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**TYPE APPROVAL**

This Type Approval is issued to attest that the following product 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 49 CFR Part 236, Subpart I.

System  
**Electronic Train Management System (ETMS)**  
Type  
**Configuration 6**

This Type Approval is not valid if presented without the full attachment schedule.

**For the Federal Railroad Administration**

At: 1200 New Jersey Ave SE

Washington DC 20590

Jo Strang

Associate Administrator for Railroad Safety/Chief Safety Officer

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Date of Issue: June 15, 2011

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This Type Approval remains valid unless canceled or revoked by FRA for cause. This Type Approval will not be valid if the applicant makes any changes or modifications to the approved system which have not been notified to, and approved by the Federal Railroad Administration.

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This certificate consist of 9 pages

## THE SCHEDULE OF APPROVAL

### 1. SYSTEM DESCRIPTION

- 1.2 Purpose** ETMS is a non-vital, safety-critical, “overlay system 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. 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 ETMS provides the means to issue digitally transmitted authorities, this approval does not allow replacing existing written paperwork for authorities.
- 1.3 Main System Components:** ETMS is made up of four unique segments: the Office segment, the Communication segment, the Wayside segment, and the Locomotive segment.
- 1.4 The Office Segment:** The Office segment consists of a CAD system that provides the train dispatcher the ability to generate electronic track authorities, manage relevant train operation information (e.g., train sheet, train consist, train schedules), and provides electronic management of track restrictions and work zone directives. The CAD system generates and maintains the required electronic datasets that support ETMS functionality. The Office segment includes the Transportation Support System (TSS application), Train Management & Dispatch System (TMDS) Back Office Safety Server (BOSS), Dynamic Data Distributor (D3) server, Communication Gateway Server, RF Net Monitor Server, Track Database Server, and Event Database Server.
- 1.5 The Communication 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, 802.11 access points). The ETMS wireless communication is based upon a MeteorComm low band VHF RF network using the MCC-545C and MCC 6100 SDR packet data radio in a “star” network configuration”. The D3 server end of each base station connection is presented as a TCP/IP socket to D3. The MCC-545C end of each connection is a 9600 baud serial connection.

The network uses proprietary MBNET200 protocols that define link, network, and transport layers. In the RF portion of the link, layers provide an error-free point-to-point communication channel. The link protocols support ARQ retransmission and

Reed-Solomon Forward Error Correction (FEC). Every 14 bytes of data are protected by a pair of CRC-16 bytes. In the non-RF portion of the network, link layer services are provided by TCP/IP.

All addressing within the network layer is by station ID. All applications, radios, and D3 servers have station IDs. Any station can address packets to any other station. D3 servers support source routing network addressing.

Locomotive Communications segment equipment includes:

2 Sinclair low-profile low-band VHF antennas and cabling; and

2 GPS antennas and cabling;

1 locomotive radio enclosure containing the following items:

2 MCC-6100 SDR radios;

2 low-band VHF notch filters;

2 72V-to-12V inverters to power MCC-6100 SDRs and terminal server;

1 Locomotive I/O PCA with CIMs;

1 miniature TCP/IP terminal server interface (TMC interface);

1 RS422 – RS232 converter (Wabtec fuel sensor interface);

1 802.11 antenna; and

Cabling

Wayside Communications segment equipment for signal sites includes:

1 ½ wave low band VHF antenna and cabling;

1 Polyphaser lightning arrestor;

1 DC/DC Wilmore converter;

1 Wayside Interface Module (WIM) PCA with CIM for 545C locations or RS232—modem card with data cable for 6100 SDR locations;

1 MCC-545C or MCC 6100 SDR radio; and

Cabling

Wayside Communications segment equipment for switch sites includes:

1 ½ wave low band VHF antenna and cabling;

1 solar panel;

1 Polyphaser lightning arrestor;

1 Lead acid battery (in locations using NEMA enclosure);

1 solar regulator;

1 Switch I/O or WIM PCA with CIM;

1 MCC-545C radio;

1 DC/DC Wilmore converter (in locations using signal shelter); and

Cabling

Locomotive to Office and Locomotive to Wayside communications correspond to two MCC 6100 SDR radios onboard the locomotive.

