ITEM OPPORTUNITY SYNOPSIS: Amtrak – 2015-2

TECHNICAL INFORMATION

Description of Item(s) Sought:
Brake Control Equipment – The brake control equipment includes all of the electronic, pneumatic and mechanical devices required to receive and process brake control commands received from the operator or train control system and to generate the appropriate response from the brake system devices to achieve the commanded braking effort. This equipment can be categorized into three major subgroups, pictured here, from top to bottom:

- Electronic Control Unit
- Pneumatic Brake Control Unit
- Brake Valves and Specialized Pneumatic Devices

The Electronic Control Unit contains the brake control electronics, while the Pneumatic Brake Control Unit contains the pneumatic valve manifold assemblies. Together, these two types of devices contain the majority of the brake control devices.

The Brake Valves and Specialized Pneumatic Devices category covers a number of independent devices which make up the remainder of the overall integrated brake system design. It includes items such as the operator’s brake control device (Master Controller), emergency vent valves, and other separately-mounted devices which are integral to the system operation but typically physically separate from the control units themselves.

End Product/System Application:
High Speed Passenger Trainsets

Product Class and Size:
Equipment described is designed and specified by the responsible friction brake system supplier/integrator to comply with the performance requirements of the specification, prevailing industry standards, safety-related government regulations, and the characteristics of the trainset design. The equipment is designed, manufactured and tested in accordance with the proprietary standards of each brake system supplier.

Item Materials and Likely Manufacturing Processes:
The typical configuration of the required equipment is depicted in Appendices A through C.

Electronic Control Units – As depicted in Appendix A, Electronic Control Units are typically configured as electronic control cards and power supplies.
configured into standard 19” control racks. The control rack frames are typically mounted in protected electrical enclosures or lockers in each vehicle’s interior, and are normally steel or aluminum construction. In addition to the normal brake control functions, other functions such as wheel slip/slide control and detection of non-rotating axles (locked axles) is also considered part of this control package and will be incorporated into one or several distinct electronics racks.

The detailed design of the electronics hardware, as well as the control logic and associated software, are the responsibility of the brake system supplier/integrator. Design, manufacture and testing of Electronic Control Units is highly specialized and considered proprietary information by the brake system suppliers.

Pneumatic Brake Control Units – A typical example of a Pneumatic Brake Control Unit is shown in Appendix B. The vehicle-mounted units consist of a machined aluminum block with precision-bored air passages and interface ports used to pneumatically interconnect a collection of pneumatic and electro-pneumatically controlled brake valves and sensors. The valves and related sensing devices are controlled by electrical commands from the Electronic Control Unit. The manifold-mounted control devices are typically fabricated from machined or cast aluminum. This manifold arrangement facilitates inspection and maintenance of the surface-mounted devices and minimizes interconnecting piping. In many cases, the manifold-mounted pneumatic brake control devices are separated into several functional manifolds to control each truck brake system independently, to package the wheel slide control valves independently, and/or to separate the trainlined charging and emergency venting devices.

The details of the brake manifold design required to meet the performance requirements of the specification are defined by, and the responsibility of, the brake supplier/integrator. Design, manufacture and testing of Pneumatic Brake Control Units is highly specialized and considered proprietary information by the brake system suppliers.

Brake Valves and Specialized Pneumatic Devices – This category covers the safety-critical / unique brake control devices that are part of the integrated brake system design but are not an integral part of the Electronic Control Unit or the Pneumatic Brake Control Unit described above. Key items included in this category are the Master Controller and the emergency venting valves. The Master Controller is the operator interface device that initiates train brake commands. The emergency venting valves are service-specific designed valves that initiate and pneumatically propagate emergency brake commands. Illustrations of typical devices of this type are included in Appendix C. Design, manufacture and testing of Brake Valves and Specialized Pneumatic Devices is highly specialized and considered proprietary information by the brake system suppliers.

This category does not include items that are not unique to passenger rail brake system designs and which are typically available from multiple sources. Examples include pneumatic piping, pneumatic hoses, fittings, standard shut-off valves and air reservoirs.

