

## **THE SCHEDULE OF APPROVAL**

### **1. SYSTEM DESCRIPTION**

#### **1.1 Purpose**

The Interoperable Electronic Train Management System (I-ETMS®) is a vital, safety-critical, "overlay system" as defined in 49 CFR Part 236, Subpart I, Section 236.1015(e)(2), used in conjunction with existing methods of operations (e.g., CTC, INT, TWC-ABS, TWC-Non-Signaled) that interfaces to existing signal systems, wayside devices, and office train dispatching systems (CAD) via multiple communications links. I-ETMS provides the means to enforce compliance of movement authorities, speed restrictions, work zones, and switch positioning while retaining existing field signal system and CAD system functions as the primary means of maintaining train separation and protection. While I-ETMS provides the means to issue digitally transmitted authorities, this approval does not allow replacing existing written paperwork for authorities. This system is based on the Electronic Train Management System (ETMS®) basic platform developed by Wabtec Railway Electronics (WRE) which was originally approved by the Federal Railroad Administration (FRA) under 49 CFR Part 236, Subpart H, for use in revenue service on BNSF Railway (FRA-2006-23687-21), subject to certain conditions; and, more recently by FRA granting Type Approval Number FRA-TA-2011-0001 issued on June 15, 2011, for use of Configuration 6 of the system.

The I-ETMS system is designed to support different railroads and their individual methods of operations. It is intended to be implementable across a broad spectrum of railroads without modification. Customization for individual railroads is accomplished by modification of the value of a number of different variables which reflect individual railroad operations. This design approach supports interoperability across railroads as I-ETMS equipped locomotives apply consistent warning and enforcement rules regardless of trackage ownership.

#### **1.2. Main System Components**

The I-ETMS is made up of four unique segments: the Office Segment, the Wayside Segment, the Communication Segment, and the Locomotive Segment as further described in Interoperable Electronic Train Management System (I-ETMS®) Positive Train Control Development Plan (PTCDP) Version 2 dated June 1, 2011, and the specifications in Section 2:

##### **1.2.1 Office Segment**

The Office Segment is comprised of one or more Back Office Server(s) (BOS). It interfaces with other railroad back office systems or applications, the railroad dispatch system, and the Locomotive and Communications segments. The Office Segment serves as a conduit for information conveyed to the Locomotive Segment where the system's vitality resides. The Office Segment accepts mandatory directives and other information generated by the railroad's dispatching system and other railroad information systems, and provides it to the Locomotive Segment. The interface between the Office Segment and railroad dispatching and railroad information systems may be proprietary to a particular railroad. However, the Office Segment normalizes the operating data provided by a particular railroad's dispatching and information systems for exchange over an interoperable interface with the Locomotive Segment. In the current I-ETMS design, no safety-critical functions have been allocated solely to the

BOS. The Office Segment data delivery function is non-vital in the overall architecture as the vital Locomotive Segment protects itself from potential hazards caused by data delivery failures. The Office Segment provides a non-vital check of the reasonableness and integrity of data received from external sources and provides delivery of data to the Locomotive Segment; however, the Locomotive Segment provides a vital range check. The Office Segment utilizes commercial off-the-shelf operating systems and relational database management systems. In order to achieve high-availability, multiple hardware platforms are used to distribute load and provide fail-over.

### **1.2.2 Wayside Segment**

The Wayside Segment monitors and reports switch position, signal indications, or status of other monitored wayside devices directly to the Locomotive Segment and Office Segment using one or more radio networks. The Wayside Segment consists of traditional signaling equipment to which Wayside Interface Unit (WIU) function has been added. This signaling equipment is designed to be compliant with 49 CFR Part 236 Subparts A through G, and has been implemented such that they incorporate closed circuit principles consistent with § 236.5. Such appliances include interlocking controllers, signal controllers, switch circuit controllers, track circuits, track/route hazard detectors, or other field devices. Wayside Segment components may exist in either signaled or non-signaled territory.

Wayside device status may be provided through three different configurations:

- WIU-connected – a WIU is directly connected to a wayside device that publishes its status to the Locomotive and/or Office Segments via the Communications Segment;
- Office-connected –The wayside device status is forwarded to the Office Segment, which relays it to the Locomotive Segment;
- Cab Signals –the Locomotive Segment is capable of obtaining wayside device status through monitoring of the onboard cab signal system.

