this Contract which may be committed by PATH, the Contractor expressly agrees that no default, act or omission of PATH shall constitute a material breach of this Contract, entitling the Contractor to cancel or rescind this Contract or to suspend or abandon performance.

8. Submission To Jurisdiction

The Contractor hereby irrevocably submits itself to the jurisdiction of the Courts of the State of New York and New Jersey, in regard to any controversy arising out of, connected with, or in any way concerning this Contract.

The Contractor agrees that the service of process on the Contractor in relation to such jurisdiction may be made, at the option of PATH, either by registered or certified mail addressed to it at the address of the Contractor indicated on the signature sheet, or by actual personal delivery to the Contractor, if the Contractor is an individual, to any partner if the Contractor be a partnership or to any officer, director or managing or general agent if the Contractor be a corporation.

Such service shall be deemed to be sufficient when jurisdiction would not lie because of the lack of basis to serve process in the manner otherwise provided by law. In any case, however, process may be served as stated above whether or not it might otherwise have been served in a different manner.

9. Harmony

a. The Contractor shall not employ any persons or use any labor, or use or have any equipment, or permit any condition to exist which shall or may cause or be conducive to any labor complaints, troubles, disputes or controversies at the Facility which interfere or are likely to interfere with the operation of PATH or with the operations of lessees, licensees or other users of the Facility or with the operations of the Contractor under this Contract.

The Contractor shall immediately give notice to the Port Authority (to be followed by written notices and reports) of any and all impending or existing labor complaints, troubles, disputes or controversies

and the progress thereof. The Contractor shall use its best efforts to resolve any such complaint, trouble, dispute or controversy. If any type of strike, boycott, picketing, work stoppage, slowdown or other labor activity is directed against the Contractor at the Facility or against any operations of the Contractor under this Contract, whether or not caused by the employees of the Contractor, and if any of the foregoing, in the opinion of PATH, results or is likely to result in any curtailment or diminution of the services to be performed hereunder or to interfere with or affect the operations of PATH, or to interfere with or affect the operations of lessees, licensees, or other users of the Facility or in the event of any other cessation or stoppage of operations by the Contractor hereunder for any reason whatsoever, PATH shall have the right at any time during the continuance thereof to suspend the operations of the Contractor under this Contract, and during the period of the suspension the Contractor shall not perform its services hereunder and the Port Authority shall have the right during said period to itself or by any third person or persons selected by it to perform said services of the Contractor using the equipment which is used by the Contractor in its operations hereunder as PATH deems necessary and without cost to PATH. During such time of suspension, the Contractor shall not be entitled to any compensation. Any flat fees, including management fees, shall be prorated. Prior to the exercise of such right by PATH, it shall give the Contractor notice thereof, which notice may be oral. No exercise by PATH of the rights granted to it in the above subparagraph shall be or be deemed to be a waiver of any rights of termination or revocation contained in this Contract or a waiver of any rights or remedies which may be available to PATH under this Contract or otherwise.

b. During the time that the Contractor is performing the Contract, other persons may be engaged in other operations on or about the worksite including Facility operations, pedestrian, bus and vehicular traffic and other Contractors performing at the worksite, all of which shall remainuninterrupted.

The Contractor shall so plan and conduct its operations as to work in harmony with others engaged at the site and not to delay, endanger or interfere with the operation of others (whether or not specifically mentioned above), all to the best interests of PATH and the public as may be directed by PATH.

10. Claims of Third Persons

The Contractor undertakes to pay all claims lawfully made against it by subcontractors, suppliers and workers, and all claims lawfully made against it by other third persons arising out of or in connection with or because of the performance of this Contract and to cause all subcontractors to pay all such claims lawfully made against them.

11. No Third Party Rights

Nothing contained in this Contract is intended for the benefit of third persons, except to the extent that the Contract specifically provides otherwise by use of the words "benefit" or "direct right of action."

12. Provisions of Law Deemed Inserted

Each and every provision of law and clause required by law to be inserted in this Contract shall be deemed to be inserted herein and the Contract shall be read and enforced as though it were included therein, and if through mistake or otherwise any such provision is not inserted, or is not correctly inserted, then upon the application of either party, the Contract shall forthwith be physically amended to make such insertion.

13. Costs Assumed By The Contractor

It is expressly understood and agreed that all costs of the Contractor of whatever kind or nature and whether imposed directly upon the Contractor under the terms and provisions hereof or in any other manner whatsoever because of the requirements of the operation of the service or otherwise under this Agreement shall be borne by the Contractor or without compensation or reimbursement from PATH, except as specifically set forth in this Agreement. The entire and complete cost and expense of the Contractor's services and operations hereunder shall be borne solely by the Contractor and under no circumstances shall

PATH be liable to any third party (including the Contractor's employees) for any such costs and expenses incurred by the Contractor and under no circumstances shall PATH be liable to the Contractor for the same, except as specifically set forth in this Section.

14. Termination Provisions (for cause or convenience)

a. If one or more of the following events shall occur:

1. If fire or other cause shall destroy all or a substantial part of the Facility.
2. If any governmental agency shall condemn or take a temporary or permanent interest in all or a substantial part of the Facility, or all of a part of PATH's interest herein;

then upon the occurrence of such event or at any time thereafter during the continuance thereof, PATH shall have the right on twenty-four (24) hours written notice to the Contractor to revoke this Contract, such revocation to be effective upon the date and time specified in such notice.

In such event this Contract shall cease and expire on the effective date of revocation as if said date were the date of the expiration of this Contract. Such revocation shall not, however, relieve the Contractor of any liabilities or obligations hereunder which shall have accrued on or prior to the effective date of revocation.

b. If one or more of the following events shall occur:

1. The Contractor shall become insolvent, or shall take the benefit of any present or future insolvency statute, or shall make a general assignment for the benefit of creditors, or file a voluntary petition in bankruptcy or a petition or answer seeking an arrangement or its reorganization or the readjustment of its indebtedness under the federal bankruptcy laws or under any other law or statute of the United States or of any State thereof, or consent to the appointment of a receiver, trustee, or liquidator of all or substantially all its property; or
2. By order or decree of a court the Contractor shall be adjudged bankrupt or an order shall be made approving a petition filed by any of the creditors, or, if the Contractor is a corporation, by any of the stockholders of the Contractor, seeking its reorganization or the readjustment of its indebtedness under the federal bankruptcy laws or under any law or statute of the United States or of any State thereof; or
3. A petition under any part of the federal bankruptcy laws or an action under any present or future insolvency law or statute shall be filed against the Contractor and shall not be dismissed within thirty (30) days after the filing thereof; or
4. The interest of the Contractor under this Contract shall be transferred to, passed to or devolve upon, by operation of law or otherwise, any other person, firm or corporation, or
5. The Contractor, if a corporation, shall, without the prior written approval of the Port Authority, become a surviving or merged corporation in a merger, a constituent corporation in a consolidation, or a corporation in dissolution; or
6. If the Contractor is a partnership, and the said partnership shall be dissolved as the result of any act or omission of its copartners or any of them, or by operation of law or the order or decree of any court having jurisdiction, or for any other reason whatsoever; or
7. By or pursuant to, or under authority of any legislative act, resolution or rule, or any order or decree of any court or governmental board, agency or officer having jurisdiction, a receiver, trustee, or liquidator shall take possession or control of all or substantially all of the property of the Contractor and such possession or control of all or substantially all of the property of the Contractor and shall continue in effect for a period of fifteen (15) days;

then upon the occurrence of any such event or at any time thereafter during the continuance thereof, the PATH shall have the right upon five (5) days notice to the Contractor to terminate this Contract

and the rights of the Contractor hereunder; termination to be effective upon the date and time specified in such notice as if said date were the date of the expiration of this Contract. Termination shall not relieve the Contractor of any liabilities or obligations hereunder which have accrued on or prior to the effective date of termination.

c. If any of the following shall occur:

1. The Contractor shall cease, abandon any part of the service, desert, stop or discontinue its services in the premises for any reason whatsoever and regardless of the fault of the Contractor; or

2. The Contractor shall fail to keep, perform and observe each and every other promise, covenant and agreement set forth in this Contract on its part to be kept, performed or observed, within five (5) days after receipt of notice of default thereunder from PATH or the Port Authority on behalf of PATH (except where fulfillment of its obligations requires activity over a greater period of time, and the Contractor shall have commenced to perform whatever may be required for fulfillment within five (5) days after receipt of noticeand continues such performance without interruption except for causes beyond its control);

then upon the occurrence of any such event or during the continuance thereof, PATH shall have the right on twenty four (24) hours notice to the Contractor to terminate this Contract and the rights of the Contractor hereunder, termination to be effective upon the date and time specified in such notice. Termination shall not relieve the Contractor of any liabilities which shall have accrued on or prior to the effective date of termination.

