

US EPA ARCHIVE DOCUMENT

# **Statement of Need For Conversion of Elmendorf AFB Vehicles to Compressed Natural Gas (CNG)**

**1.0 Program Objectives.** The objective of the Alternative Fueled Vehicle (AFV) Program is to ensure compliance with the 1992 Energy Policy Act (EPACT) and Presidential Executive Orders 12759 and 12844, which established requirements and guidance for introduction Alternative Fueled Vehicles (AFVs) into the Federal Fleet. AFVs reduce domestic dependence on foreign oil and vehicular exhaust emissions to the lowest possible level (Clean Air Act of 1990, Title II). The primary method of achieving these mandates expeditiously is to convert USAF internal combustion engine (ICE), light duty fleet vehicles, to domestically available/derived Compressed Natural Gas (CNG) and extend the nominal life of the conventional ICE gasoline powered vehicle.

## **2.0 Contract objectives.**

**2.1.1** Contractor shall provide all necessary materials, equipment and labor to train and certify six (6) EAFB personnel on each specified conversion unit listed in the Solicitation.

**2.1.2** The contractor shall provide CNG vehicle conversion systems and install/retro-fit USAF fleet vehicles at the contractor's facilities in accordance with the attached specifications. The contractor shall provide all engine family specific conversion systems calibration software, materials, labor, and furnish all standard hand tools, as well as special tools necessary to provide complete conversion of USAF light duty vehicles (LDVs: less than 8500 GVW) to a bi-fuel configuration. The bi-fuel conversion configuration shall include an independent CNG fuel delivery system that transports 3600 psig @ 70 deg. F, on-board stowed, vehicle grade SAE J1616 CNG. The contractor shall submit the following to their Proposal:

**A. Metrics.** The contractor shall quantify metrics to enable test and evaluation of the Reliability, Maintainability, System Safety, and Emissions compliance of the proposed conversion system(s). State of the art, closed loop feed-back controlled engine family specific conversion system technologies shall include but not be limited to: onboard computer management of fuel and spark, fuel injection systems (for example; port/multi-point/sequential multi-point), and Exhaust Gas Recirculation (EGR) shall be optimized to retro-fit the corresponding gasoline ICE equipment. The contractor shall provide CNG conversion systems installation familiarization to inform USAF personnel on the operation, maintenance and troubleshooting mechanics of these conversion systems. The vehicles' range shall be maximized and each vehicle shall meet or exceed a range of 70 miles, based on the projected fuel economy of the vehicle. Vehicle performance and tailpipe emissions measured at government acceptance of the vehicle shall meet the applicable 40 CFR Parts 86/88 EPA emission standards for the duration of the contract warranty period.

**B. Emission(s) Compliance.** The contractor shall select the latest advanced technologies available and preferably provide EPA Clean Fuel Vehicle (CFV); Low Emission Vehicle (LEV), Ultra Low Emission Vehicle (ULEV) or non-CFV Tier 1/TLEV certified engine family/end-item Original Equipment Manufacturer (OEM) model year vehicle ICE-specific conversion systems. In lieu of EPA certified conversion systems, the contractor shall provide a Clean Fuel Fleet Standards certified emissions compliance document for the engine family/model year vehicle specific after-market conversion system. This may include any of the following: California Air Resources Board (C.A.R.B.) certification, (using 1994 and later year conversion kit certification procedures); Federal Test Procedures (FTP) emissions data as defined in the EPA's 40 CFR Part 86 For each engine family from an EPA recognized laboratory, or an EPA compliance Statement from the conversion system engine compartment equipment manufacturer that will be coordinated through the EPA Air Enforcement Division, Office of Enforcement and Compliance Assurance, Washington, DC that specifically certifies conformance with EPA Memorandum 1A.

**C. Experience.** The contractor technicians who will be performing hands-on vehicle conversions at every contractor/subcontractor conversion/warranty work facility shall be factory authorized and trained by the engine family conversion system specific manufacturer and be Automotive Service Excellence (ASE), F-1 (CNG) certified to perform state-of-the-art vehicle conversions. Supervisors/Inspectors at each facility shall be ASE Master Technician (L-1) certified and have a minimum of three years service experience at each installation contractor, subcontractor or warranty work facility.

**2.1 Design, analysis, and test.** The contractor shall design the installation methodology for each engine family/vehicle specific conversion system in accordance with the latest editions of the National Fire Protection Association (NFPA) 52, the Texas Railroad Commission (TRRC) "Regulations for Compressed Natural Gas", published by LP-Gas Division. Thomas D. Petru, Director, Austin, Texas, and assimilated the applicable crash safety provisions of the Federal Motor Vehicle System Safety (FMVSS) 303 Standards. The contractor shall perform analysis and tests as required of the EPA tail-pipe emissions(s) minimum requirements. The contractor shall test vehicle performance and tailpipe emission profiles periodically, to ensure sustainment of same, and document any conversion system deterioration during the contract warranty period.

