Appendix A: Installation Schedule Chart
ARB Bus Installation
Schedule Chart

Day 1

Mechanical Installation

I. Exhaust System Removal
II. Coolant Pipe
III. Oil Filter Relocation

Traps System Installation

I. Main Control Box
II. Remote Control Box

Electrical Installation
ARB Bus Installation
Schedule Chart

Day 2

Mechanical Installation

IV. Traps Assemble

V. Blower Assembly

IV. Heater Cable

Electrical Installation
ARB Bus Installation
Schedule Chart

Day 3

Mechanical Installation

VII. Pneumatics Controls | VIII. Combustion Air Connections

Electrical Installation

V. Signal Wires | VI. Control Wires | Complete
ARB Bus Installation Schedule Chart

Day 4

Mechanical Installation

IX. Trap Pressure Transducers  X. Cradle Installation  XI. Intake Duct

Electrical Installation
ARB Bus Installation
Schedule Chart

Day 5

Mechanical Installation

XII. System Check
8 Hours

Electrical Installation
Appendix B: Bus Main Control Box Wiring
DCI Diesel Particulate Trap System Installation Manual

Appendix D: Bus Wire Looms
DCI Diesel Particulate Trap System Installation Manual

Appendix C: Bus Pneumatic Lines
DCI Diesel Particulate Trap System Installation Manual

Appendix E: Parts List
### ARB BUS
#### DIESEL PARTICULATE SYSTEM
#### PARTS LIST

<table>
<thead>
<tr>
<th>Qty</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>5215B232 Trap Muffler Assembly</td>
</tr>
<tr>
<td></td>
<td>o Perfed baffle inlet</td>
</tr>
<tr>
<td></td>
<td>o 5215B223 heater</td>
</tr>
<tr>
<td></td>
<td>o .12 dia TC on core face</td>
</tr>
<tr>
<td></td>
<td>o 5215B catalyzed foam face cores</td>
</tr>
<tr>
<td></td>
<td>o Scarfed, perfed tube outlet</td>
</tr>
<tr>
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<td>Bracket Assembly</td>
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<td>Inlet Manifold - 2-pieces, 5215B261</td>
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<tr>
<td>1</td>
<td>#1 Tailpipe</td>
</tr>
<tr>
<td>1</td>
<td>#2 Tailpipe</td>
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<td>Tailpipe Mounting Bracket</td>
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<td>2</td>
<td>5 inch diverter valve - WABCO, nickel plated, 1-pc shaft, bushings</td>
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<td>5215B176 Blower with 2 mounting clamps</td>
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<td>062E1 3-way Humphrey solenoids</td>
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<td>MFM04-5237 relief valve muffler</td>
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<td></td>
<td>2 Humphrey Solenoids for Diverter Valves</td>
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<td>TSI Probe #84245</td>
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<td>Modified coolant line 5215B262</td>
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<td>Remote mount oil filter kit</td>
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<td>2</td>
<td>Condensate traps</td>
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**Accessories**

1.0 ID Neoprene tubing
5.0 Sealclamps
Teflon tubing .25 OD x .12 ID
SS Swagelok fittings
Legris fittings
.25 OD SS tubing
GM RTS BUS - STOCK

WITH TRAP SYSTEM

DATA ACQUISITION

IBM PC MONITORING TRAP TEMPERATURES IN AND OUT AS WELL AS BACKPRESSURE JUST AFTER THE TURBOCHARGER

IBM PC MONITORING THE CONTROL CIRCUIT FOR THE TRAP SYSTEM
APPENDIX K

Trap Performance Data
Collected at ARB on
January 5, 1990.
## ARB 8-Mode Chassis-Dyno Cycle

**SCRTD Trap Bus 8924 (DDC 6V92TA 240 HP)**

Data Collected on Jan 5, 1990 at ARB

<table>
<thead>
<tr>
<th>Mode #</th>
<th>Actual Road rpm</th>
<th>Road Speed mph</th>
<th>Engine BP (*hg)</th>
<th>Exhaust Temp (°C)</th>
<th>Trap 2 Open Inlet (C)</th>
<th>Trap 2 Open Outlet (C)</th>
<th>Trap 1 Closed Inlet (C)</th>
<th>Trap 1 Closed Outlet (C)</th>
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<thead>
<tr>
<th>Mode #</th>
<th>Actual Road rpm</th>
<th>Road Speed mph</th>
<th>Engine BP (*hg)</th>
<th>Exhaust Temp (°C)</th>
<th>Trap 2 Open Inlet (C)</th>
<th>Trap 2 Open Outlet (C)</th>
<th>Trap 1 Closed Inlet (C)</th>
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ARB Trap System Demonstration
SCRTD Bus 8924 with DDC 6V92TA 240 hp
DCI Electric Dual Trap System