d. If any of the events enumerated in this Section shall occur prior to commencement date of this Contract PATH upon the occurrence of any such event or any time thereafter during the continuance thereof by twenty-four (24) hours notice may terminate or suspend this Contract and the rights of the Contractor hereunder, such termination or suspension to be effective upon the date specified in such notice.

e. No payment by PATH of any monies to the Contractor for any period or periods after default of any of the terms, covenants or conditions hereof to be performed, kept and observed by the Contractor and no act or thing done or omitted to be done by PATH shall be deemed to be a waiver of the right of PATH to terminate this Contract or of any other right or remedies to which PATH maybe entitled because of any breach thereof. No waiver by PATH of any default on the part of the Contractor in the performance of any of the terms, covenants and conditions hereof to be performed, kept or observed by the Contractor shall be or be construed to be a waiver by PATH of any other subsequent default in the performance of any of the said terms, covenants and conditions.

f. In addition to all other rights of revocation or termination hereunder and notwithstanding any other provision of this Contract PATH may terminate this Contract and the rights of the Contractor hereunder without cause at any time upon five (5) days written notice to the Contractor and in such event this Contract shall cease and expire on the date set forth in the notice of termination as fully and completely as though such dates were the original expiration date hereof and if such effective date of termination is other than the last day of the month, the amount of the compensation due to the Contractor from PATH shall be prorated when applicable on a daily basis. Such cancellation shall be without prejudice to the rights and obligations of the parties arising out of portions already performed but no allowance shall be made for anticipated profits.

g. Any right of termination contained in this paragraph, shall be in addition to and not in lieu of any and all rights and remedies that PATH shall have at law or in equity consequent upon the Contractor's breach of this Contract and shall be without prejudice to any and all such other rights and remedies. It is hereby specifically agreed and understood that the exercise by the Port Authority of any right of termination set forth in this paragraph shall not be or be deemed to be an exercise by the Port Authority of an election of remedies so as to preclude PATH from any right to money damages it may have for the period prior to the effective date of termination to theoriginal

expiration date of the Contract, and this provision shall be deemed to survive the termination of this Contract as aforesaid.

h. If (1) the Contractor fails to perform any of its obligations under this Contract or anyother agreement between PATH or the Port Authority and the Contractor (including its obligation to PATH or the Port Authority to pay any claim lawfully made against it by any supplier,subcontractor or worker or other person which arises out of or in connection with the performance of this Contract or any other agreement with PATH or the Port Authority) or (2) any claim (just or unjust) which arises out of or in connection with this Contract or any other agreement between PATH or the Port Authority and the Contractor is made against the Port Authority or PATH or (3) any subcontractor under this Contract or any other agreement between PATH or the Port Authority and the Contractor fails to pay any claims lawfully made against it by any supplier, subcontractor, worker or other third person which arises out of or in connection with this Contract or any other agreement between PATH or the Port Authority and the Contractor or if in the opinion of PATH or the Port Authority any of the aforesaid contingencies is likely to arise, then the Port Authority or PATH, as applicable, shall have the right, in its discretion, to withhold out of any payment (final or otherwise) such sums as PATH may deem ample to protect it against delay or loss or to assure the payment of just claims of third persons, and to apply such sums in such manner as PATH may deem proper to secure such protection or satisfy such claims. All sums so applied shall be deducted from the Contractor's compensation. Omission by PATH to withhold out of any payment, final or otherwise, a sum for any of the above contingencies, even though such contingency has occurredat the time of such payment, shall not be deemed to indicate that PATH does not intend to exerciseitsright with respect to such contingency. Neither the above provisions for rights of PATH towithhold and apply monies nor any exercise or attempted exercise of, or omission to exercise, such rights by PATH shall create any obligation of any kind to such supplier, subcontractors, worker or other third persons. If, however, the payment of any amount due the Contractor shall be improperly delayed, PATH shall pay the Contractor interest thereon at the rate of 6% per annum for the period of the delay, it being agreed that such interest shall be in lieu of and in liquidation of any damages to the Contractor because of such delay.

i. If PATH has paid any sum or has incurred any obligation or expense which the Contractor has agreed to pay or reimburse PATH, or if PATH is required or elects to pay any sum or sums or incurs any obligations or expense by reason of the failure, neglect or refusal of the Contractor to perform or fulfill any one or more of the conditions, covenants, or agreements contained in this Contract, or as a result of an act of omission of the Contractor contrary to the said conditions, covenants and agreements, the Contractor shall pay to PATH the sum or sums so paid or expense soincurred, including all interests, costs and damages, promptly upon the receipt of PATH's statement therefore. PATH may, however, in its discretion, elect to deduct said sum or sums from any payment payable by it to the Contractor.

j. If PATH pays any installment to the Contractor without reducing said installment as provided in this Contract, it may reduce any succeeding installment by the proper amount, or it may billthe Contractor for the amount by which the installment paid should have been reduced andthe Contractor shall pay to PATH any such amount promptly upon receipt of PATH'sstatement therefore.

k. PATH shall also have the rights set forth above in the event the Contractor shall become insolvent or bankrupt or if his affairs are placed in the hands of a receiver, trustee or assignee for the benefit of creditors.

15. Sales or Compensating Use Taxes

Purchases of services and tangible personal property by PATH in the States of New York and New Jersey are generally exempt from state and local sales and compensating use taxes, and from most federal excises

(Taxes). Therefore, PATH's purchase of the Contractor's services under this Contract is exempt from Taxes. Accordingly, the Contractor must not include Taxes in the price charged to PATH forthe Contractor's services under this Contract**.** The Contractor certifies that there are no such taxes includedin the prices for this Contract. The Contractor shall retain a copy of this Contract to substantiate the exempt sale.

The compensation set forth in this Agreement is the complete compensation to the Contractor, and PATH will not separately reimburse the Contractor for any taxes unless specifically set forth in this Agreement.

16. No Estoppel or Waiver

PATH shall not be precluded or estopped by any payment, final or otherwise, issued or made under this Contract, from showing at any time the true amount and character of the services performed, or from showing that any such payment is incorrect or was improperly issued or made; and PATH shall notbe precluded or estopped, notwithstanding any such payment, from recovering from the Contractor any damages which it may sustain by reason of any failure on its part to comply strictly with this Contract, and any moneys which may be paid to it or for its account in excess of those to which it is lawfully entitled.

No cancellation, rescission or annulment hereof, in whole or as to any part of the services to be provided hereunder, or because of any breach hereof, shall be deemed a waiver of any money damages to which PATH may be entitled because of such breach. Moreover, no waiver by the Authority of any breach of this Contract shall be deemed to be a waiver of any other or any subsequentbreach.

17. Records and Reports

The Contractor shall set up, keep and maintain (and shall cause its subcontractors to set up, keep and maintain) in accordance with generally accepted accounting practice during the term of this Agreement and any extensions thereof and for three years after the expiration, termination or revocation thereof, records, payroll records and books of account (including, but not limited to, records of original entry anddaily forms, payroll runs, cancelled checks, time records, union agreements, contracts with health, pension and other third party benefit providers) recording all transactions of the Contractor(and its subcontractors), at, through or in any way connected with or related to the operations of the Contractor (and its subcontractors) hereunder, including but not limited to all matters relating to the charges payable to the Contractor hereunder, all wages and supplemental benefits paid or provided to or for its employees (andits subcontractors' employees) and such additional information as PATH may from time to time and at any time require, and also including, if appropriate, recording the actual number of hours of service provided under the Contract, and keeping separate records thereof which records and books of account shall be kept at all times within the Port District. The Contractor shall permit (and cause its subcontractors to permit) in ordinary business hours during the term of this Agreement including any extensions thereof and for three years thereafter the examination and audit by the officers, employees and representatives of PATH of such records and books of account and also any records and books of account of any company which is owned or controlled by the Contractor, or which owns or controls the Contractor if said company performs services similar to those performed by the Contractor anywhere in the Port District. However, if within the aforesaid three year period PATH has notified the Contractor in writing of a pending claim by PATH under or in connection with this Contract to which any of the aforesaid records and documents of the Contractor or of its subcontractors relate either directly or indirectly, then the period of such right of access shall be extended to the expiration of six years from the date of final payment with respect to the records and documents involved.

Upon request of the Port Authority, the Contractor shall furnish or provide access to the federal Form I-9 (Employment Eligibility Verification) for each individual performing work under this Contract. This includes citizens andnoncitizens.

