

SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

SEPTA's Broad Street Subway Propulsion Control Box Retrofit

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2013 Rail Conference



Railroad Joke

**How many railroad enthusiasts
does it take to change a light
bulb?**

**No, NO!!! Not until I get a picture
of the old one!!!**




Paper Overview

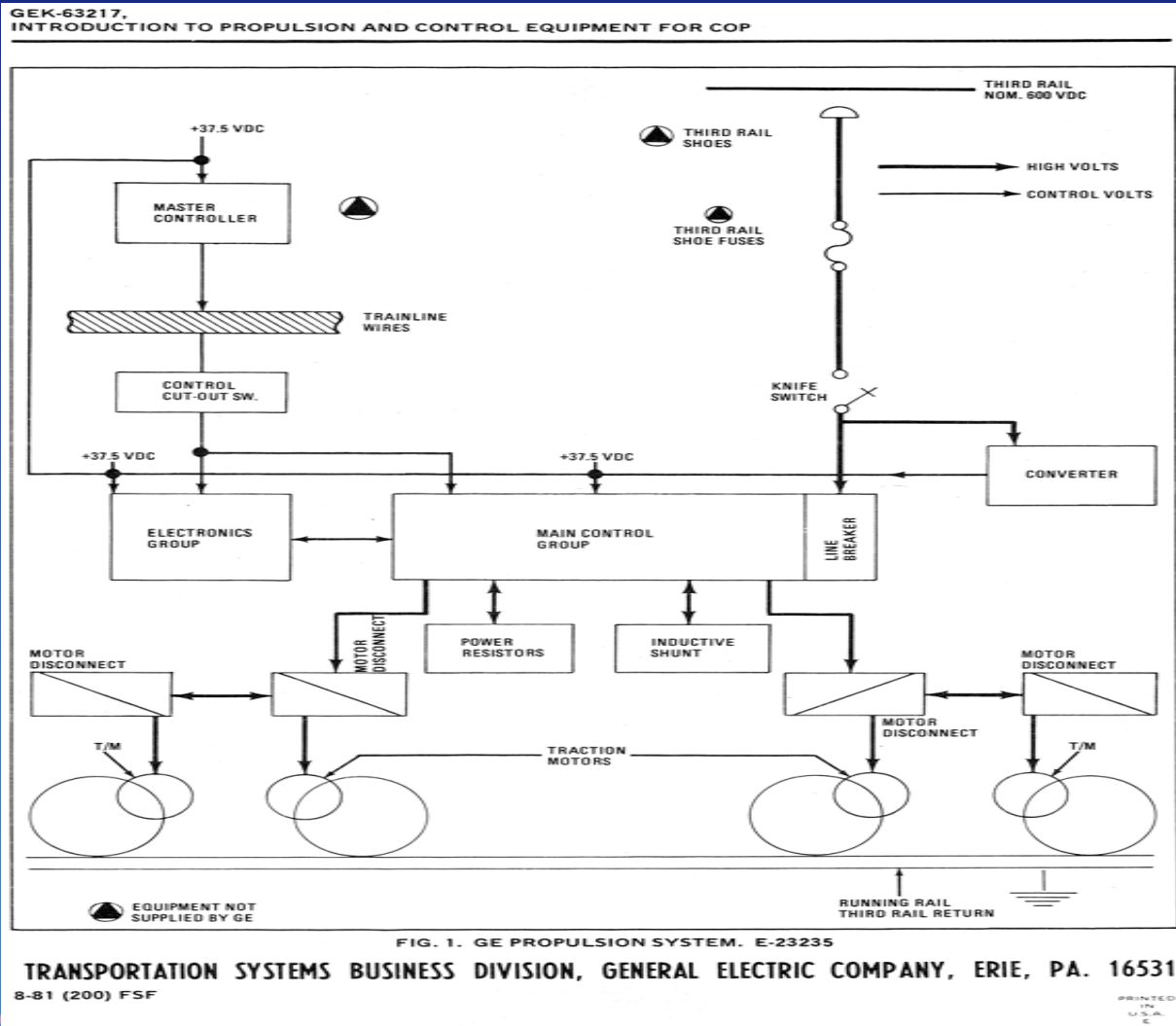
- Abstract
- Project Overview
- Realized Benefits
- Hidden Benefits
- Take-away Lessons