Hazard detectors may or may not be integrated with a signal system. When integrated with a signal system, a hazard detector will cause the attached track or signal control circuit to assume its most restrictive state upon detection of a potential hazard.

### **1.2.3 Communications Segment**

The Communications Segment provides the data communications between the Office segment, the Locomotive segment, and the Wayside segment. This provides the medium for back-office communications and peer-to-peer wayside communications. The Communication Segment provides for data transmission between the Office and Locomotive Segments, the Locomotive and Wayside Segments, and the Office and Wayside Segments. There are two primary methods of communication that are comprised of wired and wireless networks. Wireless networks are made up of narrowband networks (low data through-put and high propagation coverage) and broadband networks (high data through-put and low propagation coverage). These wireless networks are connected to wired networks at physical access points that are composed of multiple physical locals (e.g., base station locations and 802.11 access points).

Wireless networks that are planned as part of the initial deployment with I-ETMS include the following:

- 220MHz Private narrowband radio network (Interoperable standard). The frequency band of the radio will be 217.6 to 222 MHz divided in 5 kHz slices with a combination of TDMA and CDMA access. This radio configuration is required for interoperability.
- Broadband – Wi-Fi network infrastructure deployed by railroads.
- Cellular and satellite – Public wireless data networks.

Other communications network technologies the railroads already own such as 900 MHz ATCS radio networks or 44 MHz data radio networks may be used in its Communications Segment.

The messaging system, known as Interoperable Train Control Messaging or ITCM, is a messaging solution based upon open source software that has been customized to meet the requirements of I-ETMS. The architecture consists of redundant, scalable back office servers with messaging clients on remote assets, such as locomotives and wayside equipment. The ITCM is a loosely coupled, asynchronous message delivery system. Wayside, Locomotive, and Office applications communicate by simply addressing messages to one another and handing them off to the ITCM for delivery.

Messaging functions provided by the Communications Segment include the following:

- Asynchronous, connection;
- Quality of Service based network selection and bandwidth management;
- Message Queuing;
- Message Routing;
- Translation of application protocols to Communications Segment transport protocols;
- Mobility; and
- Multiple RF paths and supporting protocol adapters.

#### **1.2.4 Locomotive Segment**

The Locomotive Segment provides the interface into the relevant locomotive systems and interlocks the locomotive operations in connection with the other three segments to provide the requisite safety benefits. The Locomotive Segment onboard configurations consist of a single Train Management Computer (TMC), one or more Computer Display Unit (CDU), Router Switch Module, Electronic Air Brake Interface (EAB), Emergency Brake Interface, one or more GPS receivers, locomotive event recorder, and locomotive ID module.

The Locomotive Segment accepts movement authorities, temporary speed restrictions, other mandatory directives, train consist data, and other information from the Office Segment. Switch position and signal

indications may be directly received by the Locomotive Segment via Peer-To-Peer communication with the Wayside Segment. The Locomotive Segment interfaces with other locomotive devices including an event recorder, train line data sensors, the horn circuit, brake systems, cab signal system (if equipped), and the Communication Segment.

Multiple train control processing modules, executing identical application software, are used to perform all train control functions such as determination of current position, calculation of warning and braking distances, management of limits or restrictions conveyed by verbal or electronic mandatory directive or signal indication, management of off-board communications, and communication with the CDU. Graphical displays on the CDU reinforce situational awareness to promote compliance with movement authorities and speed restrictions in a safe manner.

The Locomotive Segment includes diagnostic capabilities to identify and report module-level failures. Failure reports are transmitted to the back office when possible and may be forwarded to the railroad's existing maintenance or monitoring systems to facilitate the issuance of repair or trouble tickets for critical faults and to prevent non-critical faults from degrading further. In the event of a critical failure, the Locomotive Segment would have to be manually cut-out to allow locomotive movement until the failure can be repaired.

The Locomotive Segment provides status information and position reports to the Office Segment and acknowledges messages received from the Office Segment.

## **2. DOCUMENTS AND DRAWINGS**

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document applies, including amendments.

