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# Vancouver, WA Switchyard Locomotive Idle Reduction Project

## Final Report to EPA

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# Vancouver, WA Switchyard Locomotive Idle Reduction Project

## FINAL REPORT

### February 2004 - May 2005

## KEY FINDINGS

- ▸ Total locomotive idle hours reduced - 9,733 hours.
- ▸ Total emissions reduced – all pollutants combined - 15 tons per year.
- ▸ Total emissions reduced – only NOx and PM combined – 9 tons per year.
- ▸ Total fuel saved – 47,730 gallons over one year period for three locomotives.
- ▸ Cost effectiveness for NOx and PM combined – approximately $1340 per ton of pollutant over 10 years.
- ▸ Cost effectiveness for all pollutants combined – approximately $809 per ton of pollutant over 10 years.
- ▸ Local rail yard management involvement is needed at the onset to facilitate technology installation and data retrieval.
- ▸ The availability of a satellite uplink feature reduces railroad staff interface, speeds up data retrieval, and provides early notification of equipment problems.

## BACKGROUND

The Southwest Clean Air Agency was notified by the U.S. Environmental Protection Agency (EPA) in April 2003 of a grant program for diesel retrofit projects, including idle reduction projects. A proposal by the Southwest Clean Air Agency and its partners to evaluate the effectiveness of idle reduction technology on locomotive switchyard engines in Vancouver, WA was approved by EPA in September 2003 for funding in the amount of $85,000.

The SWCAA proposal was modeled after the diesel locomotive retrofit project undertaken between EPA and Burlington Northern and Santa Fe Railway Company (BNSF) in Chicago Illinois in September 2002 at the BNSF rail yard at 432 W 14th Street in Chicago, Illinois. The goal of the SWCAA proposal was to apply similar technology at a West Coast location with the objective of learning about the emission reduction effectiveness of the technology.

SWCAA proposed this project for the following purposes: (1) reduce ozone and carbon monoxide emissions for Vancouver, WA / Portland, OR area, (2) reduce noise levels from a rail yard in close proximity to a neighborhood, (3) reduce long-term locomotive maintenance costs, (4) reduce toxic emissions in a port area heavily impacted with diesel and toxic emissions, and (5) significantly save fuel costs. SWCAA partners included BNSF, Kim Hotstart Manufacturing Company (manufacturer of the diesel driven heating system), and ZTR Control Systems (manufacturer of the automatic shut-down/start up technology).

The SWCAA project embodied all of the key elements of the project solicitation. Therefore, the major task for SWCAA was to expand on the existing relationship with BNSF and develop new relationships with Kim Hotstart and ZTR.

## PROJECT DESCRIPTION

The "*Vancouver Switchyard Diesel Locomotive Engine Idling Retrofit*" project installed Kim Hotstart's diesel driven heating system on 3 diesel locomotive engines in the Vancouver, WA switchyard. The funding provided by EPA would represent about 70% of the purchase and installation costs of the idle reduction technology. In-kind funding would be provided by SWCAA to manage the project, host the press event, perform public outreach and report back to EPA. BNSF funded the ZTR SmartStart systems which automatically shuts down the locomotives based on certain set parameters, and starts the Kim Hotstart technology for engine heating. BNSF also provided the maintenance personnel and absorbed the cost of the inoperable locomotives during installation of the idle reduction technology. The total capital cost of the project was approximately $125,000.

BNSF agreed that the three switchyard locomotives would remain in the Vancouver, WA switchyard on a long term basis once the idle reduction technology was installed. The locomotives need to travel to Spokane, WA or Seattle, WA to have periodic mandatory maintenance (about every 90 days) because there is no maintenance facility in Vancouver, WA. It was agreed that the locomotives would be returned to Vancouver, WA after each scheduled or unscheduled maintenance activity. Note, locomotive companies will move switch yard engines to different locations based on a variety of factors, including economics. For example, if the Vancouver, WA yard experiences a decrease in business shipments the company may move engines out of this yard. This is noteworthy because states or localities investing in mobile emission reduction projects should ensure that the mobile source remains in the area. The locomotives are identified below.

BNSF #2935: the idle reduction technology was installed on April 30, 2004 in Spokane, WA. Minor difficulties encountered were common to first time installation. The fuel filter had to be repositioned and changed to a stand-up model housing. Kim Hotstart and ZTR representatives provided training on their respective systems. BNSF anticipates future installs will be completed with less time.

BNSF #7057: the idle reduction technology was installed on May 7, 2004 in Vancouver, WA. Difficulties with this installation were also common to first time installation. In addition, a small amount of plumbing for critical locomotive engine services needed to be rerouted to accommodate the new technology.

