CALIFORNIA ENERGY COMMISSION

California Energy Commission

Clean Transportation Program

FINAL PROJECT REPORT

Huntington Beach Union High School District

Compressed Natural Gas Refueling Station Expansion

Prepared for: California Energy Commission

Prepared by: Huntington Beach Union High School District

Gavin Newsom, Governor

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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-14-608 to expand an existing compressed natural gas refueling station at 7180 Yorktown Avenue, Huntington Beach (Orange County). In response to PON-14-608, the recipient submitted an application which was proposed for funding in the CEC's notice of proposed awards August 12, 2015, and the agreement was executed as ARV-15-053 on December 8, 2015.

ABSTRACT

The Huntington Beach Union High School District refueling station project upgraded the existing and outdated compressed natural gas refueling station at 7180 Yorktown Avenue in Huntington Beach (Orange County). A grant from the California Energy Commission allowed the district to expand the existing compressed natural gas fueling station, which was completed in February 2018. The compressed natural gas station was upgraded to add fast-fill refueling capabilities and 15 time-fill posts for the district's expanded compressed natural gas fleet of student transportation vehicles.

The compressed natural gas fleet has increased from 11 compressed natural gas buses in 2016 to 17 Type D and two Type C compressed natural gas buses at the time the station was commissioned in 2017. An additional 15 Type D compressed natural gas buses are on order and expected to be delivered by mid-2019. The new station increased compressed natural gas filling capacity to accommodate these needs and included electrical upgrades and spatial and infrastructure provisions for future expansion.

The project provided an upgraded electrical service, two new 50-horsepower compressed natural gas compressors, one fast-fill fueling dispenser with two fueling houses and 15 dual-hose time-fill posts. The fast-fill system is designed so two full-size buses can refuel simultaneously and deliver 30 gallons of gasoline equivalent per hose in a continuous five- to eight-minute period.

The fast-fill component will allow the district to enter refueling station access agreements with neighboring public agencies or to sell compressed natural gas at retail prices for personal vehicles. The district received verbal commitments for station usage from several other public entities in the area with a need for access to compressed natural gas fuel for their own fleets of transportation vehicles.

Keywords: Huntington Beach Union High School District, compressed natural gas, CNG fueling station, natural gas infrastructure, natural gas bus fleets

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EXECUTIVE SUMMARY

The project sought to upgrade the existing compressed natural gas refueling station at Huntington Beach Union High School District's Maintenance, Operations, and Transportation facility. The district upgraded the refueling station to add fast-fill refueling capabilities and 15 time-fill posts for the district's expanded compressed natural gas fleet of student transportation vehicles. The fleet has increased from 11 compressed natural gas buses in 2016 to 17 Type D and two Type C compressed natural gas buses at the time the station was commissioned in 2017. An additional 15 Type D compressed natural gas buses are on order and are expected to be delivered by mid-2019.

With CEC funding, the district was able to construct the expanded compressed natural gas fueling station project. The district contracted AECOM Technical Services, Inc. to be the lead agent for the design, construction, and commissioning of the compressed natural gas fueling station and engineered by Allsup Corporation. The design and construction started on September 23, 2016, and was fully commissioned in February 2018.

The district installed two new 50-horsepower natural gas compressors, added two fast-fill refueling stations, and added 30 time-fill posts for the district's expanded compressed natural gas fleet of student transportation vehicles.

The estimated annual throughput of the system noted in the project application was 30,000 gallons of gasoline equivalent. Since the station was commissioned in February 2018, the throughput has been calculated at 13,500 gallons of gasoline equivalent through June 2018. The district anticipates that it will meet the expected annual throughput without any significant difficulties.

CHAPTER 1:
Project Purpose and Approach

Introduction

Huntington Beach is a seaside city in Orange County in Southern California. The Huntington Beach Union High School District (HBUHSD) serves more than 16,000 students in six comprehensive high schools, one alternative high school, one continuation high school, and one adult school. The schools are widely known for their commitment to academic excellence for all students and communities they serve. The mission statement of the district is to educate, prepare, and inspire its students to change the world.

Background

The district has 11 compressed natural gas (CNG) buses in its fleet and is looking to upgrade about 15 more from diesel to CNG in the very near future. The existing CNG station, at the HBUHSD Maintenance, Operations, and Transportation (MOT) facility, can accommodate only 11 vehicles with an overnight slow-fill, so any additional CNG buses will need to be driven to an off-site retail CNG fill station each day. This capacity issue is preventing the district from upgrading the rest of its student transportation fleet from old diesel buses to clean-burning CNG buses. The existing station infrastructure is at maximum capacity and cannot support any expansion, so the associated demolition and the construction of a new station have been deemed financially desirable.

