EMC & The Rail & Transit Industry

“A Growing Awareness”

Presented By:

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Outline

- Some History
- Trends & New Systems of Importance
- The EMI Model, Challenges & EMI Problems
- Typical EMC Compliance Programs
- Utilized Standards
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Some History
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- Very Electro Mechanical Device Dependent
- “Big Motors and Big Relays”
- And very reliable (something to remember moving forward)
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Signal System Simple & Effective

Three Aspect Automatic Block System

- Insulated Joint
- Direction of Train ➔
- Stopping distance from maximum speed
- Each block has an independent track circuit
Basic Track Circuit
SHOWING CLEARTRACK

- Insulated Joints
- Rails
- Track Battery
- Armature
- Coils
- Circuit for Green Lamp
- Circuit for Red Lamp
- Track Relay
- Track Circuit
- Resistor
- Insulated Joints

DIRECTION OF TRAVEL →

Signal Battery
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The brains behind a signal system may be many miles from the hardware in the field. Banks of relays are required to make a signal system work. Some relays generate codes; others send commands to signals, switches, and other equipment in the field. Although modern signal-control equipment has been moving toward solid-state components, the proven reliability of traditional relays still makes them preferred equipment in many situations. Relays can function reliably for decades with minimal maintenance. Brian Soloman
Early Improvements

Cab Signaling

- Established in the late 1920’s
- Brought the signals into the cab
- Eventually matured into a speed control system
- Still in use today
- Signal code inductively coupled from the track circuits to sensors on the locomotive
Cab signals have several benefits, including continuous signal visibility to a locomotive engineer, which greatly reduces the chance of a wayside signal being overlooked or misread. It gives the locomotive engineer peace of mind while constantly reminding him of the speed he should be traveling. In this case, a Metro-North GENESIS locomotive engineer is running on Rule 106, “Medium Cab.” The cab signal indicator is the vertical white box on the beam between the windshields to the engineer’s left. **Inset:** A Metro-North cab signal displays rule 105, “Limited Cab,” which indicates “proceed at limited speed” (45 mph). With MN cab signals, engineers are not provided with route information and are expected to operate their trains in accordance with the speed dictated by cab signal aspects. In most places, the only wayside signals are at interlockings and terminals.  

*Patrick Yough*
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While Effective It Is The Problem

The Blocks Are Fixed
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New Systems of Importance & Technological Trends
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Solutions to “Fixed Blocks”

- Positive Train Control
- Communications Based Train Control
Positive Train Control

A wireless train control system which controls “movement authority” ensuring train separation and collision avoidance, providing speed restriction enforcement.

(Most Based on GPS Technology)
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Communication Based Train Control

An automated control system for railways that ensures safe operation of rail vehicles using data communications between various control entities that make up the system
Ongoing Technological Improvements

Trains Jan. 2009

FRA issues rules on ECP brakes

On Oct. 15, the Federal Railroad Administration issued a final rule on electronically controlled pneumatic brakes that establishes performance requirements and encourages implementation. ECP technology provides simultaneous and graduated application and release of brakes on all cars in a train, resulting in shorter stopping distances and enabling railroads to run longer trains that can operate at faster speeds.
Ongoing Technological Improvements

Trains  Feb 2009
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The EMI Model, Challenges & EMI Problems
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THE BASIC MODEL

SUBWAY TRAIN

THIRD RAIL

POWER

COMMO

SIGNAL
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“EMI ON-THE-RAILS”

LIGHTNING

SUBWAY TRAIN

THIRD RAIL

POWER

COMMO

SIGNAL

“OTHER COMMO”

ARC WELDING
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EMI Problems

- Display Monitors in NYC Financial District being impacted by passing NYC Subways.
- New Electronic Speed Controls on Light Rail cars interference with signaling circuits.
- Power transfer switches being tripped with walkie talkies
Metro set to fix doors on oldest, 'uncrashworthy' rail cars

By: Kytja Weir
Examiner Staff Writer
September 23, 2009

Metro is planning to spend more than a half-million dollars and take more than two years to upgrade the doors of a series of rail cars that federal investigators told the transit agency to get rid of three years ago.

The agency needs to hire Alstom, which made the cars' automatic train controls, to add some hardware to stop electromagnetic interference that caused the doors to open when running in automatic mode, he said. The trains have been operating manually since the crash.
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EMI Challenges

- Harsh industrial environment – vibration, metal dust, salt fog, urban issues
- Many known radiators – police & fire communications, arc welding, ISM issues on or near the property
- Ongoing maintenance issues that can defeat EMI controls, such as proper grounding and shielding
- Lack of EMI awareness
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What has the industry done?

- National Associations (AREMA) has become more active and established committee and is involved in standards writing activities
- FRA also involved with Federal Rule Making
- The American Public Transportation Association (APTA) has developed a standard for EMC Compatibility Plans
- BUT NYCT has been in the lead.
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Typical NYCT EMC Compliance Program:

Based in:

- “Forced” Awareness
- Site Surveys
- Laboratory Testing
- On Site Compliance or Compatibility Testing
- Education
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Forced Awareness:
- Assignment of a EMC Project Engineer
- Development of EMC Documentation
  1. Management Plans
  2. Implementation Plans
  3. Control Plans
  4. Grounding, Shielding, Filtering Plans
  5. Site Survey, Laboratory & Final Compatibility Test Procedures
Site Surveys

Site Surveys are performed primarily for use in evaluating and potentially modifying laboratory test limits.

