

## ACX-10 Field Installation and Evaluation Oct 21<sup>st</sup> through Nov 1st, 2002 Silver State and CR England Fleets

### Authors:

Tony Thorne  
Manager of Electrical Engineering

David DeLeon  
Project Engineer

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### Overview

The ACX-10 is nearing the final stages of development with revision #4 nearing the internal engineering qualification test completion. The beta test field trials determine proper operation and the product meets the customer's expectations.

Two customers are presently participating in the beta program, Silver State cement truck fleet located in Henderson Nevada, and CR England fleet trucks located in Salt Lake City Utah.

The beta test program provides data loggers and ACX-10 air conditioner (A/C) control units for the test fleet. The trucks were broken into 2 groups, 50% were fitted with specialized event data loggers (X-Logger™) with ACX control units, and the other 50% of the fleet trucks were fitted with X-Loggers only.

The data loggers capture the events during normal "in-service" operation which shows several key data points:

- Engine ON cycles (number of times the engine is started)
- Number of hours of engine operation
- Number of A/C Clutch cycles (closures)
- Number of accumulated hours the A/C unit is running
- Truck serial (identifier) number
- Miles of truck
- Hours of truck

The two fleets have various maintenance cycles, each with different degrees of A/C failure issues. The ACX-10, when installed reduces the number of times the clutch is cycled, thereby reducing overheating or premature failure.

### Silver State

Located in Henderson NV, 72 freightliner cement trucks were fitted with equipment; 33 with data loggers only, 34 with both data loggers and ACX-10. These trucks are distributed at three Silver State facilities located around the Las Vegas vicinity.

The 72 cement trucks make prime beta program candidates because approximately 90% of their time is spent idling under Nevada conditions which reduces under hood airflow and increases the air conditioner burden.

Tom Hogan, (shown below) is the Assistant Maintenance Manager responsible for all three plants. Tom mentioned he has a very high failure rate of compressors because of the low engine RPM (idle time), and high temperature applications in cement truck duty.



### ACX Module Installation:

The ACX-10 is basically performed in three steps;

- Access & connect wire harness switched power and ground
- Bolt ACX to bulk head (or other fixed and secure point)
- Connect interface connectors to the A/C compressor and input control

The kits were configured for single wire A/C clutch control, dual wire A/C clutch control, and the single and dual wire installations with data logger only.



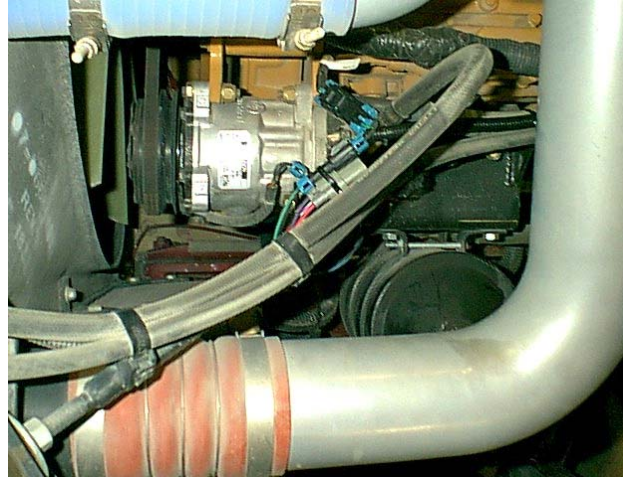
The trucks were rotated through the facility, each requiring 10 to 30 minutes of install time.



The newer vehicles had more challenges with coolant overflow tanks, accumulators, and other devices in the way of installation, but still the process was relatively easy.



The trucks' vintage varied, as did the brands of A/C compressors and their installed locations. The easiest to work on were trucks with compressors located on the lower drivers side of the CAT 10 liter engines (shown below).

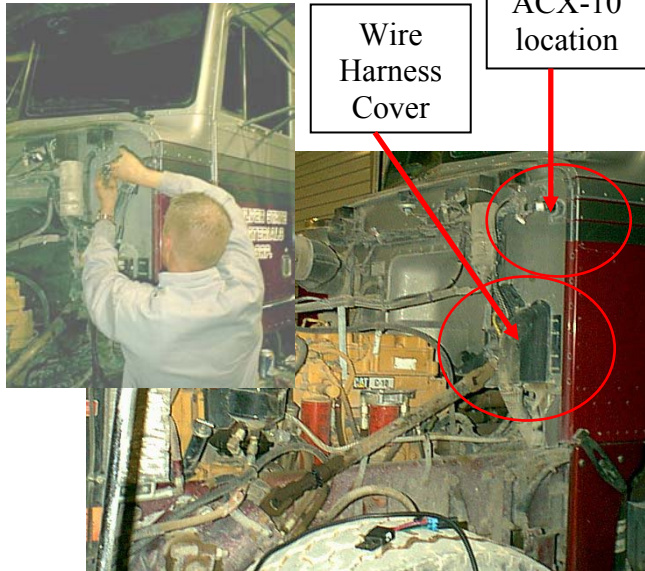


The top mounted version, although still an easy install required more care routing wires and connectors to clear the radiator fan and drive belts.