Original Station

The original station is a "time-fill" refueling station with 12 slow-fill fuel dispensers The average monthly throughput was 1,900 gas gallon equivalent (GGE) or about 23,100 GGE (27,804 therms) annually. The district has about 15 diesel buses, many of which are close to the end of their useful lives. According to the mandates put forth by the South Coast Air Quality Management District (SCAQMD), the new replacement buses are required to use alternative fuels, such as CNG. While the district has a small CNG fill station located at the MOT facility, it is undersized for its current needs and would be inadequate for additional CNG buses. The current refueling station has no redundancy and is unreliable. Furthermore, the existing 15-horsepower (HP) converted air compressor and the current infrastructure do not allow for expansion.

Project Objective

The project proposed the design and construction of a new CNG fill station at the HBUHSD in Huntington Beach. The project objectives were to:

- Design a CNG fueling infrastructure.
- Remove existing fueling infrastructure.
- Construct the new CNG fueling infrastructure at the same location.

- Provide fueling capacity that will support additional CNG vehicles to be integrated in the HBUHSD fleet.

While the district submitted the funding application to the CEC, the fleet consisted of 11 CNG buses, and the district anticipated converting an additional 13 diesel buses to CNG upon completion of the new CNG station. The original CNG station, located at the HBUHSD MOT facility, could accommodate only 11 vehicles with overnight slow fill, so any additional CNG buses would be required to refuel at an off-site retail CNG fill station each day. The capacity issue prevented the district from upgrading the rest of the student transportation fleet from the old diesel buses to clean-burning CNG buses. The original station infrastructure was at maximum capacity and unable to support expansion and was demolished. In its place, the district proposed to install a new 24-station CNG plant that provides the fueling infrastructure required to convert the rest of the diesel buses to CNG, as required by the SCAQMD. During the design process, the district decided to increase the number of time-fill posts from 24 to 30, which provide enough capacity for additional CNG buses that the district was awarded through a grant program offered by the SCAQMD.

The project objective was to upgrade the existing CNG refueling station to provide fast-fill refueling capabilities and provide additional time-fill posts to support the district's growing CNG fleet. The station was upgraded with the following new components:

- Two CNG compressors
- Time-fill/fast-fill starter panel
- Natural gas dryer
- Storage containers
- A valve panel
- An uncovered fueling island with one dual-hose fast-fill fueling dispenser
- Fuel management system (for use with third-party users at the fast-fill dispenser)
- Fifteen dual-hose time-fill posts for 30 total time-fill hoses

Technical Scope of Work

The scope of work approved in the grant included the following technical tasks related to the design, engineering, and construction of the new CNG refueling station.

Task 2: Engineering and Design

- Prepared draft design drawings
- Reviewed design with CEC
- Finalized 100 percent drawings

Products: 100 percent design drawings.

Task 3: Electrical Upgrade

This task was to upgrade the electrical service at the new CNG station. The larger equipment that was installed in this project will exceed the available capacity provided by Southern California Edison.

- Worked with utility provider to design upgraded lineside service.
- Coordinated all efforts with Southern California Edison.

Products: New 480-volt alternating current (AC), three-phase electrical service for the fueling station suitable for running two of the ANGI NG50E 50-HP compressors simultaneously and all other electrical loads necessary for operating the time-fill CNG fueling system.

Task 4: Permitting of CNG Station Work

This task was to acquire all necessary city building permits to construct the CNG fill station.

- Submitted all necessary documentation to the City of Huntington Beach Permit Center.
- Paid all required fees to the Huntington Beach Permit Center.

Products: Building permits for plumbing, electrical, and fire.

Task 5: CNG Equipment Procurement

This task was to procure all CNG equipment for installation.

- Procured all necessary equipment to build and operate the CNG fill station.
- Ordered all equipment and parts.

Products: Procured equipment included one new ANGI Energy Systems NG50E natural gas compressor; one single-tower, nonregenerative gas dryer; K-rail system for CNG distribution piping and time-fill fueling dispenser for 30 time-fill posts with a hose length of 25 feet and retractable pulley; and all other equipment and appurtenances necessary and required to construct and house the fully functional CNG fill station.

Task 6: Construction

This task was to construct the CNG station as outlined in the project application:

- Completed all site work necessary for the new CNG station using approved design plans.
- Complied with all current code requirements with regard to construction method.
- Completed all inspections and approvals necessary for jurisdictional approval for the operation of the CNG refueling station.
- Took delivery of all equipment and supplies at the site.
- Completed quality assurance checks on key components of the system.
- Coordinated placement and logistics for off-loading equipment and component skids.
- Installed equipment on respective foundations.
- Installed underground and aboveground piping conduits to transport natural gas from the new, enlarged gas company meter set assembly to the existing gas dryer and installed power to new compressors.
- Performed final checks and startup into service per approved test plan.
- Removed and properly disposed of the old equipment after the installation of the new CNG infrastructure.

