CALIFORNIA ENERGY COMMISSION

CALIFORNIA NATURAL RESOURCES AGENCY

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Oceanside Unified School District Compressed Natural Gas Upgrade Project

Prepared for: California Energy Commission

Prepared by: Oceanside Unified School District

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California Energy Commission

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program. The statute authorizes the California Energy Commission (CEC) to develop and deploy alternative and renewable fuels and advanced transportation technologies to help attain the state's climate change policies. Assembly Bill 8 (Perea, Chapter 401, Statutes of 2013) reauthorizes the Clean Transportation Program through January 1, 2024, and specifies that the CEC allocate up to $20 million per year (or up to 20 percent of each fiscal year's funds) in funding for hydrogen station development until at least 100 stations are operational.

The Clean Transportation Program has an annual budget of about $100 million and provides financial support for projects that:

- Reduce California's use and dependence on petroleum transportation fuels and increase the use of alternative and renewable fuels and advanced vehicle technologies.
- Produce sustainable alternative and renewable low-carbon fuels in California.
- Expand alternative fueling infrastructure and fueling stations.
- Improve the efficiency, performance and market viability of alternative light-, medium-, and heavy-duty vehicle technologies.
- Retrofit medium- and heavy-duty on-road and nonroad vehicle fleets to alternative technologies or fuel use.
- Expand the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors.
- Establish workforce-training programs and conduct public outreach on the benefits of alternative transportation fuels and vehicle technologies.

To be eligible for funding under the Clean Transportation Program, a project must be consistent with the CEC's annual Clean Transportation Program Investment Plan Update. The CEC issued PON-12-605 to support the installation of new natural gas fueling infrastructure and upgrades to existing natural gas fueling infrastructure. In response to PON-12-605, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 2, 2013 and the agreement was executed as ARV-13-006 on January 21, 2014.

ABSTRACT

Oceanside Unified School District originally installed a compressed natural gas time-fill fueling facility for its fleet use in 2002 located at 2070 Mission Avenue, Oceanside, California 92054. During the early part of 2012, the performance of both compressors started to substantially deteriorate, and by March 2012, the compressors were no longer functional. The school district fleet had to travel to the nearest fueling station located in Carlsbad. In August 2013, the school district had no choice to but to replace the compressors in order to keep their fleet of 29 natural gas buses running.

Grants from the California Energy Commission and District funding allowed the school district to purchase a new dryer to compliment the new compressors, and to replacing the aging natural gas infrastructure in order to have a more efficient and safer fueling system. In April of 2015, AMTEK Construction was awarded the installation contract. The installation of the equipment was completed in October 2015. Since the completion of the fueling station upgrade, the school district has purchased three additional natural gas vehicles.

Keywords: California Energy Commission, Oceanside Unified School District, compressed natural gas, natural gas, school bus fleet, CNG fueling station

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EXECUTIVE SUMMARY

Oceanside Unified School District originally installed a compressed natural gas time-fill fueling facility for its fleet use in 2002 located at 2070 Mission Avenue, Oceanside, California 92054. The facility is owned and operated by Oceanside Unified School District and uses non-renewable natural gas provided by Sempra Energy.

The facility has consistently fueled over 50,400 standard cubic feet of compressed natural gas or 373 diesel gallon equivalents per day for their existing fleet of 29 school buses over the last ten years.

During the early part of 2012, the performance of both compressors started to substantially deteriorate. The compressors suffered massive operational failures which rendered them all but impossible to repair, given their obsolescence and scarcity of parts. The original compressors were manufactured in the United Kingdom and had minimal domestic support. CNG consultants who have visited the facility agreed it was economically unfeasible to re-build the compressors.

In March 2012, the compressors were no longer functional. This resulted in crippling 38 percent of the fleet. Without a compressed natural gas fueling facility on site, the school district fleet would have to travel to the nearest compressed natural gas fueling station located in Carlsbad, a neighboring city. This would entail significant additional costs associated with additional labor, vehicle depreciation, fueling charges, etc. The school district had to immediately bring in rental equipment to fulfill their transportation obligation to their community. However, the rental equipment was not always reliable and created many disruptions in the operation. In August 2013, the school district had no choice but to somehow come up with funding to replace the compressors.