**2.1** Interoperable Electronic Train Management System (I-ETMS®) Positive Train Control Development Plan (PTCDP) Version 2 dated June 1, 2011

**2.2** 49 CFR 234.211, "Grade Crossing Signal System Safety", Subpart D, "Maintenance, Inspection, and Testing Maintenance Standards", "Security of Warning System Apparatus" – December 5, 2005

**2.3** 49 CFR 229.135, "Railroad Locomotive Safety Standards", "Event Recorders" – January 15, 2010

**2.4** "BNSF Railway – Product Safety Plan" Version 2.1; October 12, 2006

**2.5** PTC Back Office Segment - Energy Management Interface Control Document (ICD), Version 1.0, December 2, 2010

**2.6** IEEE STD 1483-2000, "IEEE Standard for Verification of Vital Function in Processor-Based Systems Used in Rail Transit Control", IEEE Vehicular Technology Society, March 30, 2000

**2.7** Association of American Railroads (AAR S-9202), "ITC Wayside Interface Unit Requirements"

**2.8** Association of American Railroads (AAR S-9355), "Class C Messaging Specification"

**2.9** Association of American Railroads (AAR S-9356), "Class D Messaging Specification"

**2.10** Association of American Railroads (AAR S-9354), “Edge Messaging Protocol Specification”

**2.11** Association of American Railroads (AAR S-9352A), “ITC Locomotive-Office ICD”

**2.12** Association of American Railroads (AAR S-9352B), “ITC Wayside-Locomotive ICD

**2.13** Association of American Railroads (AAR S-9501), “PTC Data Management Architecture”

**2.14** Association of American Railroads (AAR S-9350), “ITC Message (ITCM) System Specification”

**2.15** Association of American Railroads (AAR S-61213), “Railroad Use of 802.11”

**2.16** Association of American Railroads (AAR S-9054), “I-ETMS Human Machine Interface (HMI) Standards Guide”

### **3. APPLICATION/LIMITATIONS/PROVISIONS**

#### **3.1 Application**

Properly implemented, I-ETMS as described in Section 2 of the PTCDP may be used to achieve PTC functionalities required by 49 CFR Part 236, Subpart I. Any deviations from this Type Approval without prior FRA approval invalidate this Type Approval for use as described in § 236.1015(c).

#### **3.2. Limitations**

**3.2.1** This Type Approval does not authorize operation of I-ETMS in revenue or revenue demonstration service without prior FRA approval.

**3.2.2.** This Type Approval does not authorize operation of I-ETMS for testing on the general rail system without FRA prior approval.

**3.2.3** Prior to the installation and use of I-ETMS on a subdivision where a guest railroad operates, formal written notification to the guest railroad is required. The guest railroad must acknowledge receipt of the notification and any conditions imposed. A completed copy of the notification and receipt is to be kept on file on the territory in question and available for inspection and duplication by the FRA during normal business hours. In the event of errors or malfunctions, the requirements of § 236.1023 shall apply.

**3.2.4** Electronic delivery of authorities to the crew by I-ETMS as the sole means of providing movement authorization is NOT approved until a method of providing visibility and interaction of authorities by all locomotive cab crewmembers that is satisfactory to FRA has been provided.

**3.2.5** All claims of a vital implementation of I-ETMS must be demonstrated to the satisfaction of FRA in the applicable railroad’s PTCSP submission. This Type Approval does not represent automatic approval of the I-ETMS system for vital applications. A system is an organized, purposeful structure regarded as a whole and consisting of interrelated and interdependent elements (components, entities, factors, members, parts etc.) that influence one another (directly or indirectly) to achieve a set of functional goals.

**3.2.6** Unless roadway workers are utilizing an EIC terminal which allows the EIC to control access of the train into and through the work zone, I-ETMS acknowledgement by the engineer of a verbal authority

from the EIC requires an acknowledgement, followed by a confirmation of the acknowledgement, before the locomotive is allowed to proceed into the work zone.

**3.2.7** No more than 5% of the cars in any I-ETMS train consist may have brakes known to be inoperative.

### **3.3 Provisions**

**3.3.1** I-ETMS Locomotive Segments shall utilize a single software executable configuration.

**3.3.2** I-ETMS systems will implement certain Concepts of Operations with common requirements for System Initialization, Wayside Beacons, and Systems Management.

**3.3.3** I-ETMS systems shall implement a common “look and feel” in regard to the Human-Machine Interface onboard the locomotive as specified in Document 2.4 above.