- Completed and submitted all required monthly progress reports to the CEC.

Products: Copies of equipment and parts order forms, startup test plan, monthly progress reports, and completed fully functional CNG fill station capable of fueling 30 CNG vehicles simultaneously.

Figure 1: HBUHSD CNG Refueling Station—Two 50-HP Compressors

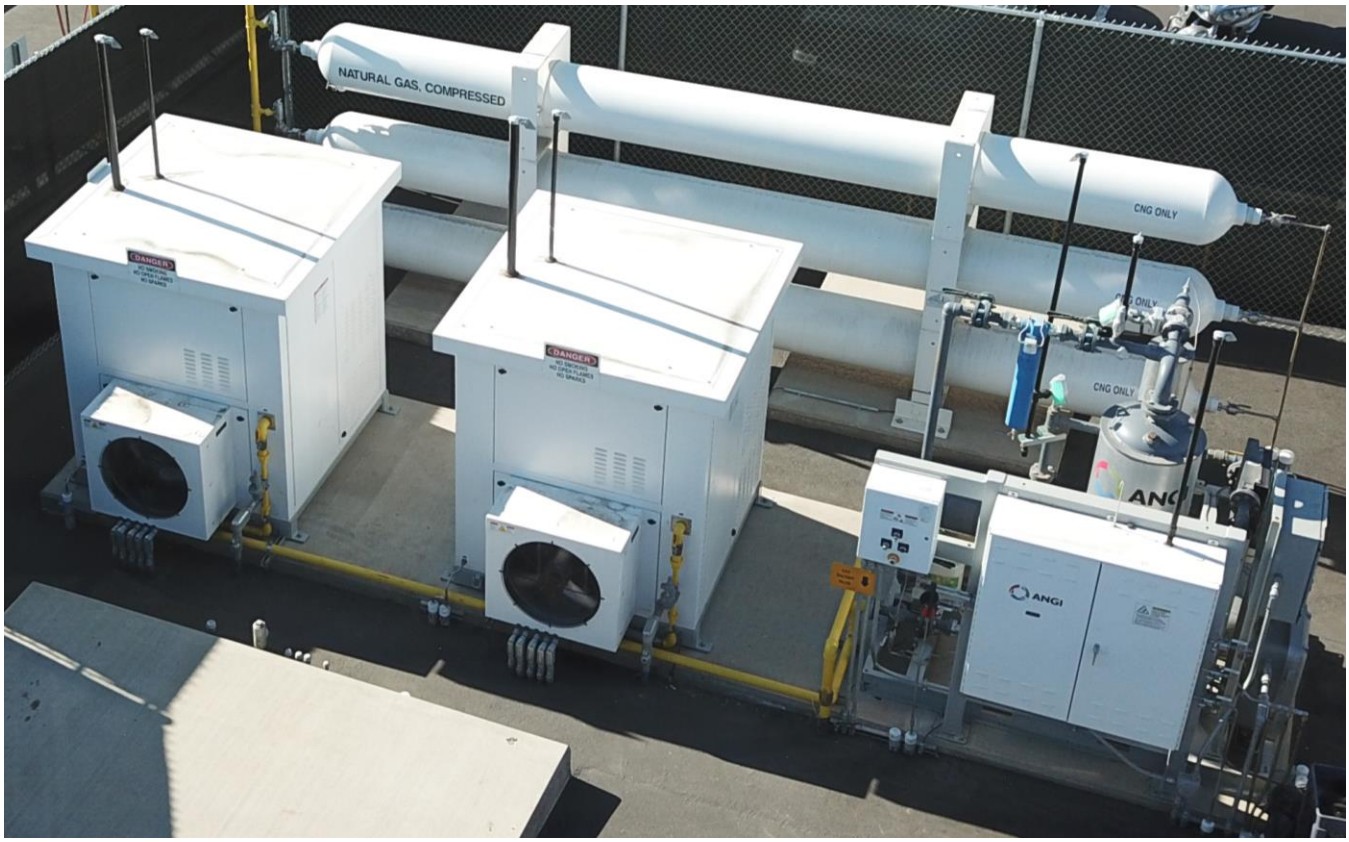

Photo credit: AECOM Technical Services, Inc.

Changes to Station Access

The fast-fill component of the station will allow HBUHSD to enter into refueling station access agreements with neighboring public agencies or sell CNG at retail prices for personal vehicles, thereby improving the viability of CNG vehicles in the SCAQMD region. HBUHSD received verbal commitments for use of the station from several public entities in the area that need CNG fuel for their own vehicle fleets. The district is reviewing the tax implications of selling CNG at retail prices but still plans to provide this access in the near future.