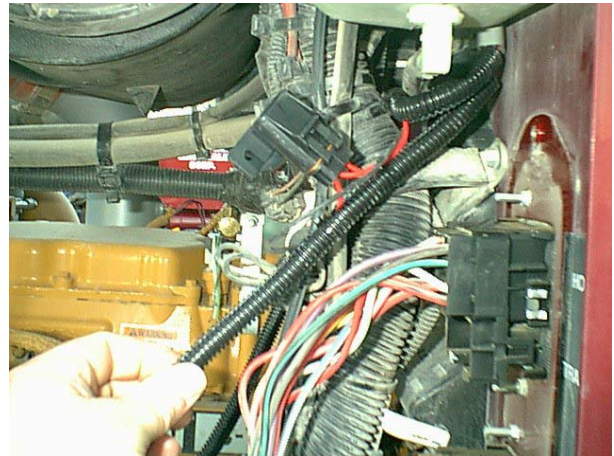


**Step 1: Access Wire harness for Power & Ground:**

There are differences between some trucks based on their vintage and configuration. Some have extra coolant capture tanks and accumulator which may make installation more of a challenge.



The ACX wire harness is routed to the Cab wire duct:



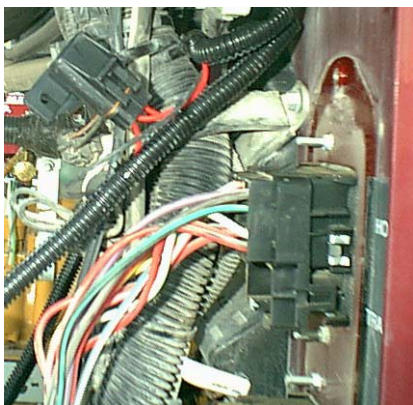
Using the trucks wiring diagram a switched DC accessory (ACC) wire was located. The first wire tapped into turned out to also run the reverse warning beeper (and some non-critical accessory lighting).

The manufacturer wiring diagrams did not show these connections to the AUX lines, so care must be taken when selecting a source of switched power. A proper wire connection was later found and properly installed.

The “cab and truck wire harness” access cover (shown below) provides access to the 12V switched and fused accessory wire that powers the ACX module when the ignition is turned on.



Cab wiring cover is removed:



The cab wire access cover is re-installed. Special attention was placed in ensuring the connector was protected from abrasion and zip tied for relief:



Mounted to the engine harness mounting bolt which also provides the ground point.



**Step 2: Install and Mount ACX-10:**

The ACX-10 routed into position:

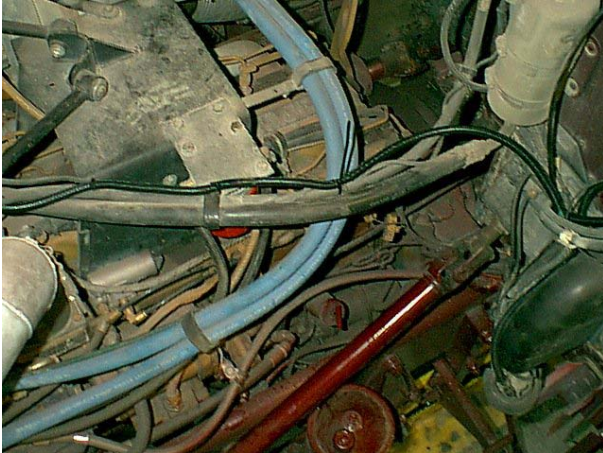


Finished view (truck without coolant recovery tank shown below)



**Step 3: Route and Connect the Interface Wires:**

Routing the wires along the A/C hoses secured with Zip Ties©



Connection to the A/C compressor included the Index Sensors X-Logger™. The data logger is mounted to a spare compressor mounting lug, including the X-Logger ground wire (when required). The data collection port is shown below and very accessible:



There were discussions of the low pressure and high pressure switches, and how the Index Switches are better than the OEM (TI) versions. David will make up a few samples for Silver State to test.

Although there are not a lot of failures, the switch that does fail is the low pressure side, attributed to the constant cycling of the clutch caused by cyclic pressures.

Low pressure Switch:



High Pressure Switch:



**Applications & Systems Discoveries:**

During the evaluation, it was discovered the size of the condenser was oversized when used with the viscous clutch engine fan. Air-driven fans which do not run continuously seem to operate properly.

Since the viscous engine fan basically runs continuously, the refrigerant pressure is never allowed to build and operate efficiently. These systems with large condensers had experienced clutch failures. In trucks utilizing modified condensers with ½ the tubes bypassed (not shown), the systems operated correctly.



### CR England

The CR England fleet, located in Salt Lake City Utah is home to approximately 1000 fleet trucks (majority are 15 liter diesel Freightliner). Working with Grant Oakeson and utilizing their data base, we located over a dozen trucks on the lot.

