



California Energy Commission Clean Transportation Program

FINAL PROJECT REPORT

Los Angeles Unified School District San Julian Bus Lot Compressed Natural Gas Station

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PREFACE

Assembly Bill 118 (Núñez, Chapter 750, Statutes of 2007) created the Clean Transportation Program, formerly known as the Alternative and Renewable Fuel and Vehicle Technology 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-11-602 to provide funding opportunities for projects that develop infrastructure necessary to store, distribute, and dispense electricity, E85, propane, diesel substitutes, and natural gas. In response to PON-11-602, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards April 24, 2012, and the agreement was executed as ARV-12-041 on June 13, 2013.

ABSTRACT

The Los Angeles Unified School District Transportation Services Division constructed the compressed natural gas station funded under ARV-12-041 at 1425 South San Pedro Street, Los Angeles, California 90015. The station provides compressed natural gas fueling capacity for the District's fleet of compressed natural gas school buses housed at their San Julian bus lot. The station consists of a natural gas compression system; one fast-fill dispenser; 42 single-hose time-fill posts for dispensing; 30 dual hose time-fill posts for dispensing; and 72 post stands for concrete pedestal mounts for the hoses.

Keywords: Compressed natural gas station, Los Angeles Unified School District

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EXECUTIVE SUMMARY

The Los Angeles Unified School District operates one of the largest compressed natural gas school bus fleets in the United States. The fleet consists of 530 school buses that run on compressed natural gas. The Los Angeles Unified School District compressed natural gas station in the San Julian Bus Lot is the third compressed natural gas project completed by the Los Angeles Unified School District. The station is equipped with one fast-fill dispenser and 102 slow-fill hoses. As the fleet continues to expand, Los Angeles Unified School District will have a continuing need for increased compressed natural gas fueling.

The addition of the compressed natural gas station in the San Julian Bus Lot is a part of Los Angeles Unified School District's initiative to replace the oldest diesel buses in its fleet with new buses powered with alternative fuels, such as compressed natural gas, to reduce the exposure of students and other members of the school community to harmful emissions. In addition to reducing emissions, the project will improve the safety and operational efficiencies as well as provide more compressed natural gas fueling support in the downtown Los Angeles area.

The Los Angeles Unified School District San Julian Bus Lot compressed natural gas station was funded under the Public Opportunity Notice (PON)-11-602 Alternative Fuels Infrastructure: Electric, Natural Gas, Propane, E85 & Diesel Substitutes Terminals issued by the California Energy Commission.

CHAPTER 1: Station Design and Construction

This chapter summarizes steps taken to complete the Los Angeles Unified School District (LAUSD) San Julian compressed natural gas (CNG) station project, with the overall goal of promoting a safe environment for students. According to South Coast Air Quality Management District Rule 1195 – Clean On-Road School Buses, and the California Air Resources Board Truck and Bus Regulation,¹ fleet operators must use filtration devices and acquire alternative-fueled school buses when adding or replacing buses. The LAUSD estimates replacement of up to 158 buses, potentially model years that range from 1978 through 1994. The San Julian CNG station, alone, cannot accommodate all of the LAUSD buses in the future, but the station will help meet some of today's fueling needs. According to Donald Wilke, LAUSD's Transportation Director, "CNG is good for the environment and serves us well."

Site Selection, Design, and Construction

Beginning in late 2013, the LAUSD identified and selected an appropriate site for the CNG station and they selected San Julian from the five lots they own. LAUSD constructed CNG stations on two others in Sun Valley and Gardena. With the intention to maximize CNG fueling capacity, LAUSD selected San Julian, the lot with the largest footprint, as the third site to have CNG fueling capability. LAUSD did not select the other two remaining lots because one can accommodate mostly small non-CNG buses and the other lot falls under another office's jurisdiction.