Estimated Annual Throughput (GGE)

The estimated annual throughput of the new system will support the total number of CNG buses that will use the station on time-fill and fast-fill dispensers is 30,000 GGE.

Goals of the Agreement

This agreement will help HBUHSD remove the existing CNG fueling infrastructure and build a new CNG station at the same location. The new station will have at least 24 slow-fill

dispensers that will provide HBUHSD the necessary infrastructure to meet the demand of its growing CNG fleet reliably.

This agreement with HBUHSD to design and construct a CNG fill station addresses the grant program goals by reducing California's use and dependence on petroleum transportation fuels by allowing HBUHSD to convert their student transportation fleet from diesel to CNG. In addition, the project expands the alternative fueling infrastructure available to existing fleets, public transit, and transportation corridors by providing a critical piece of infrastructure to allow the district to not only convert its existing fleet, but add more CNG vehicles to its fleet. The district is executing agreements for nearby public agencies to use the fast-fill dispenser at the station to refuel their CNG vehicles.

Objectives of the Agreement

The agreement objectives are to:

- Design a CNG fueling infrastructure.
- Remove existing fueling infrastructure.
- Construct the new CNG fueling infrastructure at the same location.
- Provide fueling capacity that will support additional CNG vehicles to be integrated into the HBUHSD fleet.

The completed project accomplished all these objectives for HBUHSD as demonstrated by the information provided in Chapter 2.

CHAPTER 2:
Project Activities and Results

Project Approach

This project was to upgrade the district's existing CNG fueling station to support its growing CNG fleet and address the goals of the CEC to increase alternative fuel infrastructure while reducing dependence on petroleum-based fuels for student transportation. The HBUHSD board approved the project on September 8, 2016. The board awarded the contract to AECOM Technical Services, Inc. and issued the notice to proceed on September 23, 2016. Construction started shortly after the contract was awarded. The cost to upgrade the CNG station was roughly $2.1 million; therefore, the $500,000 grant awarded to the district by the CEC provided much needed financial assistance.

Station Design Intent

For details on the upgraded fueling station scope of work, refer to Chapter 1. A summary is included below.

The scope included the following new equipment and facility upgrades:

- Two 50-HP ANGI Energy Systems natural gas compressors
    - 75 standard cubic feet per minute (SCFM) at 15 pounds per square inch gauge (PSIG) at the compressor inlet and 4,500 PSIG discharge pressure
    - ANGI control system
    - Weatherproof, sound-attenuated enclosure
    - On-skid starter panel
    - One single-tower, nonregenerative gas dryer with digital dew point meter
    - 316 stainless steel tubing for distributing CNG to the fueling island and time-fill posts
    - Fueling island (no canopy) with one fast-fill fueling dispenser with two fueling hoses
    - Three CNG storage cylinders
    - Fifteen dual-hose time-fill posts (30 hoses total)
- The time-fill system shall be capable of dispensing up to 576 GGE overnight in an eight-hour window (typically from 9 p.m. to 5 a.m.). This capability will comfortably satisfy time-fill fueling requirements for up to 30 buses.
    - Necessary provisions will be included for future nine time-fill posts with two hoses.
- Fast-fill performance capabilities
    - The system shall be designed so that two full-size school buses can refuel simultaneously.

- The system shall be able to deliver 30 GGE of CNG per fueling hose (when filling a vehicle to 3,600 PSIG) in a continuous five- to eight-minute period when both fueling hoses are operating simultaneously.
- A three-pack of storage cylinders, 30,000 cubic feet (CF) each at 5,000 pounds per square inch (PSI), of which 30 percent are considered usable, or 10,000 CF of usable storage (78 GGE). With storage cylinders charged, two buses requiring 30 GGE each can be filled simultaneously within five to eight minutes.
- Necessary infrastructure will be provided for the addition of one future fast-fill dispenser with two hoses and one additional three-pack storage cylinders.

The equipment is sized to move fuel into natural gas vehicles using compression and ground storage. Ground storage is an important component of a station that uses midsized compressor frames. If direct fill is used with a flow rate of 250 SCFM (one compressor operating) and the fast-fill line is connected to a refuse truck having a 50-GGE fill requirement, the time fill alone would be about 25 minutes, not including the time to connect, authorize, disconnect, and drive away. Therefore, the use of ground storage saves time by allowing up to eight GGE per minute of flow through the hose during the fill using an NGV-1 nozzle and even higher if a transit nozzle is used. Ground storage also serves as a buffer to compressors, allowing them to run for longer continuous periods rather than a series of short runs with several starts and stops.