In December 2013, it became apparent that the current dryer was not operating as efficiently, causing the buses to have outages due to the dryer releasing moisture into the system. Along with these issues targeting the buses, the entire compressed natural gas fueling station started to fail. The infrastructure itself had deteriorated due to exposure and age. Fuel lines had cracks and nozzles were not seating correctly, which was causing safety concerns during venting. With the inefficiency of the dryer, the compressor was working overtime pumping natural gas into the atmosphere within the range of pedestrians and employees.

The Director of Transportation approached the District with his concerns about the compressed natural gas fueling station. Due to budget constraints, Oceanside Unified School District knew that applying for grant funding would be the only feasible option. Oceanside Unified School District applied for a grant through the California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program's natural gas fueling infrastructure and upgrades solicitation. In January 2014, the school district was awarded grant funding from the California Energy Commission.

The compressed natural gas fueling station system design and specifications were already in place. The project would include upgrading the system with a new dryer, hoses, nozzles, and time fill posts. In addition to replacing twenty-three fill posts at 3,000 pound-force per square

inch, four-time fill posts designed for 3,600 pound-force per square inch would need to be installed for a total of seven 3,600 pound-force per square inch fill posts.

In February 2015, Oceanside Unified School District started the bid process to rebuild the compressed natural gas fueling station. There were several companies interested in the project. A job walk was conducted in March 2015. Because of the safety and concerns involved with the old fueling system, the school district was able to quickly award the work contract to AMTEK Construction in April 2015.

AMTEK Construction selected and procured all the equipment needed for the fueling station upgrade. The site preparation for the equipment was minimal since the project only involved replacing old equipment with new equipment. The installation of the equipment took a total of two weeks to complete. However, after the installation was complete, a few issues arose causing some equipment damage.

Oceanside Unified School District contacted AMTEK Construction regarding the issues and AMTEK Construction immediately contacted Hoke Controls, manufacturer of the time-fill posts. The engineers at Hoke Controls were able to diagnose the issues and repair the equipment.

The installation of the equipment was completed on October 13, 2015. The Fire Marshall inspection was completed on October 28, 2015.

Overall, Oceanside Unified School District is very pleased with the final outcome of the upgraded compressed natural gas fueling station, and the attention the school district received from all companies involved. Since the completion of the fueling station upgrade, the school district has purchased three additional compressed natural gas vehicles.

CHAPTER 1:
Project Background and Objectives

1.1 Background

Oceanside Unified School District originally installed a compressed natural gas (CNG) time-fill fueling facility for its fleet use in 2002 located at 2070 Mission Avenue, Oceanside, California 92054. The facility is owned and operated by Oceanside Unified School District and uses non-renewable natural gas provided by Sempra Energy. The CNG fueling station consisted of:

- One single tower regenerative dryer sized for 150 standard cubic feet per minute (SCFM)
- Two electric motor driven, multi-stage gas compressors, each with the capability of providing 70 SCFM.
- Twenty-two single hose fueling posts
- Five dual hose fueling posts

The facility has consistently fueled over 50,400 standard cubic feet of CNG or 373 diesel gallon equivalents per day for their existing fleet of 29 school buses over the last ten years. The existing fleet consists of:

- Eight 39-passenger BlueBird CNG buses
- Six 78-passenger BlueBird CNG buses
- Fifteen 84-passenger BlueBird CNG buses

During the early part of 2012, the performance of both compressors started to substantially deteriorate. The compressors suffered massive operational failures which rendered them all but impossible to repair, given their obsolescence and scarcity of parts. The original compressors were manufactured in the United Kingdom and had minimal domestic support. CNG consultants who have visited the facility agreed it was economically unfeasible to re-build the compressors.

In March 2012, the compressors were no longer functional. This resulted in crippling 38 percent of the fleet. Without a CNG fueling facility on site, the school district fleet would have to travel to the nearest CNG fueling station located in Carlsbad, a neighboring city. This would entail significant additional costs associated with additional labor, vehicle depreciation, fueling charges, etc. The school district had to immediately bring in rental equipment to fulfill their transportation obligation to their community. However, the rental equipment was not always reliable and created many disruptions in the operation. In August 2013, the school district had no choice but to somehow come up with funding to replace the compressors.