Engine Back Pressure (" hg)

Exhaust Thru Trap 2  Exhaust Thru Trap 1

ARB Chassis Dyno Mode #

AET-ORTECH International
ARB Trap System Demonstration
SCRTD Bus 8924 with DDC 6V92TA 240 hp
DCI Electric Dual Trap System

Trap Temperatures (°C)

Jan 5, 1990

Exhaust Thru Trap 2

Exhaust Thru Trap 1

ARB Chassis Dyno Mode #
ARB Chassis Dyno BP Sweep Data
Jan 5, 1990

Trap 2 open
Trap 1 closed

Trap 1 open
Trap 2 closed

Backpressure (" hg)
ORTECH

Heavy-Duty Diesel Particulate Trap Demonstration
For: State of California - Air Resources Board

APPENDIX L

Trap Performance Data
Collected at ARB on
January 10, 11, 1990
ARB Trap System Demonstration
SCRTD Bus 8924 with DDC 6V92TA 240 hp
DCI Electric Dual Trap System

Engine Back Pressure (" hg)

<table>
<thead>
<tr>
<th></th>
<th>Jan 5, 1990</th>
<th>Jan 10, 1990</th>
<th>Exhaust Thru Trap 1</th>
<th>Exhaust Thru Trap 2</th>
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ARB Chassis Dyno Mode #

AET-ORTECH International
ARB Trap System Demonstration
SCRTD Bus 8924 with DDC 6V92TA 240 hp
DCI Electric Dual Trap System

Trap Temperatures (°C)

Jan 10+11, 1990

Exhaust Thru Trap 2

Exhaust Thru Trap 1

ARB Chassis Dyno Mode #
Chassis Dyno Data Collected at ARB
Jan 10, 1990 (Trap 1, no regeneration)
Mode Chassis Dyno Emission Data Collected at A1

Jan 10, 1990—(Trap 1, no regeneration)
Warm-up Dyno Emission Data Collected at ARB
Jan 11, 1990 (Trap 2, no regeneration)
Warm up Dyno Emission Data Collected at ARB
Jan 11, 1990 (Trap 2, no regeneration)
Mode Chassis Dyno Emission Data Collected at A

Jan 11, 1990 (Trap 2, no regeneration)
From ARB to SCRTD Route Data

Jan 12, 1990 (Both Traps, no regeneration)

Graph showing trap temperatures over time:
- T1 Inlet
- T1 Outlet
- T2 Inlet
- T2 Outlet
From ARB to SCRTD Route Data

Jan 12, 1990 (Both Traps, no regeneration)
Chassis Dyno Data Collected at ARB

Jan 10, 1990 (Trap 1, no regeneration)
Mode Chassis Dyno Emission Data Collected at A

Jan 11, 1990 (Trap 2, no regeneration)
From ARB to SCRTD Route Data

Jan 12, 1990 (Both Traps, no regeneration)
APPENDIX M

Trap Performance Data
Collected at ARB on
January 17, 18, 1990.
SCRTD Bus Wash Route

Jan 18, 1990 (Automatic Mode)

Trap Temperatures (℃)

05:45 AM  06:14 AM  06:43 AM  07:12 AM

Trap 2 Inlet  +  Outlet  Face
SCRTD Bus Wash Route
Jan 18, 1990 (Automatic Mode)

Graph showing Trap Temperatures (°C) over time from 05:45 AM to 07:12 AM, with peaks and dips indicating changes in temperature.

- Trap 1 Inlet
- Outlet
- Pace
APPENDIX N

Technical Report from Corning Inc.
Southern California Rapid Transit District

September 11, 1990

William J. von Hagn

Corning Incorporated
Research and Development Division
Corning, NY 14831
Procedure

Two overloaded filters, ID# 5215B149-43, and ID# 5215B149-44 were received from SCRTD.

