INCH - POUND
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PERFORMANCE SPECIFICATION

HEATER, SPACE - CONVECTIVE, SELF-POWERED, LIQUID FUEL, SHC 90K

This performance documentation is approved for use by all Departments and Agencies of the Department of Defense.

1. SCOPE

1.1 Scope. This documentation covers the performance and acceptance requirements for a self-powered, liquid fuel burning, convective space heater

1.2 Classification.

Space Heater Convective (SHC 90K), 90,000 BTU/hr

Comments, suggestions, or questions on this document should be addressed to U.S. Army Soldier Systems Center, Natick, MA 01760-5018 or emailed to Joseph.A.Mackoul.civ@Mail.Mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil .

AMSC N/A FSC 4520

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

MIL-STD-810 Environmental Test Methods and Engineering Guidelines

(Copies of these documents are available online at https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094)

2.3 Non-Government Publications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of the documents which are DoD adopted are those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) cited in the solicitation. Unless otherwise specified, the issues of documents not listed in the DoDISS are the issues of the documents cited in the solicitation (see 6.2).

AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 51 Laboratory Methods of Testing Fans for Rating Purposes

(Application for copies should be addressed to American Society of Heating, Refrigeration and Air Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329. The web address is http://www.ashrae.org .)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D2156 – Standard Test Method for Smoke Density in Flue Gases from Burning Distillate Fuels

(Application for copies should be addressed to American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428-2959. The web address is http://www.astm.org .)

2.4 Order of Precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to a first article inspection in accordance with 4.1.1.

3.2 Conformance and end item examination. Items furnished under this specification shall be subjected to conformance inspection and end item examination in accordance with 4.1.2 and 4.1.3.

3.3 Operating requirements. The heater shall satisfy the following user-oriented requirements.

3.3.1 Description. The SHC 90K shall be a 90,000 BTU, lightweight, portable, multi-fuel, self-powered heater that operates outside military tents and provides forced hot air recirculation via sealed, detachable, quick connect, flexible air ducts, without the need for an external power supply. The SHC 90K shall operate on diesel and JP-8 fuels and generate its own internal electrical power without any moving parts. Fuel ignition will be accomplished by a one-switch startup procedure on a remote control located inside the tent. The remote control will have a visual display to show heater functions and fault codes. Heater operation will include completely automatic safety and temperature controls as well as built-in troubleshooting diagnostics. The SHC 90K will be equipped with an internal fuel tank to provide a minimum of 15 hours of continuous operation and will have the capability to operate on an external fuel supply as well. It will have a protective enclosure that can withstand extreme environmental and field conditions. It will be forkliftable and have handrails/handles and wheels if required to support local movement and positioning.

3.3.1.1 Heat output. The heater shall provide a minimum of 90,000 BTU/Hr (±1,500 BTU/hr) heat output when the thermostat is not satisfied using JP-8 fuel and a maximum of 60,000 BTU/Hr (+4,000 BTU/hr) heat output with JP-8 when the thermostat is satisfied at altitudes up to 5,000 ft. Heat output shall be derated 15% at altitudes up to 10,000 ft.

3.3.1.2 Indicated efficiency. The burner system shall operate, during any temperature setting, at a minimum of 80 % indicated combustion efficiency.

3.3.1.3 Burner smoke spot. After 5 minutes of burner operation the heater shall not produce a smoke spot number greater than 3, per ASTM D2156, in any mode of operation under any identified performance test condition.

3.3.1.4 Fuel capability. The heater shall be safely operated with all of the fuels listed in Table I at the corresponding environmental conditions, with no operator adjustments required to accommodate varying fuel types. The primary fuel will be JP-8 and the alternate fuels will be K-1, DF-A, DF-1, JP-5 and DF-2.

TABLE 1. Compatible Fuels

Ambient Temperature Range	National Stock Number	Military Symbol CONUS
Above +25°F	9140-01-286-5294	DF-2
Above +10°F	9140-01-286-5286	DF-1
Above -25°F		K-1
Above -60°F	9130-01-031-5816	JP-8
Above -60°F	9140-01-286-5283	DFA

3.3.1.5 Operational temperature range. The heater shall operate in a temperature range of +60°F to -60°F.

3.4 Fuel system. The fuel system shall permit the heater to operate continuously without flooding. The heater shall operate from either an integral fuel tank or from an external fuel supply. A fuel system diagram shall be mounted on the heater.

3.4.1 Integral fuel tank. The heater shall have an integral fuel tank of sufficient capacity to provide a minimum 15 hours (Threshold) and 24 hours (Objective) of operation at maximum rated heat output.

3.4.1.1 Fuel tank material. The fuel tank shall be constructed of corrosion resistant materials or treated to provide protection against corrosion and deterioration that may be encountered in any applicable operating and storage environment. The fuel tank shall be compatible with the fuels specified in Table 1.

3.4.1.2 Fuel tank equipment. The fuel tank shall be equipped with an overflow vent, water drain, quantity gauge, a removable filler strainer, and a filler neck/cap recessed flush with the enclosure exterior surface. The fuel tank filler shall be accessible for easy fueling. The cap shall be captive to prevent loss of the cap. The captive cap shall permit unobstructed refueling of the tank. The fuel tank shall be equipped with a drain connection separated from the fuel supply line. The drain connection shall be leak proof. The fuel tank drain shall be labeled, well-located, and protected from transportation damage and excessive heat.

3.4.2 Operate from external fuel supply. The heater shall be capable of operating from an external fuel supply. The fuel system shall permit the heater to operate continuously without flooding, with the fuel container 12 inches below the base of the heater and up to 10 feet above the heater.

3.4.2.1 External fuel fitting. A quick disconnect fitting shall be flush mounted on the heater exterior for mating with an external fuel hose.

3.4.2.2 External fuel hose. A 25-foot external fuel hose shall be provided. It shall be ¼ inch ID hose and must meet or exceed the requirements of MIL-DTL-8794, conform to SAE standards for low pressure, for fuel transfer from an external fuel supply. The fittings must meet the requirements of MIL-DTL-5070 and the hose assemblies shall meet or exceed the requirements of MIL-DTL-8795. The fuel hoses shall have an operating temperature range of –60° to +250°F. The hose shall have captive protective caps. One end of the hose shall have quick disconnect fittings for connection to the heater. For connection to the external fuel supply, the other end of the hose shall be a female flare connector with the designation 5/16” JIC by ¼” pushlock barb.

3.4.3 Manual fuel valve. The heater shall be equipped with a manual fuel valve to permit operation from either the external fuel supply or the integral fuel tank.

3.4.4 Fuel filtering and water separation. A fuel filtering device, capable of running in a military environment, shall be incorporated to remove foreign particles-and suspended ice crystals, separate water from the fuel, and protect the fuel system downstream. The filtering device housing shall be clear to allow for visual inspection. The filter shall be located within a protected area and shall not break due to freezing of entrapped water. Access to the filter for service and replacement shall be simple and rapid.

3.4.5 Automatic shut-off capability. Fuel flow shall stop within 2 seconds when the heater start switch is turned to the off position or when a fault is detected by the system controller during operation. When the start switch is in the off position, and the heater is connected to an internal fuel supply, no fuel shall flow from the filter assembly when disassembled for cleaning.

3.4.6 Residual fuel. The heater shall provide a means to drain residual fuel from the fuel system reservoir areas such as the tank, filter element, and float after operation.

3.4.7 Trapped air. Bleeding of any trapped air in the fuel line and fuel system shall be automatic and without fuel leakage during use of internal fuel tank. An air purge mechanism shall be provided for use with the external fuel supply.

3.5 Heated air system. The heater shall provide clean, heated, re-circulated, breathable air for shelters.

3.5.1 Airflow volume. The heated air system shall provide a minimum of 1000 CFM (± 100 CFM) indicated heated air at 0.50 (Threshold), 0.75 (Objective) inches water gauge when the thermostat is not satisfied using both air ducts.

3.5.2 Maximum air outlet temperature. The maximum outlet air temperature measured at the outlet end of the flexible duct shall not exceed 225°F. The heater shall automatically shut off if the heated air at the outlet of the flexible duct exceeds 225° F.

3.5.3 Modular fan system. The blower or fan system shall be modular to permit simple removal for service or replacement.

3.5.4 Fresh air makeup. If required, the heater shall be capable of delivering fresh makeup air up to a minimum 5 percent of the total heater airflow. The fresh makeup air inlet shall be adjustable. Intakes for fresh makeup air shall be positioned to minimize the introduction of contaminated air from the exhaust opening.

3.5.5 Air inlet and outlet openings. The air inlet opening and heated air outlet opening shall incorporate a debris and finger guard to prevent any objects larger than ¾” diameter from entering the enclosure. The air inlet and outlet openings shall be fitted with a rigid collar. The inlet collar shall have three J-slot connectors located 120 degrees apart, and the outlet collar shall have three pins located 120 degrees apart for making connection to flexible ducts.

3.5.6 Flexible air ducts. A 10 ft. heated air supply duct and a 10 ft. return duct shall be provided. The heater ducts shall be sized for compatibility with standard shelter openings. The duct construction shall conform to AIA/NAS 1369. Attaching the ducts to the heater shall require no tools and be performed wearing anti-contact gloves NSN 8415-00-227-1220. The duct rigid collar shall have J-slot connectors located 120 degrees apart on the inlet end, and three pins located 120 degrees apart on the outlet end. The heater return air duct shall have a

debris guard installed in the tent end of this duct assembly preventing debris larger than ¾" diameter entering into the duct. The outer liner of the ducts shall meet FAR 25.853 flammability requirements. The duct assembly shall meet NAS1369 Type B, Form C duct requirements. The ducts shall be stowable with the heater. The duct color shall be olive drab. The flexible air ducts shall not off-gas or create a haze with air temperatures up to 250°F.

3.6 Major components. The following major components shall be provided with the heater.

3.6.1 Internal power generation system. The heater shall contain an internal electrical power generation system that is silent, contains no moving parts, is self-contained, and requires no adjustments before, during, or after heater operation. No special periodic maintenance shall be required. The generator output wattage shall provide sufficient electrical power to operate the heater during all thermostat settings during and after battery charging. The generator system shall have built-in "FAIL-SAFE" protection from overheating, overcharging, shock hazards, etc. The generator and related components shall be modular for ease of repair and replacement.

3.6.2 Power storage battery. The power storage battery shall be mounted to the heater and shall not require installation or removal when the heater is in use or being transported. It shall be included in the overall weight of the heater. The battery shall be replaceable by one person within 15 minutes. The battery shall have a minimum storage life of two years.

3.6.2.1 Battery safety. The battery shall be fuse protected within the battery case. The fuse holder(s) shall be weather proof. The fuse(s) shall be easily removable for inspection and maintenance in all temperatures. The battery shall be classified as a non-spillable battery. The battery, when subjected to any attitude, shall display no leakage of caustic, hazardous material or liquid and shall be transportable by all modes of shipment. The power storage battery and stowage location shall be vented to the atmosphere. No fumes or liquid shall enter the heated air stream, combustion air stream or electronic circuits and electrical component areas in the event of a mechanical rupture or battery over heat condition.

3.6.2.2 Battery starting and recharge. Sufficient basic cold starting power shall be stored in the battery to provide three complete start cycles at -40°F after being charged by the heater. Once started at -40°F, the battery shall accept a charge in ambient temperatures to -60°F. After the battery charged light is illuminated during operation and the heater is shut down for refueling and PMCS for 30 minutes in ambient temperatures of -60°F, the battery shall be able to restart the heater. Within an ambient temperature range of -25°F to +60°F, the battery pack shall be 99% recharged within 60 minutes. The recharge time is measured from the actuation of the ON/OFF control switch to illumination of the charged light. Prolonged usage in temperatures from -25°F to –60°F, with shut off times of one hour, shall not shorten the life or reduce the charging reliability of the battery.

3.6.2.3 External battery charge. The power storage battery shall have provisions for being charged using a commercially available 115 volt AC to 24 volt DC battery charger. If an adapter is necessary to charge the battery with the 24V DC battery charger, it shall be included within the accessory package.

3.6.2.4 Assisted start from vehicle NATO adapter. In the case of a dead battery, the heater shall have an interface which allows the heater to be started from a military vehicle NATO connector with the use of a NATO cable. The heater shall provide indication when it is safe to disconnect the NATO cable after the assisted start.

3.6.3 Combustion system. The combustion system shall provide for the functions of the burner, combustion chamber, heat exchanger, and exhaust stack. The combustion system shall provide continuous, safe, and efficient combustion of specified fuels. The combustion system shall not fail from exposure to any condition encountered during operation at any condition specified herein, or during testing specified herein. These conditions shall include, but not be limited to, extreme operating temperatures, corrosion, and rough handling and transport. The combustion system shall be designed to permit disassembly and cleaning. The combustion system must not leak combustion products into the heated air.

3.6.3.1 Burner. The burner shall provide a means of introducing and mixing fuel and combustion air for ignition and initiation of the combustion process. The burner shall be accessible for cleaning in 15 minutes or less. The burner shall be capable of operating 1,500 (Threshold) to 2,000 (Objective) hours on a combination of 50% JP-8 and 50% DF-2 before maintenance is required. As an objective, a visible means of flame indication (observation port) shall be provided.

3.6.3.2 Combustion chamber. The combustion chamber shall be a separable, removable chamber or a part of the heat exchanger and shall serve to continue mixing and completion of the combustion process.

3.6.3.3 Exhaust outlet. The exhaust discharge outlet shall be located and positioned to prevent the ingestion of exhaust gases into the heater breathable air. The exhaust outlet shall be provided with a rain cap to keep out rain in sufficient quantities so heater operation is not adversely affected. The rain cap shall be designed to prevent the exhaust gases from being directed at the operator and causing an interference when operating the heater.

3.6.3.4 Emissions. The burner shall not produce a smoke spot number greater than 3 on the Bacharach Scale. The burner smoke number shall not degrade at increasing altitudes up to 5,000 feet and temperatures ranging from -60F to +65F and burning the fuels listed in Table 1. Heater shall remain operational to 10,000 foot altitude with a maximum smoke number of 3.

3.6.3.5 Fuel post-purge. The heater shall have a post-purge cycle that insures sufficient evacuation of burner fumes and cool down of components for safe relocation, PMCS, or refueling after any time fuel has entered the burner area.