**2.2 Configuration Management.** The contractor shall establish a product baseline to define the configuration of the CNG vehicle conversion system(s) and the corresponding ICE engine specific interface. The contractor shall establish and maintain an in process configuration management program to control the CNG vehicle conversion system configuration, to include engineering changes, deviations, and waivers for the contract duration. The contractor shall provide as-converted engine specific calibrations for each engine family/vehicle (OEM) specific conversion system/ICE interface. The contractor shall document the design of the end item's product baseline through the use of engineering data. The configuration of the conversion system, sub-systems, components and ICE interface engine calibrations shall be managed to enable continuous update of the commercial technical manuals. The contractor shall maintain a close working relationship with the 3rd Transportation Squadron Vehicle Maintenance Flight to assess advanced conversion system technologies and establish applicable milestones as required to incorporate these technologies throughout the contract durations with respect to the

following: A) emerging technology availability, B) system safety features, C) Life Cycle Cost (LCC), D) end item vehicle OEM on-board diagnostics (OBD) interface, E) operator and maintainer CNG conversion systems familiarization, and F) maintenance technical data. The contractor shall provide guidance that will be required to compensate conversion system(s) calibrations for difference in operating environments, outside the Base specific regional locations where the conversions takes place, e.g. USAF Base Realignment, deployment, etc.

**2.3 Quality Control.** The contractor shall develop and maintain an in-process Quality Control Program to ensure installation methodology employed is in accordance with the conversion system(s), i.e., onboard CNG fuel delivery, and engine computer management equipment manufacture's recommended practice and engineering data. The contractor shall develop and implement procedures to properly maintain specialized shop equipment calibrations in accordance with equipment manufacture's standard commercial practices. The contractor shall develop and implement procedures to ensure appropriate warranty actions and disposition of non-conforming quality deficient components.

**2.4 Integrated Logistics Support.** The contractor shall provide data in accordance with attached DD Form 1423s.

**3.0 Management objectives.** The first management objective is to allow the contractor maximum flexibility to innovatively manage program schedule, performance, risks, warranties, contracts and subcontracts, vendors, and data required to deliver an effective CNG/ELV conversion program. The second management objective is to maintain clear government visibility into program schedule, technical performance, and risk. It is the government's responsibility to field an alternative bi-fueled vehicle conversion system that is a model for the industry and the general public at large.

# EXTENDED LIFE VEHICLE (ELV) SYSTEM SPECIFICATION

## 1.0 COMPRESSED NATURAL GAS (CNG) SYSTEM SPECIFICATIONS

**1.1 Reliability.** The contractor shall provide state-of-the-art conversion systems that, as a minimum, include a complete closed loop feedback electronic controller, capable of maintaining the air/fuel ratio @ stoichiometric for natural gas combustion on naturally aspirated engines. The closed loop feed-back control system shall have an adaptive learning system which can analyze the following equipment: manifold air pressure (map sensor), oxygen sensor (O<sub>2</sub>), and engine revolutions per minute (rpm); and subsequently manage system operation of the following equipment: fuel delivery and fuel distribution to the intake plenum and spark timing in an optimized and advanced matrix schedule throughout the operating mode for all applications. Operation on CNG shall not affect the adaptive memory of the end-item vehicle OEM electronic engine control module, such that the vehicle operating performance or emissions are diminished after switching back to the "gasoline operating mode". The contractor shall install the conversion system in a manner that does not affect the operation of the ICE engine speed governor. The engine speed governor shall sustain operation and without interruption, when the vehicle is operating on both CNG and gasoline. The USAF vehicle conversion systems shall be a transparent retro-fit in terms of the engine family/end-item OEM vehicle specific performance specifications, with the exceptions of allowable deviations specifically stated in this specification. Vehicles converted shall be configured to enable immediate forward battlefield deployment, and operate on gasoline in accordance with the end-item vehicle OEM performance specifications.

**1.1.1 Performance.** The contractor shall generate an inspection and test plan to determine engine family/vehicle specific Reliability/Performance metrics of the conversion system/end-item ICE interface. These metrics shall be defined quantitatively to represent all vehicle operating and regional specific environmental conditions, to include, but not be limited to fuel (gasoline and CNG) economy and the peak lambda excess air ratio as a function of the percentage of time at a specific lambda in accordance with attached DD Form 1423.