The filters were weighed prior to and after each process step to identify the total weight reduction, with the exception of the starting weight of filter #5215B149-44. The starting weight was not obtained. This filter was vacuumed prior to obtaining a starting weight in order to confirm a suspected melted area. (see Table I)

Six thermocouples were inserted into the exit end of the filter. These thermocouples were used to identify the light off of the accumulated soot and to watch for any major thermal gradients within the filter during regeneration. The temperature of the filters never exceeded 650°C.

A piece of fiberfrax was placed over both ends of the filter to limit the oxygen entering the filter during the peak regeneration temperatures. This step is highly recommended.

After the filters were regenerated the filters were integrity tested. Several areas of both filters failed the integrity test. Filter #5215B149-43 showed excessive adjoining cell failures. Filter #5215B149-44 was confirmed to have a melted region.
Firing Schedule

After visually inspecting the filter and observing excessive soot on the entrance end of the filter, the firing schedule was modified. Two schedules for the regeneration of overloaded filters are recommended. The first is for extreme overloading and the second is for filters identified as possible or suspect of overloading.

A recommended schedule for regenerating extremely overloaded filters is as follows.

100°C/hr. to 200°C
hold @ 200°C/4 hr.
100°C/hr to 450°C
hold @ 450°C/4 hr.
100°C/hr to 550°
hold @ 550°/12 hr.

A recommended schedule for regenerating filters suspect of overloading is as follows.

100°C/hr. to 200°C
hold @ 200°C/1 hr.
100°C/hr to 450°C
hold @ 450°C/1 hr.
100°C/hr to 550°
hold @ 550°/8 hr.
<table>
<thead>
<tr>
<th>TABLE I</th>
</tr>
</thead>
<tbody>
<tr>
<td>WEIGHT REDUCTION</td>
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</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>wt. of filter as received</th>
<th>wt. after vacuum</th>
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</thead>
<tbody>
<tr>
<td>wt. after firing</td>
<td>13,011 grams</td>
<td>12,768 grams</td>
</tr>
<tr>
<td>wt. after vacuum</td>
<td>13,004 grams</td>
<td>12,754 grams</td>
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<tr>
<td>TOTAL</td>
<td>455 gm</td>
<td>347 gm</td>
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</tbody>
</table>

*Note: Weights are rounded for simplicity.*
Photo #1 is of the box as it was received. The soot is visible leaking from the box.
Photo #2 is of the entrance end of the filter. Photo #3 is the ID# of the filter. Photo #4 is the exit end of the filter. The multiple blackened dots are a good indication of internal failure.
Photo #5 illustrates the vacuuming of the entrance end of the filter. In Photo #6 a piece of welding rod is inserted into the exit end of the filter in an attempt to identify any possible melted regions within the filter. Photo #7 is again the filter identification number. The oxidation of the can is evident in this photo. This occurs after furnace regeneration. Photo #8 is of the clear tape that was placed on the exit end of the filter. The filter was loaded with graphite and rolled to identify any possible failures within the filter. The graphite will stick to the tape in these failed areas.
Photo #9 is of the removal of the filter can. A plasma arc cutting rig is used in the cutting process. This is thought to cause the least damage to the filter during removal of the can. Photo #10 is of the filter after half the can was removed. The red dots were placed along the crack lines as a photographic aid. Photos #11 and #12 are the filter after merely push on the filter. The topographical appearance of filter is a clear indicator of thermal fatigue. The black areas are residual carbon and the brown areas are the catalyst on the filter.
APPENDIX O

SCRTD Trap System Data
(July 25, 26, 1990)
APPENDIX P

SCRTD Trap System Data
(August 24, 25, 1990)
APPENDIX Q

Field Report to SCRTD to Correct Problem with Trap
Bus #8924
Trip Report - Visit to SCRTD to Correct Problem with Trap bus
For: Air Resources Board

Air Resources Board
State of California
9528 Telstar Avenue
El Monte, CA 91731

Attention: Mr. M. O'Connor

Submitted by:
Kong Ha
Advanced Engine Technology

February 28, 1990
BACKGROUND

- SCRTD personnel could not download the data logger storage (SM 716) data to the project laptop computer (Bondwell 300).
- Data logger did not appear to have collected recent data. The last SM 716 contained a very limited amount of data.
- The Bondwell 300 loaded with Measure was not communicating with the trap controller.
- Error lights #6 and #17 appear regularly. The error lights appear to indicate a faulty air flow sensor. An erroneous low air flow signal input to the trap controller will result in a low k factor and thus causing insufficient particulate loading regeneration. An erroneous high air flow signal input to the trap controller will result in a high k factor and thus over loaded trap regeneration may occur. This concern suggests prompt action is needed to resolve the above issues.