Another criterion for the site selection was the location's desirability. With the Sun Valley CNG station located in the northern end of the District and Gardena at the southern end, San Julian presented a central location in downtown Los Angeles (L.A.) at 1425 South San Pedro Street, for 92 buses. Prior to the completion of this project, CNG school buses operating in the area were stationed at the Sun Valley and Gardena lots, about 15 miles from downtown L.A. Driving to and from those locations could take up to an hour depending on traffic. Having the San Julian site in downtown L.A. reduces fuel and staff time for driving.

LAUSD issued a task order for the station design drawing on September 30, 2013. The City of Los Angeles required revisions to the design including an increased clearance for the bus entrance and exit on South San Pedro Street, thereby redirecting the buses to an alternate driveway and allowing for the circulation of about 92 buses. The revision was for a change of seven feet to the location of the entrance, and this resulted in a significant delay.

¹ The buses comply with <u>South Coast Air Quality Management District</u> (http://www.aqmd.gov/) Rule 1195, Clean On-Road School Buses, and the <u>California Air Resources Board</u> (https://ww2.arb.ca.gov/our-work/programs/truck-and-bus-regulation) On-Road Heavy-Duty Diesel Vehicles (In-Use) Regulation.

Additionally, there were a few other minor delays associated with issuing the LAUSD's request for proposal and selecting the contractor. LAUSD made changes to the request for proposal's drawings to include some slow-fill posts along San Julian Street mounted on K-rails that are temporary concrete traffic barriers. After the City of Los Angeles approved the final construction drawings, LAUSD issued the RFP on September 10, 2014. The LAUSD Board of Education approved the construction contract in March 2015, and the Los Angeles Fire Department approved the station drawings on June 30, 2015. Construction began in July 2015 and was completed in January 2016, as shown in Figure 1.



Figure 1: Slow-Fill Posts on Top of K-Rails

Photo credit: LAUSD

To facilitate the installation, the contractor constructed trenches to install the tubing, piping, and electrical infrastructure required to support the CNG slow-fill posts. The contractor filled and paved the trenches to match existing pavement after removing underground concrete. The contractor resurfaced and restriped the entire bus lot. The contractor prepared the CNG compressor area by removing existing concrete, replacing the pad and walkways, and installing a new chain link fence. Trillium CNG, a business unit of Integrys Energy Group Inc., designed and built the station and continues to operate and maintain the station. Figure 2 shows the lot prior to construction, Figure 3 shows the site plan, and Figure 4 shows the final construction drawing.



Figure 2: San Julian Bus Lot before Construction

Source: LAUSD

Figure 3: Site Plan





Figure 4: Final Construction Drawing

Source: LAUSD

Equipment Procurement, Delivery, and Installation

The CNG equipment for the station consists of the following:

- Two 150-horsepower Ariel JGQ-2-4 compressors
- One natural gas dryer sized for 10 million standard cubic feet
- Three storage spheres, 48" interior diameter, 5,500 pounds per square inch (PSI) maximum allowable working pressure
- One custom valve panel
- Control and electrical distribution equipment

Inlet natural gas is compressed by one of two compressors at the CNG station for storage and transport through the pipes with one compressor used at a time. The two compressors provide backup for each other in case of downtime for repair or maintenance. Figure 5 shows the compressors installed in the equipment compound.



Figure 5: Two CNG Compressors Installed at the Site

Photo credit: LAUSD

The gas dryer (Figure 6) removes the moisture from the natural gas to prevent potential condensation that may cause problems for the station and vehicles.



Figure 6: Gas Dryer Installed at the Site

Photo credit: LAUSD

The fast-fill dispenser draws fuel directly from the CNG storage vessels (Figure 7).² Each storage vessel has a capacity of 11,340 standard cubic feet, a normal pressure of 4,500 PSI, and a maximum-allowed pressure of 5,500 PSI. Each vessel complies with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code Section VIII Division II standards.

² The storage vessels are manufactured by Allied Equipment.



Figure 7: Storage Vessels Installed at the Site

Photo credit: LAUSD

The normal operating pressure of the storage vessels is between 4,400—4,500 PSI. This pressure allows the dispenser to fill a typical CNG vehicle to a pressure of 3,600—3,900 PSI. Depending on how full the vessels are and how empty the fuel tank is, fast-fill fueling can take three to nine minutes. Figure 8 shows a fast-fill dispenser.