The Contractor (and its subcontractors) shall, at its own expense, install, maintain and use such equipment and devices for recording the labor hours of the service as shall be appropriate to its business and necessary

or desirable to keep accurate records of the same and as the general manager or the Facility Superintendent/Manager may from time to time require, and the Contractor (and its subcontractors) shall at all reasonable times allow inspection by the agents and employees of PATH of all such equipment or devices.

a. The Contractor hereby further agrees to furnish to PATH from time to time such written reports in connection with its operations hereunder as PATH may deem necessary or desirable. The format ofall forms, schedules and reports furnished by the Contractor to PATH shall be subject to the continuing approval of PATH.

b. No provision in this Contract giving PATH a right of access to records and documents is intended to impair or affect any right of access to records and documents which they would have in the absence of such provision. Additional record keeping may be required under other sections of this Contract.

18. General Obligations

a. Except where expressly required or permitted herein to be oral, all notices, requests, consents and approvals required to be given to or by either party shall be in writing and all such notices, requests, consents and approvals shall be personally delivered to the other party during regular business hours or forwarded to such party by United States certified mail, return receipt requested, addressed to the other party at its address hereinbefore or hereafter provided. Until further notice the Contractor hereby designates the address shown on the bottom of the Contractors Signature Sheet as their address to which such notices, requests, consents, or approvals may be forwarded. All notices, requests, consents, or approvals of the Contractor shall be forwarded to the Superintendent/Manager at the Facility.

b. The Contractor shall comply with the provisions of all present and future federal, state and municipal laws, rules, regulations, requirements, ordinances, orders and directions which pertain to its operations under this Contract and which affect the Contract or the performance thereof and those engaged therein as if the said Contract were being performed for a private corporation, except where stricter requirements are contained in the Contract in which case the Contract shall control. The Contractor shall procure for itself all licenses, certificates, permits or other authorization from all governmental authorities, if any, having jurisdiction over the Contractor's operations hereunder which may be necessary for the Contractor's operations. The Contractor's obligation to comply with governmental requirements are not to be construed as a submission by PATH or the Port Authority to the application to itself of such requirements.

c. The Contractor shall pay all taxes, license, certification, permit and examination fees and excises which may be assessed on its property or operations hereunder or income therefrom, and shall make all applications, reports and returns required in connection therewith.

d. The Contractor shall, in conducting its operations hereunder, take all necessary precautions to protect the general environment and to prevent environmental pollution, contamination, damage to property and personal injury. In the event the Contractor encounters material reasonably believed tobe asbestos, polychlorinated biphenyl (PCB) or any other hazardous material, in conducting its operations hereunder, the Contractor shall immediately stop Work in the area affected and report the condition in writing to the Superintendent/Manager. Work in the affected area shall not thereafter be resumed by the Contractor except upon the issuance of a written order to that effect fromthe Superintendent/Manager.

e. The Contractor shall promptly observe, comply with and execute the provisions of any and all present and future rules and regulations, requirements, standard orders and directions of the American Insurance Association, the Insurance Services Office, National Fire Protection Association, and any other body or organization exercising similar functions which may pertain or apply to the Contractor's operations hereunder.

The Contractor shall not do or permit to be done any actwhich:

1. will invalidate or be in conflict with any fire insurance policies covering the Facility or any part thereof or upon the contents of any building thereon; or
2. will increase the rate of any fire insurance, extended coverage or rental insurance on the Facility or any part thereof or upon the contents of any building thereon; or
3. in the opinion of PATH will constitute a hazardous condition, so as to increase the risk normally attendant upon the operations contemplated by this Contract; or
4. may cause or produce in the premises, or upon the Facility any unusual, noxious or objectionable smoke, gases, vapors, odors; or
5. may interfere with the effectiveness or accessibility of the drainage and sewerage system, fire protection system, sprinkler system, alarm system, fire hydrants and hoses, if any, installed or located or to be installed or located in or on the Facility; or
6. shall constitute a nuisance in or on the Facility or which may result in the creation, commission or maintenance of a nuisance in or on the Facility.

f. If by reason of the Contractor's failure to comply with the provisions of this Section and provided PATH has given the Contractor five (5) days written notice of its failure and the Contractor shall not have cured said failure within said five (5) days, any fire insurance, extended coverage or rental insurance rate on the Facility or any part thereof or upon the contents of any building thereon shall at any time be higher than it otherwise would be, then the Contractor shall on demand pay PATH that part of all fire insurance, extended coverage or rental insurance premiums paid or payable by PATH which shall have been charged because of such violations by the Contractor.

g. The Contractor shall conduct its operations hereunder so as not to endanger, unreasonably interfere with, or delay the operations or activities of any tenants or occupants on the premises or the Facility and, moreover, shall use the same degree of care in performance on the premises as would be required by law of PATH and shall conduct operations hereunder in a courteous, efficient and safe manner.

h. The Contractor shall provide such equipment and medical facilities as may be necessary to supply first aid service in case of accidents to its personnel who may be injured in the furnishing of service hereunder. The Contractor shall maintain standing arrangements for the removal and hospital treatment of any of its personnel who may be injured.

19. Assignments and Subcontracting

a. The Contractor shall not sell, transfer, mortgage, pledge, subcontract or assign this Contract or any part thereof or any of the rights granted hereunder or any moneys due or to become due to it hereunder or enter into any contract requiring or permitting the doing of anything hereunder by an independent Contractor, without the prior written approval of PATH, and any such sale, transfer, mortgage, pledge, subcontract, assignment or contract without such prior written approval shall be void as to PATH.

b. All subcontractors who provide permanent personnel to the Contractor for work under this Contract shall be given written notice to comply with all requirements of the Contract. The Contractor shall be responsible and liable for the performance and acts of each subcontractor.

c. All persons to whom the Contractor sublets services shall be deemed to be its agents and no subletting or approval thereof shall be deemed to release this Contractor from its obligations under this Contract or to impose any obligations on PATH to such subcontractor or to give the subcontractor any rights against PATH.

20. Indemnification and Risks Assumed By The Contractor

To the extent permitted by law, the Contractor shall indemnify and hold harmless PATH, the Port Authority, their Directors, Commissioners, officers, representatives and employees from and against all claims and demands, just or unjust, of third persons (including Contractor's employees, employees, officers, and agents

of PATH and the Port Authority) arising out of or in any way connected or alleged to arise out of or alleged to be in any way connected with the Contract and all other services and activities of the Contractor under this Contract and for all expenses incurred by it and by them in the defense, settlement or satisfaction thereof, including without limitation thereto, claims and demands for death, for personal injury or for property damage, direct or consequential, whether they arise from the acts or omissions of the Contractor, of PATH, of the Port Authority, third persons (including Contractor's employees, employees, officers, and agents of PATH and the Port Authority), or from the acts of God or the public enemy, orotherwise, including claims and demands of any local jurisdiction against the Port Authority in connection with this Contract.

The Contractor assumes the following risks, whether such risks arise from acts or omissions (negligent or not) of the Contractor, PATH, the Port Authority, or third persons (including Contractor's employees, employees, officers, and agents of PATH and the Port Authority) or from any other cause, excepting only risks occasioned solely by affirmative willful acts of PATH or the Port Authority, as applicable, done subsequent to the opening of proposals on this Contract, and shall to the extent permitted by law indemnify PATH and the Port Authority for all loss or damage incurred in connection with such risks:

a. The risk of any and all loss or damage to PATH or Port Authority property, equipment (including but not limited to automotive and/or mobile equipment), materials and possessions, on or off the premises, the loss or damage of which shall arise out of the Contractor's operations hereunder. The Contractor shall if so directed by PATH, repair, replace or rebuild to the satisfaction of PATH or the Port Authority, as applicable, any and all parts of the premises or the Facility which may be damaged or destroyed by the acts or omissions of the Contractor, its officers, agents, or employees and if the Contractor shall fail so to repair, replace, or rebuild with due diligence PATH or the Port Authority, as applicable, may, at its option, perform any of the foregoing work and the Contractor shall pay to PATH or the Port Authority as applicable the cost thereof.

b. The risk of any and all loss or damage of the Contractor's property, equipment (including but not limited to automotive and/or mobile equipment) materials and possessions on the Facility.

c. The risk of claim, whether made against the Contractor, the Port Authority or PATH, for any and all loss or damages occurring to any property, equipment (including but not limited to automotive and/or mobile equipment), materials and possessions of the Contractor's agents, employees, materialmen and others performing work hereunder.

d. The risk of claims for injuries, damage or loss of any kind just or unjust of third persons arisingor alleged to arise out of the performance of work hereunder, whether such claims are made againstthe Contractor, the Port Authority or PATH.