Wayside to Office and Wayside to Locomotive communications, the wayside uses one MCC-545C or MCC 6100 SDR radio located at the wayside.

Office to Locomotive and Office to Wayside communications, the D3 server selects the MCC-545C base station radios that have connections with the locomotives and waysides.

- 1.6 The Wayside Segment:** The Wayside segment includes all stationary wayside apparatuses that integrate into ETMS operations. These currently include hand-operated and power-operated switch position indicators, absolute signals, intermediate signals, operational and non-operational D-signals, and track integrity circuits. The wayside apparatuses provide detailed wayside status information to the Locomotive and Office segments (e.g., switch position, signal aspect, and rail continuity information). The Wayside segment application – either a Wayside Interface Module (WIM) or Switch I/O Printed Circuit Assembly (PCA) – interfaces with on-site signal, switch, or track circuit equipment by connecting through a proprietary synchronous serial port to the radio. Both PCAs host a device called the Configuration Information Module (CIM). The CIM is programmed with the MCC-545C or MCC-6100 radio configuration that defines the site. The WIM I/O PCA supports up to 32 discrete inputs. The Switch I/O PCA supports up to four analog inputs that are used for connections to a switch circuit controller used to detect switch position.
- 1.7 The 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 safety benefits. The Onboard Locomotive segment configurations consist of a single Train Management Computer (either TMC-300 or TMC-04), a single Computer Display Unit (CDU-300), and interfacing locomotive components (dedicated/isolated Ethernet LAN using the TCP/IP protocol, dedicated power supply, Electronic Air Brake Interface (ECI-300), and Locomotive ID module).

## **2. DOCUMENTS AND DRAWINGS**

- 2.1** Electronic Train Management System Product Safety Plan v3.1 May 21, 2010
- 2.2** Electronic Train Management System Product Safety Plan Change Document Version 1.1 July 13, 2010
- 2.3** Electronic Train Management System Product Concept of Operations Rev 2.6 May 21, 2010
- 2.4** Electronic Train Management System Operating Rules and Procedures Modification Version 2.1 May 21, 2010
- 2.5** Electronic Train Management System Product Safety Plan v3.1 Appendix A (Hazard Logs)
- 2.6** Electronic Train Management System Product Safety Plan v3.1 Appendix B Preliminary Hazard Assessment (PHA)

- 2.7 Electronic Train Management System Product Safety Plan v3.1 Appendix D Failure Modes and Effects Analysis (FMEA)
- 2.8 Electronic Train Management System Operations and Maintenance Manual Version 2.3 May 25, 2010

### 3. APPLICATION/LIMITATIONS/PROVISIONS

- 3.1 **Application:** ETMS Configuration 6 as described in Reference 2.3 and 2.4 may be used to achieve PTC functionalities required by 49 CFR Part 236, Subpart I when operated as defined in Reference 2.1 and 2.2, and with the following limitations and provisions.
  - 3.1.1 The ETMS system must be operated in accordance with reference 2.8. Operations must not exceed any operational limits established by testing, and under no circumstances may they exceed the manufacturer's design recommendations.
  - 3.1.2 ETMS Configuration 6 is not authorized for use by passenger trains with a consist above five cars or operating in excess of 79 miles per hour, and on trackage with mountain grade until completion of a passenger test program satisfactory to the FRA.
  - 3.1.3 ETMS is authorized for GE Dash-9 and GE Evolution locomotives.
  - 3.1.4 Prior to the installation and use of ETMS on a BNSF territory 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 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.
  - 3.1.5 ETMS is not authorized for use on grades that are 2% or greater until completion of a formal braking analysis and associated sensitivity study, acceptable to the FRA, that clearly demonstrates an acceptable level of risk in the event of ETMS brake application on the worst mountain grade for which operation is desired.
  - 3.1.6 ETMS is not authorized for use with consists exceeding the size, weight, or length previously tested without conducting satisfactory brake tests witnessed by FRA.
  - 3.1.7 Electronic delivery of authorities to the crew by 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 crew members that is satisfactory to FRA has been provided.
  - 3.1.8 No more than 5% of cars in any ETMS train may have brakes known to be inoperative.