**1.2 Maintainability.** The contractor shall provide diagnostics electronic componentry and associated software, equipment manufacturer's engine family/vehicle specific calibrations, etc. to properly maintain and trouble-shoot conversion system/OEM electronics interface, and necessary to meet or exceed vehicle performance and emissions objectives shall be supplied to the USAF Base installation. The magnitude, i.e., quantity and capability of the diagnostics equipment shall be supplied to enable centralized maintenance and troubleshooting mechanics for the number of fleet vehicles being converted.

**1.2.1 Configuration.** The contractor shall install all conversion systems and CNG fuel delivery components to include auxiliary interconnects for user friendly accessibility to service and maintain same. The conversion system and fuel delivery tubing network design lay-out metric

shall be the capability for a single novice USAF maintainer to perform routine service, maintenance and trouble-shooting of the CNG conversion system. The conversion systems shall not interfere with the routine ICE maintenance tasks, e.g., tune-ups, checking fluid levels, battery installations, belt replacements, etc. The conversion system components shall be identified easily with a color-coded scheme to enable immediate differentiation/ identification of the respective components in the engine compartment. All conversion systems attaching hardware shall incorporate threaded nylon locking inserts or equivalent corrosion resistance and locking features. The contractor shall document engineering design changes in order to update maintenance, and trouble-shooting tech data for the contract duration.

**1.3 Exhaust Emissions.** The contractor shall provide a conversion system that is capable of meeting or exceeding vehicular tailpipe exhaust emissions according to the EPA engine family specific model year emissions) standards while running on gasoline (at date of manufacture) and CNG (MY 1994 and later for the calendar year it was converted), respectively. The contractor shall provide a closed-loop conversion system that has a zero evaporative emissions profile. Original Equipment Manufacturer's (OEM) Vehicle Identification Numbers (VIN #s) will be supplied by the government for each vehicle conversion to enable determination of the engine family specific EPA emission standard for engine family/vehicle specific end-item equipment. The 3rd Transportation Squadron Vehicle Maintenance Flight reserves the right to conduct emission and fuel economy tests on converted vehicles. These vehicles will be selected at random. The government will bear the cost of these emission and fuel economy tests. In the event that the engine family specific conversion system does not satisfy the EPA Emissions Standards applicable to the vehicle at time of manufacture, the contractor shall be required to recall the vehicle and similar fleet vehicles and to make necessary adjustments to enable the vehicle to meet the established emission standard. The contractor shall test and provide emissions data to the 3rd Transportation Squadron Vehicle Maintenance Flight to assure deficiencies identified have been corrected satisfactorily in accordance with applicable EPA emission standards that are found to be non-conforming.

**1.3.1 OEM Pollution Control System (PCS).** The contractor shall provide a CNG conversion system that, when installed, shall not alter the vehicle's OEM PCS, as installed by the vehicle OEM. At a minimum, all OEM sensors, warning, and vehicle diagnostic systems shall be fully functional in the "gasoline operating mode".

**1.4 Common Components.** The contractor shall provide common engine family/vehicle specific conversion system hardware and onboard storage tanks that incorporate the same part numbered component(s) to enable standardized spare/replacement part(s) inventories.

**1.5 Appearance and Structural Integrity.** The contractor shall provide a CNG conversion system that, when installed, does not alter the external physical appearance of the vehicle, nor shall it diminish the vehicle's structural integrity. The center of gravity shall not be displaced as a result of on-board storage tank installation. The CNG tanks shall be installed symmetrically along the longitudinal axis of the vehicle or perpendicular to the longitudinal axis. The conversion system components shall be installed in accordance with the conversion system component manufacturer's instructions and recommendations.

**1.6 Fuel Injection System.** The contractor shall provide a conversion system, preferably configured with the corresponding hardware interface that is consistent with the Original Equipment Manufacturer's (OEM) end-item vehicle Internal Combustion Engine (ICE), e.g., a sequential multi-point port fuel injection system will be configured with a sequential multi-point port fuel injection conversion hardware system. The CNG fuel shall be introduced at the engine specific ICE fuel injection termination interface based on the availability of advanced technologies. The gasoline fuel injection system shall be retrofit in conjunction with the conversion systems hardware, by a means that will not damage the ICE injectors and ancillary interconnects/components, while the engine is operating on either gasoline or SAE J1616 natural gas. The gasoline fuel injectors shall be disabled during CNG operation for those engine family/vehicle specific applications where advanced technologies are not currently available.

**1.6.1 Fuel pump.** The contractor shall provide a conversion system that manages the gasoline fuel pump to be preferably operational in both the CNG and gasoline operating modes. The fuel pump design life cycle integrity shall not be compromised due to insufficient onboard gasoline fuel supply or other operating conditions that would cause premature wear-out or interfere with the normal operating performance of the gasoline fuel pump assembly.