Summary of Technical Specifications and Performance Requirements:
The overall braking performance requirements of the trainset are included in Appendix D. Detailed performance requirements for the brake control equipment are defined by the friction brake system supplier/integrator in conjunction with the carbuilder. Key elements that are essential to defining the detailed requirements of these components include, but are not limited to, available space envelope, mounting provisions, clearance and weight limits, trainset weight, dynamic brake contribution, speed profiles, thermal limits and required duty cycles under normal and defined exceptional conditions.
BUSINESS INFORMATION

Estimate of Potential Business Volume (Number of Units per Year):
Assumptions: Eight (8) to twenty-eight (28) trainsets. Component quantities are shown for 9 and 11 four-axle vehicle trainsets. Components are produced over a 24 month period.

<table>
<thead>
<tr>
<th>Item</th>
<th>Totals for 9 Vehicle Trainset</th>
<th>Totals for 11 Vehicle Trainset</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8 TS</td>
<td>28 TS</td>
</tr>
<tr>
<td>Electronic Brake Control Units (ECU)*</td>
<td>72</td>
<td>252</td>
</tr>
<tr>
<td>Pneumatic Brake Control Valve Manifolds BCU(s) (Control Vehicles)</td>
<td>16</td>
<td>56</td>
</tr>
<tr>
<td>Pneumatic Brake Control Valve Manifolds BCU(s) (Trailer Vehicles)</td>
<td>56</td>
<td>196</td>
</tr>
<tr>
<td>Brake Valves and Specialized Pneumatic Devices</td>
<td>72</td>
<td>252</td>
</tr>
<tr>
<td>• Master Controller and Emergency PB/E3 Valve</td>
<td>16</td>
<td>56</td>
</tr>
</tbody>
</table>

* As noted previously, the ECU(s) and BCU(s) may be separated into more than one assembly.

** A typical ‘set’ is assumed to be one ‘No. 8 type’ vent valve, two emergency activation valves, and two ‘E-3 type’ vent valves. A 50% contingency is included in the below target price to include other unidentified items in this general category.

Target Price / Cost Information:

<table>
<thead>
<tr>
<th>Item</th>
<th>Est. Price*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic Brake Control Units</td>
<td>$50,000</td>
</tr>
<tr>
<td>Pneumatic Brake Control Valve Manifolds (Control Vehicles)</td>
<td>$25,000</td>
</tr>
<tr>
<td>Pneumatic Brake Control Valve Manifolds (Control Vehicles)</td>
<td>$10,000</td>
</tr>
<tr>
<td>Brake Valves and Specialized Pneumatic Devices (See** note above)</td>
<td>$1,700</td>
</tr>
<tr>
<td>• Master Controller and Emergency PB/E3 Valve</td>
<td>$26,000</td>
</tr>
</tbody>
</table>

*Prices shown are based on estimating tables for standard passenger railcar components used in the described application. Special design requirements to meet exceptional High-Speed Trainset requirements may be considerably higher. In addition, it is noted that the prices reflect production size procurements thus will necessarily be significantly higher for ongoing spares and maintenance replacement procurements.

Certification Requirements: The quality and certification requirements for these components are defined by the brake system supplier and considered proprietary.

OTHER NOTES

Other Information about supply that is noteworthy:

The brake system components addressed here are highly customized and unique to passenger rail vehicle applications. The brake system is considered safety critical and the brake system supplier is ultimately responsible for determining the design requirements necessary to comply with the vehicle performance specification, and in-turn specifying these requirements to the final internal or external component producers.
APPENDIX A: ELECTRONIC CONTROL UNIT

Electronic Control Unit
APPENDIX B: PNEUMATIC BRAKE CONTROL UNIT
Figure 10-3.1 (Sheet 2 of 4) Brake Control Unit Assembly
Figure 10-3.1 (Sheet 3 of 4) Brake Control Unit Assembly
Figure 10-3.1 (Sheet 4 of 4) Brake Control Unit Assembly
APPENDIX C: BRAKE VALVES AND SPECIALIZED PNEUMATIC DEVICES
Vent Valve Assembly w/ Pipe Bracket
Figure 10-5.7 E-3 Brake Application Valve
APPENDIX D: BRAKING SYSTEM PERFORMANCE REQUIREMENTS

8.12.i General Description

The brake Equipment shall be of a Service-Proven design. The Contractor shall provide a detailed description of the proposed braking System, identifying clearly those areas where developments are necessary to fulfill the requirements of the operating conditions of the Owner's System.

The brake System shall be capable of stopping a fully loaded Trainset from its maximum Operating Speed within the signal spacing existing on the track over which the train is operating, and/or within the given movement authority, under all operating conditions.

