TECHNOLOGY MANAGEMENT
ANNEXURE *A* TO SPECIFICATION

SPECIFICATION BBB1776 VERSION 3
EOT PROTOCOL CHANGES AND CLARIFICATION

INTRODUCTION

TFR specification BBB 1776 for End of Train devices (EoT's / "Telemeters") makes use of the Association of American Railroads' standard S-5701 *as basis* for the communication protocols between the front and rear units, *but also* specifies additional and slightly different requirements as necessitated by TFR's unique / local circumstances.
This document therefore serves to define the extra two "GPS" data blocks required by TFR and to clarify minor changes and additions to AAR S5701 protocol details, in an attempt to minimize possible mis-interpretations.

A Message Format: Rear to Front Communication

1. "BASIC" Message Block per AAR S-5701 Para. 3.7.1.

1.1 The AAR message block shall be structured as per the format of AAR S-5701 3.7.1.

1.2 For clarification & confirmation, the fields for this block will be as follows:

Field	Bits	Compliance	Clarification
Bit Sync	69	AAR S-5701 2.3.6.1	Shall always start with a "0" bit, such as: bit 1 <010101 ….. 01010 > bit 69
Frame Sync	11	AAR S-5701 2.3.6.1	Send as specified MSD <01001000111> LSD
Chaining Bit	2	AAR S-5701 2.3.6.2	Send as specified
Device Battery Condition	2	AAR S-5701 2.3.6.3	Send as specified
Message Type	3	AAR S-5701 2.3.6.4	000 = Indicates positive air ***pressure*** 111 = Rear Brake ARM request 101 = Indicates ***vacuum***
Rear Unit Address Code	17	AAR S-5701 2.3.6.5	Send as specified
Rear Brake Pipe Status & Pressure	7	AAR S-5701 2.3.6.6	Unsigned binary integer Air Brakes : 0 to125 psig. Vacuum Brakes : 0 to -99 Kpa

Spare	1	Spare	**Not** to be used without TFR approval
% Battery Charge Used	7	AAR S-5701 3.7.2.3	Send % battery charge depleted. "0000000" = Fully charged (e.g. 12.8V) "1100100" = Fully depleted (e.g. 10.8V) Calculations must be based on 40hour standby.
Valve Circuit Status	1	AAR S-5701 3.7.2.1	To be used for RBA confirmation
Confirmation Indicator	1	AAR S-5701 3.7.2.2	Send as specified
Air Turbine / Generator Equipped	1	AAR S-5701 2.3.6.9	Send as specified *This only indicates "Air Turbine Equipped". Battery condition & -status must be used to determine whether Air Turbine has failed or not.*
Motion Detection	1	AAR S-5701 2.3.6.8	Send as specified
Spare	1	Spare	**Not** to be used without TFR approval
Marker Light Status	1	AAR S-5701 2.3.6.10	Send as specified
Basic Block BCH Code	18	AAR S-5701 2.3.6.11	Send as specified
Trailing Bit	1	AAR S-5701 2.3.6.12	Send as specified
Total Length	**144**		

NOTE: The blocks are sent starting with the Bit Sync and ending with the Trailing Bit, sending LSB first for each field as defined by the AAR.

Battery Status: The accuracy of "% battery charge depleted" which is transmitted, shall be such as to enable the CU to display the "Remaining Battery Hours" to an acceptable accuracy (+/- 10%).

When sent from a Repeater, the Trailing Bit shall be "0".

2. First Additional "GPS Latitude" Data Block per BBB1776:

Field	Bits	Description	Clarification
Bit Sync	69	AAR S-5701 2.3.6.1	Shall always start with a "0" bit such as: bit 1 <010101 ….. 01010> bit 69. The "0" bit shall be sent directly after the AAR block trailing bit.
Frame Sync	16	Use the AAR S-5701 2.3.6.1 frame sync by padding with "**01010**"	MSD > 0100100011**01010** > LSD
Chaining Bit	2	AAR S-5701 2.3.6.2	Send as specified
Manufacturer's Code	2	A 2 Bit Code "00" to identify the manufacturer	"00" = EMS Industries "01" = Inteletrack
Message Format	4	This is a 4 bit message "**0001**" identifying the block	**"0001" = Latitude block** "1000" = Longitude block New values to be approved by TFR.