In December 2013, it became apparent that the current dryer was not operating as efficiently, causing the buses to have outages due to the dryer releasing moisture into the system. Along with these issues targeting the buses, the entire CNG fueling station started to fail. The infrastructure itself had deteriorated due to exposure and age. Fuel lines had cracks and nozzles were not seating correctly, which was causing safety concerns during venting. With the inefficiency of the dryer, the compressor was working overtime pumping natural gas into the atmosphere within the range of pedestrians and employees.

1.2 Project Goals

Oceanside Unified School District needed to upgrade the existing CNG fueling station that currently refuels a fleet of 29 CNG school buses to be able to continue to provide consistent and reliable transportation for the students of the district. The purpose of the project was to purchase a new dryer to compliment the new compressors, and to replace the aging CNG infrastructure in order to have a more efficient and safer fueling system.

CHAPTER 2:
Project Approach

2.1 Approach to Achieve Project Purpose

In December 2013, the Director of Transportation approached Oceanside Unified School District with his concerns about the CNG fueling station. Due to budget constraints, Oceanside Unified School District knew that applying for grant funding would be the only feasible option. Oceanside Unified School District applied for a grant through the California Energy Commission's Alternative and Renewable Fuel and Vehicle Technology Program's natural gas fueling infrastructure and upgrades solicitation. In January 2014, the school district was awarded grant funding from the California Energy Commission.

Due to a Director of Transportation change, the project was set aside until the position could be filled. With additional time elapsing and the continuation of the CNG infrastructure deterioration, in February 2015, the Transportation Department contacted Chris Wright, the District Assistant Superintendent, with their concerns. Chris Wright then contacted the Accounting / Purchasing Department to see what needed to be implemented for the CNG infrastructure upgrade.

The CNG fueling station system design and specifications were already in place. The project would include upgrading the system with a new dryer, hoses, nozzles, and time fill posts. In addition to replacing twenty-three fill posts at 3,000 pound-force per square inch, four-time fill posts designed for 3,600 pound-force per square inch would need to be installed for a total of seven 3,600 pound-force per square inch fill posts.

In February 2015, Oceanside Unified School District started the bid process to rebuild the CNG fueling station. There were several companies interested in the project. A job walk was conducted in March 2015. Because of the safety and concerns involved with the old fueling system, the school district was able to quickly award the work contract to AMTEK Construction in April 2015.

AMTEK Construction selected and procured all the equipment needed for the fueling station upgrade. The site preparation for the equipment was minimal since the project only involved replacing old equipment with new equipment.

Figure 1 and Figure 2 below shows the concrete work laid for the CNG dryer and the CNG dryer shipped to location. Additional images from the project can be found in the Appendix of this report.

Figure 1: CNG Dryer Concrete Work

Figure 2: CNG Dryer

The anticipated time from AMTEK Construction for the installation was three days, to be completed prior to the commencement of school on August 17, 2015. This included the time frame for the installation of the fueling posts, hoses, nozzles and dryers. However, the installation took a total of two weeks.

Additional issues occurred due to the fuel lines not being adequately blown out. This caused stainless steel shavings to become jammed into several bus fuel lines, causing the bus to expel fuel from the tanks. Oceanside Unified School District's Transportation Department absorbed the cost of wasted fuel, labor for repairs, and out of service vehicles at a total of $790.00.

Other issues that occurred included equipment damage to gauges (see Figure 3 below), broken fuel / vent handles, and the O-rings installed on the nozzles were inoperative due to blowing out (see Figure 4 below). A few time-fill posts had inadequate welds, causing the posts to break away from their securements.

Figure 3: Cracked Gauge

Figure 4: Defective O-Ring

Oceanside Unified School District contacted AMTEK Construction regarding the issues. AMTEK Construction immediately contacted Hoke Controls, manufacturer of the time-fill posts. The engineers at Hoke Controls diagnosed the issues, repaired the nozzles, and reinstalled new time-fill posts within 24 hours. The Lead Engineer from Hoke Controls trained the school district's service technician on how to check each post, hose and nozzle, and how to maintain the equipment. An Oceanside Unified School District service-certified technician will be inspecting the equipment on a weekly basis.

The installation of the equipment was completed on October 13, 2015. The Fire Marshall inspection was completed on October 28, 2015.