Abstract

- After thorough investigation and consultation with LTK Engineering Services into the increasing capital and operating expenditures along with decreasing fleet reliability, SEPTA decided to acquire a new propulsion control box instead of upgrading the existing one.
 - SEPTA awarded the contract to a Germany-based company named Vossloh Kiepe in 2005 and completed installation on the 127 car fleet in 2011. We would like to share some of the realized and hidden benefits of our retrofit.
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Project Overview



Original B-IV GE Propulsion System Overview

Project Overview

- LTK determined that a combination of root causes were found to contribute to the excessive propulsion system failures which led SEPTA to create a specification for a computer-controlled cam controller.

Update to
Computer
Controlled (CCM
or E-Cam)

Complete replacement of the 17KG411A1 with a new enclosure (using the same mounting points) with a computerized cam package and replacement of the 17KG412A1 electronic group with the new enclosure.

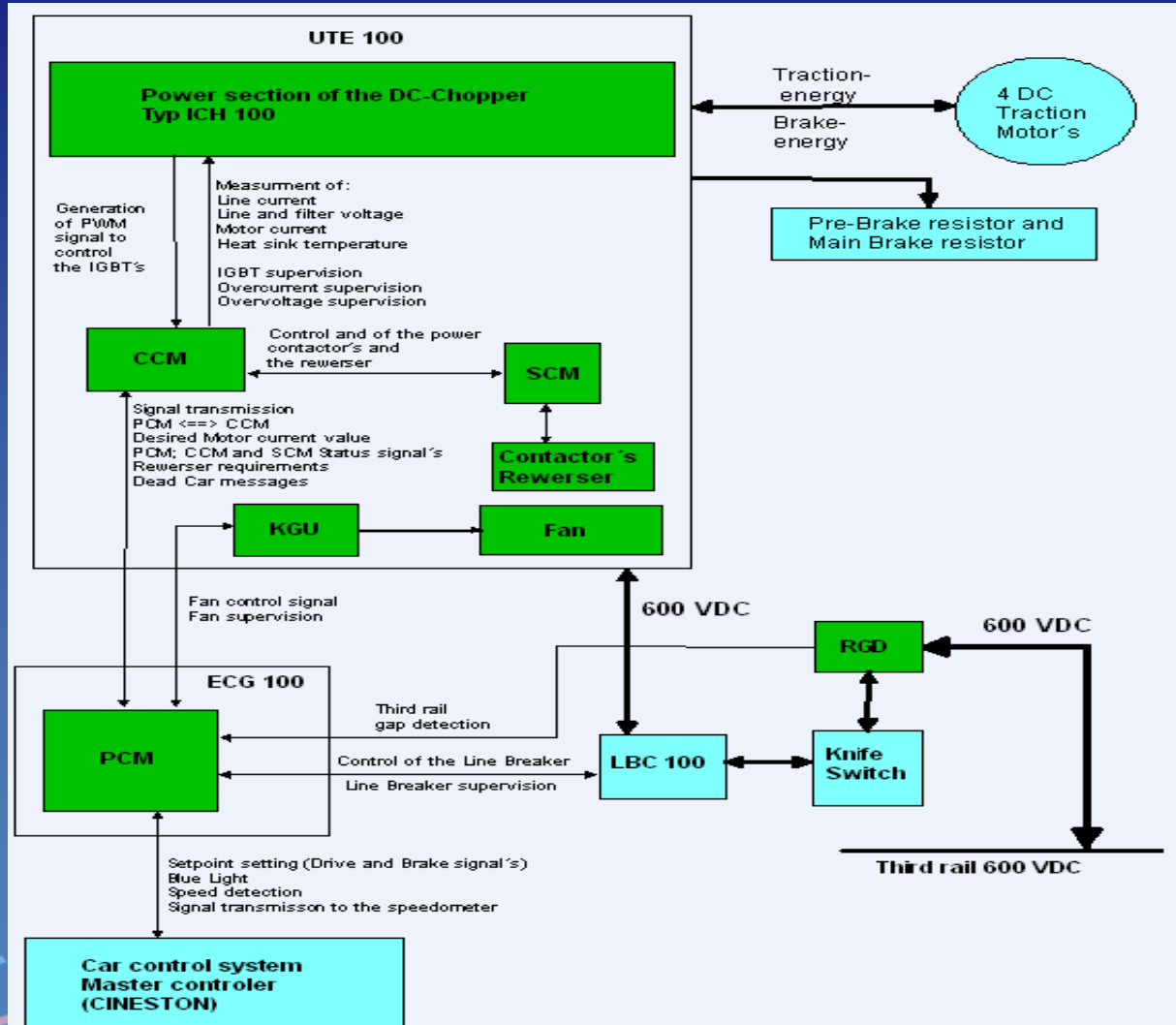
Project Overview

■ When the specification was sent out for industry review, both Vossloh Kiepe and a Czech firm indicated interest in a Chopper design. The Specification was revised to allow Chopper control.