If so directed, the Contractor shall at its own expense defend any suit based upon any such claim or demand, even if such suit, claim or demand is groundless, false or fraudulent, and in handling such shall not, without obtaining express advance permission from the General Counsel of the Port Authority, raise any defense involving in any way the jurisdiction of the tribunal over the person of the Port Authority or PATH, the immunity of the Port Authority or PATH, their Directors, Commissioners, officers, agents or employees, the governmental nature of the Port Authority or PATH or the provision of any statutes respecting suits against PATH or the Port Authority.

Neither the requirements of PATH under this Contract, nor of PATH of the methods of performance hereunder nor the failure of PATH to call attention to improper or inadequate methods or to require a change in the method of performance hereunder nor the failure of PATH to direct the Contractor to take any particular precaution or other action or to refrain from doing any particular thing shall relieve the Contractor of its liability for injuries to persons or damage to property or environmental impairment arising out of its operations.

21. Approval of Methods

Neither the approval of PATH of the methods of furnishing services hereunder nor the failure of PATH to

call attention to improper or inadequate methods or to require a change in the method of furnishing services hereunder, nor the failure of PATH to direct the Contractor to take any particular precautions or to refrain from doing any particular thing shall relieve the Contractor of its liability for injuries to persons or damage to property or environmental impairment arising out of its operations.

22. Safety and Cleanliness

a. The Contractor shall, in the furnishing of services hereunder, exercise every precaution to prevent injury to person or damage to property or environmental impairment and avoid inconvenience to the occupants of or any visitors to the Facility. The Contractor shall, without limiting the generality hereof, place such personnel, erect such barricades and railings, give such warnings, display such lights, signals or signs, place such cones and exercise precautions as may be necessary, proper or desirable.

b. The Contractor shall in case of unsafe floor conditions due to construction, wetness, spillage, sickness and all other types of hazardous conditions proceed to rope off the unsafe area and place appropriate warnings signs to prevent accidents from occurring. The Contractor shall clean said area to the satisfaction of the Superintendent/Manager.

c. The Contractor shall at all times maintain in a clean and orderly condition and appearance any and all facilities provided by PATH for the Contractor's operations, and all fixtures, sink closets, equipment, and other personal property of PATH which are located in said facilities.

23. Accident Reports

The Contractor shall promptly report in writing to the Manager of the Facility and to the Deputy Chief, Litigation Management of the Port Authority all accidents whatsoever arising out of or in connection with its operations hereunder and which result in death or injury to persons or damage to property, setting forth such details thereof as PATH may desire. In addition, if death or serious injury or serious damage is caused, such accidents shall be immediately reported by telephone to the aforesaid representatives of PATH (or the Port Authority, as applicable).

24. Trash Removal

The Contractor shall remove daily from the Facility by means provided by the Contractor all garbage, debris and other waste material (solid or liquid) arising out of or in connection with its operations hereunder, and any such garbage, debris and other waste material not immediately removed shall be temporarily stored in a clear and sanitary condition, approved by the Superintendent/Manager and shall be kept covered except when filling or emptying them. The Contractor shall exercise care in removing such garbage, debris and other waste materials from the Facility. The manner of such storage and removal shall always be subject in all respects to the continual approval of PATH. No equipment or facilities of PATH shall be used in such removal unless with its prior consent in writing. No such garbage, debris or other waste materials shall be or be permitted to be thrown, discharged or disposed into or upon the waters at or bounding the Facility.

25. Lost and Found Property

The Contractor shall instruct its personnel that all items of personal property found by the Contractor's employees at the Site must be turned in to PATH and a receipt will be issued therefor.

26. Property of the Contractor

a. All property of the Contractor at the Site by virtue of this Contract shall be removed on or before the expiration or sooner termination or revocation of this Contract.

b. If the Contractor shall fail to remove its property upon the expiration, termination or revocation of this Contract PATH may, at its option, dispose of such property as waste or as agent for the Contractor and at the risk and expense of the Contractor, remove such property to a public warehouse, or may retainthe same in its own possession, and in either event after the expiration of thirty (30) days may sell the same in

accordance with any method deemed appropriate; the proceeds of any such sale shall be applied first, to the expenses of sale and second, to any sums owed by the Contractor to PATH; any balance remaining shall be paid to the Contractor. Any excess of the total cost of removal, storage and sale and othercosts incurred by PATH as a result of such failure of performance by the Contractor over the proceeds of sale shall be paid by the Contractor to PATH upondemand.

27. Modification of Contract

This Contract may not be changed except in writing signed by PATH and the Contractor. The Contractor agrees that no representation or warranties shall be binding upon PATH unless expressed in writing in this Contract.

28. Invalid Clauses

If any provision of this Contract shall be such as to destroy its mutuality or to render it invalid or illegal, then, if it shall not appear to have been so material that without it the Contract would not have been made by the parties, it shall not be deemed to form part thereof but the balance of the Contract shall remain in full force and effect.

29. Approval of Materials, Supplies and Equipment

Only Port Authority/PATH approved materials, supplies, and equipment are to be used by the Contractor in performing the Work hereunder. Inclusion of chemical containing materials or supplies on the Port Authority/ PATH Approved Products List – Environmental Protection Supplies constitutes approval. The list may be revised from time to time and at any time by the Port Authority/PATH and it shall be incumbent upon the Contractor to obtain the most current list from the Superintendent/Manager of the Facility.

At anytime during the Solicitation, pre-performance or performance periods, the Contractor may propose the use of an alternate product or products to those on the Approved Products List – Environmental Protection Supplies, which product(s) shall be subject to review and approval by the Port Authority. Any alternate product so approved by the Port Authority/PATH may be used by the Contractor in performing the Services hereunder. Until such approval is given, only products on the Approved Products List – Environmental Protection Supplies may be used.

30. Intellectual Property

The right to use all patented materials, appliances, processes of manufacture or types of construction, trade and service marks, copyrights and trade secrets, collectively hereinafter referred to as "Intellectual Property Rights", in the performance of the work, shall be obtained by the Contractor without separate or additional compensation. Where the services under this Agreement require the Contractor to provide materials, equipment or software for the use of PATH/the Port Authority or its employees or agents, PATH/the Port Authority shall be provided with the Intellectual Property Rights required for such use without further compensation than is provided for under this Agreement.

The Contractor shall indemnify PATH and the Port Authority against and save it harmless from all loss and expense incurred as a result of any claims in the nature of Intellectual Property Rights infringement arising out of the Contractor's or PATH or the Port Authority's use, in accordance with the above immediately preceding paragraph, of any Intellectual Property. The Contractor, if requested, shall conduct all negotiations with respect to and defend such claims. If the Contractor, the Port Authority or PATH, its employees or agents be enjoined either temporarily or permanently from the use of any subject matter as to which the Contractor is to indemnify PATH, or the Port Authority as applicable, against infringement, then PATH, or the Port Authority as applicable, may, without limiting any other rights it may have, require the Contractor to supply temporary or permanent replacement facilities approved bythe Superintendent/Manager, and if the Contractor fails to do so the Contractor shall, at its expense, remove all such enjoined facilities and refund the cost thereof to PATH or the Port Authority, as applicable, or take

such steps as may be necessary to insure compliance by the Contractor, and PATH (or the Port Authority, as applicable) with said injunction, to the satisfaction of PATH or the Port Authority as applicable.

In addition, the Contractor shall promptly and fully inform the Director/General Manager in writing of any intellectual property rights disputes, whether existing or potential, of which it has knowledge, relating to any idea, design, method, material, equipment or any other matter related to the subject matter of this Agreement or coming to its attention in connection with this Agreement.

31. Contract Records and Documents – Passwords and Codes

When the performance of the contract services requires the Contractor to produce, compile or maintain records, data, drawings, or documents of any kind, regardless of the media utilized, then all such records, drawings, data and documents which are produced, prepared or compiled in connection with this contract, shall become the property of PATH (or the Port Authority as applicable), and PATH (or the Port Authority as applicable) shall have the right to use or permit the use of them and any ideas or methods represented by them for any purpose and at any time without other compensation than that specifically provided herein.

When in the performance of the contract services the Contractor utilizes passwords or codes for any purpose, at any time during or after the performance of such services, upon written request by PATH (or the Port Authority as applicable), the Contractor shall make available to the designated PATH (or the Port Authority as applicable) representative all such passwords and codes.

32. Designated Secure Areas

Services under the Contract may be required in designated secure areas, as the same may be designated by the Superintendant/Manager from time to time ("Secure Areas"). The Port Authority shall require the observance of certain security procedures with respect to Secure Areas, which may include the escort to, at, and/or from said high security areas by security personnel designated by the Contractor or any subcontractor's personnel required to work therein. All personnel that require access to designated secure areas who are not under positive escort by an authorized individual will be required to undergo background screening and personal identityverification.