Compressor and storage sizing is calculated based on both components working together. Beginning with ground storage, each vessel holds 30,000 standard cubic feet (SCF) at 5,000 PSIG. With the vessels operating in a three-bank cascaded configuration, the efficiency is 30 percent. Therefore, three vessels can provide 27,000 SCF (equivalent to roughly 234 GGE). With all three storage cylinders charged, the system can deliver 30 GGE per hose within five to eight minutes. The time-fill system was designed to dispense 576 GGE in an eight-hour window. This demand is met by using two 50-HP natural gas compressors and a three-cylinder, 30,000 CF per unit storage pack.

The 316 stainless steel tubing will be used to convey gas from the compressor to storage and fast-fill and time-fill dispensers. For a balanced design, tubing needs to be sized to dispense fuel to the fast-fill dispenser and allow full use of storage. Therefore, from the priority valve panel to the fast-fill dispenser, the tubing was ¾ x 0.1.04 wall 316 stainless steel. The tubing was also sized for future expansion operating condition. As described, a vehicle requiring 30 GGE of fill should be able to complete its fill in five to eight minutes. Therefore, when two fast-fill hoses are fueling at the same time in the future, the pressure drop within the tubing shall not be in excess of 300 PSI from storage to the connection point of the farthest dispenser. Flow rates through ¾-inch stainless steel tubing will work best for this project. The project will continue a one-inch priority valve panel from which the fast-fill dispenser and time-fill dispensers will connect using ¾-inch stainless steel tubing using three dedicated lines for fast-fill and one dedicated for time-fill.

Project Results

The district completed the project in January 2018. Once the station was commissioned, HBUHSD began collecting monthly fuel usage data and recording them per the terms of the grant agreement. Since the district does not have an operational fuel management system, CNG usage data were provided using utility bill information received from Southern California Gas Company. The only natural gas service on-site is dedicated to the CNG refueling station.

Table 1, below, captures the monthly fuel consumption and environmental impacts reported by the district from January 2018 through June 2018. The estimated annual throughput of the newly upgraded CNG station was 57,840 DGE. The total throughput for the first six months of the commissioning of the station is 28,900 DGE.

Table 1: Monthly Fuel Consumption and GHG Impacts

	18-Apr	18-May	18-Jun	18-July	18-Aug	18-Sept
Therms Documented by Utility Bills	4,750	5,604	3535	3,163	1,977	4,937
Compressor Run Time (Hours per month/ day)	48/3 hours	46/2.5 hours	36/2 hours	32/2 hours	22/1.5 hours	52/2.5 hours
Natural Gas Dispensed (cubic feet)	4,648 CF	5,462 CF	3478 CF	3,048 CF	1,919 CF	4,798 CF
Average Number of Nondistrict Vehicles Fueled per Month	0	0	0	0	0	0
Average Number of Type C Bus Fueled per Month	2	2	2	2	2	2
Average Number of Type D Bus Fueled per Month	17	17	17	17	17	17
Number of Days per Month Vehicles Were Fueled	16	22	18	13	3	19
Miles Traveled per Bus by Odometer Reading	17,324	19,501	12,572	9,250	7,495	18,148
Gallons of Diesel Fuel Displaced (Calculated based on therms)	3,502.4 DGE	4,115.7 DGE	3502.4 DGE	2,296.7 DGE	1,446 DGE	3,615.4 DGE
Gallons of DGE Displaced (Calculated based on Mileage)	3,966 DGE	4,679 DGE	2729 DGE	1,862 DGE	1,627 DGE	3,792 DGE
GHG Emissions Avoided	17,493.67 lbs. of CO2E	20,557.37 lbs. of CO2E	13,090.17 lbs. of CO2E	8,621.06 lbs. of CO2E	7,598.09 lbs. of CO2E	16,722.72 lbs. of CO2E

*Diesel miles per gallon is equivalent to about five miles per gallon.

Source: Huntington Beach Union High School District

Assumptions and Conversion Factors

The district used the following conversion factors in calculating the environmental impacts noted above (GHG Emissions Avoided):

- The project team estimated of natural gas dispensed (therms of standard cubic feet) and converted therms or SCF into British thermal units (Btus) (one therm = 100,000 Btus).
- Using SCF, district staff used the U.S. Energy Information Administration's estimate that California's natural gas has: 1,036 Btu/SCF.
- CNG dispensed was converted into megajoules (MJ) by using one MJ = 947.8 Btu.
- DGE dispensed was calculated by dividing MJ of CNG fuel dispensed by MJ per gallon of diesel (146.3 MF/diesel gal.).

For greenhouse gas emissions avoided:

- The project team multiplied the MJs of CNG dispensed by differential between CNG and diesel carbon intensity: 15.74 gCO2e/MJ.
- The team then converted the grams figure into pounds of carbon dioxide equivalent (CO2e).