The design of the brake Equipment shall:

.a) Comply with the performance requirements detailed in this Specification and shall be in accordance with the Owner's Operating Plan.

.b) Comply with all proposed Tier III brake System criteria defined in 49CFR Part 238.731 and ETF_001-03 – Proposed Rule text for NPRM.

.c) Provide wheel slip/slide protection (WSP) for all traction and braking cases to limit wheel damage.

.d) Provide and display System monitoring and Fault indications.

In the case of partial or complete loss of Electric Brake, the friction brake shall be capable of achieving the desired speed reduction rates and maximum mandated stop distances under all operating conditions.

Loss of power or failure of the Electric Brake shall not result in exceeding the allowable stopping distance as defined in this Specification.

The friction brake alone shall be adequate to safely stop the train under all operating conditions defined in this Specification. The friction brakes shall be sized to permit the completion of the Trainset's trip, with friction brakes alone, after one emergency brake application at any location. On the Owner's network.

An Interface between friction brakes, Cab signal, alerter, ATC/PTC System, and train diagnostic and monitoring Systems shall be provided.

A redundant multi-master brake control configuration shall be provided. For the Trainset, 238 CFR 431 mandates an independent failure detection System that shall compare brake commands with brake System output to determine if a failure has occurred. At individual car level, beside the WSC (wheel slip control) element, the DNRA (detection of non-rotating axles) comes as a secondary brake control element, in case of a WSC failure.

The control of the braking System is Safety “Critical”. The brake control unit shall be configured for graduated release only; i.e. the brake system is designed to release (reduce) the brake cylinders pressure proportional to the brake pipe pressure rise, increment from brake full service to brake release condition.

The Trainset shall provide a continuous application of partial brake (e.g., on one Vehicle) during the brake test segment of the pre-departure test, sufficient to hold position at terminal stations. Particular attention shall be paid to the impact of degraded mode operation on this function.

Provisions shall be made to allow release of the Trainset parking brakes (e.g., spring applied, air released) using an independent means in emergency situations (i.e., Trainset stopped in a tunnel), when
the power from the Trainset batteries is not available...

The Trainset will operate on the existing NEC and consequently will be required to comply with existing stop distances up to an Operating Speed of 250 km/h (155 mph) refer to table below. The Contractor shall use the pertinent parts of 2008 HS RST TSI to determine service braking stop distances for speeds greater than 250 km/h (155 mph).

<table>
<thead>
<tr>
<th>Entry Speed</th>
<th>Maximum Stop Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>257.5 km/h (160 mph)</td>
<td>3400 m (11,154 feet)</td>
</tr>
<tr>
<td>241 km/h (150 mph)</td>
<td>2988 m (9,803 feet)</td>
</tr>
<tr>
<td>201 km/h (125 mph)</td>
<td>2075 m (6,808 feet)</td>
</tr>
</tbody>
</table>

Stop distances provided up to 250 km/h (155 mph) shall be met with full friction, Dynamic Braking capability, no allowances for degraded modes or degradation due to wheel adhesion and with a fully seated and crewed Trainset, ready to run, The Contractor's brake System and control scheme shall be in compliance with relevant parts of 49CFR Part 238 for Tier III operation.

The Contractor shall determine the emergency braking performance for the Trainset per 2008 HS RST TSI Section 4.2.4.1, Case A, for speeds up to 257.5 km/h (160 mph). Eddy current track braking is permissible for emergency braking purposes only.

8.12.2 Types of Brake Subsystems

The Trainset braking system shall utilize Electric Braking and friction braking to achieve the Specified Trainset braking rates and stopping distances.

Electric Braking may consist of Dynamic Braking, and, if proposed, eddy current braking. Eddy current track braking is prohibited on Amtrak’s infrastructure for service braking purposes for all speeds.

If tread brakes are not part of the Trainset friction brake design, alternative provisions shall be made to account for tread cleaning, as required to meet the Specified performance requirements.

The friction rake shall have sufficient capacity to brake the Trainset to a standstill from the maximum operating in emergency with all of the Electric Braking Systems inoperable. Other than increased wear of consumable components, there shall be no damage to the braking System as a result of such duty.

The Contractor shall demonstrate, through Analysis and testing, that the braking System does not exceed the thermal duty cycle of the brake components under any braking scenario, while respecting the maximum stop distance identified for safe operation.