BNSF #2339: the idle reduction technology was installed on June 8, 2004 in Vancouver, WA. Difficulties with this installation were also common to first time installation. This is the locomotive displayed for the press event on June 30, 2004 as shown below.

Many switchyard locomotive engines have event recorders installed to record limited operational data. These event recorders are required to be installed on line-haul locomotives to assist with accident investigations, derailments, and other short term minor events. The typical event recorder duration is 5 to 8 days in length and is of little value in assessing typical operations at a switchyard due to the limited hours of data that can be stored in the event recorder. In addition, this data has to be manually downloaded. For long term studies of a year or more, this information is costly to gather and has limited value because the locomotives are not assigned to a particular switchyard. The operation of a given locomotive is not otherwise affected by installation of the technology chosen under this project. Event recorder data may be useful in evaluating the cost/benefit of different locations and helpful to identify those locations that have the largest idling impacts. Because of the structure of this project, this type of data is of little value for this project. Post processing of the data gathered by this project provides extremely detailed information as to the cost benefit for this project.

BNSF Retrofit Locomotive Used for Media Event in Vancouver, WA June 2004

**Table A**

**Summary of Locomotive Engines Retrofitted in Vancouver, WA**

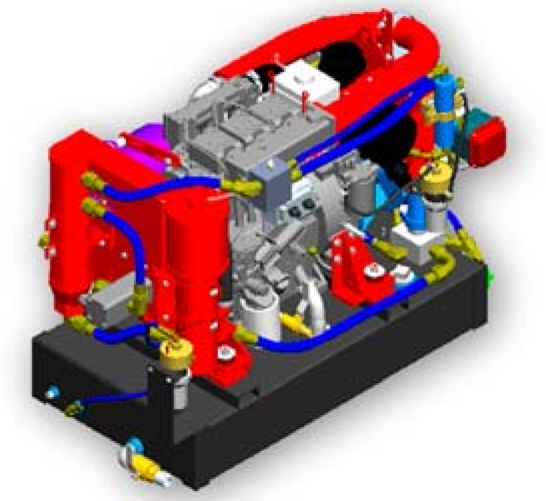
| Locomotive Number | Engine Manufacturer | Model Number | Horsepower | Year Built |
|---|---|---|---|---|
| 2935 | EMD | GP39E 645D3 16 cyl | 2300 | 03/64 |
| 7057 | EMD | SD39-2 645E3B 16 cyl | 2300 | 06/78 |
| 2339 | EMD | GP38-2 645E 16 cyl | 2000 | 03/72 |

## Technology Description

Similar to the Chicago project, the idle reduction technology for the BNSF Vancouver, WA switchyard project consisted of the following:

1. Kim Hotstart – Diesel Driven Heating System (DDHS)

   - 3-Cylinder, 27 hp EPA Certified Diesel Engine – Tier 1 (Lister Petter LPWS 3).
   - Consumes up to 1.23 gallons per hour of diesel fuel.
   - System of heat exchangers provides up to 30kW of heat output to the locomotive engine fluids.
   - Temperature controller regulates main engine coolant temperature between 100-120°F.
   - 72-volt, 80 ampere alternator charges batteries and powers auxiliary cab heaters.
   - 12-volt DC signal is available for visible/audible/wireless alarm (supplied by customer).
   - Extended 22-gallon oil sump ensures long-life and minimal maintenance.
   - Automatically starts/stops and changes speed as necessary to maintain locomotive coolant temperature and battery charging needs.



Graphic of Kim Hotstart Diesel Driven Heating System

Kim Hotstart's Diesel Driven Heating System (DDHS) specifications are as follows:

- Dimensions: 23" (w) x 47" (l) x 34.5" (h).
- Alternator - 72-volt, 80 ampere:
  - Powers electric immersion heater for main engine water
  - Charges locomotive batteries
  - Powers locomotive cab heaters.
- Temperature controller regulates main engine coolant temperature above $100^{o}$F.
- Locomotive engine coolant and oil heating supplied through multiple heat exchangers on the DDHS engine.
- 12-volt DC signal is supplied for visible/audible/wireless alarm (supplied by customer).
- Control box is a NEMA (National Electrical Manufacturers Association) 12 enclosure that contains electrical control and monitoring components. Controls and indicators include a High Speed Hour Meter, Total Hours Meter, Amps Meter and Engine Controls (Manual/Off/Auto). LED diagnostic indicators are also provided.

- Install location: walkway of the switcher or inside the cab body.
- Upon locomotive shut-down, the DDHS is automatically started. Upon locomotive start-up, the DDHS is automatically shut-down.
- Cost: $28,500 each.