CHAPTER 3:
Project Assessment

The project sought to expand the existing refueling station to support the district's growing CNG fleet, which addresses the goals of the Clean Transportation Program by reducing dependence on fossil fuels and expanding alternative fuel infrastructure in California. The completed CNG refueling station expansion project succeeded in helping the district achieve these goals and the goals of the CEC.

Project Success

The project effectively added one dual-hose, fast-fill dispenser and 30 time-fill posts. The added time-fill posts allow HBUHSD to refuel the 15 new CNG buses locally that will replace its old diesel vehicles. In addition, the project provided added infrastructure so that the CNG station can be expanded by:

- Upgrading electrical service so that a third 50-HP CNG compressor can be installed.
- Sizing the nonregenerative gas dryers for three 50-HP CNG compressors.
- Extending time-fill piping for an additional 18 buses.
- Providing necessary provisions for an additional dual-hose, fast-fill fueling dispenser.

Although the upgrades completed as part of this project provides the capabilities of supporting the district's CNG fleet, HBUHSD future goals are to publicize the CNG refueling station. To do this, the district must perform the aforementioned expansion. HBUHSD is applying for another grant to help fund an additional expansion project. The HBUHSD has submitted the necessary paperwork to sell CNG fuel at a retail rate and understands the tax implications.

Figure 2: HBUHSD Buses Refueling Using Time-Fill Posts

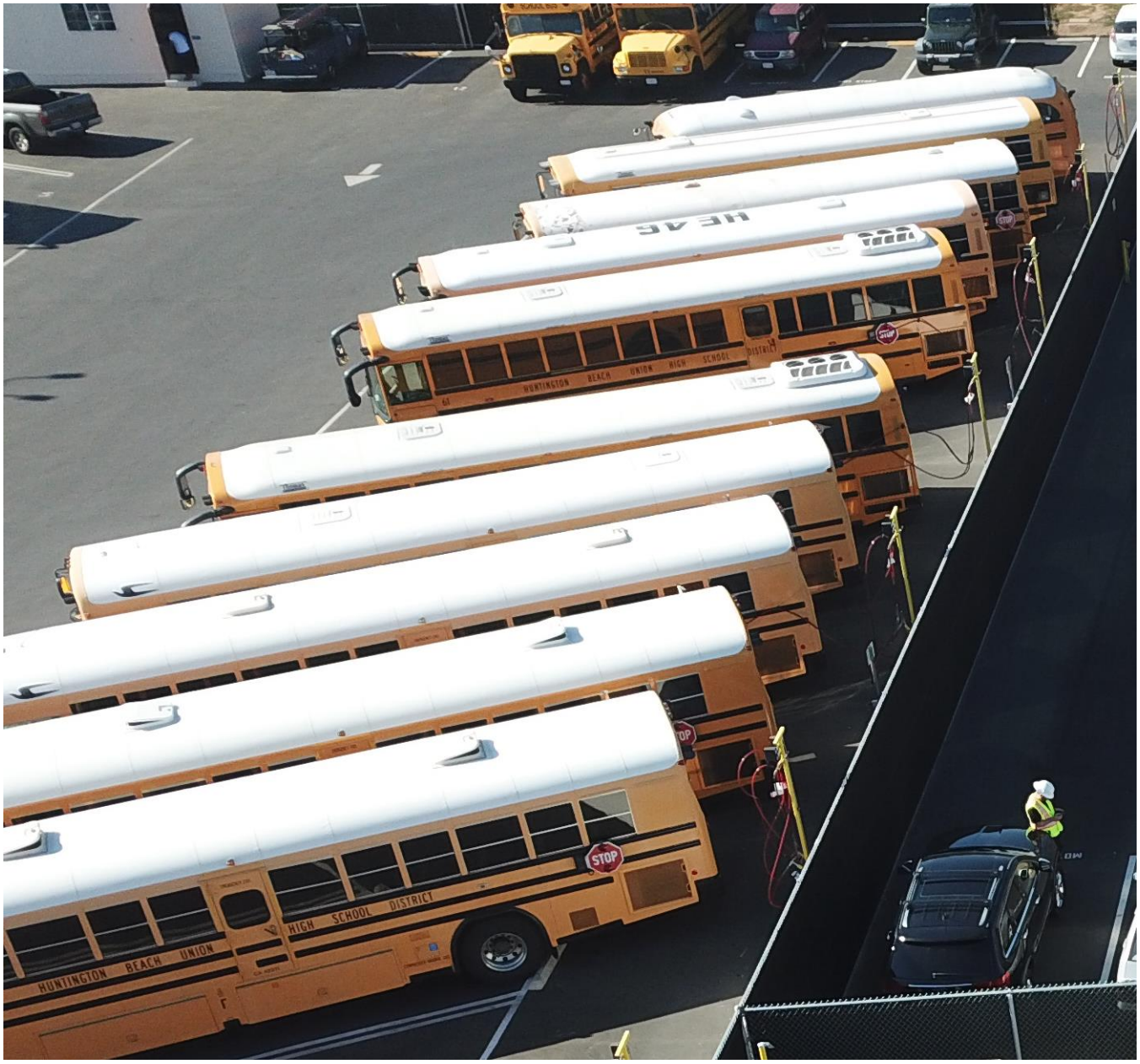

Photo credit: AECOM Technical Services, Inc.