3.6.3.6 Heat exchanger. The heat exchanger shall provide for the necessary heat transfer between the combustion gasses and the ventilating air to be heated. The heat exchanger shall be a separable modular component. The heat exchanger shall prevent combustion products from entering the heated air stream. The heat exchanger shall be designed for maximum efficiency consistent with maintaining the discharge temperature of the exhaust gases above the dew point in the exhaust stack. At no time during operation under any environmental condition specified herein, shall ice formation from the

exhaust accumulate within or on any of the combustion system components including the exhaust pipe discharge area. No condensate shall be allowed to collect on the heater surface.

3.6.3.6.1 Heat exchanger over-temperature protection sensor. The heat exchanger shall be protected by a temperature sensor to prevent excessive overheating resulting from possible abnormal operating conditions. The sensor shall positively stop fuel flow to the burner in the event of a heat exchanger over temperature condition. The heat exchanger and related combustion system components shall not suffer any loss of performance or damage when overheated to the point of sensor activation. The heater shall automatically reset following the over-temperature condition after the heat exchanger cools down.

3.7 Gauges.

3.7.1 Hour meter. An hour meter shall be installed on the remote control box to record hours of operation. The hour meter shall be easily accessible for viewing.

3.7.2 Fuel tank gauge. The integral fuel tank shall be equipped with a fuel gauge to indicate the remaining quantity of fuel.

3.8 Controls.

3.8.1 Remote control box. All controls and instruments required for operation of the heater shall be located together on a compact sealed control panel. The control box shall allow attachment to a horizontal member in the shelter. The control box shall be connected to the heater by a separable 25 foot cable. The cable connections shall be weatherproof. The control box, cable, and heater shall have protective caps fastened to each connector for use when disconnected from the cable. The control box shall be designed to provide protection to the controls and indicators from damage if dropped or if improperly packed for shipping or storage. Storage for the remote control box and cable shall be provided on-board the heater. The control box shall contain the On/Off switch, the thermostat, the visual indicator display panel, audible fault alarm, and the remote CO sensor.

3.8.1.1 On/Off switch. A single On/Off switch shall be located on the control box to initiate the start and stop functions of the heater. The switch shall be located so that accidental contact by personnel shall not operate the switch.

3.8.1.2 Thermostat. A thermostat shall be provided on the remote control box to supply temperature input for control of the heater fire rate in unison with the manually adjusted temperature control knob. By rotation of the control knob the heater shall increase or decrease the burner fire rate in relation to the setting of the control knob and the tent thermostat sensing device. The control shall be manually adjustable within the 40°F (± 5°F) to 80°F (± 5°F) temperature range. There shall be an indication when the thermostat is satisfied.

3.8.1.3 Visual indicator display panel. The visual indicator display panel shall provide information on heater operation and generated fault codes. It shall display real-time text based feedback on heater function and a timed countdown for start-up. It shall have the

capability to display the number of starts, operating hours, and the initial condition of the battery voltage prior to operation. It shall also display a historical log of activated faults and provide monitored parameters. A “RUN” indication shall display when the battery is supplying operating power. A "CHARGING" indication shall display when the battery begins to accept a charge from the internal power generation system; a "BATTERY CHARGED" indication shall display when the battery has reached its normal starting potential; an indication of thermostat “SATISFIED” or “UNSATISFIED” condition shall be displayed. The Fault Code number shall display when a fault is encountered.

3.8.1.4 Audible fault alarm. An audible alarm shall be present on the control box to provide an audible tone when a fault is encountered or when the CO sensor is activated.

3.8.1.5 CO sensor. The heater shall incorporate a carbon monoxide (CO) sensor which, when activated, will cause an audible and a visual alarm to be activated and will shut down the burner. The visual alarm shall remain on after system shutdown until it is reset. The CO sensor shall be located on the remote control box.

3.8.2 Alternate emergency control panel on heater. The heater shall have a toggle switch that allows the heater to operate in the event the remote control panel is lost or damaged. In the emergency mode, all of the safety controls shall remain operational with the exception of the CO monitor. If a Fault is encountered, the heater shall shut down; however, the Fault Codes shall not be displayed. The heater shall maintain a comfortable and safe shelter temperature when operated in the “Emergency Mode”.

3.8.3 Prevention of accidental actuation. Controls shall be designed and located so that they are not susceptible to being moved accidentally, particularly controls whose inadvertent operation might cause damage to equipment, injury to personnel, or degradation of system functions. Cycling through the control “On/Off” position shall be avoided.

3.8.4 Human factors engineering of controls. Controls shall be located within the operator’s functional reach and view without the need to assume an uncomfortable or unusual posture. Control design shall facilitate accurate and efficient system operation.

3.8.5 Consistency of movement. Direction of control movement shall be consistent with the effect of change. For example, the movement of a control forward, clockwise, to the right, up, or pressing a control, shall turn the equipment or component on, or cause the quantity to increase.

3.8.6 Positive indication. An indication of control activation shall be provided (e.g. snap feel, audible click, or indicator light illumination).

3.9 Automatic built in test capability (ABIT). The heater shall have built in test capability.

3.9.1 ABIT system controls. The ABIT shall control starting, stopping, power generation, fault shut off and identification, burner modulation and operational functions. All functions shall be automatically executed without input from the user other than activation of the On/Off switch and adjustment of the thermostat control. The ABIT system shall provide prediction and detection of malfunction or degradation of systems, subsystems or components specified. When

a self monitored function or component falls outside of its safe operating level the ABIT system shall automatically initiate a shut down of the heater. The ABIT system shall isolate the fault to the lowest replaceable component or fuel supply and identify the specific manual diagnostic for correction during pre-start, start, and operation. The fault code shall be displayed on the control panel accompanied by an audible tone. The visual and audible fault codes shall be annunciated on the control panel until the switch is positioned to the "Off" position, with the exception of the burner maintenance fault, which shall be presented once after the completion of the post purge cycle during normal shut down. An audible alarm shall be checked at startup.

3.9.1.1 Visual display. The ABIT visual display shall provide real-time text based heater function feedback to the operator. Real-time displayed functions shall include but not be limited to: timed countdown for start-up, run, battery charging, battery charged, thermostat condition, fault code and post-purge.

3.9.1.2 Pre-purge diagnostic control. The pre-purge cycle in the heater control system shall provide component and electrical operational checks and evacuation of fuel vapors in the burner to insure safe reliable starting. At a minimum, the combustion air flow, low starting voltage, tilt, flame sensor, igniter and ignition power source shall be checked for proper operating ranges. If a safe and reliable burner start is not probable then the burner start sequence shall be terminated and the identifying fault shall be presented. If fuel has been introduced into the burner area, a post-purge cycle shall follow. This pre-purge, pre-run function shall be automatic and shall provide a fault code and tone if terminated, identifying the source of shut down. The fuel flow to the burner shall be stopped within 2 seconds (if initiated) after detection of a fault condition or if the ON/OFF switch is positioned to the "OFF" position. Three repeated failed start attempts shall not create a safety hazard.

3.9.1.3 Start cycle control. The burner start cycle shall consist of three start attempts and shall be a consistent automatic timed function. If combustion cannot be initiated within this allotted time, the fuel delivery system shall stop followed by the post- purge and identifying fault code with tone. There shall not be an unsafe or hazardous condition created by a failed start attempt.

3.9.1.4 Post-purge diagnostic control. The post-purge cycle shall ensure sufficient evacuation of burner fumes and cool down of components for safe relocation, PMCS, or refueling after any time fuel has entered the burner area. When the On/Off switch is positioned to the Off position or a fault is detected after fuel flow has entered the burner, fuel flow shall be shut off, followed by the post purge cycle or post purge cycle and fault code. Post-purge shall be a minimum of 1.5 minutes after 5 minutes of burner operation

3.9.1.5 Hot re-light diagnostic control. The heater shall be controlled so that it cannot be restarted until the completion of the post purge cycle.

3.9.2 ABIT system faults. The heater shall have the capability to identify, at a minimum, the following system faults, each with its own distinct fault code. Audible and visual text-based notification of fault code number and name shall be provided when a fault is encountered.

Fault codes shall activate a visual and audible alarm prior to or simultaneously with the start of post-purge.

3.9.2.1 CO level fault. The heater shall incorporate carbon monoxide (CO) sensors which will activate an audible and visual alarm and shut down the burner when excessive carbon monoxide is detected. The fuel flow shall be shut off followed by the post-purge cycle. The visual alarm shall remain on after system shutdown until it is reset.

3.9.2.2 Low system voltage fault. When a voltage level not sufficient for start or to safely continue heater operation is detected, the fuel flow to the burner shall stop, followed by the post-purge cycle if fuel was introduced into the burner, fault code and audible tone. The low voltage shut off value during heater operation (after start) shall provide adequate power reserves for the full post-purge cycle and repetitive display of the identifying fault code and audible tone for a minimum of 10 minutes.

3.9.2.3 Combustion fan wiring fault. If the combustion fan wiring is open or shorted and is inoperable during start up, the heater shall automatically shut off and the identifying fault code and audible tone displayed.

3.9.2.4 Combustion fan blower motor fault. If the burner combustion fan blower motor fails to supply adequate combustion air flow, or is inoperable during start up, the heater shall automatically shut off, provide post-purge, and present the identifying fault code and audible tone.

3.9.2.5 Loss of flame fault. If the burner flame goes out during start up or operation, the fuel flow shall be shut off within 2 seconds, followed by the post-purge cycle. The identifying fault code and audible tone shall be presented.

3.9.2.6 Flame sensor fault. If the flame sensor is shorted and inoperable at startup, the heater shall automatically shut off, give the identifying fault code and an audible tone.

3.9.2.7 Burner maintenance fault. The ABIT shall monitor burner condition after each use. If a condition is detected which requires burner maintenance, a distinct code shall be presented one time on the control panel, after SHC shutdown and post-purge.

3.9.2.8 Ignition element fault. If the ignition element is open, shorted or becomes inoperable, the heater shall automatically terminate the start cycle and provide the identifying fault code and audible tone.

3.9.2.9 Generator over temperature fault. If the operating temperature of the generator becomes high enough to degrade its performance, or becomes hazardous, the fuel shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.10 High voltage fault. When a voltage level is detected above safe operating levels which will result in unsafe operation or component degradation or failure, the fuel flow to the burner shall stop, followed by the post-purge cycle, fault code and audible tone.

3.9.2.11 Tilt fault. The heater shall operate up to a 15 degree tilt in any direction. When the heater is operating or a start is attempted at a tilt greater than the maximum angle allowable for normal safe operation, fuel shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.12 Generator temperature sensor fault. If the temperature sensor on the TEG is open or shorted, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.13 Tent over-temperature fault. If the temperature inside the tent exceeds 110°F, the fuel flow to the burner shall be shut off followed by the post purge, fault code and audible tone.

3.9.2.14 Vent fan motor fault. If the vent fan motor fails to supply adequate air flow, or is inoperable during start up, the heater shall automatically shut off, and the identifying fault code and audible tone shall be presented.

3.9.2.15 Vent fan wiring fault. If the wiring to the vent fan motor is shorted, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.16 Fuel pressure sensor fault. If the system provides a fuel pressure sensor and the sensor is open or shorted, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.17 Heat exchanger over-temperature fault. If the operating temperature of the heat exchanger becomes high enough to degrade its performance, or becomes hazardous, the fuel flow shall be shut off to the burner followed by a post-purge, fault code and audible tone.

3.9.2.18 Inlet air temperature fault. If the system provides an inlet air temperature fault and the inlet vent air is above the safe operational limits, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.19 Inlet air temperature sensor fault. If an inlet air temperature sensor is provided, and the inlet vent air temperature sensor is open or shorted, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.20 Battery temperature sensor fault. If a battery temperature sensor is provided, and the battery requires temperature control, the heater will have a safety feature to prevent a battery over-temperature condition. If the safety sensor is open or shorted, the fuel flow shall be shut off to the burner followed by the post-purge cycle, fault code and audible tone.

3.9.2.21 Fuel delivery fault. If an electronic fuel delivery system is utilized and the electronic mechanism is shorted, the fuel flow to the burner shall be shut off followed by a post-purge cycle, fault code and audible tone.

3.9.2.22 Combustion inlet temperature sensor fault. If a combustion inlet temperature sensor is provided, and the combustion inlet temperature sensor is open or shorted, the fuel flow to the burner shall be shut off followed by the post-purge cycle, fault code and audible tone.

3.9.2.23 Start attempts fault. After a single unsuccessful start cycle, which includes three start attempts, the fuel flow to the burner shall be shut off followed by a post-purge cycle, fault code and audible tone.

3.9.2.24 Remote communications fault. If the heater loses communication with the remote or the 25 foot remote cable becomes damaged or disconnected, the fuel flow to the burner shall be shut off, followed by a post-purge and a remote communications fault shall be recorded in the historical log.

3.9.2.25 Carbon monoxide sensor fault. If the carbon monoxide sensor is open or shorted, the fuel flow to the burner shall be shut off followed by the post-purge cycle, fault code and audible tone. This fault shall indicate failure of the carbon monoxide sensor or sensor circuit.

3.9.2.26 System audible alarm fault. If the system audible alarm is open or shorted, the fuel flow to the burner shall be shut off, followed by the post-purge cycle and fault code.

3.9.2.27 Microprocessor fault. If a microprocessor is used and in the event of a microprocessor failure the unit shall shutdown safely and provide a fault code and audible tone.

3.9.2.28 Brownout fault. If a brownout fault is provided and a component is pulling current down faster than under normal operating conditions, the fuel flow to the burner shall be shut off followed by the post-purge, fault code and audible tone.

3.9.2.29 Outlet air temperature fault. If the outlet air temperature exceeds safe operating temperatures at the end of the outlet duct, the fuel flow to the burner shall be shut off followed by the post-purge, fault code and audible tone.

3.9.2.30 Outlet air temperature sensor fault. If the outlet air temperature sensor is open or shorted, the fuel flow to the burner shall be shut off followed by the post-purge, fault code and audible tone.

3.9.2.31 Fuel pump fault. If the fuel pump or pump circuit is open or shorted, the fuel flow to the burner shall be shut off followed by the post-purge, fault code and audible tone.

3.9.3 ABIT system monitored parameters. The ABIT system shall monitor the status of major components to be used as a developmental diagnostic and verification tool. A computer interface shall be provided to view the parameters. These parameters shall not be accessible to the user.