**3.3.4** I-ETMS systems shall utilize common data definitions and information relationships for track, wayside, and locomotive assets.

**3.3.5** I-ETMS systems shall utilize standardized interface protocols between the Wayside, Locomotive, and Back Office Segments.

**3.3.6** I-ETMS systems shall implement interoperable communication systems to enable the delivery of messages between assets owned by multiple railroads located in the Back Office, Locomotive, and Wayside Segments.

**3.3.7** I-ETMS system employing railroads shall share access to their 220 MHz Radio Base Stations with other railroads physically adjacent to their PTC operating territory.

## **4. TYPE APPROVAL VALIDITY**

**4.1** This Type Approval will remain valid if any component implementations are upgraded to a newer version as long as the manufacturer or railroad presenting this Type Approval notifies and receives FRA’s agreement that no change is introduced to the intended functionality and/or applicability of the named components. FRA will require a proof that newer versions of I-ETMS component design underwent a full safety engineering analysis, full regression testing if applicable, and meets all software safety criteria, and did not in any way compromise safety.

**4.2** Any significant modification to I-ETMS hardware and/or software components listed in Section 1.2 that changes the intended functionality and/or applicability of I-ETMS will require a new type approval.

**4.3** Any deviations from the documents and drawings listed in Section 2 and the supplementary conditions listed in Section 3 that introduces changes in I-ETMS system principle of operation or applicability will require a new type approval.

## **5. PRODUCTION SURVEY REQUIREMENTS**

**5.1** I-ETMS is to be manufactured and installed in accordance with the approved type described in this Type Approval. Conformance testing of the installed system must be done to assure that the system faithfully implements the specifications and meets the interoperability requirements. The documentation

on conformance testing of I-ETMS hardware/software must follow a standard format that includes the description of the product, condition to claim conformance, core profile, extension profile (if applicable), implementation defined features, alternative features (if applicable), reference implementation used, and conformance test suite used. All testing must comply with the requirements of § 236.1035.

**5.2** Railroads implementing PTC systems under the auspices of this Type Approval must demonstrate compliance with the requirements of § 236.1015(b).

**5.3** FRA reserves the right to attend and modify tests, conduct examinations of installation work, or perform relevant audits.

## **6. SYSTEM CERTIFICATION PROCESS FOR THE USERS OF THIS TYPE APPROVAL**

This Type Approval does not constitute System Certification for revenue operation. In order to obtain System Certification for the system designed and build using I-ETMS architecture under this Type Approval, the applicant referencing this Type Approval must fulfill all the requirements of § 236. 1015.

## **7. DISCLAIMER**

The United States Government nor any of their employees, makes any warranty, expressed or implied, including the warranties of merchantability and fitness for a particular purpose, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark,

manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government, and shall not be used for advertising or product endorsement purposes.

**End of Document**

---

## TYPE APPROVAL

This Type Approval is issued to attest that the following system meets the minimum regulatory performance requirements for Positive Train Control (PTC) systems required by Section 104 of the Rail Safety Improvement Act of 2008 (RSIA) and by 49 Code of Federal Regulations (CFR) Part 236, Subpart I.

System

**Interoperable Electronic Train Management System (I-ETMS)**

Type

**I-ETMS**

This Type Approval is not valid if presented without the full attachment schedule composed of seven sections.

**This Type Approval may expire 5 years from the date of issuance if at least one PTC system has not been issued a System Certification using the subject PTC system.**

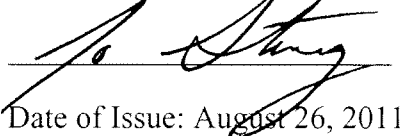
**For Federal Railroad Administration,**

At: 1200 New Jersey Ave, SE

Washington DC 20590

Jo Strang

Associate Administrator for Railroad Safety/Chief Safety Officer



Date of Issue: August 26, 2011

---

This Type Approval remains valid until the date 5 years from its issuance, unless canceled or revoked, subject to automatic and indefinite extension provided that at least one FRA PTC System Certification using the subject PTC system has been issued within that period and not revoked and the product remains satisfactory in service. This Type Approval will not be valid if the applicant makes any changes or modifications to the approved product, which have not been notified to, and agreed upon, by the Federal Railroad Administration.

---