Forty-eight (48) hours prior to the proposed performance of any work in a Secure Area, the Contractor shall notify the Superintendant/Manager. The Contractor shall conform to the procedures as may be established by the Superintendant/Manager from time to time and at any time for access to Secure Areas andthe escorting of personnel hereunder. Prior to the start of work, the Contractor shall request a description from the Superintendant/Manager of the Secure Areas which will be in effect on the commencement date. The description of Secure Areas may be changed from time to time and at any time bythe Superintendant/Manager during the term of the Contract.

33. Notification of Security Requirements

PATH has the responsibility of ensuring safe, reliable and secure transportation facilities, systems, and projects to maintain the well-being and economic competitiveness of the region. Therefore, PATH reserves the right to deny access to certain documents, sensitive security construction sites and facilities (including rental spaces) to any person that declines to abide by Port Authority or PATH security procedures and protocols, any person with a criminal record with respect to certain crimes or who may otherwise poses a threat to the construction site or facility security. The Authority and PATH reserve the right to impose multiple layers of security requirements on the Contractor, its staff and subcontractors and their staffs depending upon the level of security required, or may make any amendments with respect to such requirements as determined by the Authority and/orPATH.

These security requirements may include but are not limited to thefollowing:

- <u>Execution of Port Authority Approved Non-disclosure Agreements</u>

  At the direction of the Port Authority, the Contractor shall be required to have its principals, staff and/or subcontractor(s) and their staff, execute Port Authority approved non-disclosure agreements.

- Contractor/ Subcontractor identity checks and background screening

  PATH and the Port Authority's designated background screening provider may require inspection of not less than two forms of valid/current government issued identification (at least one having an official photograph) to verify staff's name and residence; screening federal, state, and/or local criminal justice agency information databases and files; screening of any terrorist identification files; access identification to include some form of biometric security methodology such as fingerprint, facial or iris scanning, or the like.

  The Contractor may be required to have its staff, and any subcontractor's staff, material-men, visitors or others over whom the Contractor/subcontractor has control, authorize the Authority or its designee to perform background checks, and a personal identity verification check. Such authorization shall be in a form acceptable to the Authority and/or PATH. The Contractor and subcontractors may also be required to use an organization designated by the Authority and/or PATH to perform the background checks.

  As of January 29, 2007, the Secure Worker Access Consortium (S.W.A.C.) is the only Port Authority approved provider to be used to conduct background screening and personal identity verification, except as otherwise required by federal law and/or regulation (such as the Transportation Worker Identification Credential for personnel performing in secure areas at Maritime facilities). Information about S.W.A.C., instructions, corporate enrollment, online applications, and location of processing centers can be found at http://www.secureworker.com, or S.W.A.C. may be contacted directly at (877) 522-7922 for more information and the latest pricing. The cost for said background checks for staff that pass and are granted a credential shall be reimbursable to the Contractor (and its subcontractors) as an out-of-pocket expense as provided herein. Staff that are rejected for a credential for any reason are notreimbursable.

- Issuance of Photo Identification Credential

  No person will be permitted on or about a Port Authority or PATH construction site or facility (including rental spaces) without a facility-specific photo identification credential approved by the Authority and/or PATH. If the authority requires facility-specific identification credential for the Contractor's and the subcontractor's staff, the Authority and/or PATH will supply such identification at no cost to the Contractor or its subcontractors. Such facility-specific identification credential shall remain the property of the Authority and/or PATH and shall be returned to the Authority and/or PATH at the completion or upon request prior to completion of the individual's assignment at the specific facility. It is the responsibility of the appropriate Contractor or subcontractor to immediately report to the Authority and/or PATH the loss of any staff member's individual facility-specific identification credential. The Contractor or subcontractor shall be billed for the cost of the replacement identification credential. Contractor's and subcontractor's staff shall display Identification badges in a conspicuous and clearly visible manner, when entering, working or leaving an Authority or PATH construction site or facility.

  Employees may be required to produce not less than two forms of valid/current government issued identification having an official photograph and an original, unlaminated social security card for identify and SSN verification. Where applicable, for sensitive security construction sites or facilities, successful completion of the application, screening and identify verification for all employees of the Contractor and subcontractors shall be completed prior to being provided a S.W.A.C. ID Photo Identification credential.

- Access control, inspection, and monitoring by securityguards

  The Authority may provide for Authority and/or PATH construction site or facility (including rental spaces) access control, inspection and monitoring by Port Authority Police, Authority or PATH retained contractor security guards. However, this provision shall not relieve the Contractor of its responsibilityto secure its equipment and work and that of its subconsultant/subcontractor's and service suppliers at the Authority or PATH construction site or facility (including rental spaces). In addition, the Contractor, subcontractor or service provider is not permitted to take photographs, digital images, electronic copying and/or electronic transmission or video recordings or make sketches on any other medium at the Authority or PATH construction sites or facilities (including rental spaces), except when necessary to perform the

Work under this Contract, without prior written permission from the Authority or PATH. Upon request, any photograph, digital images, video recording or sketches made of the Authority construction site or facility shall be submitted to the Authority to determine compliance with this paragraph, which submission shall be conclusive and binding on the submitting entity.

- Compliance with the Port Authority Information Security Handbook

The Contract may require access to Port Authority or PATH information considered Protected Information ("PI") as defined in the Port Authority Information Security Handbook ("Handbook"), dated October, 2008, corrected as of November 14, 2013, and as may be further amended. The Handbook and its requirements are hereby incorporated into this agreement and will govern the possession, distribution and use of PI if at any point during the lifecycle of the project or solicitation it becomes necessary for the Contractor to have access to PI. Protecting sensitive information requires the application of uniform safeguarding measures to prevent unauthorized disclosure and to control any authorized disclosure of this information within the Port Authority or when released by the Port Authority to outside entities. The following is an outline of some of the procedures, obligations and directives contained in the Handbook:

(1) require that the Contractor and subcontractors, when appropriate, sign Non-Disclosure Agreements (NDAs), or an Acknowledgment of an existing NDA, provided by the Authority as a condition of being granted access to Protected Information categorized and protected as per the Handbook;

(2) require that individuals needing access to PI be required to undergo a background check, pursuant to the process and requirements noted in § 3.2 of the Information Security Handbook.

(3) require Contractors and commercial enterprises to attend training to ensure security awareness regarding Port Authority and PATH information;

(4) specific guidelines and requirements for the handling of PI to ensure that the storage and protection of PI;

(5) restrictions on the transfer, shipping, and mailing of PI;

(6) prohibitions on the publication, posting, modifying, copying, reproducing, republishing, uploading, transmitting, or distributing PI on websites or web pages. This may also include restricting persons, who either have not passed a pre-screening background check, or who have not been granted access to PI, from viewing such information;

(7) require that PI be destroyed using certain methods, measures or technology pursuant to the requirements set forth in the Handbook;

(8) require the Contractor to mandate that each of its subcontractors maintain the same levels of security required of the Contractor under any Port Authority or PATH awarded contract.

(9) prohibit the publication, exchange or dissemination of PI developed from the project or contained in reports, except between Contractors and subcontractors, without prior approval of the Port Authority;

(10) require that PI only be reproduced or copied pursuant to the requirements set forth in the Handbook.

- Audits for Compliance with Security Requirements

The Port Authority and/or PATH may conduct random or scheduled examinations of business practices under this section entitled "NOTIFICATION OF SECURITY REQUIREMENTS" and the Handbook in order to assess the extent of compliance with security requirements, Protected Information procedures, protocols and practices, which may include, but not be limited to, verification of background check status, confirmation of completion of specified training, and/or a site visit to view material storage locations and protocols.

34. Construction In Progress

The Contractor recognizes that construction may be in progress at the Facility and may continue throughout the term of this Contract. Notwithstanding, the Contractor shall at all times during the term hereofmaintain the same standards of performance and cleanliness as prevails in non-affected areas as required by the standards hereunder.

35. Permit-Required Confined Space Work

Prior to commencement of any work, the Contractor shall request and obtain from PATH a description of all spaces at the facility which are permit-required confined spaces requiring issuance of an OSHA permit.

Prior to the commencement of any work in a permit-required confined space at a Port Authority facility requiring issuance of an OSHA permit, the Contractor shall contact the Superintendent/Manager to obtain a PATH Contractor Permit-Required Confined Space Notification form. The notification form must be filled out and submitted prior to commencing permit-required confined space work. All confined space work shall be performed in accordance with all applicable OSHA requirements. The Contractor shall provide its employees with a copy of its own company permit and shall furnish PATH with a copy of the permit upon completion of the work. The Contractor must supply all equipment required for working in aconfined space.