3.9.3.1 List of monitored parameters. As a minimum monitored parameters provided shall include, battery voltage, battery heater voltage, battery charge status, TEG voltage, TEG current, BUS voltage, fuel pump status, TEG temperature, inlet air temperature, outlet air temperature, tent temperature, vent fan rpm, and combustion blower rpm.

3.9.4 ABIT system historical log. The ABIT system shall maintain a historical log of the last 10 fault codes generated, number of start attempts, initial battery condition at first start attempt, operating hours, and provide the results on the display when requested.

3.10 Safety. The heater shall be designed so that under all conditions of normal use (installation, operation, and maintenance) and under a likely fault condition (including human error), it protects against the risk of electric shock, noise, temperature, trauma, and other hazards that could cause death, illness, or reduced job performance. The equipment shall provide maximum access and safety to personnel during installation, operation, and maintenance. All hazards shall be eliminated or reduced to the lowest risk level practicable using methods in the following order of precedence: design; incorporation of safety devices; incorporation of warning devices; and procedures/training. Catastrophic or critical hazards shall not rely solely on warnings, cautions, or procedures/training for control of risk. All safety hazards not eliminated through design shall be addressed in the appropriate technical manuals. Information regarding hazard-avoiding procedures and safety warning labels on equipment shall be included in all manuals. Maintenance technical manuals shall address replacement procedures for damaged or missing safety labels. The heater shall be evaluated against SEL Form 1183, System Safety Design Verification Checklist. SEL Form 1183 shall be used as a guideline to address any safety issues that may pertain to the heater, but have not been specified. The safety design parameters from SEL Form 1183 that are applicable to the heater shall be reviewed and incorporated.

3.10.1 Electric shock. The heater shall have provisions to protect the operator from electric shock or burns.

3.10.2 Electrical wiring safety. The electrical wiring design, protection, methods and materials shall meet the environmental and performance requirements and shall conform to the National Fire Protection Association (NFPA) National Electric Code, Standard 70.

3.10.3 Fuse protection. Necessary fuse protection shall be incorporated to protect against component damage, electrical shorts, and personnel burns. Fuses shall be readily accessible for removal or replacement and protected from accidental grounding. No special tools shall be required for fuse replacement. Spare fuses shall be included with on-board spare parts and located for easy access without tools.

3.10.4 Sharp edges. Non-functional sharp edges and projections shall be eliminated. All exposed edges and corners shall be rounded to a minimum of 0.03-inch radius. Sharp edges and corners that can present a personnel safety hazard or cause equipment damage during operation and maintenance shall be rounded to a radius not less than 0.05 inches.

3.10.5 Moving parts. The heater design shall provide operator protection from all moving parts.

3.10.6 Surface temperatures. All surface areas of the heater shall be below 120°F during operation except for the exhaust pipe, exhaust pipe connection point, heated breathable air outlet duct connection point, and, the heated air duct outlet finger guard.

3.10.7 Fuel system safety. Components of the fuel system shall be routed, located or guarded so as to be protected from mechanical damage and extreme temperatures. The appropriate fuel types for heater operation shall be clearly labeled at the fuel fill port. Fuel drains shall not allow fuel accumulation, spills, or overflows to run onto hot surfaces or electrical equipment.

3.10.8 Material safety. Materials used in the heater shall be fire retarding and shall not emit noxious or toxic fumes during operation. Toxic materials contained within the heater shall be controlled so that they do not present a hazard to the user under any condition. Asbestos materials shall not be used. Certain chemicals have been identified in the Occupational Safety and Health Act (OSHA) as cancer-producing substances. Before using any materials, which might contain these chemicals, they should be evaluated in accordance with 29 CFR 1910. Consideration of the human toxicity of a substance should be given prior to material selection. Glass fiber materials shall not be used as the outer surface or covering on cables, wire or other items where they may cause skin irritation to operating personnel. When maintenance procedures require access to glass fibers, such as insulation, a proper caution note should be provided.

3.10.9 Environmental hazards. Materials and parts containing mercury shall not be used unless use of mercury is specifically required and approved by the Government.

3.10.10 Noise. Noise levels, shall meet the requirements of MIL-STD-1474, Requirement 1, Category E. The noise level shall be measured at a distance 3 feet from the heater in any direction, at ear level, and shall not exceed 75 dB as a Threshold (T) and 65 dB as an Objective (O).

3.10.11 Breathable air quality. Products of combustion shall remain separated from the breathable air stream. Heated air shall be within the 8-hour Threshold Limit Values-Time Weighted Average (TLV-TWA) for carbon dioxide, carbon monoxide, SOx, NOx, and formaldehyde.

3.11 Support or ownership requirements.

3.11.1 Weight. The weight of the heater without accessories shall not exceed 400 pounds. The heater and all accessories and spares shall not exceed 450 pounds. Wheels, if required, are not included in the weight.

3.11.2 Volume. The outside dimensions of the heater shall not exceed 30 cubic feet.

3.11.3 Transportability. The heater shall be capable of being transported by a standard military truck or a two-wheeled trailer restrained to the cargo bed. The heater shall be transportable by trains, marine vessels, fixed wing and rotary wing aircraft and must be capable of withstanding the conditions encountered in shipment without damage or permanent deformation. The heater shall be equipped with tie-down and slinging provisions.

3.11.3.1 Slinging and tie-down provisions. The heater shall have slinging provisions and tie-down provisions. A combination of multipurpose, slinging and tie-down provisions may be used to meet the requirement. Slinging provisions shall be located above the heater's center of gravity. Provisions that can be removed without the use of tools shall not be used. All slinging and tie-down provisions shall be designed to

prevent movable parts from freezing in place in cold weather. The lift provisions shall be non-protruding and self-concealing. The minimum inside dimension of each provision shall be 3 inches. The tie down locations shall be permanently marked.

3.11.3.2 Stackable and restrainable. The heater shall be sized to accommodate 9 heaters with accessories on a 463L pallet (104" wide x 84" long x 96" high) and be stackable and secured together by positive means. During air transport the tie-down provisions shall be capable of withstanding 4.0 times the gross weight of the heater in the forward and aft direction of the longitudinal axis of the heater; 2.0 times the gross weight in the downward direction of the vertical axis of the heater; and 1.5 times the gross weight in each direction of the lateral axis of the heater.

3.11.4 Lifting and mobility. The heater shall be designed so that it can be handled and lifted safely. The weight distribution of the heater components shall provide a safe and stable configuration in all operating positions and during movement. The heater shall be capable of being lifted by a forklift and moved for short distances manually.

3.11.4.1 Housing and chassis assembly. The heater shall be fully enclosed in a lightweight, substantially constructed cabinet or frame. The cabinet or frame shall be an integral chassis with skids.

3.11.4.2 Accessibility. All working parts of the various subassemblies of the heater shall be accessible. All instruments and controls for operation of the heater shall be accessible to the operator by opening a small cover. If access doors are provided, they shall be equipped with safety links or be otherwise locked in the open position to prevent injury to the operator or other damage by inadvertently closing.

3.11.4.3 Weather resistance. The heater shall resist weather conditions and prevent rain, water, snow, ice, sand, mud, or dust from collecting in quantities which would prevent satisfactory operation.

3.11.4.4 Forklift access skid. The heater shall be equipped with an integral forklift access skid. The skid shall be wide, ski-like for ease of movement over mud or snow. Each forklift tunnel shall be a minimum of 3 inches high and 10 inches wide and located a minimum of 18" and a maximum of 60" apart. The objective (O) shall be to locate the heater center of gravity between the forklift pockets. The forklift access skid shall be designed to prevent damage to other components on the heater when a forklift is in use.

3.11.4.5 Wheels. If required (see 6.2), the heater shall be equipped with wheels to facilitate movement of the heater. The wheels shall be removable or retractable without the use of external tools. Provisions shall be made for securing the wheels to the heater when not installed for use. The heater shall be provided with a three-point or four point support when the wheels are installed and with integral means to prevent movement of the heater when parked in the level or specified inclined positions.

3.11.4.6 Manual movement provisions. The heater shall be soldier-portable for short distances and shall be designed to assist in manual localized movement and positioning in field conditions. The heater shall have continuous handrails or handles to assist in

manual localized movement and positioning. The objective (O) shall be to locate the handrails above the center of gravity. The handrail or handles shall conform to the requirements of MIL-STD-1472, Human Engineering.

3.11.5 Outside tent operation. The heater shall be designed for outside tent operation and unprotected climatic exposure. Special consideration shall be given to the heater enclosure and exhaust outlet design to prevent damage or fire to any tent fabric that may come into contact with the enclosure and related components during movement of the tent walls in wind gust conditions.

3.11.6 Tent wall modification kit (TWMK). When specified (see 6.2), the heater shall be provided with a kit that shall allow the operator to modify a plain tent wall to interface with the heater inlet and outlet ducts. The TWMK shall include all necessary components and hardware to modify the tent wall for outside operation.

3.11.7 Exterior openings. The heater exterior openings (air inlet, air outlet, control panels, etc.) that may be open during heater operation shall be designed to include means for closing or covering to prevent elements of weather from collecting in quantities that will prevent satisfactory operation of the heater. A means shall be provided to prevent foreign objects and weather elements from entering the heater when it is not in use.

3.11.8 On-board storage. The objective (O) is to provide on-board storage for all external components used during operation. Storage shall be provided for the exhaust stack with rain cap, cables, remote control panel, remote CO monitor, technical manual compact disc, fuel hose for external fuel operation, quick start instructions, ducts, and any other external component. If the objective cannot be met then an accessories bag shall be provided to hold components that are not stored on-board. The Technical Manual CD storage shall be weatherproof.

3.11.9 Set up and teardown time. The heater shall be capable of being set-up and placed into operation by a crew of two personnel within 20 minutes of arrival on site. Set-up includes making all tent connections, fuel supply connections, fuel fill, pre-operational checks and services, and any other necessary operations. Set-up shall not include obtaining fuel for the operation. Two operator personnel shall disassemble the heater to the transport configuration within 20 minutes. The two personnel shall be responsible for reversing all activities associated with set-up in addition to any other operations necessary to achieve the transport configuration.

3.11.10 Human factors engineering. The heater shall be operable and maintainable by 5th through 95th percentile soldiers dressed in the Battle Dress Uniform (BDU), cold-wet weather protective clothing, arctic clothing, and the protective ensembles for Mission Oriented Protective Posture (MOPP) Level IV. The heater shall be started and operated by a single operator. The heater will be operable and maintainable in daylight and darkness (with use of a flashlight) by representative soldiers dressed appropriately for the anticipated environments for use (arctic, etc.) All components will be located to permit easy access for operating and maintaining the heater. The heater shall be designed and/or configured to provide an efficient and effective user interface for all critical install, operate, and maintain (IOM) task or procedures.

3.12 Labels. The heater shall have permanent, legible warnings and information labels providing quick and easy identification of assembly, setup, components, spare parts list, safety cautions, operating instructions, PMCS instructions, electrical wiring diagram, fuel system diagram, and proper fuels, affixed to the heater, accessories enclosures or panels. The labels shall stay permanently affixed to the heater under all operating and transport conditions. The labels shall be located on a permanent part of the heater. The labels shall be read quickly and easily from left to right. Label shall be placed on or near the item they identify. Controls shall not obscure labels. Labels shall be located in a consistent manner throughout the heater system. Labels shall be printed in capitals. All letters shall be black, except when using a black background, then letters shall be white. Label backgrounds shall be red for danger, yellow for caution and black for information. The safety and cautionary label letter size and color shall be sufficient to be easily read from a distance of six feet in daylight or with a flashlight when dark. Access panels shall be labeled, identifying the component protected inside.

3.12.1 Set up and operating instructions labels. Basic instructions for set up, starting, operating, and stopping the heater shall be located near the operator's control panel in such a manner as to be readily visible to the operator during those actions. Operating instructions shall include all the information needed to operate the heater as intended and warn the user against reasonably foreseeable risks of injury to persons. The heading "OPERATING INSTRUCTIONS" or the equivalent shall precede these instructions. Operating instructions shall explain and describe the location, function and operation of each user-operated control of the heater, safety cautions, and warn against tampering with such devices.

3.12.2 Electrical wiring and fuel system diagrams. Labels depicting the electrical wiring diagram and the fuel system diagram shall be affixed to the heater.

3.12.3 User interface component identification labels. Labels identifying major user interface components such as switches, controls, and indicators shall be present on the heater near the identified component.

3.12.4 Permanent identification label. The following information shall be marked on the heater: Unique Identification (UID), the manufacturer or vendor name or identifying symbol, a distinctive type or model number, a serial number, a contract number, date of manufacture, the firing rate of the burner expressed to the nearest 0.1 gallons per hour, and the grade of fuel.

3.12.5 Safety markings and labels. Safety markings and labels shall be provided identifying potential hazards to personnel and shall include lifting requirements, hot surface identification of any surface over 120°F, and shock hazards. Safety markings shall comply with ANSI Z535.4. Safety labels shall not be obscured or removed when a barrier or access door is opened or removed. Cautionary markings shall be legible and visible from the position normally assumed by the operator when starting the heater or from the position normally assumed for the specific operation involved. Colors of safety critical controls and indicators shall be yellow for caution and red for danger. A marking intended to inform the user of a risk of fire, electrical shock, or injury shall be prefixed by a signal word "CAUTION" or "WARNING". The marking shall be in letters not less than 3/32-inch high. The signal word shall be more prominent than any other required marking on the heater. Additionally, the marking shall contain a statement of the risk involved, for example, "Risk of Electric Shock". The heater shall be permanently marked to indicate the heater must be disconnected from the battery when cleaning or servicing is performed.

3.13 Durability and materials.

3.13.1 Material deterioration prevention and control. The heater shall be fabricated from compatible materials, inherently corrosion resistant or treated to provide protection against the various forms of corrosion and deterioration that may be encountered in applicable storage and operating environments.

3.13.2 Dissimilar metals. Dissimilar metals shall not be used in intimate contact with each other unless protected against galvanic corrosion. Dissimilar metals and methods of protection are defined and detailed in MIL-STD-889.