The objectives for this trip are to download data collected by the X-Logger™ from as many trucks as possible during the two day trip.

The fleet trucks are located across three areas: receiving, refit, and ready to roll. Covering the few-hundred acre facility looking for trucks was challenging as the trucks may arrive at any time and some trucks are moving from place to place.



Data from the located trucks were downloaded using a laptop and the X-Logger software:



Some of the compressors were located on top the engine which made access more difficult.



We also discovered that some trucks had batteries that were at 11.8VDC, below the acceptable data logger level. This required starting the trucks to charge the batteries and allow the data to be downloaded. Improvements to the data logger for future beta tests should include:

- Longer data port for easier access
- DC input low voltage cutout lowered to 10VDC
- Mark the wire harness and connectors to where they plug into
- Serial number and model sticker on X-Logger
- Change the output connector to a standard RS232 nine pin cable with weather cover

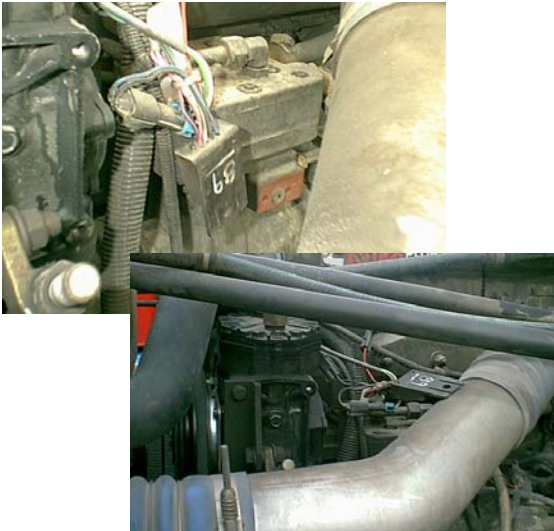
Other suggested improvements are to utilize a PDA type RS232 interface such as a \$99.00 Palm-Pilot M-100. Downloads would be easier and less intrusive for customers who may not have laptops to take to the trucks. This also provides a communicating device for future Index products.



CR England continued:

Two of the trucks underwent field repair of the A/C compressors of where the technicians unplugged or removed the data loggers and ACX units. Two other units were also serviced where the A/C clutches were replaced and the data logger was not reconnected. It is apparent the technicians did not know what this device was.

We spoke with Grant about additional printed materials, cards, or labels that would help provide the technicians more information. David DeLeon will explore other methods such as wire labels or tags for the wire harnesses.



Once downloaded, the data provided eye opening numbers. The cycle rates of the A/C compressor clutches are more than what we expected, confirming that the cost of repairs can be reduced if the A/C system can be protected from over-cycling.

CR England - Fleet Truck Results:

Overall annual average for these fleet trucks are 5000 hours engine run time, for 45,000 clutch cycles, and 1100 hours of A/C operation.

Silver State - Cement Truck Results:

The data is still coming in, but the average of this trip showed 5700 clutch cycles per week. The trend is for every 10 hours of engine operation, the A/C ran for an equivalent of 3 hours. The ratio of A/C to truck operation for 3000 hours per year equates to 1000 hours A/C operation with over 20,000-50,000 clutch cycles per year (assumptions depend on regional climates and system integrity).

**Conclusion**

The ACX-10 has demonstrated to the customer the reduced A/C maintenance caused by premature clutch failure (none ACX trucks required clutch replacements).

It is apparent from the limited data below that these systems are run very hard and require a controlled A/C system to prevent premature costs associated with failed compressor clutches.



Five Month Data:  
(CR England's Fleet)

Truck Number	Mileage	Power Cycles	Power On Time (hrs)	Clutch Cycles	Clutch On Time (hrs)	ACX	Log
53186	256602	2278	3592.46	15639	285.16		X
52835	359159	278	1361.33	17653	600.79	X	X
52897	368629	4541	3590.19	9293	379.63		X
53490	298400	14	1784.35	50270	1022.45	X	X
90987	84550	1266	3617.05	32190	1480.79		X
52187	490650	2030	3596.08	10719	352.52		X
52975	82835	2525	3594.86	2440	255.8		X
52187	490289	901	1892.4	9670	288.3		X
53119	366077	1443	1912.59	13916	261.37		X
53657	136473	1856	1919.73	42039	402		X
52897	317560	2847	1889.71	59073	245.6		X
53443	303261	1026	988.26	47068	776.55	X	X
52606		768	1893.91	5030	1170		X
51867		86	112.9	209	9.4		X
53395	196061	512	1426.5	22028	962.97	X	X
52932	106662	1391	1381.81	44363	1031.84	X	X
52392	459230	512	524.72	37134	339.55	X	X
Sum	X	24274	35078.85	418734	9864.72		
Avg/June-Nov	5-Month	1427.9	2063.5	24631.4	580.3		
	Per Month	285.6	412.7	4926.3	116.1		
Approx	Per Year	3426.9	4952.3	59115.4	1392.7		