■ Vossloh Kiepe won the bid, GE was second at about \$5M higher with the cam controller, and the Czech firm came in at about \$20M but they included new motors. The DC chopper controller system was awarded to Vossloh Kiepe headquartered in Germany in 2005.



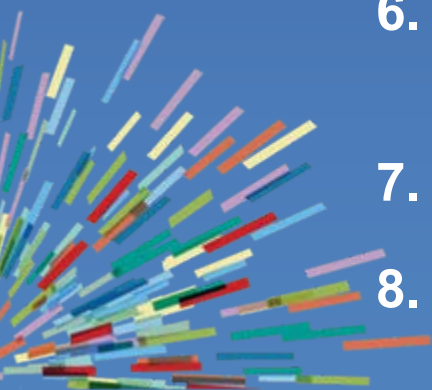
Project Overview



Block diagram of the new propulsion system

Project Overview-Deliverables

1. **136 Propulsion Control Assemblies (9 spares)**
2. **On-car and back shop diagnostic equipment with training**
3. **Maintenance documentation**
4. **Software documentation**
5. **10 spare sets of electronic modules and circuit boards**
6. **Structural analysis with instructions for reinforcement where required**
7. **Installation procedure**
8. **Performance test plan**



Project Overview-Contract Changes

1. **Contract language clarification about test equipment (No Cost).**
2. **Purchase of anti-rollback feature and associated components.**
3. **Purchase of additional heavy maintenance training.**
4. **Purchase of new MZE300 central unit modules were needed to assure the PCM sub-system computer was operating at peak speed efficiency with full memory capacity for current and future system upgrades.**