Electric Braking shall be maximized as a percentage of the total Trainset braking effort required. For at least 90% of the time period over which braking is demanded, the brake force necessary to meet the Owner's Operating Plan shall be achieved without the use of friction brakes.

It shall be possible to test the application and release of the mechanical brakes from the driving Cab. The Contractor shall declare the application times for all braking modes.

The Contractor shall provide the control logic necessary to ensure smooth integration of the friction brake and wheel slip/slide Equipment and to coordinate electric and friction brake blending.

An "insufficient brake" detection circuit shall be provided on each Vehicle. The "insufficient brake" detection System shall be configured to detect actual levels of brake cylinder pressure and Electric Brake effort.
8.12.3 Protection of an Immobilized Train

It shall be possible to keep a train with a full load stationary for an unlimited period of time under normal operating conditions, i.e. air is available/compressor is working, on the maximum gradient to be encountered with the maximum operational brake cylinder pressure applied and without assistance from the parking brakes.

It shall be possible to hold a train with a full load stationary for an unlimited period on the maximum gradient to be encountered with parking brakes.

The parking brake shall be able to be applied and released by hand from the Operator’s Normal seated position in each Cab of the Trainset. Each Vehicle shall be equipped with a means to release the parking brake manually, preferably from the interior of the Trainset.

8.12.4 Power Management System

A power management System shall be provided to store and/or to dissipate Dynamic Braking energy when the OCS is non-receptive and the maximum amount of energy has been supplied to auxiliary loads.

Braking resistors, if used, shall be double insulated and sized for duty cycles without any dependency upon Regenerative Braking to dissipate all Dynamic Braking energy commanded by the brake management System. Power dissipating resistors shall be adequately ventilated to prevent overheating under worst-case operating conditions. Power dissipation grids shall be designed and installed with sufficient isolation to prevent combustion between resistor elements and combustible material.

8.12.5 Wheel Slip/Slide Protection (WSP)

A WSP shall be fitted to each Vehicle, having the role of reducing excessive wheel slide (resulting from brake applications) and wheel slip (resulting from traction applications) in situations where wheel/rail adhesion is temporarily impaired (e.g., inclement weather conditions, fouling of the rail), and of preventing wheels from locking. The Contractor shall outline the control philosophy for the WSP, which shall be redundant and act independently on all axles or Bogies under its control. The Contractor shall submit details describing how the WSP System has been designed for use at high speeds in the Owner's environment.

The function shall operate with all wheel sizes and shall maintain performance with degraded rail conditions. The WSP shall be interfaced with the sanding trainlines, if provided.

The design and operation of the WSP shall be submitted to the Owner for review and approval.

The Trainsets shall also be provided with rotation monitoring Equipment to detect locked axles and to indicate this condition in the operating Cab through an audible and/or visual alarm.

8.12.6 Emergency Brake Devices

The Trainsets shall be provided with emergency brake Devices, in each Cab and crew office, that can be used to initiate an emergency brake application. The Operator shall not be capable of releasing the brakes until the Trainset has come to a complete stop.

8.12.7 Passenger Brake Alarms

A passenger brake alarm shall be provided in the passenger compartment that initiates a retrievable penalty brake application, which uses a brake rate consistent with prevailing adhesion, passenger safety, and brake System thermal capacity. The Operator shall be capable of releasing the brakes to allow the Trainset to be stopped at a safe location.
8.12.8 Pre-Departure Test

Pre-departure brake tests shall be initiated by the Operator from the driving Ccib. Such tests shall also include WSP System tests.

8.12.9 Rescue Operations

The brake System design shall allow a disabled train's friction brakes to be controlled by a Rescue Vehicle, during a rescue operation. The Contractor shall be responsible for any Interface units that may be required between the Rescue Vehicle and the disabled Trainset. The Rescue Vehicle shall only be capable of supplying main reservoir pressure, and brake pipe pressure control (refer to Section 8.22).

8.13 DOOR SYSTEMS

8.13.1 General Requirements

Each passenger Vehicle shall have a minimum of 1 electrically controlled, power operated entrance door per side. Each doorway shall have minimum clear opening dimensions of 815 mm (32 inches) horizontal by 1880 mm (74 inches) vertical.

The side entry door System shall be designed and constructed such that no single point malfunction of door System components shall create an unsafe condition.