3.13.3 Surface finish. Unless otherwise specified, the paint shall be a Chemical Agent Resistant Coating (CARC). The exterior surface of the heater shall be clean, treated and painted to prevent corrosion. Application and inspection of the CARC paint shall be in accordance with MIL-STD-53072. Paint colors shall be in accordance with FED-STD-595. The color of the heater shall be; green, tan, or white as specified. Externally exposed surfaces of the heater shall be cleaned, treated and painted unless otherwise specified herein. No deterioration, corrosion or damage to paint or treatment of externally exposed surfaces shall be observed.

3.13.4 Unpainted surfaces. No deterioration, corrosion or damage to treatment of unpainted surfaces shall be observed. All sheet metal interior surfaces of the heater, including those behind insulation materiel, shall be cleaned and treated, but do not need to be painted.

3.13.5 Fastener hardware. Any and all fasteners used in the design and fabrication of this item shall meet the requirements of the applicable ANSI specification. Externally threaded fasteners (e.g., bolts) shall also meet the requirements of SAE J429. Bolt holes shall have the burrs removed. All fasteners shall have full thread engagement. The upset rivet heads shall be in accordance with SAE J492. The objective (O) shall be no sheet metal or self-tapping screws are used. Appropriate means shall be used for quick opening access required for operating adjustments and Preventive Maintenance Checks and Services (PMCS).

3.13.6 Common parts. Maximum practicable use shall be made of interchangeable hardware and fastening devices (bolts, screws, nuts, washers, and similar components) along with a minimum number of types and sizes. All fasteners shall be treated to be corrosion resistant under all environmental conditions specified herein. Fasteners shall be installed securely to prevent inadvertent loosening which may lead to potential foreign object damage.

3.13.7 Gaskets and seals. All gaskets, synthetic rubber seals, etc., shall be suitable for use with fuels specified herein, temperatures from -65 to +300°F, and in all environmental conditions specified herein.

3.13.8 Bearing lubrication. Bearings shall be sealed and permanently lubricated for operation in an ambient temperature range of -65F to +250 F.

3.13.9 Metal fabrication. Metal used in fabrication shall be free from kinks. Sharp edges; sharp bends and corners shall be square and true and fabricated to minimize surfaces that would trap contaminants or decontaminants. All bends shall be made by controlled means to ensure uniformity of size and shape.

3.13.10 Welding and brazing. All welding shall be in accordance with AWS D1.1, AWS D1.2, as applicable. The contractor shall obtain certification that each welder or welding operator is certified in accordance with AWS D1.1, AWS D1.2, AWS B2.1, as applicable. Certification shall be made available for review by the contracting officer or designated representative. Brazing of steels, copper alloys and nickel shall conform to AWS B2.2. During the brazing operation, care shall be exercised to protect all components from deformation and damage. Heavy beads and fillets of braze material shall be avoided.

3.13.11 Severe climate manipulation. The heater shall be compatible with temperatures of -60F, allowing unpacking, connection to tent and stowage. Breathable air ducts, battery, flame sensor, igniter, control panel, remote CO monitor, cables, fuel hose, and hose couplers shall remain flexible, replaceable and operational.

3.13.12 Electrical wiring. The electrical wiring design, protection, methods and materials shall meet the environmental and performance requirements specified herein and shall conform to the National Electrical Code 70 (NFPA 70). Wire numbering or color coding shall be used to the maximum extent to aid in following wiring diagrams and troubleshooting electrical problems. Electrical wiring shall be supplied as removable harnesses for ease of replacement. A wiring diagram shall be present on the heater. Cables and wires shall be secured with mechanically mounted cable clamps to ensure correct routing, so that cables or wires do not hinder or obstruct equipment maintenance, and to prevent chaffing from contact with adjacent structures. Wires shall be routed so that they do not contact sharp corners, are not pinched between components, and strain relief is provided. Wire ties shall be used to make wiring look neat and professional. Excess wire tie ends shall be cut off close and straight. The presence of external wiring shall be minimized.

3.13.13 Electrical connectors. Electrical connections shall be of a quick disconnect type wherever feasible. When the use of connectors of the same shell size in adjacent location cannot be avoided, differences in the keying arrangement shall be used. Multi-contact connectors, including printed circuit assembly connections, shall be keyed, polarized, or of a contact configuration to prevent improper connection.

3.14 Reliability, maintainability, and serviceability.

3.14.1 Mean Time Between Essential Function Failure MTBEFF. The quantitative reliability requirement is an objective (O) MTBEFF of 1250 hours with at least 80 percent confidence and a threshold (T) MTBEFF of 1150 hours with at least 80 percent confidence. An essential function failure (EFF) shall be scored when an incident results in the loss or significant degradation of an essential function that can not be quickly (within 15 minutes) corrected by the crew using only on board tools, spares and repair parts. An incident that causes catastrophic or critical hazards shall also be scored as an EFF. Guidance for the demonstration of the reliability commitments may be found in MIL-HDBK-781A.

3.14.2 Maintenance Ratio. The heater shall demonstrate an objective (O) minimum maintenance ratio (MR) of 0.003 mmh/operating hour (maintenance man hour/operating hour) and a threshold (T) MR of 0.013 mmh/operating hour. Maintenance man hours include man hours expended for scheduled and unscheduled maintenance before, during and after services, including time spent for inspection, diagnosis, adjustment of heater, and repair of failed

components and assemblies. Preventive maintenance checks and services performed by the operator in 20 minutes or less are excluded.

3.14.3 Preventative Maintenance Checks and Services PMCS. PMCS shall not exceed 20 minutes to accomplish during any climatic condition specified in this performance documentation, during daylight or in the dark using a flashlight. Minimum PMCS shall include: inspection of fuel filter for water or dirt contamination and cleaning if necessary; fuel supply connections, and exhaust stack connection, secure connection of ducts, secure connection of control box and CO monitor; snow or ice blockage; inspect for fuel leaks and general condition to permit operation.

3.14.4 Endurance. The heater shall have a minimum endurance of 2,000 hours before a durability failure. Durability failures are defined as any malfunction that precludes further operation of the heater and repair is costly enough to justify scrapping major components.

3.14.5 Field serviceability. The heater shall be designed for ease of maintenance. Modular component use shall be maximized. Standard parts shall be used whenever practicable. Mission critical items, such as the burner, which require rapid maintenance, shall be most accessible. All major components (TEG, heat exchanger, combustion assembly, controls, etc.) shall be located for ample and rapid access. The objective shall be to access components within five minutes for inspection, cleaning or repair using no tools or tools supplied with the SHC. Sufficient and reasonable accessibility shall be afforded for cleaning, inspection, repair and replacement of all critical heater components. Items requiring most frequent access shall be most accessible. High failure rate items shall be accessible for replacement without moving or removing non-failed items. The heater shall require use of only those tools in the general mechanics kit specified in Supply Catalog SC 5180 90 CL N26. Test, Measurement, and Diagnostic Equipment (TMDE) required for maintenance shall currently exist in the DoD supply system. Spare parts shall be capable of being removed and replaced within the operational environment by MOS nonspecific personnel wearing anti-contact gloves NSN 8415-00-227-1220 within 15 minutes. Fielding the SHC shall have no impact on the manpower or personnel structure. Spare parts shall be installed and wired for field maintenance to - 60°F.

3.14.6 Design for maintenance. The heater shall be designed for ease of maintenance with general purpose tools (common hand tools) and equipment normally available commercially. It must be user friendly and capable of being operated and maintained by personnel wearing arctic clothing and nuclear, biological, and chemical (NBC) warfare defense protective ensemble. Where practical, parts and components shall be located or positioned for rapid and simple inspection and recognition of excessive wear or potential failure. Standard parts shall be used whenever practicable. Cam lock latches shall be used for access panels. Oversized captive screws shall be used whenever possible. No small removable screws shall be used on field serviceable components.

3.14.7 Error proof design. The heater shall be designed to preclude improper assembly or installation. The heater shall be designed to prevent the interchange of items of a same or similar form that are not in fact functionally interchangeable. Physical measures shall be taken to prohibit improper mounting of units or components. Measures shall be taken to facilitate the identification, orientation, and alignment of cables and connectors.

3.14.8 Operational clearance. To the maximum extent possible, the heater shall be designed to allow operation, servicing, and maintenance at low ambient temperatures convenient to personnel wearing arctic clothing and chemical warfare gear. Intricate locking devices, controls, and fasteners that can be easily over-torqued by personnel lacking feeling through cold weather/chemical warfare clothing shall be avoided. Covers and plates that must be removed for component adjustment/operation shall be equipped with fasteners that can be easily operated using cold weather/chemical warfare clothing.

3.14.9 Scheduled maintenance. Scheduled maintenance shall not be required more frequently than each 750 hours of operation as a threshold (T) and 1,500 hours as an objective (O). Scheduled maintenance shall not be at any level higher than operational.

3.15 Spares, accessories, and tools.

3.15.1 On-board spares. Spare parts shall include the igniter, fuel filter/strainer element, flame sensor, fuses, fuse caps and any other recommended components. Spares shall be located within a secure area with the heater or inside an accessories bag when specified.

3.15.2 Accessories. The heater shall include the following accessories: two breathable air ducts, remote control panel, control panel connection cable, remote CO monitor, fuel hose for external fuel operation, battery charging adapter, exhaust stack with rain cap, accessories storage bag, quick start instructions, and a technical manual compact disc. All accessories that are not stored on board the heater shall fit in the accessories bag.

3.15.3 Tools. Tool(s) required to remove or replace any on-board spare parts shall be included and stowed within the heater or in the accessories bag.

3.15.4 Accessories bag. If all accessories, spares, or tools are not stored on-board then an accessories bag shall be provided to hold these items. The accessories bag shall be rugged and the hand holds shall provide uniform load distribution.

3.16 Electromagnetic Environmental Effects.

3.16.1 Electromagnetic Interference (EMI) Radiated. Electric field emissions shall not be radiated from the heater or any interconnecting cables in excess of those shown in MIL-STD-461E, Method RE102, radiated emissions (ground applications), electric field, 10 kHz to 18 GHz.

3.16.2 Nuclear, Biological Chemical (NBC) compatibility. As a threshold (T) the heater shall be Chemical Agent Resistant coating (CARC) painted. As an objective (O) the heater shall be compatible with soldiers in full Mission Oriented Protective Posture IV (MOPP IV) ensemble. The heater shall be NBC survivable, hardened against the effects of chemical agents and decontaminants, and able to be decontaminated to negligible risk levels

3.17 Environmental requirements.

3.17.1 Basic climate operations. The heater and accessories shall be operable in temperatures of +60°F to 0°F and provide a range of 90 KBTU/hr minimum (high setting) and 60 KBTU/hr maximum (low setting).

3.17.2 Basic cold climate operation. The heater and accessories shall be operable in temperatures down to -25°F and provide a minimum of 90 KBTU/hr.

3.17.3 Severe cold climate operation. When using specified fuels, the heater and accessories shall be operable and provide a minimum of 90 KBTU/hr when cold soaked and started without preheating at a threshold (T) ambient temperature of -40°F and operated to -60°F. The heater and accessories shall be operable and provide a minimum of 90 KBTU/hr when cold soaked and started using NATO assist without preheating at an objective (O) ambient temperature of -60°F and operated to -60°F.

3.17.4 High altitude. The heater shall operate without loss of performance (80% minimum efficiency and smoke spot less than #3) or component degradation when operated at altitudes of 5,000 feet above sea level and operate to 10,000 feet with a derated heat output of 15%.

3.17.5 Inclined operation. The heater shall start and operate while inclined on any axis when operated from external fuel or with a half-full fuel tank at any angle up to 15 degrees without fuel leakage or damage to components.

3.17.6 Salt fog. The heater shall meet the requirements of MIL-STD-810, Method 509.4. The heater and accessories shall show no evidence of peeling, blistering paint, possible electrical shorts due to salt deposits, deterioration, clogging or binding of moving parts, or change in tolerance limits of any internal or external parts. The heater shall remain operational after salt fog testing.

3.17.7 Wind and rain. The heater shall meet the requirements of MIL-STD-810, Method 506.4, Procedure I – Blowing Rain. The heater shall be operable in winds up to 40 mph and rain of 4 inches per hour.

3.17.8 Icing and freezing. The heater shall meet the requirements of MIL-STD-810, Method 521.2 covered in a 6 mm thick coating of ice glaze.

3.17.9 Sand and dust. The heater shall meet the requirements of MIL-STD-810, Method 510.4, Procedure I – Blowing Dust and Procedure II – Blowing Sand. The heater shall remain storable and operational in a sand and dust environment.

3.17.10 Storage. The heater shall meet the requirements of MIL-STD-810, Method 501.4, Procedure I – Storage. The heater and accessories shall remain operable and show no signs of impairment due to storage at 155°F for 4 hours daily.

3.17.11 Vibration. The heater shall meet the requirements of MIL-STD-810, Method 514.5, Procedure I – General Vibration – Transportation, Restrained Cargo. The heater shall be transportable in a truck or two-wheeled trailer. The heater shall be capable of transportation over primary roads, secondary roads, and cross-country terrain without damage.

3.17.12 Shock. The heater shall meet the requirements of MIL-STD-810, Method 516.5, Procedure IV, Transit Drop. The heater and accessories shall remain fully operational after being subjected to drop testing.

3.18 Minimum run cycle. The minimum run cycle shall consist of operation of the heater for a sufficient amount of time to verify that the heater exhibits battery "Charged" on the remote display. The fuel flow rate, BTU output, smoke number, combustion efficiency, excess air, CO2, and flue temperature shall be recorded.

4. VERIFICATION

4.1 Classification of Inspections. The inspection requirements specified herein are classified as follows:

a. First article inspection (see 4.1.1).
b. Conformance inspection (see 4.1.2).

4.1.1 First article inspection. When a first article inspection is required (see 3.1, 6.2), the SHC shall undergo all the tests and examinations outlined in Table II unless otherwise specified in the contract. Sampling for first article inspection shall be as specified in the contract or purchase order (see 6.2 and 6.8).

4.1.2 Conformance inspection. Conformance inspections shall be conducted according to the tests specified in Table II. Nonconformance to any specified requirement, the failure of any test, or the presence of one or more defects shall be cause for rejection. The sampling rate for conformance inspection shall be as specified in the contract or purchase order (see 6.2 and 6.9).