36. Signs

Except with the prior written approval of PATH, the Contractor shall not erect, maintain or display any signs or posters or any advertising on or about the Facility.

37. Vending Machines, Food Preparation

The Contractor shall not install, maintain or operate on the Facility, or on any other PATH property, any vending machines without the prior written approval of the Port Authority. No foods or beverages shall be prepared or consumed at the Facility by any of the Contractor's employees except in areas as maybe specifically designated by PATH for such purpose.

38. Confidential Information/Non-Publication

a. As used herein, confidential information shall mean all information disclosed to the Contractor or the personnel provided by the Contractor hereunder which relates to the Authority's and/or PATH's past, present, and future research, development and business activities including, but not limited to, software and documentation licensed to the Authority or proprietary to the Authority and/or PATH and all associated software, source code procedures and documentation. Confidential information shall also mean any other tangible or intangible information or materials including but not limited to computer identification numbers, access codes, passwords, and reports obtained and/or used during the performance of the Contractor's Services under this Contract.

b. Confidential information shall also mean and include collectively, as per *The Port Authority of New York & New Jersey Information Security Handbook (October 15, 2008, corrected as of November 14, 2013),* Protected Information, Confidential Proprietary Information, Confidential Privileged Information and information that is labeled, marked or otherwise identified by or on behalf of the Authority so as to reasonably connote that such information is confidential, privileged, sensitive or proprietary in nature. Confidential Information shall also include all work product that contains or is derived from any of the foregoing, whether in whole or in part, regardless of whether prepared by the Authority or a third-party or when the Authority receives such information from others and agrees to treat such information as Confidential.

c. The Contractor shall hold all such confidential information in trust and confidence for the Authority, and agrees that the Contractor and the personnel provided by the Contractor hereunder shall not, during or after

the termination or expiration of this Contract, disclose to any person, firm or corporation, nor use for its own business or benefit, any information obtained by it under or in connection with the supplying of services contemplated by this Contract. The Contractor and the personnel provided by the Contractor hereunder shall not violate in any manner any patent, copyright, trade secret or other proprietary right of the Authority or third persons in connection with their services hereunder, either before or-after termination or expiration of this Contract. The Contractor and the personnel provided by the Contractor hereunder shall not willfully or otherwise perform any dishonest or fraudulent acts, breach any security procedures, or damage or destroy any hardware, software or documentation, proprietary or otherwise, in connection with their services hereunder. The Contractor shall promptly and fully inform the Director/General Manager in writing of any patent, copyright, trade secret or other intellectual property rights or disputes, whether existing or potential, of which the Contractor has knowledge, relating to any idea, design, method, material, equipment or other matter related to this Contract or coming to the Contractor's attention in connection with this Contract.

d. The Contractor shall not issue nor permit to be issued any press release, advertisement, or literature of any kind, which refers to PATH (or the Port Authority as applicable) or to the fact that goods have been, are being or will be provided to it and/or that services have been, are being or will be performed for it in connection with this Agreement, unless the vendor first obtains the written approval of PATH (or the Port Authority as applicable). Such approval may be withheld if for any reason PATH believes that the publication of such information would be harmful to the public interest or is in any way undesirable

39. Time is of the Essence

Time is of the essence in the Contractor's performance of this Contract inasmuch as the Work to be performed will affect the operation of public facilities.

40. Holidays

The following holidays will be observed at the Site:

New Year's Day	Labor Day
Martin Luther King Jr. Day	Columbus Day
Presidents' Day	Election Day
Memorial Day	Veterans Day
Independence Day	Thanksgiving Day
	Christmas Day

This list is subject to periodic revision and the Contractor shall be responsible for obtaining all updated lists from the office of the Superintendent/Manager. If any such holiday falls on a Sunday then the next day shall be considered the holiday and/or if any such holiday falls on a Saturday then the preceding day shall be considered the holiday.

41. Personnel Standards

In addition to any specific personnel requirements that may be required under the clause entitled "Personnel Requirements" in the Specifications, the Contractor (and any Subcontractor) shall furnish competent and adequately trained personnel to perform the Work hereunder. If, in the opinion ofthe Superintendent/Manager, any employee so assigned is performing their functions unsatisfactorily, they shall be replaced by the Contractor within twenty-four (24) hours following the Contractor's receipt of the Superintendent/Manager's request for such replacement.

All Contractor's employees performing Work hereunder shall have the ability to communicate in the English language to the extent necessary to comprehend directions given by either the Contractor's supervisory staff or by the Superintendent/Manager's staff. Any employee operating a motor vehicle must have a valid driver's license.

The Contractor shall verify that employees working under this Contract in the United States are legally present in the United States and authorized to work by means of the federally required I-9 program

42. General Uniform Requirements for Contractor's Personnel

In addition to any specific uniform requirements that may be required by the Specifications, uniforms must be worn at all times during which the Services are being performed hereunder. The Contractor agrees that his/her employees will present a neat, clean and orderly appearance at all times. Uniforms shall include the Contractor's identification badge with picture ID bearing the employee's name. All uniforms, colors,types and styles shall be subject to the prior approval of the Superintendent/Manager. The Contractor will alsobe responsible for ensuring that its employees are wearing shoes appropriate for the tasks performed. The Superintendent/Manager shall have the right to require removal of any employee who shall fail to wear the proper uniform and shoes, and the exercise of this right shall not limit the obligation of the Contractor to perform the Services or to furnish any required number of employees at a specific location at the Site as specified.

43. Labor, Equipment and Materials Supplied by the Contractor

The Contractor shall, at all times during the performance of this Contract, furnish all necessary labor, supervision, equipment and materials necessary for the prompt and efficient performance of the Work, whether such materials and equipment are actually employed in the furnishing of the Work or whether incidental thereto.

All materials used by the Contractor in furnishing Work hereunder shall be of such quality as to accomplish the purposes of this Contract and the Services to be furnished hereunder in such manner so as not to damage any part of the Site.

PATH by its officers, employees and representatives shall have the right at all times to examine the supplies, materials and equipment used by the Contractor, to observe the operations of the Contractor, its agents, servants and employees and to do any act or thing which PATH may be obligated or have the right to do under this Contract orotherwise.

All equipment, materials and supplies used in the performance of this Contract required hereunder shall be used in accordance with their manufacturer's instructions.

Materials and supplies to be provided by the Contractor hereunder shall comply with OSHA and all applicable regulations.

44. Contractor's Vehicles – Parking - Licenses

At the discretion of the Superintendent/Manager, PATH may permit the Contractor during the effective period of this Contract to park vehicle(s) used by it in its operations hereunder in such location as may from time to time or at any time be designated by the Superintendent/Manager. The Contractor shall comply with such existing rules, regulations and procedures as are now in force and such reasonable future rules, regulations and procedures as may hereafter be adopted by PATH for the safety and convenience of persons who park automotive vehicles in any parking area at the Site or for the safety and proper persons who park automotive vehicles in any parking area at the Site or for the safety and proper identification of such vehicles, and the Contractor shall also comply with any and all directions pertaining to such parking which may be given from time to time and at any time by the Superintendent/Manager. Any vehicle used by the Contractor hereunder shall be marked or placarded, identifying it as the Contractor's vehicle.

45. Superintendent/Manager's Authority

In the performance of the Work hereunder, the Contractor shall conform to all orders, directions and requirements of the Superintendent/Manager and shall perform the Work hereunder to the satisfaction of the Superintendent/Manager at such times and places, by such methods and in such manner and sequence as

he/she may require, and the Contract shall at all stages be subject to his/her inspection. The Superintendent/Manager shall determine the amount, quality, acceptability and fitness of all parts of the Work and shall interpret the Specifications and any orders for Extra Work. The Contractor shall employ no equipment, materials, methods or staff or personnel to which the Superintendent/Manager objects. Upon request, the Superintendent/Manager shall confirm in writing any oral order, direction, requirement or determination.

The Superintendent/Manager shall have the authority to decide all questions in connection with the Services to be performed hereunder. The exercise by the Superintendent/Manager of the powers and authorities vested in him/her by this section shall be binding and final upon PATH and the Contractor.