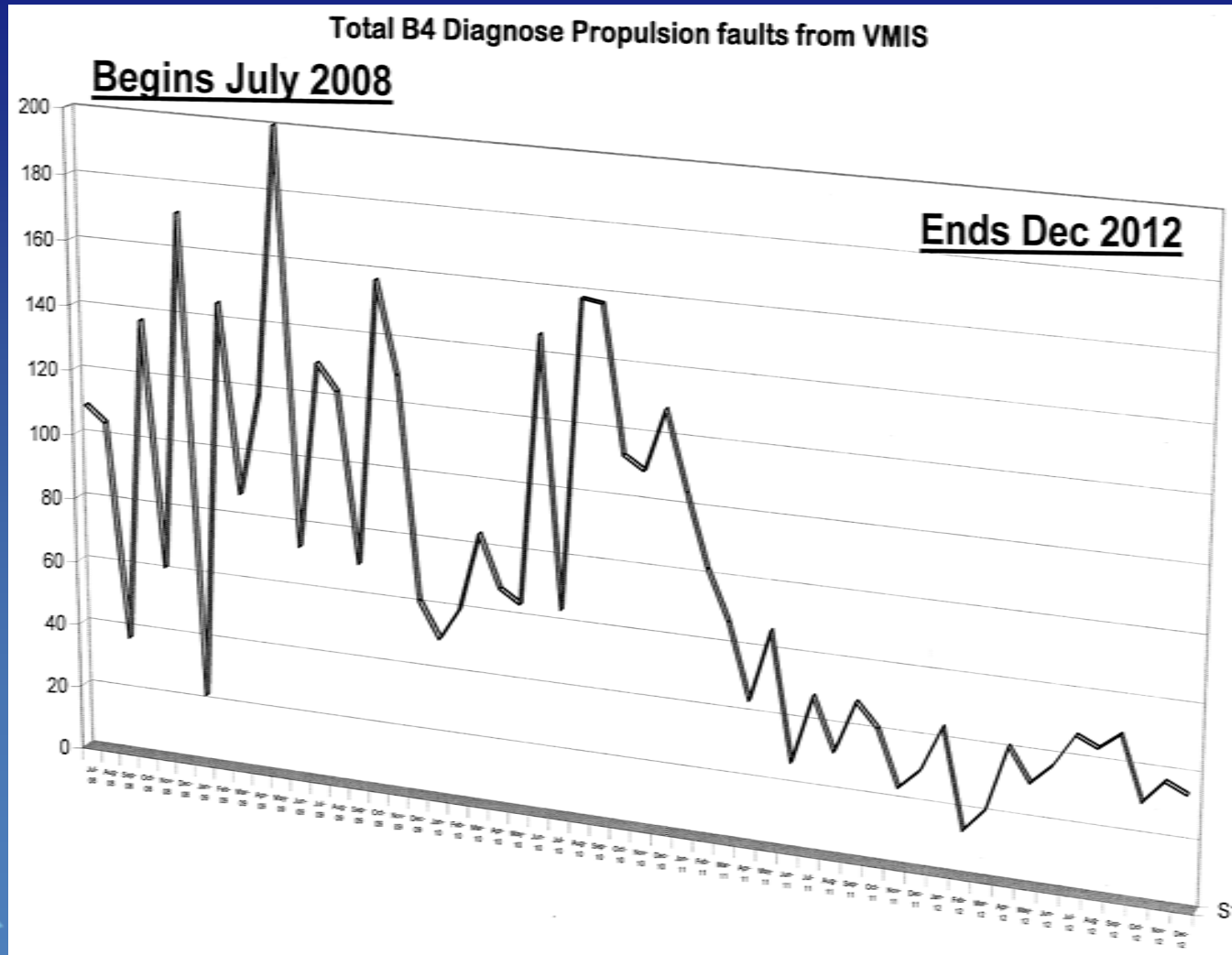


Project Overview-Cost

Contract Price w/ Change orders	\$11,381,264
Septa Installation Costs	\$1,381,927
Total SEPTA Expense	\$12,763,191



Realized Benefits-More Reliable



B-IV Propulsion Fault Chart

Realized Benefits-More Reliable

- One expected benefit was an increase in system MDBF or reduced “blue lights”. The previous figure displays propulsion faults recorded in SEPTA’s Vehicle Maintenance Information System (VMIS) before, during, and after installation.
- Before installation --- 95 propulsion faults per month
- After installation --- 35 faults per month.