2. ZTR Control Systems - Smart Start II

In addition to the diesel driven heating system (DDHS), an automatic shut-down/start up system was installed on each of the BNSF engines. This system, SmartStart, manufactured by ZTR Control Systems, is a microprocessor technology that automatically manages the shutdown and restart of locomotive engines while parked idling. It continually monitors existing conditions against a preprogrammed set of values. This system monitors the following operating conditions: reverser and throttle position, air brake cylinder pressure, engine coolant and ambient air temperature, and battery voltage and charging amperage. This system was configured to start and stop the DDHS as needed to keep the locomotive batteries charged and the engine above 100 $^o$F. This unit has an additional feature at additional cost whereby data can be automatically up-linked via satellite connection on a real time basis to monitor the status of systems. This feature was not provided on any of the locomotives under this project. The cost of the ZTR SmartStart system without the satellite uplink feature is approximately $9,000 each. The cost of the satellite uplink is $1400 for equipment per unit and $20 per month for data uplink per unit. Additional costs may be incurred for custom programming for individual units.

Graphic of ZTR Control Systems SmartStart System

## PROJECT SUCCESSES

There are several ways to measure success for any project. For this project that success can be summed up in four different areas (see below). Any discussion of success requires discussing failures. For this project, there were no failures. Certainly there were activities that presented challenges, but no single phase of this project had a failure. Challenges for the project are further discussed under lessons learned.

### Installation of Technology

The underlying premise for this project was to evaluate an idle reduction technology in a different set of geographical and weather conditions than that had already been demonstrated in a previous application. For this project, that original demonstration was made in the Chicago (September 2002). The technology selected for this project was essentially identical to that of the Chicago project and the rail company was the same, BNSF. The difference in this project was that it would be applied in a different region of the United States and would involve many personnel that were not involved in the original project in Chicago. This project demonstrated that, not only is the technology commercially viable, but that it could be repeated in other parts of the country. With the success of this project, it has been demonstrated that this technology can be applied successfully in other regions of the country and possibly to other sectors of the transportation industry that utilize diesel locomotives.

### Substantial Participation by BNSF, Kim Hotstart and ZTR Control Systems

From the onset of this project, the major participants were fully committed to making this project successful. Excellent cooperation and dedication from each company's staff was provided in the following areas: (a) EPA funds covered almost the entire cost of the diesel driven heating systems, Kim Hotstart had to contribute some funds to cover additional costs; (b) BNSF purchased the ZTR Smart Start technology for the Vancouver locomotives; (c) partners provided technical staff to oversee, direct and perform the technology installations; and (d) partners provided assistance for project roll out and press conference activities.

### Media Event

Considerable effort was spent coordinating and arranging the press conference. Press conference speakers included the following:

1. Congressman Brian Baird.
2. Washington Governor Gary Locke (Represented by Ron Shultz, Executive Policy Advisor).
3. John Iani, Regional Administrator, Region 10, U.S. EPA (Represented by Peter Murchie, Oregon Operations Office).
4. Royce Pollard, Mayor, City of Vancouver.
5. Mark Stehly, Assistant Vice President, Environment, The Burlington Northern and Santa Fe Railway Company, Fort Worth, Texas.
6. Rick Robinson, Chief Executive Officer, Kim Hotstart Manufacturing Company, Spokane, Washington.
7. William O'Neill, General Manager, Rail Division, ZTR Control Systems, Minneapolis, Minnesota (Represented by Peter Trence, Account Manager).

Local television and newspapers covered the event which received wide circulation. Members of the general public that have been impacted by diesel smoke in the past were present to view the technology. In addition, nation-wide coverage was provided by several railway and trade magazine publications. A press release packet that included a joint Press Release and brochures on the Kim Hotstart and ZTR technologies was mailed to the Presidents of all railroad companies throughout the United States as well as European Union (EU) countries. BNSF provided a locomotive that the general public and press toured to view the idle reduction technologies as installed. Kim Hotstart and ZTR Control Systems representatives provided a demonstration of the technologies by starting and stopping the locomotive. The locomotive was parked on a spur track within the switchyard with a viewing platform adjacent to the locomotive. Safety and security personnel were provided by BNSF.

Public Viewing the Idle Reduction Technology as Installed in Locomotive

Useful Data Gathered

One year of data has been gathered for the project since the installation of the idle reduction technology. This data has been collected manually on a quarterly basis and reported by BNSF, ZTR and Kim Hotstart personnel. In addition, this data has been provided to EPA in the way of periodic status reports. The data are summarized in the next section. The layout of the ZTR reports is extremely useful in that very little data manipulation is necessary to understand the direct impact of the idle reduction technology. The data indicates the number of idling hours reduced and reduced fuel consumption. The data gathered for this project is very specific to the operations at the Vancouver, WA switchyard. The potential for similar results at other locations is high; other location installations should consider the relative amount of idling time observed by locomotives at that location. There is a direct linear benefit for locations that have a similar or greater amount of locomotive idling time. If available idling time is low, project benefits are reduced. Applications where this technology is most beneficial are those situations that have a measurable amount of idling time.