**1.7 Fuel Delivery System.** The contractor shall provide conversion systems equipped with fuel storage tanks, lines and other auxiliary equipment that are designed to contain gas at working pressures up to 3,600 psig @ ambient conditions (70 °F). Tanks shall be equipped with individual shut-off valves and pressure relief devices (PRDs) approved by the latest applicable editions of the American National Standards Institute (ANSI), Natural Gas Vehicle (NGV-2) Association Standards, and the Department of Transportation (DOT) standards. All pressure tubing shall be seamless stainless steel, designed for a minimum of 3,600 psig @ 70 °F working pressure with a safety factor of four to one. These ratings and approvals shall be permanently marked or stamped on the respective components to allow visual determination of the proper selection and replacement of conversion system components.

**1.7.1 Tank/Cylinder Selection.** The contractor shall install on-board fuel tanks in accordance with the tank manufacturer's installation procedures that shall be certified to NFPA52. The contractor shall select tanks that meet or exceed ANSI/NGV-2 and FMVSS 304 standards with manual valves and safety devices in accordance with the TRRC conversion system standards. The tank installations shall not alter the Center of Gravity (CG) of the vehicles in accordance with FMVSS 303.

#### **1.7.2 DELETED**

**1.7.3 Fuel Selector.** The contractor shall provide a fuel selector that is pressure controlled, temperature compensated, electronic automatic fuel select type that designates CNG as the primary fuel without a dash mounted manual switch. The fuel selector shall be capable of automatically switching from the CNG fuel delivery mode of operation to gasoline while the vehicle is in operation. The Fuel Selector shall disable the gasoline lock-out switch when the delivery of CNG is interrupted based on the availability of onboard storage which is preferably less than or equal to 200 psig. There shall be no degradation in the vehicle/operator performance capabilities, for the duration of the switching cycle.

#### 1.7.4 DELETED.

**1.7.5 Regulator.** The contractor shall provide an approved laboratory tested and laboratory listed fuel supply regulator that includes corrosion resistant metallic fittings for engine coolant to prevent icing of the unit in cold weather. The regulator shall preferably incorporate a pre-heat device to augment cold weather starting/operation. The regulator shall be equipped with a PRD for emergency venting. The regulator shall be preferably integrated with a high pressure side, cartridge type replaceable filter, to preclude refueling contamination of electronic components.

**1.7.6 Re-fueling Receptacle.** The contractor shall provide ANSI/NGV-I approved quick coupling type refueling receptacles that are configured for system safety, user friendly refueling, and incorporate an integrated one way stainless steel check valve which automatically seals the system after refueling. The receptacles shall be co-located with existing gasoline refueling location or at the CNG fuel tank, based on the discretion of the 3<sup>RD</sup> Transportation Vehicle Maintenance Manager. All receptacles shall be located inside the geometric envelope of the vehicle body shell. The receptacle shall include a dust cap to prevent foreign matter from entering the fuel delivery system.

**1.7.7 Pressure Gauge.** The contractor shall provide a mechanically operated, nonelectric CNG fuel pressure gauges meeting the requirements of NFPA 52 at the tank location. The gauge shall indicate fuel tank pressure when the emergency shutoff valve is open. The gauge shall be mounted in an upright position, and configured in units that enables the operator/maintainer immediate observation of the fuel delivery pressure during refueling events and engine maintenance activities. The outside diameter of the gauge shall not exceed two inches in diameter.

**1.7.8 Fuel Supply Filter.** The contractor shall provide a high pressure, cartridge type replaceable redundant filter to prevent foreign particles and oil carry-over from entering the fuel delivery system. The filter shall be installed upstream of all engine compartment electronic componentry.

## 2.0 SYSTEM SAFETY STANDARDS

**2.1** The contractor conversion system installations and conversion facilities shall comply with all system safety standards-in accordance with the latest editions of NFPA 52, NFPA 88A, Society of Automotive Engineers (SAE), TRRC Standards and practices, and with all federal, state, and local regulations.

**2.2 Vehicle Crush area.** The contractor shall innovatively simulate and integrate the applicable provisions of FMVSS 303 into the design of their conversion systems installation test procedures. For example, crush areas shall be defined based on the system safety failure effects/mode due to a given accident event. The design lay-out conversion system installation methodology shall identify and include crash resistance to the maximum extent possible to preclude catastrophic failures that would endanger operating personnel.