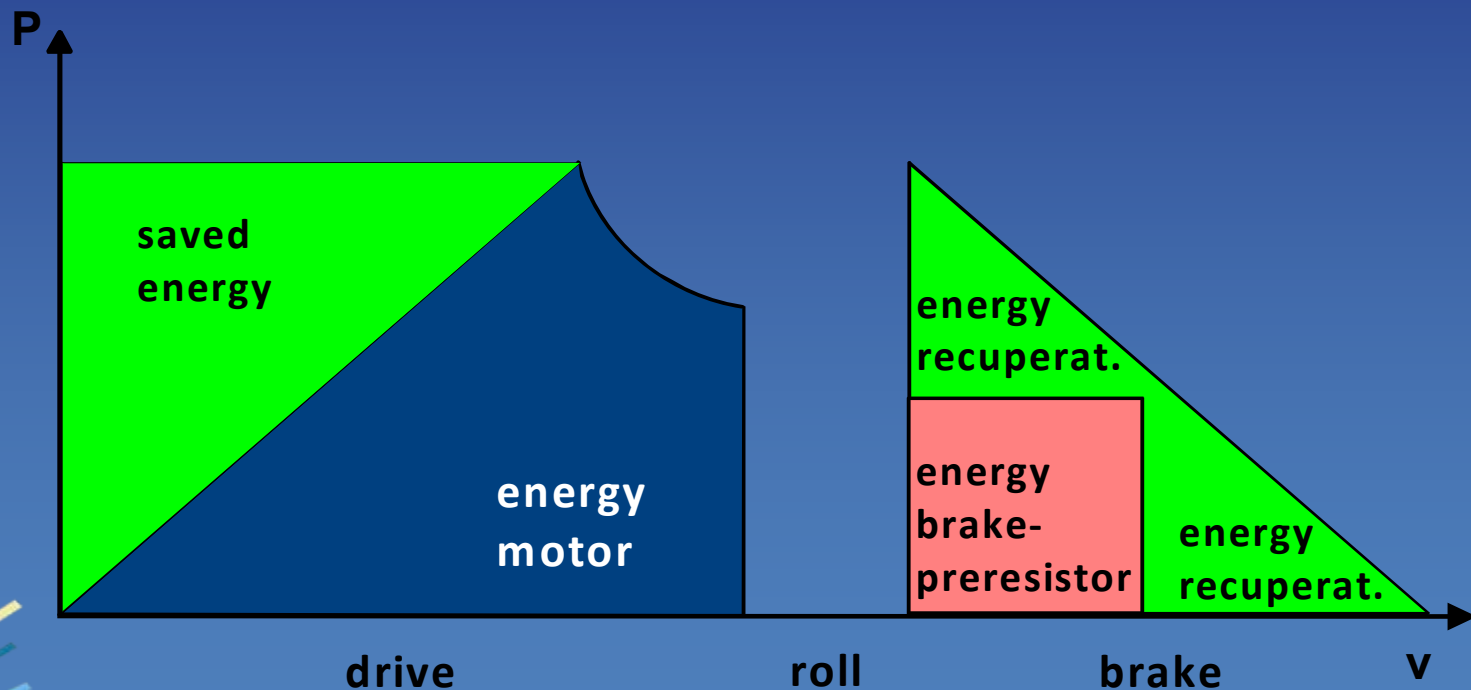


Hidden Benefits-Green Topology

DC-Chopper

■ Losses during acceleration (nearly) eliminated

■ Partial recuperation up to 70% limited by network → saving up to 20% total



Oliver Zaude 17-03-2011

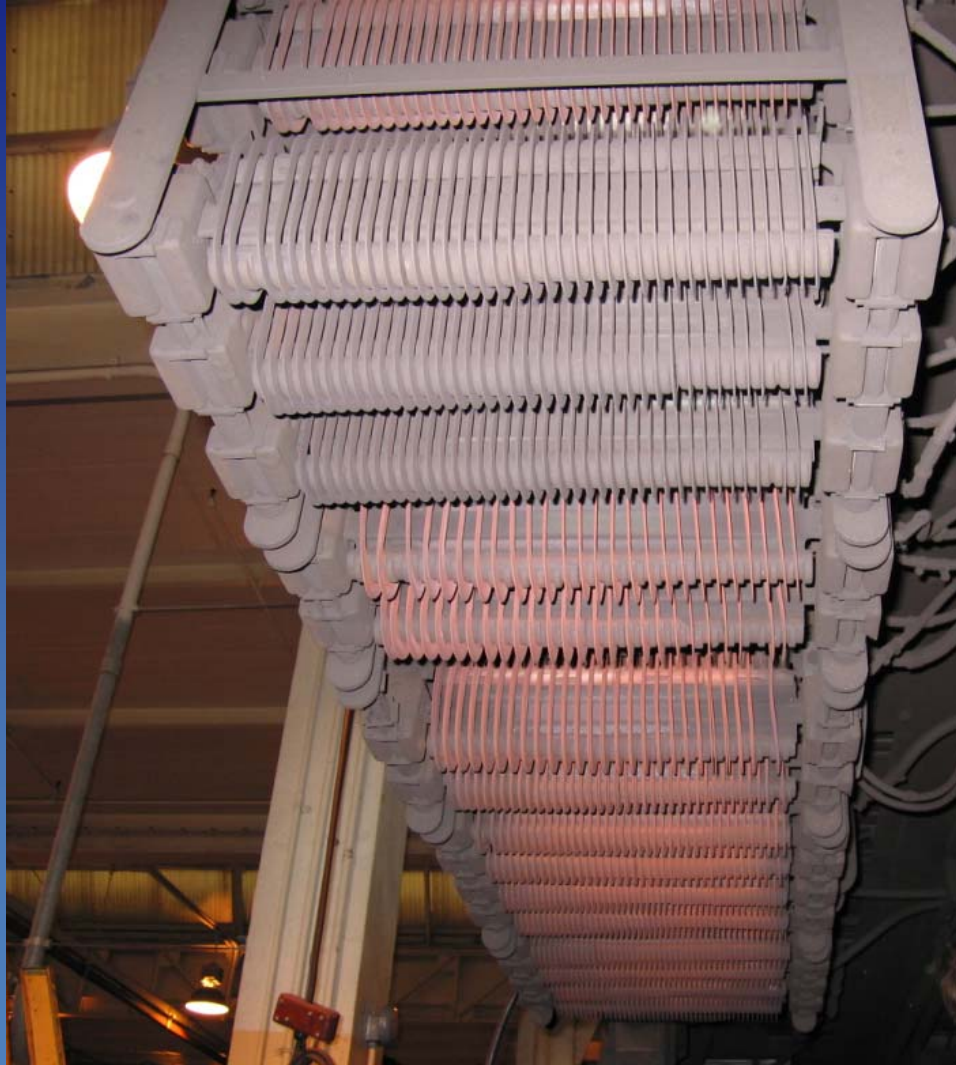
- Vossloh Kiepe UITP Presentation

Hidden Benefits-Green Topology

- SEPTA realized a significant energy cost savings (approx. \$858K per year) just by converting from a cam controller to a DC Chopper.
- The DC Chopper is more efficient since only the instantaneous voltage that is needed by the accelerating motors is applied. During acceleration, as power is applied, it does not go through resistors as it did in the original system. Instead the chopper mechanism is able to control the amount of power used to accelerate, allowing almost all of the power to be used in acceleration with very little being wasted (3).



Hidden Benefits-Squealing Noise



Grid Resistors



Hidden Benefits-Squealing Noise

- Re-use of the brake resistors had the unexpected consequence of causing a squealing noise that the 1250 HZ pulse frequency of the DC Chopper was creating as it flowed through the brake resistors during dynamic braking
- Operators and passengers alike thought that we were having brake troubles, when it was actually just our resistors squealing.
- When we enabled regenerative braking, the “squealing brake” noise stopped because the energy was sent back in to the 3rd rail and not dropped across the brake resistors. Therefore, enabling the regenerative braking functionality led to an additional power savings (\$40K per year , 4-month sample), and it also took away SEPTA’ squealing brake resistor problem.