## PROJECT DATA SUMMARY

### Hours

The three BNSF locomotives recorded 9,732.8 hours of reduced idling attributable to the idle reduction technology in a time period defined as the period of June 29, 2004 to May 29, 2005. Because the actual install dates on each locomotive are different, there is additional data for two of the locomotives that were outfitted earlier than the third engine. For review purposes, the data collected prior to June 29, 2004 has not been included in this evaluation because of the installation date differences between the engines. An estimated additional 1,500 hours is thought to have occurred for Locomotive #7057, but data from this download was lost because of a hard drive failure on the laptop computer used to retrieve the data. Additional shutdown hours could have been recorded for Locomotive #2935 but the DDHS technology was not available because a battery had been removed from this engine.

### Emissions

The total amount of emissions reduced from the locomotive engines as a result of the idle reduction technology is calculated to be 14.31 tons for an 11 month period, all pollutants combined. These data are summarized in Table B below. For those situations where only NOx and PM emissions are considered for reductions, total reductions of these two pollutants combined is 8.55 tons in the 11 month period. For a 12 month period the adjusted figure is 9.33 tons per year.

Part of the idle reduction technology, however, emits $NO_{x,}$ CO, HC, $SO_2$ and PM emissions. The DDHS uses a Lister Petter engine that is certified by EPA in accordance with 40 CFR Part 89 at Tier 1 levels. The emission levels of the Lister Petter diesel engine are shown in Table C. The Lister Petter engine is rated at 27 brake-horsepower at 3,000 rpm. As used in the Kim Hotstart DDHS system, the Lister Petter engine operates at either 1,800 rpm or 2,500 rpm depending on the need for either heat or electrical demand to maintain locomotive conditions. Emissions from the DDHS engine have been calculated and summarized in Table C below. The additional amount of pollutants emitted as a result of operation of the DDHS engine was approximately 0.21 tons for an 11 month period.

Actual emissions reduced by this project over the 11 month time period are therefore 14.1 tons. Interpolated emission reductions for a one year period suggest annual reductions of about 15.4 tons per year of all criteria pollutants combined. This project did not evaluate or consider toxic emissions or reduction thereof.

### Fuel

Emission reductions are the primary major benefit from installation of this idle reduction technology. The secondary major benefit is the reduction in fuel consumption for these locomotive engines. For the 11 month period, 14,796.7 gallons of diesel fuel per locomotive were saved by turning off the idling locomotives. The DDHS engine consumed an additional 633.9 gallons during the project period. The net result is a fuel savings of approximately 43,753 gallons for 11 months. Scaling this fuel savings to a 12 month period results in a net savings of about 47,730 gallons per year for three locomotives.

### Cost Effectiveness of Technology

Assuming that switchyard operations do not change drastically over a 10 year period, and an average life of 10 years for this idle reduction technology, the total tons of emissions reduced over a 10 year period would be 154.5 tons. Capital cost of the equipment for this project is estimated at about $125,000. Average cost effectiveness on this basis alone is approximately $809/ton of emissions.

Over a 10 year average period, fuel savings are projected to be 477,300 gallons of diesel. Average historical cost for railway diesel is estimated at $1.00 per gallon. Fuel savings over a 10 year period are projected to be $477,300. The value of this savings is expected to increase over the next 10 year period as the cost of diesel and other fossil fuels are experiencing a considerable increase in cost and are forecast to go higher.

Several factors are not included in the above calculation. A more refined cost effectiveness value could be computed if additional data were available. Additional factors could include annualizing the capital cost, federal tax incentive programs, pollution control device incentives, increased costs for maintenance on the idle reduction technology, reduced maintenance cost for the locomotive engines, additional scheduling constraints for keeping these locomotives in the Vancouver switchyard, reduced fuel cost due to reduced fuel consumption, engineer and maintenance personnel training and operation times, and tracking and reporting of data collected by these systems.

### Noise

The Vancouver BNSF switchyard is located in an industrial area but is adjacent to residential neighborhoods. This project area of Vancouver, WA is in an older well developed area that likely will not be rezoned in the foreseeable future. Therefore, noise and pollution from the nearby switchyard will continue to be an issue for local residents. From the onset of this project, impact to these neighbors was a consideration for implementing the idle reduction project. There were no provisions made in this project to measure or study noise levels. It was recognized that any reduction in idle times would be a significant benefit to the nearby residents. Idle reduction has been identified to be one of the easiest and most effective solutions to reducing noise and emissions without significantly impacting railroad operations.