Figure 5: Fueling Post

Subcontractors for Project

Oceanside Unified School District used two subcontractors for the project, Environmental Vehicle Services and AMTEK Construction. Table 1 below provides details for each subcontractor.

Table 1: Subcontractors for the Project

	Major Subcontractor	Minor Subcontractor
Subcontractor Name	AMTEK Construction	Environmental Vehicle Services
Address	12409 Slauson Avenue Whittier, California 90606	1433 Merganser Drive McKinleyville, California 95519
Subcontractor Total Amount	$304,771.00	$11,350.00
Energy Commission Reimbursed Amount	$290,437.00	$5,625.00
Subcontract Term	Term started 3/10/2015	5/27/2014 to 8/11/2015
Purpose of subcontract	Installation of CNG fueling station equipment.	Consulting for CNG upgrade project. Scope includes: • Information gathering, compiling and reduction, and analysis • Bid specification generation, support, and review • Construction support • On-site visits and meetings

Source: Oceanside Unified School District.

Commissioning and Training

AMTEK Construction and Hoke Control's engineers explained both the proper maintenance of the dryers, time-fill posts, and nozzles and the maintenance and operations manual with Oceanside Unified School District's service worker assigned to maintain the system. AllSup Corporation also sent a copy of the Maintenance and Operations manual, as well as a technician to help explain how to troubleshoot the system during unexpected outages.

CHAPTER 3:
Results of Data Collection

3.1 Data Collection

The grant agreement required six months of data collection from the use from the upgraded CNG fueling station. Data collection commenced on August 2015 and continued until March 2016. Table 2 shows the data results over this 6-month collection period

Table 2: Six Month Data Collection

Data Collection Period	8/17/2015 - 10/30/2015	10/30/2015-12/8/2015	12/8/2015-1/7/2016	1/7/2016-2/9/2016	2/9/2016-3/11/2016	3/11/2016-4/12/2016
Therms as Documented by Utility Bills	2,704	6,286	5,139	8,129	8,907	6,802
Compressor Run Time (Hours)	88	84	92	74	82	80
Costs (Electricity + Therms)	$8,990.00	$6,736.94	$4,957.26	$8,954.00	$9,366.56	
SCFM	270.335	628.449	513.777	812.705	890.487	680.037
Number of CNG Buses Fueled	28	28	28	28	28	28
Number of Diesel Buses Fueled	43	43	43	43	43	43
Number of Days Vehicles Fueled	22	21	23	20	21	22
Maximum Capacity of New Fueling System (SCFM)	75	75	75	75	75	75
Mileage Documented (CNG Buses)	60,940	26,594	11,028	20,794	21,956	22,908

Data Collection Period	8/17/2015 - 10/30/2015	10/30/2015-12/8/2015	12/8/2015-1/7/2016	1/7/2016-2/9/2016	2/9/2016-3/11/2016	3/11/2016-4/12/2016
Mileage Documented (Diesel Buses)	104,914	45,611	28,486	49,572	42,380	39,451
Gallons of Gasoline/Diesel Fuel Displaced by Using Natural Gas (with associated mileage information)	2,165	5,146	4,398	1,722	7,132	5,821

Source: Oceanside Unified School District, San Diego Gas and Electric Utility Bills, SOCO Group Bills.

3.2 Analysis

Starting in October, the CNG fueling station had no further outages and began to run efficiently.

In January, the CNG fueling station experienced an outage for 24 hours due to a San Diego Gas & Electric generator fuse loss. The school district continued operations by fueling at another CNG fueling station located nearby in Carlsbad.

3.3 Greenhouse Gas Emission Reductions

At the beginning of the data collection period, there were a total of 73 school buses (28 CNG, 43 diesel, and 2 gas) in Oceanside Unified School District's fleet.