4.1.3 End item examination. Each SHC shall be examined for the requirements specified in Table II. Any redesign or modification of the contractor's product to comply with specified requirements, or any necessary redesign or modification following failure to meet the specified requirements shall receive particular attention for adequacy and suitability. Nonconformance to any specified requirement, the failure of any test, or the presence of one or more defects shall be cause for rejection. The contractor may prepare a test plan to verify all the end item examination requirements in Table II in a manner that best fits their manufacturing practices.

4.2 Verification methods. Verification methods can include visual examination, measurement, testing, simulation, modeling, engineering evaluation, component properties analysis, certification, and similarity to previously approved or previously qualified designs. Unless otherwise specified, all verifications shall be conducted under ambient conditions of 60°+/- 5°F.

4.2.1 Verification alternatives. The contractor may propose alternative test methods, techniques, or equipment, including application of statistical process control, tool control, or cost-effective sampling procedures to verify performance (see 6.7).

TABLE II. Requirement and Verification Outline

Requirement	Requirement paragraph	Verification paragraph	First article inspection	Conformance inspection	End item examination
Operating requirements	**3.3**	**4.3**			
Description	3.3.1	4.3.1	X		
Heat output	3.3.1.1	4.3.1.1	X	X	

TABLE II. Requirement and Verification Outline – Continued.

Indicated efficiency	3.3.1.2	4.3.1.2	X	X	X
Burner smoke spot	3.3.1.3	4.3.1.3	X	X	X
Fuel capability	3.3.1.4	4.3.1.4	X	X	
Operational temperature range	3.3.1.5	4.3.1.5	X		
Fuel system	**3.4**	**4.4**	X	X	
Integral fuel tank	3.4.1	4.4.1	X		
Fuel tank material	3.4.1.1	4.4.1.1	X		
Fuel tank equipment	3.4.1.2	4.4.1.2	X	X	
Operate from external fuel supply	3.4.2	4.4.2	X	X	
External fuel fitting	3.4.2.1	4.4.2.1	X	X	
External fuel hose	3.4.2.2	4.4.2.2	X	X	
Manual fuel valve	3.4.3	4.4.3	X	X	
Fuel filtering and water separation	3.4.4	4.4.4	X	X	
Automatic shut-off capability	3.4.5	4.4.5	X	X	
Residual fuel	3.4.6	4.4.6	X	X	
Trapped air	3.4.7	4.4.7	X	X	
Heated air system	**3.5**	**4.5**			
Airflow volume	3.5.1	4.5.1	X	X	
Maximum air outlet temperature	3.5.2	4.5.2	X	X	
Modular fan system	3.5.3	4.5.3	X		
Fresh air makeup	3.5.4	4.5.4	X		
Air inlet and outlet openings	3.5.5	4.5.5	X	X	
Flexible air ducts	3.5.6	4.5.6	X	X	
Major components	**3.6**	**4.6**			
Internal power generation system	3.6.1	4.6.1	X		
Power storage battery	3.6.2	4.6.2	X		
Battery safety	3.6.2.1	4.6.2.1	X	X	
Battery starting and recharge	3.6.2.2	4.6.2.2	X	X	
External battery charge	3.6.2.3	4.6.2.3	X		X
Starting from vehicle NATO adapter.	3.6.2.4	4.6.2.4	X	X	
Combustion system	3.6.3	4.6.3	X		
Burner	3.6.3.1	4.6.3.1	X		
Combustion chamber	3.6.3.2	4.6.3.2	X		
Exhaust outlet	3.6.3.3	4.6.3.3	X		
Emissions	3.6.3.4	4.6.3.4	X	X	
Fuel post-purge	3.6.3.5	4.6.3.5	X	X	X
Heat exchanger	3.6.3.6	4.6.3.6	X	X	
Heat exchanger over-temperature protection sensor	3.6.3.6.1	4.6.3.6.1	X	X	
Gauges	**3.7**	**4.7**			
Hour meter	3.7.1	4.7.1	X	X	
Fuel tank gauge	3.7.2	4.7.2	X	X	
Controls	**3.8**	**4.8**			
Remote control box	3.8.1	4.8.1	X	X	
On/Off switch	3.8.1.1	4.8.1.1	X	X	
Thermostat	3.8.1.2	4.8.1.2	X	X	
Visual indicator display panel	3.8.1.3	4.8.1.3	X	X	X
Audible fault alarm	3.8.1.4	4.8.1.4	X	X	X
CO sensor	3.8.1.5	4.8.1.5	X	X	
Alternate emergency control panel on heater	3.8.2	4.8.2	X	X	

TABLE II. Requirement and Verification Outline – Continued.

Prevention of accidental actuation	3.8.3	4.8.3	X		
Human factors engineering of controls	3.8.4	4.8.4	X		
Consistency of movement	3.8.5	4.8.5	X		
Positive indication	3.8.6	4.8.6	X		
Automatic built in test capability (ABIT)	**3.9**	**4.9**			
ABIT system controls	3.9.1	4.9.1	**X**	**X**	
Visual display	3.9.1.1	4.9.1.1	**X**	**X**	
Pre-purge diagnostic control	3.9.1.2	4.9.1.2	X	X	
Start cycle control	3.9.1.3	4.9.1.3	X	X	
Post-purge diagnostic control	3.9.1.4	4.9.1.4	X	X	X
Hot relight diagnostic control	3.9.1.5	4.9.1.5	X	X	
ABIT system faults	3.9.2	4.9.2	X	X	
CO level fault	3.9.2.1	4.9.2.1	X	X	
Low battery voltage fault	3.9.2.2	4.9.2.2	X	X	
Combustion fan wiring fault	3.9.2.3	4.9.2.3	X	X	
Combustion fan blower motor fault	3.9.2.4	4.9.2.4	X	X	
Loss of flame fault	3.9.2.5	4.9.2.5	X	X	X
Flame sensor fault	3.9.2.6	4.9.2.6	X	X	
Burner maintenance fault	3.9.2.7	4.9.2.7	X		
Ignition element fault	3.9.2.8	4.9.2.8	X	X	X
Generator over-temperature fault	3.9.2.9	4.9.2.9	X	X	
High voltage fault	3.9.2.10	4.9.2.10	X	X	
Tilt fault	3.9.2.11	4.9.2.11	X	X	
Generator temperature sensor fault	3.9.2.12	4.9.2.12	X	X	
Tent over-temperature fault	3.9.2.13	4.9.2.13	X	X	
Vent fan motor fault	3.9.2.14	4.9.2.14	X	X	
Vent fan wiring fault	3.9.2.15	4.9.2.15	X	X	
Fuel pressure sensor fault	3.9.2.16	4.9.2.16	X	X	
Heat exchanger over-temperature fault	3.9.2.17	4.9.2.17	X	X	
Inlet air temperature fault	3.9.2.18	4.9.2.18	X	**X**	
Inlet air temperature sensor fault	3.9.2.19	4.9.2.19	X	**X**	
Battery temperature sensor fault	3.9.2.20	4.9.2.20	X	**X**	
Fuel delivery fault	3.9.2.21	4.9.2.21	X	X	
Combustion inlet temperature sensor fault	3.9.2.22	4.9.2.22	X	X	
Start attempts fault	3.9.2.23	4.9.2.23	**X**	**X**	
Remote communications fault	3.9.2.24	4.9.2.24	X	X	
Carbon monoxide sensor fault	3.9.2.25	4.9.2.25	X	X	
System audible alarm fault	3.9.2.26	4.9.2.26	X	X	
Microprocessor fault	3.9.2.27	4.9.2.27	X	X	
Brownout fault	3.9.2.28	4.9.2.28	X	X	
Outlet air temperature fault	3.9.2.29	4.9.2.29	X	X	
Outlet air temperature sensor fault	3.9.2.30	4.9.2.30	X	X	
Fuel pump fault	3.9.2.31	4.9.2.31	X	X	
ABIT system monitored parameters	3.9.3	4.9.3	X	X	
List of monitored parameters	3.9.3.1	4.9.3.1	X	X	
ABIT system historical log	3.9.4	4.9.4	X	X	

TABLE II. Requirement and Verification Outline – Continued.

Safety	**3.10**	**4.10**			
Electric shock	3.10.1	4.10.1	X		
Electrical wiring safety	3.10.2	4.10.2	X	X	
Fuse protection	3.10.3	4.10.3	X	X	
Sharp edges	3.10.4	4.10.4	X	X	X
Moving parts	3.10.5	4.10.5	X		
Surface temperatures	3.10.6	4.10.6	X		
Fuel system safety	3.10.7	4.10.7	X	X	
Material safety	3.10.8	4.10.8	X		
Environmental hazards	3.10.9	4.10.9	X		
Noise	3.10.10	4.10.10	X		
Breathable air quality	3.10.11	4.10.11	X	X	
Support and ownership requirements	**3.11**	**4.11**			
Weight	3.11.1	4.11.1	X		
Volume	3.11.2	4.11.2	X		
Transportability	3.11.3	4.11.3	X		
Slinging and tie-down provisions	3.11.3.1	4.11.3.1	X	X	
Stackable and restrainable	3.11.3.2	4.11.3.2	X		
Lifting and mobility	3.11.4	4.11.4	X		
Housing and chassis assembly	3.11.4.1	4.11.4.1	X		
Accessibility	3.11.4.2	4.11.4.2	X	X	
Weather resistance	3.11.4.3	4.11.4.3	X		
Forklift access skid	3.11.4.4	4.11.4.4	X		
Wheels	3.11.4.5	4.11.4.5	X		
Manual movement provisions	3.11.4.6	4.11.4.6	X		
Outside tent operation	3.11.5	4.11.5	X		
Tent wall modification kit	3.11.6	4.11.6	X		
Exterior openings	3.11.7	4.11.7	X		
On-board storage	3.11.8	4.11.8	X		
Set up and teardown time	3.11.9	4.11.9	X		
Human factors engineering	3.11.10	4.11.10	X		
Labels	**3.12**	**4.12**	X	X	
Set up and operating instruction labels	3.12.1	4.12.1	X	X	X
Electrical wiring and fuel system diagrams	3.12.2	4.12.2	X	X	X
User interface component identification labels	3.12.3	4.12.3	X	X	X
Permanent identification label	3.12.4	4.12.4	X	X	X
Safety markings and labels	3.12.5	4.12.5	X	X	X
Durability and materials	**3.13**	**4.13**			
Material deterioration prevention and control	3.13.1	4.13.1	X		
Dissimilar metals	3.13.2	4.13.2	X		
Surface finish	3.13.3	4.13.3	X		
Unpainted surfaces	3.13.4	4.13.4	X		
Fastener hardware	3.13.5	4.13.5	X		
Common parts	3.13.6	4.13.6	X		
Gaskets and seals	3.13.7	4.13.7	X		
Bearing lubrication	3.13.8	4.13.8	X		
Metal fabrication	3.13.9	4.13.9	X	X	

TABLE II. Requirement and Verification Outline – Continued.

Welding and brazing	3.13.10	4.13.10	X		
Severe climate manipulation	3.13.11	4.1311	X		
Electrical wiring	3.13.12	4.13.12	X	X	X
Electrical connectors	3.13.13	4.13.13	X		
Reliability, maintainability, and serviceability	**3.14**	**4.14**			
Mean Time Between Essential Function Failure (MTBEFF)	3.14.1	4.14.1	X		
Maintenance Ratio (MR)	3.14.2	4.14.2	X		
Preventative Maintenance Checks and Service (PMCS)	3.14.3	4.14.3	X		
Endurance	3.14.4	4.14.4	X		
Field serviceability	3.14.5	4.14.5	X		
Design for maintenance	3.14.6	4.14.6	X		
Error proof design	3.14.7	4.14.7	X		
Operational clearance	3.14.8	4.14.8	X		
Scheduled maintenance	3.14.9	4.14.9	X		
Spares, accessories, and tools	**3.15**	**4.15**			
On-board spares	3.15.1	4.15.1	X	X	X
Accessories	3.15.2	4.15.2	X	X	X
Tools	3.15.3	4.15.3	X	X	X
Accessories bag	3.15.4	4.15.4	X	X	X
Electromagnetic, environmental effects	**3.16**	**4.16**			
Electromagnetic interference (EMI) Radiated	3.16.1	4.16.1	X		
Nuclear, Biological, Chemical (NBC) compatibility	3.16.2	4.16.2	X		
Environmental requirements	**3.17**	**4.17**			
Basic climate operation	3.17.1	4.17.1	X		
Basic cold climate operation	3.17.2	4.17.2	X		
Severe cold climate operation	3.17.3	4.17.3	X	X	
High altitude	3.17.4	4.17.4	X		
Inclined operation	3.17.5	4.17.5	X		
Salt fog	3.17.6	4.17.6	X		
Wind and rain	3.17.7	4.17.7	X		
Icing and freezing	3.17.8	4.17.8	X		
Sand and dust	3.17.9	4.17.9	X		
Storage	3.17.10	4.17.10	X		
Vibration	3.17.11	4.17.11	X		
Shock	3.17.12	4.17.12	X		
Minimum run cycle	**3.18**	**4.18**	X	X	X

4.3 Operating requirements. The heater shall satisfy the following user-oriented requirements.

4.3.1 Description. Operate the SHC 90K in its normal configuration. Verify the SHC 90K is a 90,000 BTU, lightweight, portable, multi-fuel, self-powered heater that operates outside military tents and provides forced hot air recirculation via sealed, detachable, quick connect, flexible air ducts, without the need for an external power supply. Verify the SHC 90K operates on diesel and JP-8 fuels and generate its own internal electrical power without any moving parts. Verify fuel

ignition is accomplished by a one-switch startup procedure on a remote control located inside the tent. Verify the remote control has a visual display to show heater functions and fault codes. Verify heater operation includes completely automatic safety and temperature controls as well as built-in troubleshooting diagnostics. Verify the SHC 90K is equipped with an internal fuel tank to provide a minimum of 15 hours of continuous operation and has the capability to operate on an external fuel supply as well. Verify it has a protective enclosure that can withstand extreme environmental and field conditions. Verify it is forkliftable and has handrails/handles and wheels if required to support local movement and positioning.