## Table B
## Locomotive Engine Hours, Fuel and Emissions Summary

| | **First Period (6/29/2004 Thru 11/1/2004)** | **Second Period (11/1/2004 Thru 2/27/2005)** | **Third Period (2/27/2005 Thru 5/29/05)** | **Summary** |
|---|---|---|---|---|
| SS/HS Shutdown hours in period:* | 4,401.70 | 2,978.90** | 2,352.20 | 3244.26 avg |
| SS/HS Shutdown hours since install* | 4,401.70 | 7,380.60 | 9,732.80 | 9,732.80 |
| Gallons fuel reduced in period: | 20,499.12 | 13,353.54 | 10,534.52 | 14,796.7 avg |
| Gallons fuel reduced since install: | 20,499.12 | 33,852.66 | 44,387.18 | 44,387.18 |
| DDHS hours at 1800 RPM | 362.7 | 271.9 | 197.2 | 831.8 |
| DDHS hours at 2500 RPM | 20.8 | 26.5 | 8.2 | 55.5 |

| **Pollutant** | **Emission Factor (gm/hr)** | **Emissions Reduced in Period 1 (lbs)** | **Emissions Reduced in Period 2 (lbs)** | **Emissions Reduced in Period 3 (lbs)** | **Actual Annual Emissions Reduced (11 mo) (tpy)** |
|---|---|---|---|---|---|
| Hydrocarbons | 142 | 1,377.98 | 932.56 | 736.37 | 1.52 |
| Carbon Monoxide | 225 | 2,183.42 | 1,477.65 | 1,166.78 | 2.41 |
| Nitrogen Oxides | 777 | 7,540.07 | 5,102.83 | 4,029.30 | 8.34 |
| Particulate Matter | 20 | 194.08 | 131.35 | 103.71 | 0.21 |
| Sulfur Dioxide | 0.5% wt* | 1,680.93 | 1,094.99 | 863.83 | 1.82 |
| **Totals** | | 12,976.48 | 8,739.38 | 6,900.00 | **14.31** |

* SS/HS – SmartStart/Hotstart – hours available for the technology to function
** Approximately 2 months of data was lost for Locomotive 7057 – estimate a loss of 1500 hours of reduction time based on the two months reported – additional unknown hours not operated for Locomotive 2935 due to battery removal on DDHS system.

## Table C
## Lister Petter LPWS 3 Emissions Information 1800 rpm

(System loading is 62% = 10.2 bhp = fuel consumption of 0.68 gal/hr = total project hours @ rpm = 831.8)

| **Pollutant** | **Emission Factor (gr/bhp-hr)** | **Emission Factor (gr/hr)** | **Emissions (grams)** | **Emissions (tpy)** |
|---|---|---|---|---|
| Hydrocarbons | 1.6 | (1.6 x 10.2) = 16.32 | (16.32 x 831.8) = 13,575 | 0.015 |
| Carbon Monoxide | 3.1 | (3.1 x 10.2) = 31.62 | (31.62 x 831.8) = 26,302 | 0.029 |
| Nitrogen Oxides | 12.6 | (12.6 x 10.2) = 128.52 | (128.52 x 831.8) = 106,903 | 0.118 |
| Particulate Matter | 0.66 | (0.66 x 10.2) = 6.73 | (6.73 x 831.8) = 5,598 | 0.006 |
| Sulfur Dioxide | 0.50 % by wt of fuel consumed | (0.68 x 0.005 x 3719.46 x 64 / 32) = 25.29 | (25.29 x 831.8) = 21,038 | 0.023 |

### Lister Petter LPWS 3 Emissions Information 2500 rpm (interpolated)

(System loading is 85% = 19.6 bhp = fuel consumption of 1.23 gal/hr = total project hours @ rpm = 55.5)

| Pollutant | Emission Factor (gr/bhp-hr) | Emission Factor (gr/hr) | Emissions (grams) | Emissions (tpy) |
|---|---|---|---|---|
| Hydrocarbons | 1.49 | (1.49 x 19.6) = 29.20 | (29.20 x 55.5) = 1,621 | 0.002 |
| Carbon Monoxide | 5.55 | (5.55 x 19.6) = 108.78 | (108.78 x 55.5) = 6,037 | 0.007 |
| Nitrogen Oxides | 8.4 | (8.4 x 19.6) = 164.64 | (164.64 x 55.5) = 9,138 | 0.010 |
| Particulate Matter | 1.12 | (1.12 x 19.6) = 21.95 | (21.95 x 55.5) = 1,218 | 0.001 |
| Sulfur Dioxide | 0.50 % by wt of fuel consumed | (1.23 x 0.005 x 3719.46 x 64 / 32) = 45.75 | (45.75 x 55.5) = 2,539 | 0.003 |