The greenhouse gas emission reductions from this project can be estimated using the estimated diesel displacement from the bottom row of Table 2 in combination with the carbon intensity values from the Low Carbon Fuel Standard. Based on Table 2, the average diesel fuel displaced by this project is approximately 4,397 gallons per month. The Low Carbon Fuel Standard estimates that carbon intensity of diesel fuel to be 98.03 grams carbon dioxide-equivalent per megajoule, and the carbon intensity of CNG to be 67.70 grams carbon dioxide-equivalent per megajoule. Based on these intensities, the average greenhouse gas reduction from the project would be approximately XX metric tons carbon dioxide-equivalent per month, or XX metric tons carbon dioxide-equivalent per year.[1]

[1] Carbon intensity values derived from ULSD001 and CNG001 pathways under the California Low Carbon Fuel Standard, as well as a diesel energy density of 134.47 megajoules per gallon. California Air Resources Board, "Table 7: Carbon Intensity Lookup Table for Diesel and Fuels that Substitute for Diesel," available at: http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf.

CHAPTER 4:
Conclusion

Oceanside Unified School District is very pleased with the final outcome of the upgraded CNG fueling station, and the attention the school district received from all companies involved (AMTEK Construction, Hoke Controls, and Allsup Corporation). The companies involved were able to repair and troubleshoot the issues the project had during the installation process. Oceanside Unified School District would recommend all of these companies for CNG fueling station upgrades and expansions.

Since the completion of the fueling station upgrade, the school district has purchased three additional CNG vehicles.

GLOSSARY

CALIFORNIA ENERGY COMMISSION (CEC)—The state agency established by the Warren-Alquist State Energy Resources Conservation and Development Act in 1974 (Public Resources Code, Sections 25000 et seq.) responsible for energy policy. The CEC's five major areas of responsibilities are:

1. Forecasting future statewide energy needs.
2. Licensing power plants sufficient to meet those needs.
3. Promoting energy conservation and efficiency measures.
4. Developing renewable and alternative energy resources, including providing assistance to develop clean transportation fuels.
5. Planning for and directing state response to energy emergencies.

Funding for the CEC's activities comes from the Energy Resources Program Account, Federal Petroleum Violation Escrow Account, and other sources.

COMPRESSED NATURAL GAS (CNG)—Natural gas that has been compressed under high pressure, typically between 2,000 and 3,600 pounds per square inch, held in a container. The gas expands when released for use as a fuel.

STANDARD CUBIC FEET PER MINUTE (SCFM)—The molar flow rate of a gas corrected to standardized conditions of temperature and pressure, thus representing a fixed number of moles of gas regardless of composition and actual flow conditions.

APPENDIX A:
Project Photos

These photos were all taken by Oceanside Unified School District staff. Figures 6 to 9 below depict the defective CNG fueling station before upgrades. The system was experiencing outages as the fueling lines were clogged with contaminated oil from the old compressor. Oil seeped through the nozzles causing the bearings to become weak and not secured down, which caused the fittings to be thrown off at high speeds.

Figure 6: Rust around Fueling Post

Source: Linda Horton, Oceanside Unified School District Transportation Director.

The old hoses had become frayed and cracked, some through the rubber casing to the mesh inner layer. The school district had to put those hoses out of service because of the danger that a small pinhole could cause high pressure injections.

The hose and fitting assemblies no longer stayed secured to the posts because of the rust, expansion and overuse. The hoses also had dangerous bulges on and around the nozzles where the drivers connected the nozzles to the tanks. The hoses would also lie on the ground as the pulleys no longer worked properly.