**2.3** The contractor shall provide high pressure CNG fuel lines that meet NFPA 52 and be 3/8" O.D. minimum from the fuel supply nozzle to on-board storage when the linear length of this tubing segment is greater than 36" and 1/4" O.D. minimum when the segment length is less than 36" and from the CNG storage cylinder to the engine compartment. The tubing shall be ASTM A-213, cold drawn, bright annealed 304 or 316 seamless stainless steel in accordance with ASTM A269. Fuel lines shall be secured to the body or frame in a manner to avoid pinching or chafing. Fuel lines shall be installed alongside the frame rails to the maximum extent possible or these fuel lines shall be shielded from damage due to rocks, debris, etc. The CNG fuel delivery system tubing network shall not be installed adjacent to any exhaust system component or heat radiating source and a minimum 8" air gap or proper heat shielding shall be installed in accordance with NFPA 52. Bulkhead connectors or applicable grommets shall be installed where fuel lines pass through modular body parts, e.g., cabled, cab/frame, etc. or bulkheads.

**2.4 Emergency Shut-off.** The contractor shall install a remote "1/4 turn" manual emergency shut-off valve, consistent with the latest edition of NFPA 52. The valve handle shall be bright red for easy identification to be located immediately under the driver's side door for user friendly access. The valve shall be located within 18 inches of the outside geometric envelope of the vehicle body shell.

**2.5 Emergency Shut-Down (ESD).** The contractor shall install a device that automatically shuts off the flow of natural gas to the engine when the engine is not running and the end-item vehicle ignition, switch is in the on position.

**2.6 Onboard Fuel Storage Standards.** The contractor shall seal off the passenger compartment, e.g., when fuel tank is trunk mounted. Attaching hardware, i.e., valves, with fittings shall be plumbed to an area outside the body shell with non-resistive metallic tubing which shall preclude fuel vapor from entering the passenger air space. The contractor shall provide protective shields to protect the safety valve/manifold assembly on the installed CNG storage tanks. A laboratory approved and listed vapor bag shall also be included around all interior mounted tank valve assemblies or a laboratory approved and listed ventilation tank valve assembly. The pressure relief valves shall be vented to the outside of the body shell. The installed components shall comply with all federal, state, local, and industry standards and regulations regarding the onboard storage and highway transport of compressed natural gas.

**2.7 Pressure Relief Devices (PRDs).** The contractor shall inspect/test all PRD's prior to re-fueling the vehicle for the government's acceptance of the vehicle to ensure proper operation/serviceability.

### **3.0 TASKS**

**3.1 Training.** Contractor shall provide all necessary materials, equipment and labor to train and certify six (6) EAFB personnel on each specified conversion unit listed in the Solicitation.

**3.2 Pre-Conversion System(s) Installation.** The contractor shall install conversion systems that are new and designed for CNG specific use. CNG system components shall meet the NFPA 52,

ANSI/NGV standards or recognized laboratory approved tested and laboratory listed. Each conversion shall commence only after the following: 1) contractor verification that engine has been tuned by the 3rd Transportation Squadron Vehicle Maintenance Flight to the OEM manufacturer's specifications, 2) the tailpipe pollution levels inspected and recorded. The contractor shall provide pre-conversion test procedures, in accordance with attached DD Form 1423.

**3.3 Post-Conversion System(s) Installation.** The contractor shall install the conversion system components and ancillary interconnects so that they do not interfere with normal maintenance tasks, i.e., tune ups, checking fluid levels, battery installations, belt replacements, etc. The conversion system hardware shall be located for maintenance access, filling, and wire routing to engine sensors located in the engine compartment. The contractor shall provide comprehensive "in-process" conversion systems installation test procedures for each engine family/USAF vehicle specific ICE interface in accordance with attached DD Form 1423.

**3.4 Engine Calibrations.** The contractor shall calibrate each engine family conversion system/end-item USAF vehicle ICE specific interface in accordance with the conversion system equipment manufacturer's engineering data, the contractor's inspection and test plan generated in paragraph I. I. I, and end-item vehicle OEM specifications.

**3.5 Electrical distribution.** The contractor shall install electrical devices and associated wiring that are environmentally sealed and resistant to normal wear and tear. These electrical systems shall be both oil and gas resistant. The contractor shall terminate all electrical interconnects with the end-item vehicle wiring harness/hardware in accordance with the vehicle OEM Qualified specifications. All conversion system engine compartment wiring termination's shall preferably include complete weatherproof pin connectors, consistent with the end-item vehicle OEM installation/production grade practices.

**3.5.1 Fuses.** The contractor shall configure all conversion system electrical devices with fuse protection in accordance with the end-item vehicle OEM Qualified procedures. The fuses shall be easily replaced and centrally located for maintenance friendly access and identification.