Figure 3: New Dual Hose Fast-Fill Dispenser

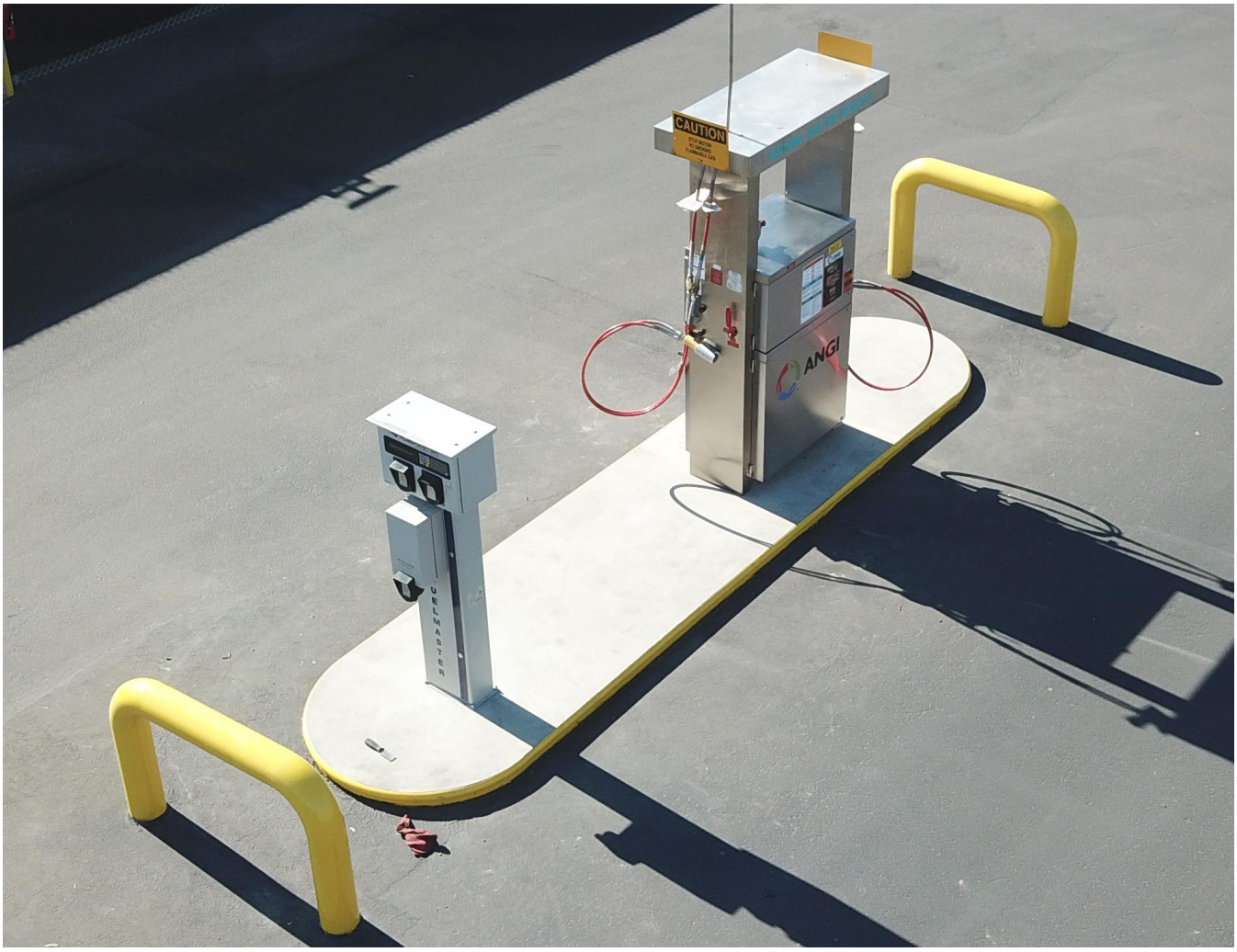

Photo credit: AECOM Technical Services, Inc.

Determining fuel efficiency of CNG buses is an important component to measuring the success of the project. Table 1 also shows the monthly mileage of the district's CNG fleet. The miles per DGE are calculated using an average of five miles per gallon for diesel. Over the six-month span, the station displaced 20,100 diesel gallons equivalent of CNG across 100,500 miles of service. This amount equates to about five in fuel efficiency.