Both Radiated and Conducted Measurements are taken
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Typical Site Survey Test Setup
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Typical Site Survey Test Setup
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Laboratory Testing

Testing has been based in three areas:

- Mil-Std-461E (Army Ground Support)
- FCC Part 15
- IEC ESD Testing
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Typical Mil-Std Test Setup
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On-Site Compliance/Compatibility Testing

Based Primarily on the compatibility of the installed systems with various forms of NYCT and "other" communications
Forms of Communications Used:

- NYCT Maintainers Radios
- Traditional Cell Phones
- “Potentially” Police and Fire Radios
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Figure 1 - General Test Setup

NOTE: During actual testing, all cabinet doors were open.
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### Typical Final Compatibility Test Frequencies

<table>
<thead>
<tr>
<th>OPERATING FREQ (MHz)</th>
<th>MODEL NO.</th>
<th>MANUFACTURER</th>
<th>DESCRIPTION</th>
<th>POWER OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>154</td>
<td>MT1000,33GCU7100AN</td>
<td>MOTOROLA</td>
<td>VHF COMMUNICATIONS</td>
<td>5.0 W</td>
</tr>
<tr>
<td>460 - 470</td>
<td>JBX-455</td>
<td>RITRON</td>
<td>UHF COMMUNICATIONS</td>
<td>5.0 W</td>
</tr>
<tr>
<td>806 - 825</td>
<td>i90c</td>
<td>NEXTEL</td>
<td>CELL PHONE iDEN MODULATION</td>
<td>0.6 W</td>
</tr>
<tr>
<td>806 - 821</td>
<td>MTX 8250</td>
<td>MOTOROLA</td>
<td>UHF COMMUNICATIONS</td>
<td>2.5 W</td>
</tr>
<tr>
<td>1900</td>
<td>VI660</td>
<td>SAMSUNG</td>
<td>CELL PHONE DIGITAL</td>
<td>0.293 W</td>
</tr>
<tr>
<td>2400</td>
<td>27925GE3-A</td>
<td>GENERAL ELECTRIC</td>
<td>WIRELESS PHONE SPREAD SPECTRUM</td>
<td>0.05 V/M @ 1 meter</td>
</tr>
<tr>
<td>5800</td>
<td>25838GE3-A</td>
<td>GENERAL ELECTRIC</td>
<td>WIRELESS PHONE SPREAD SPECTRUM</td>
<td>0.5 V/M @ 1 meter</td>
</tr>
</tbody>
</table>
### Typical Test Points For Final Compatibility Testing

<table>
<thead>
<tr>
<th>Test Surface</th>
<th>6 Inch Scan</th>
<th>1 Foot Scan (If necessary)</th>
<th>1 Meter Scan (If necessary)</th>
<th>Threshold Distance (If necessary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Code Cabinets</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PC Cabinets</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UPS Racks</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintainers Panels</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Transfer Panels</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Racks</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ground Detector Racks</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master Tower Control Panel</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Rail Indication Panel</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trouble Indication Panel</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dispatcher Indication Panels</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
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A Quick Comment on Locomotives & Powered Units

Urban Mass Transit Association (UMTA) Standards

- Track and Radiated Measurements to ensure no interference with track circuits and wayside

- “Of late” include Final EMC Compatibility Testing with Communications Equipment
Education:

- There is an EMC educational component in each and every NYCT signal equipment upgrade contract.
- It mandates training for both NYCT and Vendor personnel.
2.9 EMI/EMC Training Course

a. The EMI/EMC engineer or his approved representative, shall conduct a course on EMI/EMC control, design and the EMI/EMC requirements, to designated personnel of each of the organizations performing design work and installation work on this Contract and 35 Authority personnel.

b. The EMI/EMC engineer or his approved representative, shall conduct a two (2) day course on Testing and Certification of Wireless Devices given by National Technical Systems, to designated personnel of each of the organizations performing design and installation work on this Contract and 35 personnel from the Authority.

c. The Course shall be conducted on two days, one day for the Authority personnel and one day for the Contractor personnel. The course shall be given at a Contractor provided location within New York City, within 120 days after the notice of award.

d. The training program shall consist of all major topics that are included in the EMI/EMC Compliance Program. Furnish four (4) instructor’s guides for NYCT’s future training requirements in accordance with Sections 17C and 17V. Furnish a participant’s guide to every attendee in accordance with Sections 17C and 17V. The instructor shall use audio/visual training aids, as well as lecturing the trainees. The training session shall also include hands-on training for all specialized equipment and procedures required to perform EMI/EMC field and laboratory testing.

d. The Contractor shall furnish training in accordance with Sections 17C and 17V. The Contractor’s attendance list, location and dates of the course shall be submitted with the EMI/EMC Compliance Program for approval of the Engineer.
2.10 EMI/EMC Video

a. The Contractor shall prepare a thirty (30) minute video DVD on EMI/EMC fundamentals. The training video shall explain:

1. The dangers of no EMI control.
2. Threats from electronic terrorism.
5. EMI/EMC Program Requirements:
   - EMC Management
   - EMC Control
   - EMC Implementation
   - EMC Testing
   - EMC Grounding
   - EMC Cable Routing
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Some Closing Thoughts:

1. Economic, Cultural and Regulatory Needs will continue to pressure the Rail and Transit sector.

2. Technology will continue to impact this industry sector as the need for improved technology increases.

3. EMC “issues” will continue to grow, however awareness will also grow.
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Some Recommended Reading:

*Railroad Signaling*
*By: Brian Solomon*
*MBI Press*

A Recommended Course: (3 day)
*Engineering Fundamentals of Rail Transit Passenger Systems: Light Rail, Commuter Rail, Rapid Transit*

*University of Wisconsin, Madison*
*Department of Engineering Professional Development*
Thank You!!!

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