**3.6 CNG Fuel Delivery System.** The contractor shall provide the following configuration for each vehicle.

**3.6.1 Tank Capacity/Vehicle Range.** Installed cylinders shall have a capacity sufficient to provide each vehicle with a minimum range of 100 miles based on published EPA vehicle mileage estimates for each application as follows:

$$\text{CNG Range} = \frac{\text{Standard Cubic Feet (SCF) stored @ 3600 psig}}{120} \times \text{EPA est. (mpg) @ 3600 psig.}$$

**3.6.2 Tank Installation/Protective Covers.** The contractor shall install CNG fuel tanks with integrally venting valves. The contractor shall install CNG fuel tanks that are structurally anchored to the vehicle frame/roof structure or to a structural member of the vehicle chassis in accordance with NFPA 52. The contractor shall devise a monolithic gusset plate that uniformly

distributes the resultant point loads (bolted attachments), symmetrically across the vehicle chassis/frame. The following vehicle specific installation methodologies shall be utilized:

**Sedans:** Tanks shall be mounted in the trunk compartment. The tanks and associated installation hardware geometric envelope shall not occupy greater than 40% of the useable trunk space.

**Pick-up trucks:** Tanks shall be located in the bed of the truck, immediately behind the cab, and enclosed in a protective wear plate/composite material enclosure. The enclosure shall be Ultra-Violet (UV) light resistant based on the exterior UV coating of the tanks. The enclosure shall be finished out with a corrosion resistant and aesthetic enclosure, that is color coordinated to the end-item vehicle.

**Vans:** A) certified roof-mounted tanks shall be configured in accordance with prevailing industry standards and finished out with the end-item vehicle specific OEM fairing kit that is color coordinated with the USAF vehicle paint scheme; B) certified tank installations underneath the vehicle shall be configured with prevailing industry standards; C) tanks interior to the vehicle shall be centered immediately behind the driver/passenger seat(s) and perpendicular to the longitudinal axis of the vehicle, and be enclosed in a fire retarding, light weight composite material, that is color coordinated to the interior of the vehicle, at the discretion of the 3rd Transportation Vehicle Maintenance Flight. The contractor shall design exterior and interior tank enclosures with aesthetic and user friendly access doors to enable routine maintenance/inspection of the valve/gauge assemblies/PRDs without removal of the enclosure. At a minimum, each vehicle conversion "as-installed" cylinder/tank mounting design shall be certified by the tank manufacturer to the latest editions of NFPA 52 and submitted to the government in accordance with attached DD Form 1423. An NFPA 52 stress analysis certified by a State specific registered professional engineer shall be required for any deviations from the tank manufacturer's NFPA 52 certified installation procedures in the event the tank manufacturer's recommended installation procedures are not certified in accordance with NFPA 52.

**3.6.3 Tube bending/fittings.** The contractor shall install tube fittings in accordance with the manufacturer's installation procedures. Tube bending performance parameters shall be in accordance with the TRRC conversion system workmanship standards. Installation of high pressure compression fittings shall include metrology of every tubing/fitting ferrule interface to ensure complete engagement. Tubing shall be routed from the onboard storage tank to the engine compartment fuel injection conversion system in accordance with NFPA 52. The tube fitting threaded union interconnects and corresponding interface shall be marked permanently whence the commercial standard 1 and 1/4-turn revolution is secured.

**3.7 Heat Dissipation.** The contractor shall configure the primary components of the conversion system located in the engine compartment, e.g., onboard computer firmware, regulators, wiring harness, and fuel delivery system so that these components are not located in close proximity to exhaust manifolds, engine block, radiator, transmission, or other heat emanating sources, that would impact premature degradation of conversion system or performance of same. The CNG

fuel delivery system, from the onboard storage tanks to the engine compartment, shall not be located in close proximity to the transmission, catalytic converter, exhaust mufflers, or other heat emanating sources that would also impact the Life Cycle design of the conversion system or performance of same. High pressure fuel carrying stainless steel tubing shall not be directly within eight inches of any engine exhaust system component without proper shielding, either shielding the exhaust system component or shielding the tubing itself.

**3.8 Sealant** The contractor shall apply Society of Automotive Engineers (SAE) approved sealant on the conversion system, ICE interface, as required to ensure complete environmental protection of conversion system hardware retrofit interconnects. The sealant shall not interfere with the oxygen-sensor reliability or performance.

#### **4.0 PERFORMANCE SPECIFICATIONS**

**4.1 Performance Testing.** Contractor may provide testing documents, results, or other performance test certifications for each vehicle engine family listed in the bid schedule as an alternative to locally performing the tests specified in sections 4.1.1 and 4.2.

**4.1.1 Power loss.** The contractor shall validate that each USAF vehicle conversion system maintains 85% or better performance after conversion to CNG in terms of horsepower output as measured on a horsepower dynamometer. The documented results recorded before conversion shall be compared to the results recorded after conversion and mathematically computed in terms of a decimal fraction equivalent ( $> 0.85$ ) and supplied to the government in accordance with attached DD Form 1423.