### Lister Petter LPWS 3 Emissions Summary

| Pollutant | Emissions 1800 rpm (grams) | Emissions 2500 rpm (grams) | Emissions Total (grams) | Emissions Total (tpy) |
|---|---|---|---|---|
| Hydrocarbons | 13,575 | 1,621 | 15,196 | 0.0168 |
| Carbon Monoxide | 26,302 | 6,037 | 32,339 | 0.0356 |
| Nitrogen Oxides | 106,903 | 9,138 | 116,041 | 0.128 |
| Particulate Matter | 5,598 | 1,218 | 6,816 | 0.0075 |
| Sulfur Dioxide | 21,038 | 2,539 | 23,577 | 0.026 |
| | | | **TOTAL** | **0.214** |

## PROJECT CHALLENGES

This project presented several challenges to SWCAA staff because it was outside of the normal type of source regulated by the Agency. Locomotives and other mobile diesel equipment are not regulated as a stationary source by SWCAA. The challenges are described individually below.

Existing Relationship Between BNSF and SWCAA

Prior to this project the only existing relationship between SWCAA and BNSF was the reporting and summary of the quantity of diesel fuel dispensed at the local switchyard. SWCAA assumed that the switchyard locomotives were fueled locally because BNSF had a limited locomotive fueling facility. Locomotives are classified as a mobile source and as such are not subject to new source permitting under the federal and state stationary source air quality rules. State wide emission inventories in Washington State for this type of source are done for the whole state and not on a regional basis by the individual local clean air agencies.

The relationship necessary for this project to succeed required substantial relationship building with a very large company – BNSF. There were local rail yard managers, regional managers, safety managers, security managers, maintenance managers and operations managers who had to be involved, advised and educated about the project objectives. These areas of responsibility within BNSF reside at different locations including Vancouver, Seattle and Spokane, WA, Topeka, Kansas, and Fort Worth, Texas.

SWCAA's Limited Knowledge of Rail Yard Operations

Prior to this project SWCAA staff had extremely limited interaction with BNSF personnel. SWCAA had little understanding of day-to-day rail yard operations, scheduling and maintenance issues. Each of these factors had a steep learning curve to be able to coordinate all the necessary actions to make this project successful. BNSF corporate staff was very helpful in providing the necessary insight into these factors, however that process was time consuming and not anticipated under the original project proposal. In addition, the technical coordination had to occur across two time zones and with BNSF staff in Topeka, KS and Fort Worth, TX and ZTR staff in Minneapolis, MN.

### Limited Buy-in by Local BNSF Staff

One aspect of the project that was not well understood initially was the role of the local Vancouver Switchyard Manager. The Switchyard Manager was not involved with SWCAA in any of the early discussions on the project. When it came time for the press conference and to coordinate the roll-out of the idle reduction technology in Vancouver, SWCAA staff quickly learned the importance of having a well developed working relationship with the local Switchyard Manager. This relationship was fostered in time to keep the project on a successful track. This coordination also included needing to assure that security and safety issues in and around the switchyard were addressed for the press event. Local and regional BNSF staffs were very accommodating for the press conference and completion of the installations on time.

### Long Term Technology Installation Challenges

A key part in the success of any project is the buy-in from the local personnel that are responsible for day-to-day operations of the equipment after the project roll-out. This was satisfactorily accomplished by having two of the locomotive upgrades completed in the Vancouver, WA switchyard. The other installation (i.e. the first locomotive BNSF #2935) was completed in a maintenance shop in Spokane, WA. The installations that were completed in Vancouver presented additional challenges due to the limited facilities and personnel available to perform this first of a kind type of activity. They did have the benefit of other BNSF maintenance personnel having performed the first installation in Spokane, WA. While all three locomotives were EMD equipment, the dates of manufacture were 1964, 1972 and 1978. These locomotives were similar but not identical and each presented a unique challenge because of minor differences “under the hood”. The size of the engine, the space available under the hood, the typical configuration of fuel filter adapters, electrical connections, differences due to dates of manufacture, etc. all contribute to minor differences that need to be accommodated during each technology installation. No two installations appear to be identical.

### Installation Challenges Under Union Shop

The challenge presented by the installations in Vancouver was the lack of a complete maintenance shop. Additional installation support was provided by the technology providers to overcome this challenge. Because this type of activity is not routine for the Vancouver switchyard, the personnel involved in the idle reduction installation activities had other primary areas of responsibility with different priorities. This issue provided challenges to working schedules and coordination with union craft laborers to perform the installation tasks.