**3.1.9** The PTC system must not take action on received authorities for train meets and passes in dark or ABS territory until completion of the meet or pass is confirmed by receipt of a voided track warrant.

**3.1.10** ETMS may use "43 MHz" (2 way land mobile) or "220 MHz" (Land Mobile, fixed, and maritime mobile) spectrum. Alternative bands solutions are allowable if an equivalent or better performance and reliability of radio transmission is proven. For the use of the alternative spectrums, prior FRA agreement is required, FCC certified equipment is required, and the requestor must show that they are a primary, as opposed to secondary, user in the proposed frequencies.

## **3.2 Provisions**

**3.2.1** The ETMS system must be operated in accordance with reference 2.8.

**3.2.2** In the event that more than 5% of cars in any ETMS train have brakes known to be inoperative, the dispatcher shall be informed. ETMS will be cutout and the train operated under the requirements of § 236.1029. The dispatcher will specifically inform the crew that a running brake test should be performed when safe to do so and that the displayed braking distances for warning and enforcement may not be valid. The communication will be logged by the dispatcher and the crew. During any subsequent crew change, the new crew shall be notified by the previous crew or dispatcher of this fact. This shall continue until the percentage of interoperable brakes has been reduced to or less than 5% and the dispatcher has been notified.

**3.2.3** Training for personnel must be provided with respect to the operational limits of the system, as well as any updates of BNSF Operating Rules and Special Instructions for the ETMS territory, will be completed prior to commencing ETMS operations on a territory. This training includes operating crewmembers (engineers, conductors, fireman, brakemen or the equivalent) dispatchers; signal, telecommunications, mechanical employees, supervisors, contractors; and any employee who will install and maintain onboard and field equipment. Satisfactory completion of this training will be documented in the individual's training record in an auditable form. This information will also be available on the territory for review and duplication by FRA during normal business hours. Changes to the locomotive engineer or conductor training are to be submitted as part of the next BNSF 49 CFR Part 240 filing. Training for crewmembers will include if and how each crewmember's role will change while operating ETMS equipped trains. Training for personnel involved in ETMS operation and maintenance will include normal operations, system failures, and other unusual situations that may arise because of ETMS operations.

**3.2.4** Prior to operation of ETMS on any BNSF subdivision, BNSF shall determine the accuracy of the location of any critical feature on that subdivision to be within 2.2 meters of the corresponding onboard database location. BNSF shall provide written certification to FRA that this performance specification has been met for each subdivision and that the information has been verified and validated prior to ETMS operation on that subdivision. In addition, all wayside interface inputs/

outputs shall be verified and validated prior to ETMS operation on any BNSF subdivision. BNSF shall provide written certification to FRA that this performance specification has been met for each subdivision and that the information has been verified and validated prior to ETMS operation on that subdivision.

- 3.2.5** A critical feature is defined as: all integer mileposts, all signals, all highway-rail grade crossings, all switches, all interlockings, all permanent speed restrictions, all track integrity and train detection circuits in non-signaled territory, all clearance point locations for every switch location installed on the main and siding tracks, and any inside switches equipped with switch circuit controllers throughout the ETMS territory being implemented. A certified copy of the results of this verification and validation are to be kept on file on each subdivision in an auditable form for review and duplication by FRA during normal business hours. FRA may elect, at their option, to witness, or cause to be witnessed, the track database verification and validation at any time.

FRA may require BNSF to demonstrate that the critical features have been properly mapped at any time.

- 3.2.6** Prior to operation of ETMS on any BNSF subdivision, BNSF shall determine the accuracy, upon discovery, of any problem that results in the issuance of a Category 1 or 2 software problem trouble report (priority 1/priority 2 software deficiencies), any rule violation caused by ETMS, or any other critical anomalies that cause ETMS to fail to function or indicate as required by 49 CFR Part 236 resulting in a more favorable aspect than intended or other condition hazardous to the movement of a train, BNSF shall report the instance to the Staff Director, Signal and Train Control Division, Office of Safety Assurance and Compliance, and the system shall be placed in cut-out mode on all trains that may be affected until resolution of the issue. Such reports shall be submitted following the same criteria and in the same fashion as the reporting of false proceed signal failures. This includes: report within 24 hours to the National Response Center by toll free telephone, number 800-424-0201, whenever the railroad learns of the occurrence of an accident/incident (as defined in 49 CFR § 225.5) arising from a critical anomaly; and, in any case, a report of a critical anomaly is to be submitted within 15 days on Form FRA F6180.14 - False Proceed Signal Report. Examples of critical anomalies that may affect the safety of train operations and are therefore reportable are:

Failure to enforce when enforcement was required by the system applying the brakes to either stop or slow the train, and it did not;

Overrun of authority boundaries where the system applies the brakes too late and the train stops past the required stop point;

Error in received authorities where the authority sent by the dispatcher is not what was received by the train, the train did not get the correct authority and the system failed to note it, or the system presented the wrong authority to the train at the wrong time. (Note: this does not include situations such as a lightning strike disabling a radio transmitter and

preventing the dispatcher from transmitting an authority to the onboard computer. However, the failure of the onboard computer to notify the engineer that it did not have any authorities in its system, regardless of the cause, would be a critical error. Another example, there may be times that the original authority may have been generated in error from the CAD system and received correctly by the onboard system. The authority is in error, but it would not be considered a critical error if the error is outside of the ETMS system, and the system worked as intended.)

Any ETMS system anomalies that may have a bearing on the safety or individual hazards identified are to be tracked for conformity with the mitigated hazard frequency rates as identified in reference 2.5, 2.6, and 2.7. FRA's acceptance of the various hazard rate estimates associated with ETMS is predicated upon the BNSF's continued installation and use of subsystems and components identified in the risk calculations or subsequently substituted with FRA knowledge in order to achieve desired safety or reliability. Individual hazards identified are to be tracked for conformity with the mitigated hazard frequency rates as identified in the ETMS PSP Version 3.1 Appendix A1 "ETMS Hazard Log".

Before recommencement of revenue service of the system following any critical anomaly, or any software or hardware modification of the system that may affect a safety-critical function, appropriate tests shall be satisfactorily conducted. The results of such tests, as well as a report detailing the anomaly or modification, the corrective action taken, the technical justification for that action, the regression testing accomplished, persons who witnessed the testing, the rationale for the testing selected, and the relationship of the anomaly or modification to the assumptions made, must be available for inspection by FRA during normal business hours. The Staff Director, Signal and Train Control Division, Office of Safety Assurance and Compliance may, at his or her discretion, require any testing to be witnessed by an FRA Test Monitor.

#### **4. TYPE APPROVAL VALIDITY**

- 4.1** This certificate remains valid if any upgrades are performed by BNSF to ETMS Configuration 6 components provided BNSF notifies and gets 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 ETMS components underwent full regression testing, met all software safety criteria, and did not in any way compromised safety.
- 4.2** Any significant modification to hardware and/or software components listed in Section 1.2 that changes the intended functionality and/or applicability invalidate this Type Approval.
- 4.3** Any deviations from the documents and drawings listed in Section 2 and the supplementary conditions listed in Section 3 that introduce changes in ETMS



Configuration 6 system principle of operation or applicability invalidate this Type Approval.

## **5. PRODUCTION SURVEY REQUIREMENTS**

- 5.1** ETMS is to be manufactured and installed in accordance with 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 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.
- 5.2** BNSF must provide, when requested by FRA, a copy of the Positive Train Control Vendor List (PTCVL) required by § 236.1015(b)(1).
- 5.3** BNSF must also maintain in auditable form and provide during normal business hours documentation, acceptable to the FRA, that each supplier from which they are procuring PTC system equipment has established and can maintain a quality control system as required by § 236.1015(b)(2)
- 5.4** When the verification of the outputs of any components that provide safety-critical information to the ETMS system shall be conducted (e.g., when components are installed, and thereafter when a change in the subject component is made, the component becomes disarranged, or at least once every two years, whichever shall occur first) a signed copy of the results of this verification are to be kept on file on the subdivision in question in an auditable form available for review and duplication by FRA during normal business hours in accordance with § 236.1037.
- 5.5** The Federal Railroad Administration reserves the right to attend test and examinations of installation work or perform relevant audits.

## **6. 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**