**4.2 Peak Lambda/Fuel Economy.** The contractor shall inspect and provide test results of each engine family conversion system/end-item USAF vehicle specific peak lambda air ratio as a function of the percentage of time at a specific lambda in accordance with attached DD Form 1423. The contractor shall baseline this data to the engine family/vehicle specific OEM stoichiometric peak lambda air ratio specifications. The contractor shall calibrate each engine family conversion system/end-item USAF vehicle ICE specific interface in accordance with the conversion system equipment manufacturer's engineering data, the contractor's inspection and test plan generated in paragraph I.I.I, and end-item vehicle OEM specifications. Fuel economy tests shall be conducted to determine the projected miles/geg of CNG, and miles/gallon of gasoline for each post conversion system/vehicle specific ICE interface. Range of each vehicle conversion shall then be determined based on the calculated mileage of the engine family specific vehicle. Fuel economy shall not be adversely affected by the conversion system interface, when operating on gasoline. Fuel economy after conversion shall be as good as or better than gasoline when operating on CNG.

**4.3 Pre- and Post-Conversion Emission Testing.** The contractor shall perform emission tests as defined by the EPA's 40 CFR Part 88.306-94(0) or equivalent emissions testing on each vehicle. The first test shall be performed while the vehicle is operating on gasoline prior to conversion and the second and third tests shall be performed while the vehicle is operating on CNG and gasoline, respectively, after conversion. There shall be no degradation of the test results on gasoline before and after conversion. The engine shall also "cold start" on both fuels

with no throttle. The contractor shall provide these emission test results for each vehicle conversion and identify same by USAF registration number and corresponding OEM Vehicle Identification Number (VIN#) in accordance with attached DD Form 1423.

**4.3.1 Emissions degradation.** The contractor shall test 2 USAF vehicles to be selected by 3rd Transportation Vehicle Maintenance Flight as control vehicles to be tested semi-annually for the first 12 months of the warranty period and annually thereafter, to ensure sustained EPA emission standards and test results provided in accordance with attached DD Form 1423.

**4.4 Road Test.** The contractor shall perform an in-service road test on vehicles selected randomly by the 3rd Transportation Vehicle Maintenance Flight (3 TRANS/LGTM) not to exceed 50% of the total number of vehicles to be converted after performance and emissions tests have been completed satisfactorily. The vehicle shall be driven not less than 15 miles through combinations of both city and highway driving. Ease of starting, acceleration and performance shall be evaluated while operating on CNG. The engine, after conversion, shall also operate without hesitation, stalling, or surging. The 3rd Transportation Vehicle Maintenance Manager shall delegate an observer to witness road test. The contractor shall perform subsequent bench/in-service testing to fault-isolate source of any operational malfunctions to the complete satisfaction of 3TRANS/LGTM.

**4.5 Tamperproof conversion system(s).** The contractor shall install a conversion system whereby the engine calibration cannot be altered in the field without the assistance of an Automobile Service Excellence (ASE) Master Technician certified USAF maintenance personnel. The contractor shall provide a conversion system that requires no periodic scheduled/unscheduled electronic calibration adjustments after the proper setting of the excess air/fuel ratio is accomplished and the vehicle meets both the vehicle operating performance and emissions criteria. Defeat devices shall be in accordance with 40 CFR 094-22.

## 5.0 INSPECTION AND ACCEPTANCE

**5.1 Initial Vehicle.** Once the contractor is notified of the "initial" vehicle(s) to undergo CNG conversion, the contractor shall have no more than 10 business days to accept vehicle(s) for CNG conversion. The contractor shall install a CNG conversion system on to the "initial" vehicle(s) in accordance with the specifications of the contract and shall notify 3TRANS/LGTM via telephone of the time, date and place of the initial vehicle conversion no later than five (5) business days prior to such installation. This vehicle shall be subjected to performance and emissions testing in accordance with FTP 75, prior to beginning work on the balance of the fleet vehicles. The contractor shall receive no more than five (5) vehicles for conversion per delivery order. The contractor shall complete CNG conversions and return vehicle(s) to the government within 15 days of taking possession of the vehicle(s). The government will witness all testing. Comprehensive vehicle performance and emissions testing on a drive cycle chassis dynamometer and in a road test shall be the basis for accepting or rejecting the initial converted vehicle(s). Durability testing shall consist of a road test of not less than two business days or 100 total miles, whichever is less. The initial vehicle installation and testing duration shall not exceed 15 calendar days. Documentation of the installation test procedures and test results shall be submitted to 3 TRANS/LGTM.