Hidden Benefits-Buy Back

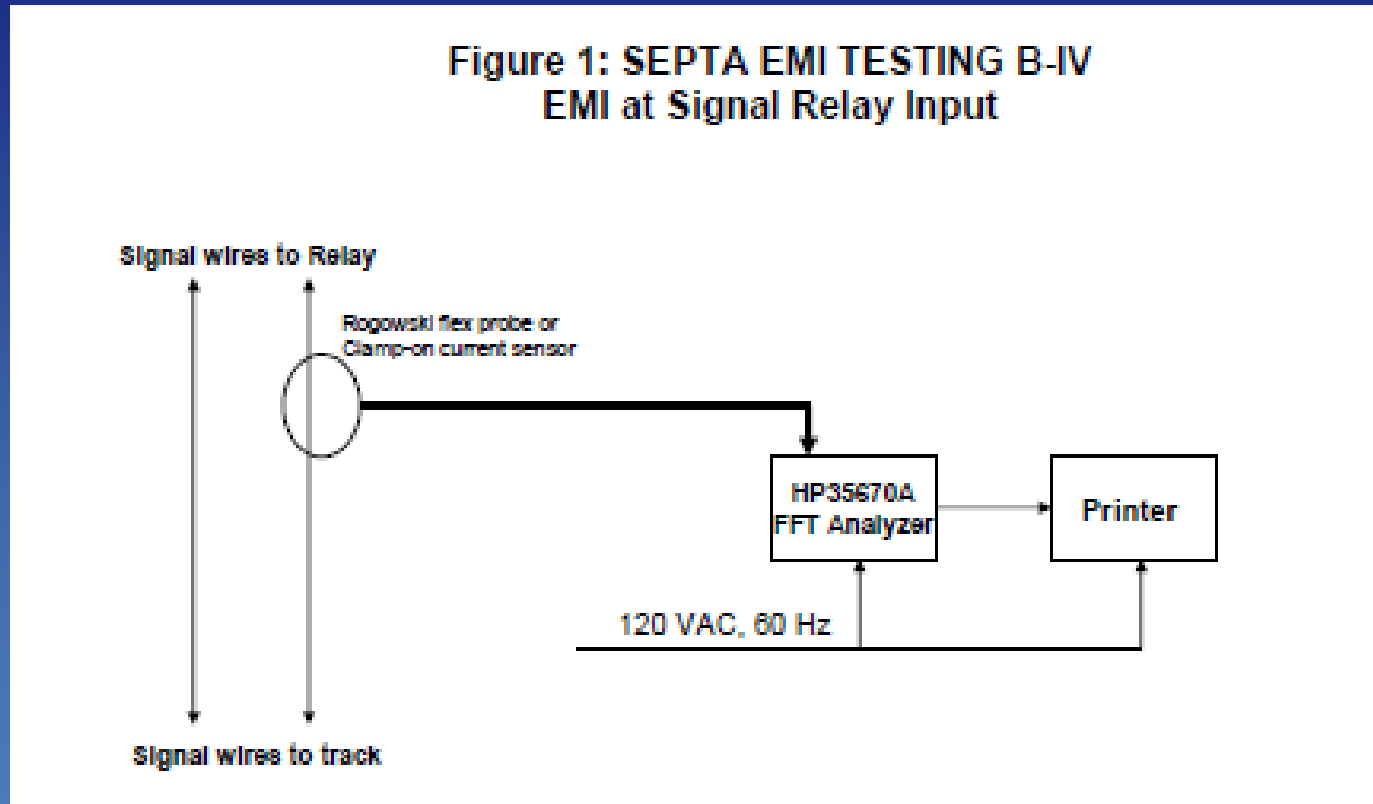
- SEPTA intends to keep the B-IV vehicle an additional 20 years. Without performing an exhaustive analysis of cost savings, one can see by looking at the following table that SEPTA's choice to retrofit the propulsion system is well on its way to being bought back.

Buy-Back without Regen	14.88 years
Buy-Back with Regen	14.21 years
Buy-Back with Regen + Motor Savings	11.41 years
Buy-Back with Regen + Motor Savings + Maintenance Savings	9.51 years



Take-away Lessons-EMI Testing

Figure 1: SEPTA EMI TESTING B-IV
EMI at Signal Relay Input



LTK EMI Test Pictorial

Take-away Lessons-EMI Testing

- Regenerative braking was initially left in a disabled state on the B-IV cars due to the fact that electromagnetic compatibility with SEPTA's signaling system was not verified during the pilot car test phase.
- At a minimum, it is recommended to require compliance to APTA's Standard for Development of an Electromagnetic Compatibility Plan (APTA SS-E-010-98) in your specification and to ensure that this testing is performed during pilot car testing.
- Tight coordination between in-house agency departments (i.e. Signals, Power, & Track) before and during the project is also vital to ensure that savings can be fully capitalized on.



Take-away Lessons-Installation

■ The amount of installation work to be performed was not well established before the contract was signed and higher than expected work created a manpower issue for SEPTA.

■ We mitigated this by diverting manpower, but it would have been better to address installation schedules in the contractual language so that if there were any significant changes in installation manpower, it would be mitigated by placing the onus on the contractor and not the authority.



Thanks You for Your Attention!

Feel free to contact me if you need more details about this project.

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