### BNSF Challenges for Scheduling

Challenges for BNSF staff included the scheduling of these identified locomotives to be out of service for an additional 4 to 10 days to complete the installations. In a system where locomotives are kept in service longer due to the cost and availability of new locomotives, this scheduling burden is not trivial. In addition, under a normal maintenance cycle in the Pacific

Northwest, once a locomotive is taken from one yard to the shop for the mandatory federal ninety-two day inspection, it is rare that the same locomotive returns to the switchyard it came from. As a condition of this project, the three locomotives now need to be returned to the Vancouver switchyard after maintenance. This presented not only an immediate scheduling burden but also an ongoing burden for BNSF.

Data Reporting Challenges

Each locomotive was outfitted with the DDHS and SmartStart technologies. The additional technology that could have been provided at extra cost was that of a satellite uplink so the data could have been made available in almost real time. However, the process used to collect the data for this project consisted of field staff using a laptop computer to retrieve the data manually from the SmartStart system. This required scheduling and personnel involvement to retrieve the data. Once the data was retrieved in the field it was electronically sent to ZTR Control Systems for formatting and then forwarded to BNSF staff who forwarded the information to SWCAA. For Locomotive #7057, a two month period of data (i.e., 11/1/2004 to 12/24/2004) was lost because of laptop computer problems. It is estimated that approximately 1500 hours of idle reduction time data was lost because of this malfunction. For purposes of this project, the satellite uplink would have remedied this failure. It also would have facilitated much quicker data retrieval and reporting to SWCAA. In addition, there was a period of time when a battery was removed from the DDHS system on Locomotive #2935. This prevented the idle reduction technology from activating and functioning as it should, thereby limiting the number of hours available for shutdown for this locomotive. This was discovered in November 2004.

## LESSONS LEARNED

### 1. Baseline Data

Success for a project of this type can be measured many different ways. The measure of success for this project was to reduce idling hours and therefore emissions, noise and fuel consumption. For this type of project to be considered for implementation elsewhere requires an understanding of the amount of idle time experienced at a location. For the Vancouver, WA project, this data was not available. It was thought that this data could be obtained by downloading the event recorder information on the individual locomotives. This was not the case for several reasons. Event recorders are not installed on all switchyard locomotives. Those locomotives that do have event recorders have them in part because they are older model recorders that are no longer sufficient for line haul locomotives. Event recorders are installed for the primary purpose of gathering event specific data for things such as derailments. Therefore, the event recorders only retain the last 5-8 days of data depending on the specific model. The type and amount of data collected is minimal. Long-term data is not available. For the Vancouver, WA switchyard, there is no routine refuel operation at the yard. As a result, the total gallons of fuel consumed by switchyard locomotives are not routinely tracked. All locomotives are required to be routinely serviced a minimum of every 92 days to ensure safety features are adequately maintained. Because of the location of maintenance facilities and the time and scheduling efforts necessary to track a locomotive, switchyard locomotives are not routinely returned to the same switchyard they came from prior to maintenance. Therefore, a service interval at a particular yard would only be available for up to 92 days. This project location was not competing with other project locations to ascertain the best location for installation of this technology. To SWCAA's knowledge, it was the only project of its kind proposed. Therefore, baseline data was a less significant factor. If several locations had been proposed for this project, baseline data could have been useful in determining the optimal location for installation of idling reduction technology.

### 2. Early Involvement by Local Rail Yard Management

SWCAA did not have a robust pre-existing relationship with the local BNSF Rail Yard Manager. Project contacts were initially made on the regional and national level with only minimal involvement of the local managers. The project could have been easier to manage had there been earlier involvement by the local BNSF rail yard managers. Specifically, this involvement could have avoided the initial reluctance of the local managers. As such, this project involvement came at the time of technology installation and little opportunity by SWCAA staff to observe the installation. Also, the project reporting data could have been gathered by local maintenance personnel on a more frequent basis providing less effort to retrieve and report the data.

### 3. Data Difficult to Obtain

Due to the limited working relationship with the local BNSF staff, there was little-to-no opportunity for collaboration on gathering either the initial baseline data or the project data as it became available. This meant extra effort was required by many project participants to gather and report idle reduction data. As part of the project plan, there was no local collaboration on who would download data, how often it would be downloaded and who would be responsible for this data. For a demonstration project, the satellite uplink feature would preferably have been part of the project, but because of fiscal constraints this was not possible. The satellite uplink feature costs an additional $1,400 in equipment per unit and an additional $20 per month per unit plus custom programming charges that are unspecified. This option is no longer readily available except in large quantities as it has not been a feature requested by customers.