Latitude (GPS)	32	Floating point number	MSD<XYYYYYYYYTTTTTTTTTTTTTTTTTTTTTTT>LSD X = 1 bit indicating Sign Y = 8 bit Exponent T = 23 bit Mantissa.
Speed (GPS)	8	Unsigned binary integer	0 to 255 km/h GPS speed e.g. MSD <00110111> LSD = 55km/h
Time (GPS)	8	Unsigned binary Integer	0 to 59 seconds GPS seconds e.g. 0 sec MSD<00000000>LSD to 59 sec MSD<00111011>LSD
CRC	16	16bit CCIT standard	X^16 + X^12 + X^5 + 1 Initial value = FFFFh CRC includes all bits between Frame Sync up to and including Time. Trailing bit excluded
Trailing Bit	1	AAR S-5701 2.3.6.12	
Total Bits	**158**		

NOTE: The blocks are sent starting with the Bit Sync and ending with the Trailing Bit, sending LSB first for each field.

All GPS data such as Latitude, Speed & Time are sent as zeros if there is no GPS fix.

3. Second Additional "GPS Longitude" Data Block per BBB1776:

Field	Bits	Description	Clarification
Bit Sync	69	AAR S-5701 2.3.6.1	Shall always start with a "0" such as: bit 1 <010101 ….. 01010> bit 69. The "0" bit shall be sent directly after the Latitude block trailing bit.
Frame sync	16	Use the AAR S-5701 2.3.6.1 frame sync by padding with "**01010**"	MSD > 0100100011101010 > LSD
Chaining bit	2	AAR S-5701 2.3.6.2	Send as specified
Manufacture code	2	A 2 bit code "00" to identify the manufacturer	00 = EMS Industries 01 = Inteletrack
Message format	4	This is a 4 bit message "**1000**" identifying the block	MSD<0000>LSD = Latitude block **MSD<1000>LSD = Longitude block** New values to be approved by TFR.
Longitude (GPS)	32	Floating point number	MSD<XYYYYYYYYTTTTTTTTTTTTTTTTTTTTTTT>LSD X = 1 bit indicating Sign Y = 8 bit Exponent T = 23 bit Mantissa.
Odometer	16	Unsigned binary Integer	0 to 65536 meters since last reset MSD < 0000000000000001 > LSD

Odometer (Cont'd)			1. The Odometer is updated every second by calculating distance from the GPS speed. 2. If the time elapsed is between 1 and 10 seconds, the speed at that moment is multiplied by the seconds elapsed. 3. If the time elapsed is > 10 sec, the latest latitude & longitude coordinates are used to update the Odometer. 4. The Odometer only counts UP. 5. When the speed is zero software must filter out the "jitter" to prevent Odometer counting up / incrementing. 6. The Odometer must overflow to zero. 7. The Odometer must reset when the rear unit is horizontal
CRC	16	16 bit CCIT standard	X^16 + X^12 + X^5 + 1 Initial value = FFFFh CRC includes all bits between Frame Sync up to and including Odometer. Trailing bit excluded
Trailing Bit	1	AAR S-5701 2.3.6.12	Send as specified
Total Bits	**158**		

NOTE: The blocks are sent starting with the Bit Sync and ending with the Trailing Bit, sending LSB first for each field.

All GPS data such as Latitude, Speed & Time are sent as zeros if there is no GPS fix.

The Latitude and Longitude blocks shall always be attached to the AAR block.

B Message Format: Front to Rear Communication

1. The RBA message transmitted by the front (Cab) unit shall be per AAR S-5701 section 3.9, with special reference to paragraphs 3.9.6 & 3.9.7.

2. The Rear Unit must only respond to the Status Update Request (Paragraph 3.9.8.6.1) if AT LEAST ONE of the three 63 bit data blocks is received correctly (error free).

3. The Rear Unit must only execute the Emergency Brake Application (Paragraph 3.9.8.6.2) if AT LEAST ONE of the three 63 bit data blocks is received correctly (error free).