Figure 8: Fast-Fill CNG Dispenser Installed at the Site

Photo credit: LAUSD

Figure 9 shows the single hose slow-fill post mounted on concrete posts. At the San Julian bus lot, there are 42 single hose posts and 30 dual hose posts (Figure 10). These slow-fill hoses will allow filling of 102 buses at one time. Depending on how many buses are fueling, it can take up to eight to 10 hours to fuel a bus. Slow-fill fueling is done overnight with the bus hooked up to the posts. By fueling off-hours, the drivers can focus on covering routes and additional assignments without having to fuel in the middle of the day, resulting in improved efficiencies and reduced overhead costs.

Figure 9: Slow-Fill Single Hose Posts



Photo credit: LAUSD

Figure 10: Slow-Fill Duel Hose Posts



Photo credit: LAUSD

Commissioning Process

The commissioning of the CNG station included: compressor alignment and verification, motor rotation, cleaning and purging of lines, piping and tubing pressure testing, control input and output verification, electrical wire insulation verification, and CNG sampling. Trillium CNG team performed the bulk of the commissioning tasks and the final startup.

Environmental Impacts

The project required limited earthwork and grading when installing footings and foundations that accommodates the new compression and dispensing equipment. The project used minimal water during construction and did not add landscaping. The project did not create additional storm water runoff within the area. The project generates limited additional traffic and emissions, and for school bus operation the LAUSD Transportation Services Division uses trip distribution patterns to identify and optimize bus routes.

CHAPTER 2: Station Use

The LAUSD CNG station is supplied with natural gas through pipeline by the Southern California Gas Company.³ The Southern California Gas Company contract provides a gas supply pressure of 165 PSI. The system is much more efficient, from a compression viewpoint, than a supply of 30—40 PSI.

Fueling and Vehicles Served

The station's two compressors, each rated at 460 standard cubic feet per minute, provides fuel via slow-fill or fast-fill subsystems. For slow-fill, one compressor can fuel 100 buses nightly and depending on how much resides in the tank, a bus may take up to 10 hours to fill. Like slow-fill, the fueling time for fast-fill depends on how much fuel resides in the tank and a second factor is the amount of CNG remaining in the storage vessels. The lower the amount of CNG remaining, the lower the pressure and the more time needed to fast-fill. Figure 11 shows a CNG bus fueling from a slow-fill post.



Figure 11: CNG Bus Fueling from a Slow-Fill Post

Photo credit: LAUSD

^{3 &}lt;u>Natural Gas Vehicles Case Study</u> (https://www.socalgas.com/documents/innovation/natural-gas-vehicles/NGV-LAUSD-CNG-School-Bus.pdf)

Fuel Throughput

Fueling from the San Julian CNG station commenced in January 2016 with over 3,000 gas gallon equivalent (GGE) throughput. The station opened after the LAUSD school year started when most CNG buses were already assigned to the other two bus lots with CNG stations; therefore, the usage experienced at the San Julian lot was low.

With a full month of use in February 2016, throughput increased to over 7,000 GGE but decreased to just over 6,000 GGE in March 2016 because of spring recess at the schools. Throughput picked up again in April and May 2016 to over 7,000 GGE. With the school year ending in June and fewer routes running in July for summer school, throughput dropped below 6,000 GGE.

Before the start of the 2016-17 school year, LAUSD repositioned additional CNG buses at the San Julian lot. As a result, when the school started in August, the CNG buses stationed there consumed more than 13,000 GGE, an increase of nearly 70 percent over the previous consumption. In September, when school was in full session, over 17,000 GGE was consumed. Figure 12 shows the throughput trend from January 2016 through October 2016.





Source: LAUSD

Trillium CNG collected data on the operation of the station for six months and LAUSD reported data to the CEC. Data include throughput, vehicle usage, GGE, and a comparison of the actual performance of the project to proposed expectations.