### 4. Project Partnering

As many grant opportunities go, the projects identified for funding are new or innovative for state and local air agency staff. Incredible effort is required to assemble a project and make a meaningful proposal, especially in areas outside of normal responsibilities. This project involved mobile source emissions and sources that are not routinely regulated by the state and local clean air agencies. Locomotive emissions are specifically regulated by EPA. Because this project was outside of SWCAA’s traditional source and technology considerations, not all difficulties could be identified up front. The first project in Chicago was key to this project’s success. In addition, the participation of BNSF in the Chicago project was key to its implementation in Vancouver, WA. At times in the proposal stage, SWCAA had to be persistent to get partnerships developed for the project because of a lack of an existing partnership with SWCAA.

### 5. “Steep Learning Curve”

SWCAA’s primary responsibility is the regulation of traditional air pollution point sources and maintaining ambient air quality standards by partnering with other local clean air agencies and state and federal agencies. Traditionally this work does not include partnering with mobile source category sources. The understanding necessary to successfully complete this project required time and patience on the part of BNSF staff to educate SWCAA on railway operations and identify what resources and data are and are not available. BNSF is a large company with a very knowledgeable and dedicated staff. The location of the dedicated BNSF staff members in various parts of the country was a challenge in achieving good communications. On this project, an exceptional amount of communication was necessary to develop the project, gather the data and hold the press event. Much of this communication was in understanding what the project can reasonably accommodate and achieve.

### 6. Union Labor Issues

Two of the three idle reduction installations were performed in the Vancouver, WA rail yard. The first installation was completed in the Spokane, WA maintenance shop very near to the Kim Hotstart manufacturing facility. BNSF maintenance staff performed the installation at the Spokane, WA location with oversight from Kim Hotstart and ZTR specialists. The maintenance staff members in the Vancouver, WA rail yard are limited in their typical maintenance activities and responsibilities. As such, these staff members have additional responsibilities and priorities. The idle reduction installation activity in the Vancouver, WA rail yard (i.e., 300 miles from Spokane) was challenging because of these different responsibilities and priorities. The installations were completed but involved some negotiating with maintenance staff as to how much of the installation could be completed by Kim Hotstart and ZTR specialists. This could have gone smoother if the local rail yard managers and maintenance personnel had been involved earlier in the project.

### 7. Media Event Activity Coordination

Additional emphasis and effort was provided by SWCAA to provide a media event that had local, state and federal level involvement as well as technology and project partner involvement. Commitments were obtained early in the process for involvement and recognition in the event. Within the final day(s) leading up to the media event, several of the featured event speakers could not attend and had to send substitutes. The lesson here is that no matter how well organized a project is, if high level dignitaries are a key participant, it is still necessary to be prepared for last minute changes in speakers. Utilizing established media networks provides additional assurances, not guarantees, of a smooth event roll-out. Nevertheless, Kim Hotstart and ZTR personnel stated at the event that the Vancouver Press Event was far superior in its success compared to the Chicago Press Event.

### 8. Leverage Prior Project Successes

Two factors contributed significantly to the success of the Vancouver, WA project. The first factor is that this type of project had been successfully implemented recently in Chicago, IL. Excellent technology was provided by the partners in addition to their contribution in the way of staff involvement and time, and the media event was considerable. SWCAA knew that it was possible to have a successful project and that success of this project would hinge on how well the Vancouver, WA project was managed.

The second contributing factor was the level of involvement and oversight by SWCAA. Coordinating multiple partners is a challenging task. The media event was planned in extreme detail to ensure that all possible factors were considered and accounted for. There was little momentum to build on from the Chicago, IL event due to the difference in political regions. This was one of the driving forces in bringing this type of project to the West Coast. The project was able to accommodate last minute changes because of the level of planning done for this project.

The success of both the Vancouver, WA and the Chicago, IL projects is evident in that additional similar projects have been announced and are being implemented in other locations around the United States. This success needs to continue to be fostered.

### 9. Results Look Better in Future

The total benefits of this project were not fully anticipated at the start of the project. There were obvious benefits such as emission reductions and noise reductions for local residents, but the continuing benefits were not fully appreciated until the project cost benefit summaries were prepared. With the continual rising cost of fuel, the idle reduction technology implemented by this project will have an even faster and higher pay back for BNSF. In addition to the fuel savings in the way of cost, this project helps to reduce the investment in fossil fuel driven activities. Because this type of project has a high rate of return in the area of emissions reduced and cost savings, the data gathered from this and similar projects should contribute significantly to future projects.