4.3.1.1 Heat output. Operate the heater at an altitude up to 5,000 feet on JP-8 fuel. Verify the heater provides a minimum of 90,000 BTU/Hr (±1,500 BTU/hr) heat output when the thermostat is not satisfied and a maximum of 60,000 BTU/Hr (+4,000 BTU/hr) heat output when the thermostat is satisfied. Operate the heater at an altitude of 10,000 feet on JP-8 fuel. Verify the heater provides a minimum of 76,500 BTU/Hr (±1,500 BTU/hr) heat output when the thermostat is not satisfied and a maximum of 60,000 BTU/Hr (+4,000 BTU/hr) heat output when the thermostat is satisfied.

4.3.1.2 Indicated efficiency. Verify the burner system operates, during any temperature setting, at a minimum of 80 % indicated combustion efficiency.

4.3.1.3 Burner smoke spot test. Perform a smoke spot test per ASTM D 2156. The Bacharach oil burner smoke tester and scale (see Appendix B) is acceptable for this test. The readings shall be taken after a minimum of 5 minutes of burner ignition. Any smoke readings greater than a #3 shall constitute a test failure.

4.3.1.4 Fuel capability. Verify the SHC operates with all of the fuels listed in Table I under the corresponding temperature ranges during basic climate, basic cold, and, severe cold environmental tests. Verify no manual compensation for varying fuel types or temperatures is necessary for operation.

4.3.1.5 Operational temperature range. Verify the heater operates in a temperature range of +60°F to -60°F.

4.4 Fuel system. Verify the heater fuel system operates continuously without flooding. Verify the heater operates from either an integral fuel tank or from an external fuel supply. Verify a fuel system diagram is mounted on the heater.

4.4.1 Integral fuel tank inspection. Verify the heater's integral fuel tank has sufficient capacity to provide a minimum 15 hours (T) to 24 hours (O) of operation at maximum rated heat output.

4.4.1.1 Fuel tank material inspection. Verify the fuel tank is constructed of corrosion resistant materials or treated to provide protection against corrosion and deterioration that may be encountered in any applicable operating and storage environment. Contractor shall certify the fuel tank is compatible with the fuels specified in Table 1.

4.4.1.2 Fuel tank equipment inspection. Verify the fuel tank is equipped with an overflow vent, water drain, quantity gauge, a removable filler strainer, and a filler neck/cap recessed flush with the enclosure exterior surface. Verify the fuel tank filler is

accessible for easy fueling. Verify the cap is captive to prevent loss of the cap and permits unobstructed refueling of the tank. Verify the fuel tank is equipped with a leak proof drain connection that is separate from the fuel supply line. The drain connection shall be leak proof. Verify the fuel tank drain is labeled, well-located, and protected from transportation damage and excessive heat.

4.4.2 Operate from external fuel supply. Verify the heater is capable of operating continuously without flooding from an external fuel supply with the fuel container 12 inches below the base of the heater and up to 10 feet above the heater.

4.4.2.1 External fuel fitting inspection. Verify a quick disconnect fitting is flush mounted on the heater exterior for mating with an external fuel hose.

4.4.2.2 External fuel hose inspection. Verify a 25-foot external fuel hose with a 1/4" - inch inner diameter and captive protective caps is provided. Verify one end of the hose has quick disconnect fittings for connection to the heater and the other end of the hose has a female flare connector with the designation 5/16" JIC by ¼" pushlock barb. The contractor shall certify the hose meets or exceeds the requirements of MIL-DTL-8794, conforms to SAE standards for low pressure fuel transfer from an external fuel supply and is rated for an operating temperature range of –65° to +250°F. The contractor shall certify the fittings meet the requirements of MIL-DTL-5070 and the hose assemblies meet or exceed the requirements of MIL-DTL-8795.

4.4.3 Manual fuel valve inspection. Verify the heater is equipped with a manual fuel valve to permit operation from either the external fuel supply or the integral fuel tank.

4.4.4 Fuel filtering and water separation inspection. Verify a fuel filtering device, capable of running in a military environment, is incorporated to remove foreign particles-and suspended ice crystals, separate water from the fuel, and protect the fuel system downstream. Verify the filtering device housing is clear to allow for visual inspection, is located within a protected area and provides access for service and replacement. Verify filter-housing durability by filling filter and housing with equal amounts of JP-8 and water, then cold soak for two hours at -25°F. Any damage to the filter or housing shall constitute a test failure.

4.4.5 Automatic shut-off capability test. Verify fuel shut off by operating the SHC for 5 minutes, position switch to OFF position and observe flow of fuel. Failure of fuel flow to stop within 2 second after activating the OFF switch shall constitute a failure. Configure the SHC for operation with the internal fuel supply by placing the selector valve to the internal fuel position. With the ON/OFF switch in the OFF position disassemble the fuel filter. Fuel flow through the disassembled filter shall constitute a failure.

4.4.6 Residual fuel. Visually inspect the internal fuel system for residual fuel after operation. Any amounts of residual fuel, which cannot be easily drained, which would prohibit the SHC from being transported safely shall constitute a failure.

4.4.7 Trapped air. Verify bleeding of any trapped air in the fuel line and fuel system is automatic and without fuel leakage when the internal fuel tank is used. Switch to an external fuel supply. Verify an air purge mechanism is provided and supplies adequate air purge.

4.5 Heated air system. The heater shall provide clean, heated, re-circulated, breathable air for shelters.

4.5.1 Airflow volume. Conduct a test per ASHRAE 51 to verify the heated air system provides a minimum of 1000 CFM (± 100 CFM) indicated heated air at 0.50 inches water gauge (T), 0.75 inches water gauge (O) when the thermostat is not satisfied.

4.5.2 Maximum air outlet temperature test. Place a temperature probe a minimum of 2 inches inside of the finger guard end of the heated air outlet duct. Operate heater, after the CHARGING indication is on, measure the outlet air temperature. If the temperature exceeds 225°F it shall constitute a failure. Slowly restrict the air flow to the intake end of the return duct while measuring the temperature of the heated air flow. Inability of the heater to stop fuel flow to the burner, provide a post-purge and the identifying fault code when the outlet air temperature reaches 225°F shall constitute a failure.

4.5.3 Modular fan system. Verify the blower or fan system is modular to permit simple removal for service or replacement.

4.5.4 Fresh air makeup. If required, provide a power supply to operate the heater vent fan. Fully open the fresh air inlet. Measure the air volume entering the heater inlet duct and the air volume exiting the heater. Verify the heater is capable of delivering fresh makeup air up to a minimum 5 percent of the total heater airflow. Verify the fresh makeup air inlet is adjustable. Verify intakes for fresh makeup air are positioned to minimize the introduction of contaminated air from the exhaust opening.

4.5.5 Air inlet and outlet openings. Inspect the air inlet opening and heated air outlet opening for the presence of a debris and finger guard. Run a metal sphere no larger than ¾ inch diameter across the inlet guard. Inability of the guard to prevent the sphere from passing through any area shall constitute a failure. Verify the inlet collar has three J-slot connectors located 120 degrees apart, and the outlet collar shall have three pins located 120 degrees apart for making connection to flexible ducts.

4.5.6 Flexible air ducts. Verify 10 foot, insulated, camouflage green supply and return ducts sized for compatibility with standard shelter openings are provided. Verify the ducts are stowable with the heater. The contractor shall certify the outer liner of the ducts meets FAR 25.853 flammability requirements and the duct assembly meets NAS1369 Type B, Form C duct requirements. Verify attaching the ducts to the heater requires no tools and can be performed wearing anti-contact gloves NSN 8415-00-227-1220. Verify the duct rigid collar shall has J-slot connector's located 120 degrees apart on the inlet end, and three pins located 120 degrees apart on the outlet end. Verify the heater return air duct has a debris guard installed in the tent end of this duct assembly preventing debris larger than ¾" diameter entering into the duct. During heater operation, ascertain the ducts do not off-gas or create a haze with heated air temperatures up to 250°F.

4.6 Major components. The following major components shall be provided with the heater.

4.6.1 Internal power generation system. Failure of the generator to be silent or containing moving parts shall constitute a failure. Failure of the generator to supply sufficient power to conform to all testing parameters shall constitute a test failure. Adjustment of the generator for

proper operation at any time shall constitute a test failure. Inability of the generator to be removed and replaced within one hour using only standard tools shall constitute a test failure. A power regulation system shall control system power in conjunction with the power generation system. Any electrical voltage or current induced heater component failure, or fault related shut down (low voltage, high voltage) during any specified performance testing shall constitute a failure.

4.6.2 Power storage battery. Visually inspect for a protected and secure battery housing located on the SHC. Examine battery manufacturer's certification. A shelf life of less than 2 years shall constitute a failure. Confirm the battery is replaceable by one person within 15 minutes.

4.6.2.1 Battery safety inspection. Verify battery is fuse protected within the battery case and fuses are easily replaced. Inspect the battery manufacturer's specifications, installation and shipping instructions. Inability for the battery to be in compliance with the vibration and pressure differential test contained in 49 CFR 173.159(d) shall constitute a failure. Inspect all batteries used after vibration and drop testing. Any signs of punctured cells or caustic liquid leakage shall constitute a test failure. Inspect the battery housing and mounting location. Any design, which could allow a direct path of battery fumes and or liquid to enter the breathable air stream or contaminate electrical components, shall constitute a failure.

4.6.2.2 Battery starting and recharge test. Verify a fully charged battery can provide a minimum of three complete start cycles at –40°F. Verify the SHC can fully charge the battery during operation at an ambient temperature of –60°F. Operate the SHC at 40°F until the BATTERY CHARGED indication comes on. Adjust the temperature of the chamber to -40°F and cold soak the heater and battery for 4 hours. Start the heater and run until the BATTERY CHARGED indication on the control panel is shown. A time to charge longer than 60 minutes for the SHC from the time the ON switch is activated to the CHARGED indication shall constitute a test failure. Shut down heater and verify the battery is at least 99% charged. Repeat this test in an ambient of +60°F. Connect a voltmeter to the battery leads to monitor the voltage during heater operation. Using the battery manufacturer’s minimum charge voltage as a baseline, operate the heater in basic climatic conditions to +60 (+/- 2) °F with the tent thermostat set to the lowest setting (tent satisfied position 1). During operation the battery voltage shall increase and remain no less than the manufacturer’s minimum charging voltage. Failure of the battery to charge and remain above the recommended minimum voltage during or after battery charge shall constitute a test failure.

4.6.2.3 External battery charge. Verify any necessary adapter for the 24 VDC battery charger is provided. Use a standard 24 VDC battery charger to charge a partially discharged battery to a fully charged state. Failure to recharge the battery shall constitute a test failure.

4.6.2.4 Assisted start from vehicle NATO adapter. Install a fully discharged battery on the heater. Connect a NATO cable to the heater interface and to the NATO connector on the military vehicle. Start the heater. Inability to start the heater with a NATO cable from the vehicle NATO adapter or damage to the vehicle batteries or heater shall constitute a failure. Verify the heater provides an indication when it is safe to disconnect the NATO cable after the assisted start.

4.6.3 Combustion system. Verify the combustion system provides continuous, safe, and efficient combustion of specified fuels. Verify the combustion system does not fail from exposure to any condition encountered during operation at any condition specified or during testing such as extreme operating temperatures, corrosion, and rough handling and transport. Examine the combustion system is designed to permit disassembly and cleaning. Verify the combustion system does not leak combustion products into the heated air during the breathable air test.

4.6.3.1 Burner. Verify the burner is accessible for cleaning in 15 minutes or less. Verify the burner is capable of operating 1,500 (T) to 2,000 (O) hours on a combination of 50% JP-8 and 50% DF-2 before maintenance is required during the MTBEFF test. Verify a visible means of flame indication (observation port) is provided, as an objective.

4.6.3.2 Combustion chamber. Verify the combustion chamber is a separable, removable chamber or a part of the heat exchanger.

4.6.3.3 Exhaust outlet. Verify the exhaust discharge outlet is located and positioned to prevent the ingestion of exhaust gases into the heater breathable air. Verify the exhaust outlet is provided with a rain cap to keep out rain in sufficient quantities so heater operation is not adversely affected. Verify the exhaust is not directed at the operator.

4.6.3.4. Emissions. Perform a smoke spot test per ASTM D 2156. The Bacharach oil burner smoke tester and scale (see Appendix B) is acceptable for this test. The readings shall be taken after a minimum of 5 minutes of burner ignition. Perform a smoke test during altitude testing at 5,000 feet, 10,000 feet, and during severe cold climate test. Any smoke readings greater than #3 shall constitute a test failure.

4.6.3.5 Fuel post-purge test. Configure the heater for operation. Shut the heater off after five minutes of operation as measured from the ignition of the burner. Measure the time from the switch off position to the end of the post-purge cycle. Repeat this test using the same battery. Verify a minimum of 1.5 minutes of post-purge is provided. Burner fuel flow shall consistently stop within 2 seconds of switch activation to the off position. Failure of the ABIT to accurately provide a post-purge, which sufficiently evacuates burner fumes and cools heater for safe relocation, PMCS, or refueling, shall constitute a failure.

4.6.3.6 Heat exchanger. Remove and replace the heat exchanger. Inability to remove and replace the heat exchanger using only common tools within 1 hour shall constitute a failure. Pressure test all production heat exchangers by blocking the necessary openings, applying 3-5 PSIG of internal pressure and submerse totally in water prior to assemblage into the heater. Any seepage of bubbles from the heat exchanger's surface shall constitute a test failure. Operate a SHC in the outside the tent configuration for a minimum of 3 hours at an ambient of -45°F. Any ice formation within the exhaust outlet on the heat exchanger or the exhaust pipe outlet shall constitute a test failure.

4.6.3.6.1 Heat exchanger over-temperature protection sensor. Completely block off breathable air stream. Operate the heater. The heater shall have a manual

reset and stop prior to damage of any components by tripping of a temperature sensor. Verify the flame loss fault is presented on the control panel. Remove heat exchanger and pressure test. Any bubbles seeping from the heat exchanger's surface shall constitute a test failure. Verify the heater automatically resets following the over-temperature condition after the heat exchanger cools.

4.7 Gauges.

4.7.1 Hour meter. Inspect the remote control box for the presence of an hour meter. An electronic hour meter is acceptable. Absence of an hour meter that can be easily read and accessed without tools shall constitute a failure.

4.7.2 Fuel tank gauge. Inspect the fuel tank for the presence of fuel gauge. Absence of a fuel gauge that can be easily read shall constitute a failure.