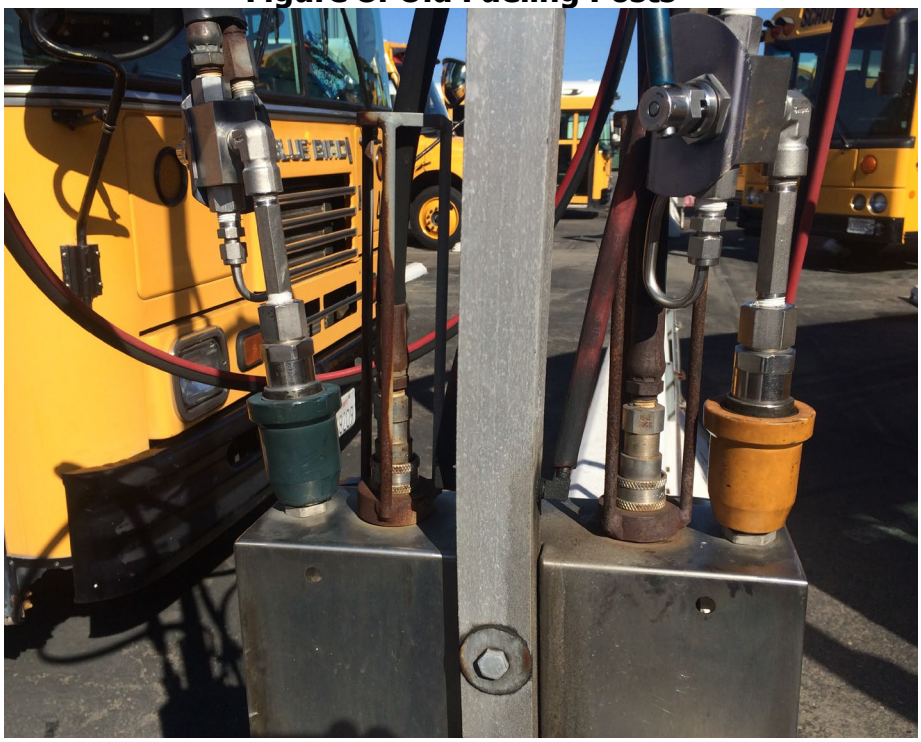
Because there were slow leaks throughout the entire system, this would cause the compressors to continually turn on, causing the compressors to overwork.

Figure 7: Cracked Hoses

Source: Linda Horton, Oceanside Unified School District Transportation Director.

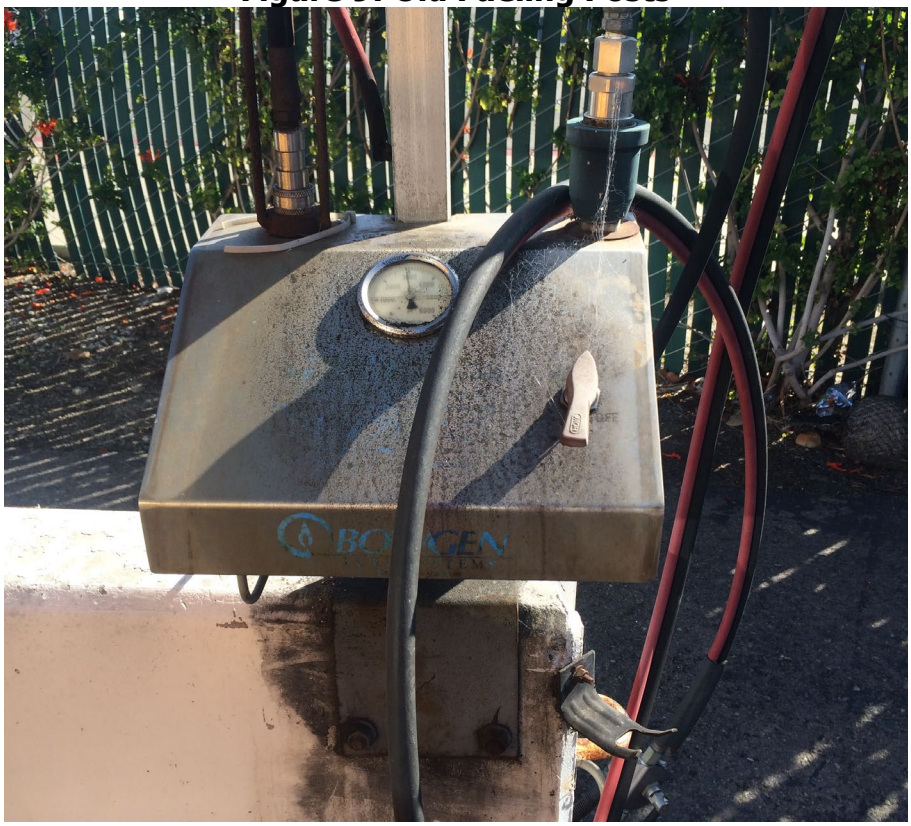
The old hoses had become frayed and cracked. This hose has cracked through the rubbing casing to the mesh inner layer.

Figure 8: Old Fueling Posts



Source: Linda Horton, Oceanside Unified School District Transportation Director.

Figure 9: Old Fueling Posts



Source: Linda Horton, Oceanside Unified School District Transportation Director.