Preparation for the February 9, 1990 visit.

- DCI is calibrating a new SCFM sensor set-up.
- A set of tested ceramic catalyzed filters were shipped to SCRTD from DCI.
- ORTECH procured a new Bondwell 310 laptop computer, with all communication hardware.
- A new Measure program was sent to ORTECH by DCI and loaded onto the Bondwell 310.

EVENTS AND RESULTS

- The Bondwell 300 was shown not to be downloading to the SM 716 and also not communicating with the trap controller.
- The Bondwell 310 was used and retrieved data from the SM 716. The SM 716 contained data collected from February 5, 1990 to February 13, 1990.
The trap system controller was reset to erase the error signal #17. The bus was then driven over a test route.

During the test route, the Bondwell 310 communicated with the trap system controller. This clearly indicated that the serial port of the Bondwell 300 needs to be repaired.

The bus was then returned to the depot. The SM 716 data was downloaded to the Bondwell 310. Very few data points (18) were collected over the 1 hour test route. Further analysis of the data appeared to indicate that the data logger was not receiving the correct exhaust temperature and this was not triggered into data collection mode. The exhaust temperature input signal was switched with trap 1 inlet temperature and used as a data collection triggered temperature. This is only a temporary solution, and ORTECH will procure new thermocouples and will install them during the week of March 5, 1990.

The bus was then driven for the next two hours in an attempt to understand the conditions at which the error lights will appear. During the test route, and when trap #1 began to regenerate, an error message #14 appeared on the Bondwell 310 followed by the error message #28. The bus was stopped but no error light appeared on the trap controller. The Bondwell 310 also was frozen and data could not be saved. Upon rebooting the Bondwell 310, it was also discovered that the Measure program was damaged (part of file missing). Attempts to reload the file were not successful.

The bus was then driven back to the depot. Exhaust is being routed through trap #2. No error lights appeared on the trap controller.

SM 716 data was downloaded to the Bondwell 310. A new data collection program (10 second collection interval) was loaded into the data logger.

Data logger software was loaded onto a computer at SCRTD and shown to be functioning correctly. This will be the backup for SCRTD to download the data from the SM 716.
ACTION ITEMS

- ORTECH will repair and upgrade the Bondwell 300.
- SCRTD will contact ORTECH as soon as an error light appears.
- ORTECH will analyze all the data collected.
- A copy of the data will be sent to DCI.
- ORTECH will procure, thermocouple to replace the defective turbo thermocouple.

SUMMARY

The error signals from the trap controller in conjunction with the faulty thermocouple, project computer and the wrong software, prompted this visit to SCRTD. Appropriate action steps were taken to diagnose the situation. Further action items will resolve all the issues.

The trap system is believed to be in good working order. New filters for emission testing at ARB have been scheduled for the week of March 5, 1990.

Kong Ha
February 28, 1990
APPENDIX R

Backpressure and Trap Temperature Graphs
ARB Particulate Trap Demonstration
SCRKD Bus 8924 (Jan 07, 1991)
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Jan 08, 1991)

Engine Back Pressure (in Hg)

05:16 AM 05:45 AM 06:14 AM 06:43 AM 07:12 AM 07:40 AM 08:09 AM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 08, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 09, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 10, 1991)

Engine Back Pressure (in Hg)

04:48 AM      09:36 AM      02:24 PM      07:12 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 11, 1991)
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Jan 12, 1991)

Engine Back Pressure (in Hg)

09:36 AM 12:00 PM 02:24 PM 04:48 PM 07:12 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 14, 1991)

Engine Back Pressure (in Hg)

04:48 AM 09:36 AM 02:24 PM 07:12 PM
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Jan 15, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 16, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 17, 1991)

Engine Back Pressure (in Hg)
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Jan 19, 1991)

[Graph showing Engine Back Pressure (in Hg) for a day]

02:24 AM 07:12 AM 12:00 PM 04:48 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jan 21, 1991)

Engine Back Pressure (in Hg)

12:00 AM 04:48 AM 09:36 AM 02:24 PM 07:12 PM
Engine Back Pressure (in Hg)
ARB Particulate Trap Demonstration
SCRTRD Bus 8924 (Jan 24, 1991)