PART III CONTRACTOR'S INTEGRITY PROVISIONS

1. Certification of No Investigation (criminal or civil anti-trust), Indictment, Conviction, Debarment, Suspension, Disqualification and Disclosure of Other Information

By bidding on this Contract, each Bidder and each person signing on behalf of any Bidder certifies, and in the case of a joint bid each party thereto certifies as to its own organization, that the Bidder and each parent and/or affiliate of the Bidder hasnot

a. been indicted or convicted in any jurisdiction;

b. been suspended, debarred, found not responsible or otherwise disqualified from entering into any contract with any governmental agency or been denied a government contract for failure to meet standards related to the integrity of the Bidder;

c. had a contract terminated by any governmental agency for breach of contract or for any cause based in whole or in part on an indictment or conviction;

d. ever used a name, trade name or abbreviated name, or an Employer Identification Number different from those inserted in the Bid;

e. had any business or professional license suspended or revoked or, within the five years prior to bid opening, had any sanction imposed in excess of fifty thousand dollars ($50,000) as a result of any judicial or administrative proceeding with respect to any license held or with respect to any violation of a federal, state or local environmental law, rule orregulation;

f. had any sanction imposed as a result of a judicial or administrative proceeding related to fraud, extortion, bribery, bid rigging, embezzlement, misrepresentation or anti-trust regardless of the dollar amount of the sanctions or the date of their imposition; and

g. been, and is not currently, the subject of a criminal investigation by any federal, state or local prosecuting or investigative agency and/or a civil anti-trust investigation by any federal, state or local prosecuting or investigative agency, including an inspector general of a governmental agency or public authority.

2. Non-Collusive Bidding, and Code of Ethics Certification, Certification of No Solicitation Based On Commission, Percentage, Brokerage, Contingent or Other Fees

By bidding on this Contract, each Bidder and each person signing on behalf of any Bidder certifies, and in the case of a joint bid, each party thereto certifies as to its own organization, that

a. the prices in its bid have been arrived at independently without collusion, consultation, communication or agreement for the purpose of restricting competition, as to any matter relating to such prices with any other bidder or with any competitor;

b. the prices quoted in its bid have not been and will not be knowingly disclosed directly or indirectly by the Bidder prior to the official opening of such bid to any other bidder or to any competitor;

c. no attempt has been made and none will be made by the Bidder to induce any other person, partnership or corporation to submit or not to submit a bid for the purpose of restricting competition;

d. this organization has not made any offers or agreements or taken any other action with respect to any Authority employee or former employee or immediate family member of eitherwhich would constitute a breach of ethical standards under the Code of Ethics dated March 11, 2014, or as may be revised, (a copy of which is available upon request) nor does this organization have any knowledge of any act on the part of an Authority employee or former Authority employee relating either directly or indirectly to this organization which constitutes a breach of the ethical standards set forth in said Code;

e. no person or selling agency other than a bona fide employee or bona fide established commercial or selling agency maintained by the Bidder for the purpose of securing business, has been employed or retained by the Bidder to solicit or secure this Contract on the understanding that a commission, percentage, brokerage, contingent, or other fee would be paid to such person or selling agency; and

f. the Bidder has not offered, promised or given, demanded or accepted, any undue advantage, directly or indirectly, to or from a public official or employee, political candidate, party or party official, or any private sector employee (including a person who directs or works for a private sector enterprise in any capacity), in order to obtain, retain, or direct business or to secure any other improper advantage in connection with this Contract.

g. no person or organization has been retained, employed or designated on behalf of the Bidder to impact any Port Authority determination with respect to (i) the solicitation, evaluation or award of this Contract, or (ii) the preparation of specifications or request for submissions in connection with this Contract.

The foregoing certifications in this Part III, Sections 1 and 2, shall be deemed to have been made by the Bidder as follows:

* if the Bidder is a corporation, such certification shall be deemed to have been made not only with respect to the Bidder itself, but also with respect to each parent, affiliate, director, and officer of the Bidder, as well as, to the best of the certifier's knowledge and belief, each stockholder of the Bidder with an ownership interest in excess of 10%;

* if the Bidder is a partnership, such certification shall be deemed to have been made not only with respect to the Bidder itself, but also with respect to each partner.

Moreover, the foregoing certifications, if made by a corporate Bidder, shall be deemed to have been authorized by the Board of Directors of the Bidder, and such authorization shall be deemed to include the signing and submission of the bid and the inclusion therein of such certification as the act and deed of the corporation.

In any case where the Bidder cannot make the foregoing certifications, the Bidder shall so state and shall

furnish with the signed bid a signed statement which sets forth in detail the reasons therefor. If the Bidderis uncertain as to whether it can make the foregoing certifications, it shall so indicate in a signed statement furnished with its bid, setting forth in such statement the reasons for its uncertainty. With respect to the foregoing certification in paragraph "2g", if the Bidder cannot make the certification, it shall provide, in writing, with the signed bid: (i) a list of the name(s), address(es), telephone number(s), and place(s) of principal employment of each such individual or organization; and (ii) a statement as to whether such individual or organization has a "financial interest" in this Contract, as described in the Procurement Disclosure policy of the Authority (a copy of which is available upon request to the ChiefProcurement Officer of the Procurement Department of the Authority). Such disclosure is to be updated, as necessary, up to the time of award of this Contract. As a result of such disclosure, the Port Authority shall take appropriate action up to and including a finding of non-responsibility.

Failure to make the required disclosures shall lead to administrative actions up to and including a finding of non-responsiveness ornon-responsibility.

Notwithstanding that the Bidder may be able to make the foregoing certifications at the time the bidis submitted, the Bidder shall immediately notify the Authority in writing during the period of irrevocability of bids and the term of the Contract, if Bidder is awarded the Contract, of any change of circumstances which might under this clause make it unable to make the foregoing certifications, might render any portion ofthe certifications previously made invalid, or require disclosure. The foregoing certifications or signed statement shall be deemed to have been made by the Bidder with full knowledge that they would become a part of the records of the Authority and that the Authority will rely on their truth and accuracy in awarding and continuing this Contract. In the event that the Authority should determine at any time prior or subsequent to the award of this Contract that the Bidder has falsely certified as to any material item in the foregoing certifications, has failed to immediately notify the Port Authority of any change in circumstances which might make it unable to make the foregoing certifications, might render any portion of the certificationspreviously made invalid, or require disclosure, or has willfully or fraudulently furnished a signed statement which is false in any material respect, or has not fully and accurately represented any circumstance with respect to any item in the foregoing certifications required to be disclosed, the Authority may determine that the Bidder is not a responsible Bidder with respect to its bid on the Contract or with respect to future bids on Authority contracts and may exercise such other remedies as are provided to it by the Contract with respect to these matters. In addition, Bidders are advised that knowingly providing a false certification or statement pursuant hereto may be the basis for prosecution for offering a false instrument for filing (see e.g. New York Penal Law, Section 175.30 et seq.). Bidders are also advised that the inability to make such certification will not in and of itself disqualify a Bidder, and that in each instance the Authority will evaluate the reasons therefor provided by the Bidder. Under certain circumstances the Bidder may be required as a condition of Contract award to enter into a Monitoring Agreement under which it will be required to take certain specified actions, including compensating an independent Monitor to be selected by the Port Authority, said Monitor to be charged with, among other things, auditing the actions of the Bidder to determine whether its business practices and relationships indicate a level of integrity sufficient to permit it to continue business with the Port Authority.

3. Bidder Eligibility for Award of Contracts - Determination by an Agency of the State of New York or New Jersey Concerning Eligibility to Receive Public Contracts

Bidders are advised that the Authority has adopted a policy to the effect that in awarding its contracts it will honor any determination by an agency of the State of New York or New Jersey that a Bidder is not eligible to bid on or be awarded public contracts because the Bidder has been determined to have engaged in illegal or dishonest conduct or to have violated prevailing rate of wage legislation.

The policy permits a Bidder whose ineligibility has been so determined by an agency of the State of New York or New Jersey to submit a bid on a Port Authority contract and then to establish that it is eligible to be awarded a contract on which it has bid because (i) the state agency determination relied upon does not apply to the Bidder, or (ii) the state agency determination relied upon was made without affording the Bidder the notice and hearing to which the Bidder was entitled by the requirements of due process of law, or (iii) the state agency determination was clearly erroneous or (iv) the state determination relied upon was not based on a finding of

conduct demonstrating a lack of integrity or violation of a prevailing rate of wage law.

The full text of the resolution adopting the policy may be found in the Minutes of the Authority's Board of Commissioners meeting of September 9,1993.

4. Contractor Responsibility, Suspension of Work and Termination

During the term of this Contract, the Contractor shall at all times during the Contract term remain responsible. The Contractor agrees, if requested by the Port Authority to present evidence of its continuing legal authority to do business in the States of New Jersey or New York, integrity, experience, ability, prior performance, and organizational and financialcapacity.