**5.1.1 Additional Vehicles.** Once notified of follow-on or additional vehicles, the contractor shall have no more than 10 business days to accept vehicle(s) for CNG conversion. The contractor shall install a CNG conversion system on to the vehicle(s) in accordance with the specifications of the contract and shall notify 3TRANS/LGTM via telephone of the time, date and place of the conversion no later than five (5) business days prior to such installation. The contractor shall receive no more than five (5) vehicles for conversion per delivery order. The contractor shall complete CNG conversions and return vehicle(s) to the government within 15 days of taking possession of the vehicle(s).

**5.2 Fleet vehicles.** The contractor shall provide products and services that meet or exceed the aforementioned system safety, vehicle performance, and emission standards. First engine families/end-item OEM vehicle platforms shall also be tested in accordance with FTP 75 for the purposes of workmanship evaluations. These tests shall provide the baseline for like engine family/vehicle platform calibrations. Test results shall be submitted in accordance with attached DD Form 1423 similar to initial vehicle FTP 75. Contractor supplied vehicle performance, emission tests, and system safety tank installation certifications for each vehicle shall be approved prior to the governments acceptance of the conversion of the vehicle.

## **6.0 CONTRACTOR FACILITIES.**

**6.1 Location.** 3TRANS/LGTM will deliver the vehicles to and from the contractors' conversion/warranty work facility if such facility is located within a 50-mile radius of Elmendorf AFB AK. Should the contractor's facility be located outside a 50-mile radius of Elmendorf AFB, the contractor shall be responsible for the pick-up of the vehicles from the USAF and the subsequent return of the vehicle to the USAF. The contractor shall be responsible for all costs associated with the pickup and delivery of vehicles to and from the USAF, should its contractor facility be outside the 50-mile radius. Note: The term "contractor's facility" is applicable to any and all prime and/or subcontractor facility.

**6.2 Mission Capability.** 3 TRANS/LGTM will provide scheduling of vehicles to be picked up by the contractor and returned to the USAF within 5 working/business days by registration number. The USAF mission is dynamic and scheduling will vary based on the Department of Defense (DOD) military conditions at the time. The quantity and turn-around time for vehicles removed from USAF service shall not exceed the number/classification of vehicles and total time out of service that would be required to sustain the USAF mission. The contractor shall work closely with 3 TRANS/LGTM to develop a roadmap that strategically sorts/selects vehicles from the independent USAF Base Squadrons, e.g.. Transportation, Civil Engineering, Environmental, Staff Vehicles, Flight line vehicles. The contractor shall include scheduling impact in their management plan to enable a continuous flow of vehicles in and out of their conversion facility.

## **7.0 WARRANTIES**

**7.1** The contractor shall warrant that the installation of their components will in no way alter, modify, or render invalid the full force and effect of the modified vehicle's original

manufacturer's warranty. This warranty shall also include Emissions Compliance of the converted vehicle in accordance with Alaska four gas tailpipe analysis emissions requirements.

## **7.2 DELETED**

**7.3** The contractor shall provide a three year or 50,000 mile (whichever comes first) warranty; inclusive of all labor, conversion system components parts, and attaching hardware/firmware that was installed on the vehicle, to correct failures that are identified as hardware interface workmanship deficiencies or a CNG conversion system defective computer software engine specific calibration anomaly for all vehicles which have been converted to operate on CNG. This warranty shall remain in effect for the warranty period commencing at the government's acceptance of the conversion of the vehicle.

**7.4** The contractor shall be responsible for damage to the vehicle ICE when it is determined that the damage was caused by the installation of the retrofit system and the engine OEM manufacturer's warranty is in effect when the engine OEM's warranty is no longer in effect. The contractor shall be responsible for the cost of repairs of those components damaged by the use of the conversion system.

## **8.0 CONVERSION SYSTEMS FAMILIARIZATION**

**8.1** The contractor shall provide CNG conversion systems installation regulatory compliance inspection familiarization to 3rd Transportation Squadron Quality Assurance Evaluator (QAE) prior to delivery of the initial vehicle (para 5.1). The contractor shall provide a minimum of five full days technical familiarization to six 3rd TRANS/LGTM personnel on CNG vehicle conversion systems relative to installation and trouble shooting prior to delivery of the fifth vehicle. Technical familiarization shall include system safety, comprehensive service, diagnostics and maintenance. The familiarization shall take place at the contractor's conversion installation facility. Specific dates and times for these familiarization periods shall be scheduled by the contractor and coordinated with the Procuring Contracting Officer (PCO).

## **9.0 REGULATIONS**

**9.1** The contractor shall provide contractor's facility, conversion systems, CNG onboard tanks, and system safety installation methodologies employed thereof, that comply with all applicable federal, state, local (building and fire codes), and USAF base level fire Marshall regulations. Conversions/Contractor's facility shall meet all Alaska State specific regulations and any certification programs.