--- Trap 1 Inlet  --- Trap 1 Outlet  ○ Exhaust

--- Trap 2 Inlet  --- Trap 2 Outlet  ○ Exhaust
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Feb 01, 1991)

Temperature (°C) (Thousands)

07:12 AM   12:00 PM   04:48 PM   09:36 PM

--- Trap 1 Inlet + Trap 1 Outlet ◯ Exhaust

--- Trap 2 Inlet + Trap 2 Outlet ◯ Exhaust
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Feb 04, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 05, 1991)

Engine Back Pressure (in Hg)

12:00 AM 04:48 AM 09:36 AM 02:24 PM 07:12 PM 12:00 AM
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Feb 06, 1991)

Engine Back Pressure (in Hg)

12:00 AM  04:48 AM  09:36 AM  02:24 PM  07:12 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 09, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 6924 (Feb 09, 1991)

12:00 AM  04:48 AM  09:36 AM  02:24 PM

--- Trap 1 Inlet  - Trap 1 Outlet  ● Exhaust

ARB Particulate Trap Demonstration

SCRTD Bus 6924 (Feb 09, 1991)

12:00 AM  04:48 AM  09:36 AM  02:24 PM

--- Trap 2 Inlet  + Trap 2 Outlet  ● Exhaust
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 11, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 12, 1991)
ARB Particulate Trap Demonstration

SCRPA Bub 8924 (Feb 13, 1991)

Engine Back Pressure (in Hg)
ARB Particulate Trap Demonstration

SCRID Bus 8924 (Feb 14, 1991)

Engine Back Pressure (in Hg)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 14, 1991)

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Temperature (C) (Thousands)

12:00 AM  04:48 AM  09:36 AM  02:24 PM  07:12 PM

---

Trap 1 Inlet  + Trap 1 Outlet  ○ Exhaust

---

ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 14, 1991)

Temperature (C) (Thousands)

12:00 AM  04:48 AM  09:36 AM  02:24 PM  07:12 PM

---

Trap 2 Inlet  + Trap 2 Outlet  ○ Exhaust
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 18, 1991)
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Feb 19, 1991)
ARB Particulate Trap Demonstration

SCRFD Bus 8924 (Mar 25, 1991)

Engine Back Pressure (in Hg)

02:24 AM 07:12 AM 12:00 PM 04:48 PM 09:36 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Apr 22, 1991)

Engine Back Pressure (in Hg)

02:24 AM  07:12 AM  12:00 PM  04:48 PM  09:36 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (May 09, 1991)
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (May 30, 1991)

Temperature (°C) (Thousands)

12:00 AM 02:24 AM 04:48 AM 07:12 AM 09:36 AM

— Trap 1 Inlet  + Trap 1 Outlet  ○ Exhaust

ARB Particulate Trap Demonstration
SCRTD Bus 8924 (May 30, 1991)

Temperature (°C) (Thousands)

12:00 AM 02:24 AM 04:48 AM 07:12 AM 09:36 AM

— Trap 2 Inlet  + Trap 2 Outlet  ○ Exhaust
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jun 03, 1991)

Engine Back Pressure (in Hg)

12:00 AM 04:48 AM 09:36 AM 02:24 PM 07:12 PM
ARB Particulate Trap Demonstration
SGRTD Bus 8924 (Jun 11, 1991)

Engine Back Pressure (in Hg)

12:00 AM  04:48 AM  09:36 AM  02:24 PM  07:12 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Jun 14, 1991)
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Oct. 11, 1991)

Temperature (°C) (Thousands)

04:48 AM  07:12 AM  09:36 AM  12:00 PM  02:24 PM  07:12 PM  09:36 PM  04:48 AM  12:00 AM

--- Trap 1 Inlet
+ Trap 1 Outlet  ○ Exhaust

ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Oct. 11, 1991)

Temperature (°C) (Thousands)

04:48 AM  07:12 AM  09:36 AM  12:00 PM  02:24 PM  07:12 PM  09:36 PM  04:48 AM  12:00 AM

--- Trap 2 Inlet
+ Trap 2 Outlet  ○ Exhaust
ARB Particulate Trap Demonstration
SCRTD Bus 8924 (Dec. 16, 1991)

Engine Back Pressure (in Hg)

02:24 AM 04:48 AM 07:12 AM 09:36 AM 12:00 PM 02:24 PM 04:48 PM 07:12 PM 09:36 PM
ARB Particulate Trap Demonstration

SCRTD Bus 8924 (Dec. 24, 1991)