4.8 Controls.

4.8.1 Remote control box. Verify all controls and instruments required for operation of the heater including the On/Off switch, the thermostat, the visual indicator display panel, audible fault alarm, and the remote CO sensor are located together on a compact sealed control panel. Verify the control box allows attachment to a horizontal member in the shelter and has a 25 foot cable to connect the control box to the heater. Verify the cable connections are weatherproof and the control box, cable, and heater have protective caps fastened to each connector for use when disconnected from the cable. Verify the control box is designed to provide protection to the controls and indicators from damage if dropped or if improperly packed for shipping or storage. Examine the heater for on-board storage for the remote control box and cable.

4.8.1.1 On/Off switch. Verify a single On/Off switch is located on the control box to initiate the start and stop functions of the heater and that it is located so that accidental contact by personnel shall not operate the switch. Failure of the switch to activate a pre-purge and start the heater when turned to the ON position shall constitute a failure. Failure of the switch to shut off the heater and provide a post- purge shall constitute a test failure.

4.8.1.2 Thermostat test. Verify presence of a manual temperature control knob and a thermostat temperature-sensing device. Attach a temperature sensor and meter to the outside of the control box adjacent to the thermostat temperature sensor. Operate the heater at 20°F (+/- 2°F) ambient temperature. Position the control knob to the lowest setting. Failure of the control panel to denote the SET POINT has been reached as the tent temperature rises and the attached temperature sensor indicates 40°F (+/- 5°F) shall constitute a failure. Position the control knob to the highest setting. The control panel SET POINT indication shall go off and remain off until the attached temperature sensor indicates 80°F (+/- 5°F).

4.8.1.3 Visual indicator display panel test. Verify the visual indicator display panel provides information on heater operation and generated fault codes. Verify it displays real-time text based feedback on heater function and a timed countdown for start-up.

Verify it has the capability to display the number of starts, operating hours, and the initial condition of the battery voltage prior to operation. Verify it displays a historical log of activated faults and provides monitored parameters. Verify the panel displays a “RUN” indication when the battery is supplying operating power; a "CHARGING" indication displays when the battery is charging from the internal power generation system; a "BATTERY CHARGED" indication displays when the battery has reached its normal starting potential; an indication of thermostat “SATISFIED” or “UNSATISFIED” condition is displayed; the Fault Code number displays when a fault is encountered. Install a properly sized shunt in the battery lead wires and attach a volt meter. Observe the current direction and the CHARGING indication on the control panel during operation. Failure of the CHARGING indication to display when the current reverses and the battery is accepting a charge from the internal generator shall constitute a test failure. When the BATTERY CHARGED light is displayed, turn the heater off and allow it to run the normal post-purge cycle. Remove the battery and perform a state of charge test as recommended by the battery manufacturer. A battery charge of less than 99% of full capacity shall constitute a test failure. Verify that the fault indication and tone activate during a fault and present the correct diagnostic code in unison for identifying the cause of shut down.

4.8.1.4 Audible fault alarm. Verify an audible alarm is present on the control box and provides an audible tone when a fault is encountered or when the CO sensor is activated.

4.8.1.5 CO sensor. Verify the remote control box incorporates a carbon monoxide (CO) sensor which, when activated, causes an audible and a visual alarm to be activated and shuts down the burner. Verify the visual alarm remains on after system shutdown until it is reset.

4.8.2 Alternate emergency control panel on heater. Verify the heater has a toggle switch that allows the heater to operate in the event the remote control panel is lost or damaged. Connect the heater to an appropriately sized tent using the inlet and outlet air ducts. Start the heater with the on-board toggle switch. Verify the heater maintains the shelter at a safe and comfortable temperature. Shut the heater down with the toggle switch and verify the heater provides a post-purge. Simulate a Fault condition. Verify the heater shuts down and provides a post-purge when the Fault condition is encountered.

4.8.3 Prevention of accidental actuation. Verify controls have been designed and located so that they are not susceptible to being moved accidentally, particularly controls whose inadvertent operation might cause damage to equipment, injury to personnel, or degradation of system functions. Verify cycling through the control “On/Off” position is avoided.

4.8.4 Human factors engineering of controls. Verify controls are located within the operator’s functional reach and view without the need to assume an uncomfortable or unusual posture. Verify control design facilitates accurate and efficient system operation.

4.8.5 Consistency of movement. Verify direction of control movement is consistent with the effect of change. For example, the movement of a control forward, clockwise, to the right, up, or pressing a control, turns the equipment or component on, or causes the quantity to increase.

4.8.6 Positive indication. Verify an indication of control activation is provided (e.g. snap feel, audible click, or indicator light illumination).

4.9 Automatic built in test capability (ABIT). Verify the heater has built in test capability.

4.9.1 ABIT system controls. Any requirement for the operator to adjust for fuel type, combustion air flow, generator electrical power routing or any other function that would require periodic operator intervention for efficient and safe heater operation, during any run mode, other than connection of the necessary air ducts, control cable, and fuel supply, shall constitute a failure. Verify a visual and audible fault code is annunciated on the control panel during all fault conditions identified below until the switch is positioned to the "off" position. Verify the audible alarm is checked at start-up.

4.9.1.1 Visual display. Verify the ABIT visual display provides real-time text based heater function feedback to the operator. Real-time displayed functions shall include but not be limited to: timed countdown for start-up, run, battery charging, battery charged, thermostat condition, fault code and post-purge.

4.9.1.2 Pre-purge diagnostic control. Configure heater for operation and perform a. through c.

a. Combustion air flow. If a combustion air blower is used to provide burner air flow, disconnect the blower electrical connector then start heater, leave the connector(s) hanging free. Repeat with the combustion motor fan/rotor blade frozen (artificially jammed) with the electrical system connected. If a combustion motor is not used, block the combustion air inlet. Failure of the ABIT system to identify combustion motor or combustion air as a cause for shut down through the fault identification and audible tone on the control panel shall constitute a failure.

b. Low starting voltage. Start the heater, after burner operation but before the battery charging indication, shut off the heater. Repeat until the battery is discharged to the point of low voltage. Failure of the ABIT system to shut off the heater, during the burner start cycle, and identify low voltage as a cause for shut down through the fault identification and audible tone on the control panel shall constitute a test failure.

c. Tilt the heater past the allowable angle for safe operation. Activate on switch. Failure of the ABIT system to identify a tilt fault through the fault identification and audible tone on the control panel shall constitute a test failure. Perform this test pitch up and down and roll left and right.

4.9.1.3 Start cycle control. Place fuel selector knob on external fuel. Empty heater of fuel and disconnect from the external fuel supply. Activate the ON switch. Measure the time between the actuation of burner fuel pump to the stoppage of fuel pump. Without changing the battery repeat test. Failure of the ABIT system to shut off the fuel pump within 2 seconds of the third timed start attempt and identify the fault as a start time out or start failure shall constitute a test failure.

4.9.1.4 Post-purge diagnostic control. Configure the heater for operation. Shut the heater off after five minutes of operation as measured from ignition of the burner.

Measure the time from the switch off position to the end of the post-purge cycle. Repeat this test using the same battery. Post-purge times shall be a minimum of 1.5 minutes. Burner fuel flow shall consistently stop within 2 seconds of switch activation to the off position. Failure of the ABIT to accurately provide a post-purge, which sufficiently evacuates burner fumes and cools heater for safe relocation, PMCS, or refueling, shall constitute a failure.

4.9.1.5 Hot re-light diagnostic control. Operate the heater until the BATTERY CHARGING indication is on. Position the ON/OFF switch to the off position for two seconds then to the on position. Failure of the heater to stop fuel flow to the burner, provide a post-purge and lock out (will not start until switched to the off position then back on) shall constitute a test failure. Position the ON/OFF switch to the off position, then to the on position. Operate the heater until the BATTERY CHARGED indication is on, then position the ON/OFF switch to the off position. Ten seconds before the end of the post-purge cycle, position the switch back to the on position. Failure of the heater to finish post-purge and lock out shall constitute a failure.

4.9.2 ABIT system faults. The ABIT system faults shall be verified as follows and provide audible and visual text-based notification of fault code number and name when a fault is encountered. Bypass any sensor or input that may trip prior to the particular fault that is being tested.

4.9.2.1 CO level fault. Operate the heater. Place the control panel with the CO sensor in an environment that exceeds 400 ppm of CO. Verify the heater provides an audible alarm, visual fault notification, and shuts down the burner when excessive carbon monoxide within 25 minutes. Verify the fuel flow shuts off and is followed by the post purge cycle. Verify the visual notification remains on after system shutdown until it is reset.

4.9.2.2 Low system voltage fault. Unplug the internal generator then operate heater using a fully charged battery. Operate until heater shuts down due to low voltage. Failure of the ABIT system to shut off the heater, provide a post-purge, and correctly identify low voltage as the cause of shut down for a minimum of 10 minutes shall constitute a test failure.

4.9.2.3 Combustion fan wiring fault. Disconnect the combustion fan. Failure of the ABIT system to shut down the heater, correctly identify the fault and provide an audible tone shall constitute a failure.

4.9.2.4 Combustion fan blower motor fault. Lock the rotor of the combustion fan in the heater, or if no fan is used, totally block the combustion air inlet. Start the heater. Failure of the ABIT system to shut down the heater, provide the normal post-purge, and correctly identify the fault code as combustion air shall constitute a failure.

4.9.2.5 Loss of flame fault. Operate the heater until the BATTERY CHARGED indication is given. Disconnect the fuel supply. Failure of the ABIT system to shut down the heater, provide the normal post-purge and correctly identify the fault code shall constitute a failure.

4.9.2.6 Flame sensor fault. Disconnect the flame sensor. Start the heater. Failure of the ABIT system to identify the flame sensor as the cause for shutdown, correctly identify the fault on the control panel and give an audible tone shall constitute a test failure.

4.9.2.7 Burner maintenance fault. Verify ABIT system is capable of detecting burner characteristics that would indicate burner maintenance is due.

4.9.2.8 Ignition element fault. Configure the heater for operation. Unplug the igniter and activate start switch. Failure of the ABIT system to identify igniter, spark plug, or ignition as the fault shall constitute a failure.

4.9.2.9 Generator over temperature fault. Operate the heater until the BATTERY CHARGED indication is given. Gradually block off the inlet of the return air duct until heater shuts down. Failure of the ABIT system to shut down the heater, provide the normal post-purge and correctly identify an over temperature condition shall constitute a failure.

4.9.2.10 High voltage fault. Operate the heater until BATTERY CHARGING indication is given. Induce an above normal voltage level in the system by disconnection of a voltage regulation device or component. Failure of the ABIT system to shut off the heater, provide a post-purge, and correctly identify high voltage as the cause of shut down for a minimum of 10 minutes shall constitute a test failure.

4.9.2.11 Tilt fault. Place the fuel selector on external fuel or provide a minimum of a half a tank of fuel. Start the heater. Verify the heater operates normally at a 15 degree tilt on all four sides. Tilt the heater past 15 degrees to the angle required for shut off. Failure of the ABIT system to shut down the heater and identify the fault code as tilt and provide a normal post-purge shall constitute a test failure. Perform this test on four sides. Verify there is no hazardous condition or spillage of fuel from the heater after tilt testing. Inspect the attitude sensing device using the manufactures product sheet. A mercury sensor shall not be used.

4.9.2.12 Generator temperature sensor fault. Disconnect the generator temperature sensor. Start the heater. Failure of the ABIT system to shut down the heater, provide the normal post-purge if fuel has entered the burner, and correctly identify the fault code as generator temperature sensor fault shall constitute a failure.

4.9.2.13 Tent over-temperature fault. Start the heater and allow the tent temperature to exceed 110°F. Failure of the ABIT system to shut down the heater, provide the normal post-purge and correctly identify the fault code as tent over temperature shall constitute a failure.

4.9.2.14 Vent fan motor fault. Lock the vent fan motor and start the heater. Failure of the ABIT system to shut down the heater, correctly identify the fault and provide an audible tone shall constitute a failure.

4.9.2.15 Vent fan wiring fault. Disconnect the vent fan wiring. Start the heater. Failure of the ABIT system to shut down the heater, provide the normal post-purge if fuel was introduced into the burner, and correctly identify the fault shall constitute a failure.

4.9.2.16 Fuel pressure sensor fault. Disconnect the fuel pressure sensor. Start the heater. Failure of the ABIT system to shut down the heater, provide the normal post-purge and correctly identify the fault code shall constitute a failure.

4.9.2.17 Heat exchanger over temperature fault. Completely block off breathable air stream. Operate the heater. The heater shall automatically stop prior to damage of any components by tripping of a temperature sensor. Verify a fuel pump open circuit fault is presented on the control panel. Remove heat exchanger and pressure test. Any bubbles seeping from the heat exchanger's surface shall constitute a test failure.

4.9.2.18 Inlet air temperature fault. If this fault is provided, make available a supply air stream at a temperature of 110 ±5°F. Start the heater. Failure of the ABIT system to shut down the heater, provide a normal post-purge, and correctly identify the fault shall constitute a failure.

4.9.2.19 Inlet air temperature sensor fault. If this fault is provided, disconnect the inlet air temperature sensor. Start the heater. Failure of the ABIT system to shut down the heater, provide the normal post-purge if fuel was introduced into the burner, and correctly identify the fault code shall constitute a failure.

4.9.2.20 Battery temperature sensor fault. Disconnect the battery temperature sensor. Start the heater. Failure of the ABIT system to identify battery temperature sensor open or short circuit as the cause for shutdown, provide the fault code and audible tone on the control panel shall constitute a test failure.

4.9.2.21 Fuel delivery fault. Safely short the wiring to the fuel delivery mechanism. Start the heater. Failure of the ABIT system to shut off fuel flow to the burner, provide a normal post-purge if fuel was introduced into the burner, identify the short circuit as the cause for shutdown and an audible tone shall constitute a failure.

4.9.2.22 Combustion inlet temperature sensor fault. If this fault is provided, attempt to start the heater at an ambient temperature of 110 ±5°F. Failure of the ABIT system to shut down the heater, provide a normal post-purge and correctly identify the over temperature fault shall constitute a failure.

4.9.2.23 Start attempts fault. Install a valve to positively prevent fuel from entering the burner. Attempt a start cycle which includes three start attempts. After the third attempt, failure of the ABIT system to shut off fuel flow to the burner, provide a post-purge cycle, and identify a start attempt fault shall constitute a failure.