CHAPTER 4:
Project Conclusions

Numerous conclusions and lessons learned have been identified because of this project. The first lesson learned throughout this project was the importance of coordinating with all public and private utilities, which may affect the project. The district encountered some scheduling issues with upgrading the gas line and electrical at the station. These setbacks were due to utility scheduling issues with Southern California Edison (electrical upgrade) and Southern California Gas Company (SoCal Gas) (gas line upgrades). In addition, the City of Huntington Beach had issued a moratorium on right-of-way permits for any work that would require excavating or cutting into Yorktown Avenue, the street where the new CNG refueling station was located. The street had been repaved the previous year, which meant that SoCal Gas had difficulty in obtaining an encroachment permit to upgrade its line, which was in the city's right-of-way.

The project was also hampered after construction was completed due to equipment issues with the utility meter installed by SoCal Gas. The old meter was misplaced and continued to send out a pulse; therefore, SoCal Gas could not activate the pulse on the new meter installed at the CNG station. HBUHSD was unable to compare estimated fuel mileage for the buses with an actual fuel bill for the first three months after the station was commissioned and operational.

GLOSSARY

AIR QUALITY MANAGEMENT DISTRICT (ACMD) – Air districts issue permits and monitor new and modified sources of air pollutants to ensure compliance with national, state, and local emission standards and ensure that emissions from such sources will not interfere with the attainment and maintenance of ambient air quality standards adopted by the California Air Resources Board (ARB) and the U.S. Environmental Protection Agency (U.S. EPA). [1]

ALTERNATING CURRENT (AC) – Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States moves in current that shifts direction at a rate of 60 times per second.

BRITISH THERMAL UNIT (Btu) – The standard measure of heat energy. It takes one Btu to raise the temperature of one pound of water by one degree Fahrenheit at sea level. MMBtu stands for one million Btu.

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:

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

CARBON DIOXIDE EQUIVALENT (CO2e) – A metric used to compare emissions of various greenhouse gases. It is the mass of carbon dioxide that would produce the same estimated radiative forcing as a given mass of another greenhouse gas. Carbon dioxide equivalents are computed by multiplying the mass of the gas emitted by its global warming potential.

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.

CUBIC FOOT (CF) – The most common unit of measurement of natural gas volume. It equals the amount of gas required to fill a volume of one cubic foot under stated conditions of temperature, pressure, and water vapor. One cubic foot of natural gas has an energy content of approximately 1,000 Btus. One hundred cubic feet equals one therm (100 ft^3 = 1 therm).

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1 California Air Resources Board (https://ww2.arb.ca.gov/)

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

GREENHOUSE GASES (GHG) – Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

HORSEPOWER (HP) – A unit for measuring the rate of doing work. One horsepower equals about three-fourths of a kilowatt (745.7 watts).

HUNTINGTON BEACH UNION HIGH SCHOOL DISTRICT (HBUHSD) – A public school district serving portions of the Orange County, the cities of Huntington Beach, Fountain Valley, Garden Grove, and Westminster. It oversees 11 sites, offering courses for students in grades nine through 12.[2]

MEGAJOULE (MJ) – A joule is a unit of work or energy equal to the amount of work done when the point of application of force of one newton is displaced one meter in the direction of the force. It takes 1,055 joules to equal a British thermal unit. It takes about one million joules to make a pot of coffee. A megajoule itself totals one million joules.

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.

POUNDS PER SQUARE INCH GAUGE (PSIG) – The pressure relative to atmosphere.

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT (SCAQMD) – The air pollution control agency for all of Orange County and the urban portions of Los Angeles, Riverside, and San Bernardino counties. This area of 10,740 square miles is home to over 17 million people—about half the population of the whole state of California. It is the second most populated urban area in the United States and one of the smoggiest. Its mission is to clean the air and protect the health of all residents in the South Coast Air District through practical and innovative strategies.

SOUTHERN CALIFORNIA GAS COMPANY (SoCal Gas) – The primary provider of natural gas to the region of Southern California. Its headquarters are located in the Gas Company Tower in downtown Los Angeles.

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2 Huntington Beach Union High School District (https://www.hbuhsd.edu/)

STANDARD CUBIC FEET PER MINUTE (SCFM) – The molar flow 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.

STANDARD CUBIC FOOT (SCF) – One cubic foot of gas at standard temperature and pressure (60˚F [15.6˚C] at sea level). Since both temperature and air pressure affect the energy content of a cubic foot of natural gas, the SCF is a way of standardizing. One SCF = 1,020 Btus.

THERM – A non-SI unit of heat energy equal to 100,000 Btu or 1.10 MMBtu.[3]

3 U.S. Energy Information Administration (https://www.eia.gov/)