The Port Authority, in its sole discretion, reserves the right to suspend any or all activities under this Contract, at any time, when it discovers information that calls into question the responsibility of the Contractor. In the event of such suspension, the Contractor will be given written notice outlining the particulars of such suspension. Upon issuance of such notice, the Contractor must comply with the terms of the suspension order. Contract activity may resume at such time as the Port Authority issues a written notice authorizing a resumption of performance under the Contract.

Upon written notice to the Contractor, and an opportunity to be heard with appropriate Port Authority officials or staff, the Contract may be terminated by Port Authority at the Contractor's expense where the Contractor is determined by the Port Authority to be non-responsible. In such event, the Port Authority or its designee may complete the contractual requirements in any manner he or she may deem advisable and pursue available legal or equitable remedies for breach, including recovery of costs from Contractor associated with such termination.

5. No Gifts, Gratuities, Offers of Employment, Etc.

At all times, the Contractor shall not offer, give or agree to give anything of value either to a Port Authority employee, agent, job shopper, consultant, construction manager or other person or firm representing the Port Authority, or to a member of the immediate family (i.e., a spouse, child, parent, brother or sister) of any of the foregoing, in connection with the performance by such employee, agent, job shopper, consultant, construction manager or other person or firm representing the Port Authority of duties involving transactions with the Contractor on behalf of the Port Authority, whether or not such duties are related to this Contract or any other Port Authority contract or matter. Any such conduct shall be deemed a material breach of this Contract.

As used herein "anything of value" shall include but not be limited to any (a) favors, such as meals, entertainment, transportation (other than that contemplated by the Contract or any other Port Authority contract), etc. which might tend to obligate the Port Authority employee to the Contractor, and (b) gift, gratuity, money, goods, equipment, services, lodging, discounts not available to the general public, offers or promises of employment, loans or the cancellation thereof, preferential treatment or business opportunity. Such termshall not include compensation contemplated by this Contract or any other Port Authority contract. Where used herein, the term "Port Authority" shall be deemed to include all subsidiaries of the Port Authority.

The Contractor shall insure that no gratuities of any kind or nature whatsoever shall be solicited or accepted by it and by its personnel for any reason whatsoever from the passengers, tenants, customers or other persons using the Facility and shall so instruct itspersonnel.

In the event that the Contractor becomes aware of the occurrence of any conduct that is prohibited bythis section entitled “No Gifts, Gratuities, Offers of Employment, Etc.”, it shall report such occurrence to the Port Authority’s Office of Inspector General within three (3) business days of obtaining such knowledge. (See “http://www.panynj.gov/inspector-general” for information about to report information to the Office of Inspector General). Failing to report such conduct shall be grounds for a finding ofnon-responsibility.

In addition, during the term of this Contract, the Contractor shall not make an offer of employment or use confidential information in a manner proscribed by the Code of Ethics and Financial Disclosure dated March 11, 2014, or as may be revised (a copy of which is available upon request to the Office of the Secretary of the Port Authority).

The Contractor shall include the provisions of this clause in each subcontract entered into under this Contract.

6. Conflict of Interest

During the term of this Contract, the Contractor shall not participate in any way in the preparation, negotiation or award of any contract (other than a contract for its own services to the Authority) to which it is contemplated the Port Authority may become a party, or participate in any way in the review or resolution of a claim in connection with such a contract if the Contractor has a substantial financial interest in the contractor or potential contractor of the Port Authority or if the Contractor has an arrangement for future employment or for any other business relationship with said contractor or potential contractor, nor shall the Contractor at any time take any other action which might be viewed as or give the appearance of conflict of interest on its part. If thepossibility of such an arrangement for future employment or for another business arrangement has been or is the subject of a previous or current discussion, or if the Contractor has reason to believe such an arrangement may bethe subject of future discussion, or if the Contractor has any financial interest, substantial or not, in a contractor or potential contractor of the Authority, and the Contractor's participation in the preparation, negotiation or award of any contract with such a contractor or the review or resolution of a claim in connection with such a contract is contemplated or if the Contractor has reason to believe that any other situation exists which might be viewed as or give the appearance of a conflict of interest, the Contractor shall immediately inform the Chief Procurement Officer in writing of such situation giving the full details thereof. Unless the Contractor receives thespecific written approval of the Chief Procurement Officer, the Contractor shall not take the contemplated action which might be viewed as or give the appearance of a conflict of interest. The Chief Procurement Officer may require the Contractor to submit a mitigation plan addressing and mitigating any disclosed or undisclosed conflict, which is subject to the approval of the Chief Procurement Officer and shall become a requirement, as though fully set forth in this Contract. In the event the Chief Procurement Officer shall determine that the performance by the Contractor of a portion of its Services under this Agreement is precluded by the provisions of this numbered paragraph, or a portion of the Contractor's said Services is determined by the ChiefProcurement Officer to be no longer appropriate because of such preclusion, then the Chief Procurement Officer shall have full authority on behalf of both parties to order that such portion of the Contractor's Services not be performed by the Contractor, reserving the right, however, to have the Services performed by others and any lump sum compensation payable hereunder which is applicable to the deleted work shall be equitably adjusted by the parties. The Contractor's execution of this document shall constitute a representation by the Contractor that at the time of such execution the Contractor knows of no circumstances, present or anticipated, which come within the provisions of this paragraph or which might otherwise be viewed as or give the appearance of a conflict of interest on the Contractor's part. The Contractor acknowledges that the Authority may preclude it from involvement in certain disposition/privatization initiatives or transactions that result from the findings of its evaluations hereunder or from participation in any contract, which results, directly or indirectly, from the Services provided by the Contractor hereunder. The Port Authority’s determination regarding any questionsof conflict of interest shall befinal.

7. Definitions

As used in this section, the following terms shallmean:

Affiliate - Two or more firms are affiliates if a parent owns more than fifty percent of the voting stock of each of the firms, or a common shareholder or group of shareholders owns more than fifty percentof the voting stock of each of the firms, or if the firms have a common proprietor or general partner.

Agency or Governmental Agency - Any federal, state, city or other local agency, including departments, offices, public authorities and corporations, boards of education and higher education,public development corporations, local development corporations and others.

Investigation - Any inquiries made by any federal, state or local criminal prosecuting and/or law enforcement agency and any inquiries concerning civil anti-trust investigations made by any federal, state or local governmental agency. Except for inquiries concerning civil anti-trust investigations, the

term does not include inquiries made by any civil government agency concerning compliance with any regulation, the nature of which does not carry criminal penalties, nor does it include any background investigations for employment, or Federal, State, and local inquiries into tax returns.

Officer - Any individual who serves as chief executive officer, chief financial officer, or chief operating officer of the Bidder by whatever titles known.

Parent - An individual, partnership, joint venture or corporation which owns more than 50% of the voting stock of the Bidder.

If the solicitation is a Request for Proposal:

Bid - shall mean Proposal;
Bidder - shall mean Proposer;
Bidding - shall mean submitting a Proposal.

In a Contract resulting from the taking of bids:

Bid - shall mean bid;
Bidder - shall mean Bidder; except and until the Contract has been awarded, then it shall mean Contractor
Bidding - shall mean executing this Contract.

In a Contract resulting from the taking of Proposals:

Bid - shall mean Proposal;
Bidder - shall mean Proposer;
Bidding - shall mean executing this Contract.

BUY AMERICA CERTIFICATION (ROLLING STOCK)

A bidder or offeror must submit to the FTA recipient the Buy America certification (below) with all bids or offers on FTA-funded contracts, except those subject to a general waiver. Bids or offers that are not accompanied by a completed Buy America certification must be rejected as nonresponsive. This requirement does not apply to lower tier subcontractors.

CERTIFICATION REQUIREMENT FOR PROCUREMENT OF BUSES, OTHER ROLLING STOCK AND ASSOCIATED EQUIPMENT (ROLLING STOCK)

Certificate of Compliance with 49 U.S.C. 5323(j)(2)(C).

The bidder or offeror hereby certifies that it will comply with the requirements of 49 U.S.C. 5323(j)(2)(C) and the regulations at 49 C.F.R. Part 661.11.

Date _____

Signature _____

Company Name _____

Title _____

Certificate of Non-Compliance with 49 U.S.C. 5323(j)(2)(C)

The bidder or offeror hereby certifies that it cannot comply with the requirements of 49 U.S.C. 5323(j)(2)(C) and 49 C.F.R. 661.11, but may qualify for an exception pursuant to 49 U.S.C. 5323(j)(2)(A), 5323(j)(2)(B), or 5323(j)(2)(D), and 49 C.F.R. 661.7.

Date _____

Signature _____

Company Name _____

Title _____