Expected Reductions in Diesel Fuel Consumption and Energy Efficiency in Compressors

Currently, about 80 CNG buses are stationed at the San Julian lot. The CNG station is used nearly 200 days out of a year on a regular basis. For the 2015-16 school year, the buses stationed at the lot traveled an average of 61 miles per day based on the internal global positioning system data for miles driven on December 8, 2016.

If these 80 buses used diesel instead of CNG, each bus would have consumed about 8.7 gallons of diesel per day, with an estimated fuel economy of seven miles per gallon. As a result of the conversion to CNG, LAUSD expects that nearly 140,000 gallons (80 buses x 8.7 gallons/day x 200 school days) of diesel fuel will be displaced annually. LAUSD also expects that the conversion of diesel buses to CNG buses stationed at the San Julian bus lot will reduce greenhouse gas emissions by more than 600 metric tons per year.

The two 150-HP compressor-drive motors in the compressors used at the LAUSD site are specified as National Electrical Manufacturers Association premium efficiency. These motors typically provide a 2.5—3 percent increase in energy efficiency compared to standard motors.

Economic Benefits

The production cost of CNG in a diesel gallon equivalent (DGE) is roughly \$1.03, including costs for gas commodity at about \$0.55, electrical power at \$0.20, and a maintenance allowance at \$0.28. The federal tax rebate of about \$0.55 per DGE for CNG use improves the economics of the CNG station further. The production cost is lower than the bulk diesel price of \$1.60 per gallon that LAUSD is paying (bulk diesel price as of the week of December 12, 2016). Compared to the retail price of \$2.85 per gallon for diesel,⁴ the savings is more significant.

⁴ The average retail price for Los Angeles as of October 30, 2016, as reported in the Los Angeles Times.

CHAPTER 3: Future Activities

LAUSD owns the CNG station and Trillium CNG will continue to operate and maintain the station. This station remains critical to supporting LAUSD's growing fleet of alternative fuel school buses. Since 2003, LAUSD has replaced over 600 of its oldest buses with CNG and propane operated buses, and this station supports the replacement of more buses.

The successful installation of the CNG fueling infrastructure at the San Julian bus lot marks a milestone in the LAUSD's commitment to environmental causes with the school bus fleet reducing emissions and improving the air quality for students and the community. As LAUSD looks to expand its operation of environmentally friendly buses, it will continue to document the savings in emissions and energy efficiency and the economic benefits of the San Julian CNG station.

CHAPTER 4: Conclusions

The convenient location of the San Julian bus lot offers CNG fueling support for buses operating in the area. These buses no longer need to travel to the Sun Valley or Gardena lots for fueling, thereby decreasing fuel and staff time use and the related pollution. The project's completion supports the LAUSD's complying with air emissions regulations and the District's plan to replace diesel school buses with buses that use alternative fuels, like CNG.

The successful installation of the CNG fueling infrastructure at the San Julian bus lot demonstrates the LAUSD's commitment to modernizing its school bus fleet to reduce harmful emissions and improve the air quality for students and the community. The project provides an example to follow when expanding their fleets.

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 Energy Commission'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 Commission'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.

DIESEL GALLON EQUIVALENT (DGE) – The amount of alternative fuel it takes to equal the energy content of one liquid gallon of diesel gasoline.

GASOLINE GALLON EQUIVALENT (GGE) – The amount of alternative fuel it takes to equal the energy content of one liquid gallon of gasoline. GGE allows consumers to compare the energy content of competing fuels against a commonly known fuel—gasoline. GGE also compares gasoline to fuels sold as a gas (natural gas, propane, and hydrogen) and electricity.

LOS ANGELES UNIFIED SCHOOL DISTRICT (LAUSD) – Second largest school district in the nation. Serves over 600,000 students in kindergarten through 12th grade at over 1,000 schools. The District also has over 200 independently-operated public charter schools, authorized by the Los Angeles Unified School District Board of Education.

POUNDS PER SQUARE INCH (PSI) – A unit of pressure or stress based on avoirdupois units. It is the pressure resulting from a force of one pound-force applied to an area of one square inch.