4.9.2.24 Remote communications fault. Operate the heater until the BATTERY CHARGED indication is given. Disconnect the 25 foot remote control cable. Failure of the ABIT system to shut down the heater, provide the normal post-purge and correctly identify the fault code in the historical log shall constitute a failure.

4.9.2.25 Carbon monoxide sensor fault. Operate the heater until the BATTERY CHARGING indication is given. Disconnect the carbon monoxide sensor. Failure of the ABIT system to shut down the heater, provide a post-purge, identify the carbon

monoxide sensor open or short circuit as the cause for shutdown and an audible tone shall constitute a test failure.

4.9.2.26 System audible alarm fault. Disconnect the system audible alarm circuit. Start the heater. Failure of the ABIT system to identify the correct fault code and shut down the heater shall constitute a failure.

4.9.2.27 Microprocessor fault. If a microprocessor is used and the microprocessor experiences a failure, verify the fuel flow to the burner shuts off and a post-purge, fault code and audible tone are provided.

4.9.2.28 Brownout fault. If this fault is provided, when a brownout condition occurs, verify the fuel flow to the burner is shut off and a post-purge, fault code and audible tone are provided.

4.9.2.29 Outlet air temperature fault. Start the heater. Slowly block the breathable air stream at the end of the outlet duct. The heater shall automatically shut down prior to the outlet air temperature reaching 225°F. Failure of the ABIT system to shut down fuel flow to the burner, provide the normal post-purge and correctly identify the fault shall constitute a failure.

4.9.2.30 Outlet air temperature sensor fault. Disconnect the outlet air temperature sensor. Start the heater. Failure of the ABIT system to shut down fuel flow to the burner, provide the normal post-purge and correctly identify the fault shall constitute a failure.

4.9.2.31 Fuel pump fault. Disconnect the fuel pump electrical connector. Start the heater. Failure of the ABIT system to shut down fuel flow to the burner, provide the normal post-purge and correctly identify the fault shall constitute a failure.

4.9.3 ABIT system monitored parameters. Verify the ABIT system monitors the status of major components that are used as a development diagnostic and verification tool. Verify a computer interface is provided to view the parameters. Verify these parameters are not accessible to the user.

4.9.3.1 List of monitored parameters. Use an appropriate computer interface and verify the following parameters are able to be monitored: battery voltage, battery heater voltage, battery charge status, TEG voltage, TEG current, BUS voltage, fuel pump status, TEG temperature, inlet air temperature, outlet air temperature, tent temperature, setpoint temperature, vent fan rpm, combustion blower rpm, fuel injector duty cycle.

4.9.4 ABIT system historical log. Verify the ABIT system maintains a historical log of the last 10 fault codes generated, number of start attempts, initial battery condition at first start attempt, operating hours, and provides the results on the display when requested.

4.10 Safety. The heater shall be designed so that under all conditions of normal use (installation, operation, and maintenance) and under a likely fault condition (including human error), it protects against the risk of electric shock, noise, temperature, trauma, and other hazards that could cause death, illness, or reduced job performance. The equipment shall provide maximum access and safety to

personnel during installation, operation, and maintenance. All hazards shall be eliminated or reduced to the lowest risk level practicable using methods in the following order of precedence: design; incorporation of safety devices; incorporation of warning devices; and procedures/training. Catastrophic or critical hazards shall not rely solely on warnings, cautions, or procedures/training for control of risk. All safety hazards not eliminated through design shall be addressed in the appropriate technical manuals. Information regarding hazard-avoiding procedures and safety warning labels on equipment shall be included in all manuals. Maintenance technical manuals shall address replacement procedures for damaged or missing safety labels. The heater shall be evaluated against SEL Form 1183, System Safety Design Verification Checklist. SEL Form 1183 shall be used as a guideline to address any safety issues that may pertain to the heater, but have not been specified. The safety design parameters from SEL Form 1183 that are applicable to the heater shall be reviewed and incorporated.

4.10.1 Electric shock. Examine the heater to determine if electric shock protection has been incorporated into the heater design so as to prevent damage, electrical shorts, personnel shock or personnel burns. Verify personnel are suitably protected from access to hazardous voltages (in excess of 30 volts between live parts and/or ground) when setting up, operating, tearing down, during maintenance, or when maintenance covers are opened. Omission of protective measures against electric shock shall constitute a design failure. The heater shall have provisions to protect the operator from electric shock or burns.

4.10.2 Electrical wiring safety. The contractor shall certify that the heater is in compliance with the National Fire Protection Association, National Electric Code, Standard 70. Examine the heater to determine whether wiring is secured with mechanical clamps and the wiring does not hinder maintenance functions. Verify wires are routed so that they do not contact sharp corners, are not pinched between components, and strain relief is provided. Verify wire ties are used to make wiring look neat and professional and excess wire tie ends are cut off close and straight. Failure of the contractor to certify that the heater design is in conformance with the above industry requirements and standards, or evidence of loose, misrouted, or pinched wiring shall constitute a design failure.

4.10.3 Fuse protection. Inspect the electrical system for necessary fuse protection and onboard spare fuses, which are accessible and replaceable without tools.

4.10.4 Sharp edges. Examine the heater for non-functional sharp edges and projections. Verify all exposed edges and corners are rounded to a minimum of 0.03-inch radius. Verify sharp edges and corners that can present a personnel safety hazard or cause equipment damage during operation and maintenance are rounded to a radius not less than 0.05 inches.

4.10.5 Moving parts. Conduct a visual examination to determine if the heater has any exposed moving parts, which may result in injury to an operator. Evidence of moving parts hazards to the operator shall constitute a design failure.

4.10.6 Surface temperatures. After one hour of operation measure all surface areas of the heater and the handles. Any temperature readings above 120 F, other than the immediate exhaust pipe outlet, exhaust pipe connection point, heated air duct connection point and the finger guard, shall constitute a test failure.

4.10.7 Fuel system safety. Conduct a visual examination of the fuel system components. Verify the components are routed, located or guarded so as to be protected from mechanical damage

and extreme temperatures. Verify the appropriate fuel types for heater operation are clearly labeled at the fuel fill port. Verify fuel drains do not allow fuel accumulation, spills, or overflows to run onto hot surfaces or electrical equipment.

4.10.8 Material safety. Contractor shall certify the selected materials are not listed in OSHA 29 CFR 1910 for cancer producing substances and human toxicity. If any material used on the heater is listed in OSHA 29 CFR 1910, this shall constitute a failure.

4.10.9 Environmental hazards. The contractor shall certify materials and parts containing mercury were not used unless use of mercury is specifically required and approved by the Government. Failure to certify the requirements shall be considered a failure.

4.10.10 Noise. Operate the heater. Measure sound levels per MIL-STD-1474 at a 3-foot distance around the outside of the heater on four sides at ear level. Any readings in excess of 75 dB shall constitute a failure.

4.10.11 Breathable air quality. Setup the heater with a tent. Test for the presence of exhaust gasses entering the tent. Any readings of carbon dioxide or carbon monoxide above the TLV-TWA as established by the American Conference of Industrial Hygienists shall constitute a failure.

4.11 Support or ownership requirements.

4.11.1 Weight. Weigh the heater and battery without accessories. Any weight readings greater than 400 pounds shall constitute a test failure. Weigh the heater and all accessories in the accessories bag. Any weight readings greater than 450 pounds shall constitute a failure. Wheels, if required, are not included in the weight.

4.11.2 Volume. Measure the outside envelope dimensions of the heater. A measurement greater than 30 cubic feet shall constitute a test failure.

4.11.3 Transportability. Inspect the volume of the heater in the transport configuration with all accessories. Assess the ability to be transported by the required vehicles listed in 3.11.3 through inspection of vehicle literature defining cargo storage dimensions and comparing with overall dimensions of the SHC. Inability to transport the SHC with any of the vehicles listed shall constitute a failure.

4.11.3.1 Slinging and tie-down provisions. Examine the heater for slinging provisions and tie-down provisions or a combination slinging/tie-down provisions. Verify the slinging provisions are located above the heater's center of gravity and cannot be removed without the use of tools. Verify the slinging and tie-down provisions are designed to prevent movable parts from freezing in place in cold weather, are non-protruding and self-concealing. Verify the minimum inside dimension of each provision is 3 inches. Verify tie down locations are permanently marked.

4.11.3.2 Stackable and restrainable. Verify the heater is sized to accommodate 9 heaters with accessories on a 463L pallet (104" wide x 84" long x 96" high) and is stackable and secured together by positive means. Conduct a pull test to measure the tie-down provision strength. Verify the tie-down provisions are capable of withstanding 4.0 times

the gross weight of the heater in the forward and aft direction of the longitudinal axis of the heater; 2.0 times the gross weight in the downward direction of the vertical axis of the heater; and 1.5 times the gross weight in each direction of the lateral axis of the heater. Loads shall be applied in the longitudinal, vertical, and lateral directions statically and independently for not less than 6 seconds.

4.11.4 Lifting and mobility. Examine the heater to determine if the weight of the heater components is distributed to provide a safe and stable configuration in all operating positions and during movement. Examine the heater for the presence of an integral forklift access skid to facilitate movement.

4.11.4.1 Housing and chassis assembly. Verify the heater is fully enclosed in a lightweight, substantially constructed cabinet or frame that is an integral chassis with skids.

4.11.4.2 Accessibility. Examine the heater for accessibility of the subassemblies. Verify all instruments and controls for operation of the heater are accessible to the operator by opening a small cover. Verify if access doors are provided, they are equipped with safety links or are otherwise locked in the open position to prevent injury to the operator or other damage by inadvertently closing.

4.11.4.3 Weather resistance. Verify the heater resists weather conditions and prevents rain, water, snow, ice, sand, mud, or dust from collecting in quantities which would prevent satisfactory operation during blowing rain, sand and dust tests.

4.11.4.4 Forklift access skid. Examine the heater for an integral forklift access skid. Verify the skid is wide, ski-like for ease of movement over mud or snow. Verify each forklift tunnel is a minimum of 3 inches high and 10 inches wide and located a minimum of 18” and a maximum of 60” apart. Verify the forklift access skid is designed to prevent damage to other components on the heater when a forklift is in use.

4.11.4.5 Wheels. If wheels are required, verify the heater is equipped with wheels that are removable or retractable without the use of external tools. Verify provisions are made for securing the wheels to the heater when not installed for use. Verify the heater has a three-point or four-point support when the wheels are installed and has an integral means to prevent movement of the heater when parked in the level or specified inclined positions.

4.11.4.6 Manual movement provisions. Check for the presence of a handrail or handles that assists in manual localized movement and positioning. Assure it conforms to the requirements of MIL-STD-1472, Human Engineering. Failure of the heater to provide a handrail or handles that assists in manual movement and positioning and personnel carrying provisions in compliance with MIL-STD-1472 shall constitute a failure.

4.11.5 Outside tent operation. Position the heater adjacent to the outside wall, run the air ducts through two sleeved entrance holes. If no entrance holes are present, and a Tent Wall Modification Kit is not available, run duct underneath the tent wall. Unpack and install all necessary components for operation. Observe the heater while operated in this configuration.

Presence of any safety hazards or loss of heater performance shall constitute a failure. Any signs of tent fabric discoloration due to heat shall constitute a failure.

4.11.6 Tent wall modification kit (TWMK). (See 6.2) Following manufacturer's instructions, install the modification kit to a tent wall. Any need for hardware other than provided shall constitute a failure. Set heater for outside operation using the modified wall. Inability of the heater ducts to pass through the duct openings or any gaps between the duct opening and the duct shall constitute a failure. Remove air ducts and close duct openings. Inability to close duct openings or presence of gaps shall constitute a failure.

4.11.7 Exterior openings. Inspect the heater exterior openings (air inlet, air outlet, control panels, etc.) that may be open during heater operation for a means to close or a design which does not allow foreign objects and elements of weather to collect in quantities that will prevent satisfactory operation of the heater. Verify a means is provided that prevents foreign objects and weather elements from entering the heater when it is not in use.

4.11.8 On-board storage. Verify the heater provides on-board storage for all external components used during operation. Storage shall be provided for the exhaust stack with rain cap, cables, remote control panel, remote CO monitor, technical manual compact disc, fuel hose for external fuel operation, quick start instructions, and any other external component. As an objective (O), verify on board duct storage is provided. Verify the Technical Manual CD storage is weatherproof.

4.11.9 Set up and teardown time. Set up shall be conducted by no more than two personnel. Position the heater adjacent to the outside wall and run the air ducts through the two sleeved entrance holes. Connect the remote control box. Fill fuel tank or connect fuel lines to outside fuel supply. Perform pre-operational checks and services and any other necessary operations. Set up time shall not exceed 20 minutes. Set-up does not include obtaining fuel for the operation. Disassemble the heater to transport configuration with no more than two people. Disassembly times greater than 20 minutes shall constitute a failure.

4.11.10 Human factors engineering. Verify human factors engineering is taken into consideration in the design of the heater. Verify the heater is operable and maintainable by 5th through 95th percentile soldiers dressed in the Battle Dress Uniform (BDU), cold-wet weather protective clothing, arctic clothing, and the protective ensembles for Mission Oriented Protective Posture (MOPP) Level IV. Verify the heater can be started and operated by a single operator. Verify all components are located to permit easy access for operating and maintaining the heater. Verify heater design facilitates accurate and efficient system operation for all installation, operation, and maintenance tasks.

4.12 Labels. Examine the heater for permanent, legible warnings and information labels providing quick and easy identification of assembly, setup, components, spare parts list, safety cautions, operating instructions, PMCS instructions, electrical wiring diagram, fuel system diagram, and proper fuels, affixed to the heater, accessories enclosures or panels. Verify the labels are permanently affixed to the heater under all operating and transport conditions. Verify the labels are located on a permanent part of the heater. Verify the labels can be read quickly and easily from left to right; and are placed on or near the item they identify. Verify controls do not obscure labels. Verify labels are located in a consistent manner throughout the heater system and are printed in capitals. Verify all letters are black, except when using a black background, then letters are white. Verify label backgrounds are red for

danger, yellow for caution and black for information. Verify the safety and cautionary label letter size and color is sufficient to be easily read from a distance of six feet in daylight or with a flashlight when dark. Verify access panels are labeled, identifying the component protected inside.

4.12.1 Set up and operating instructions label. Verify there is a label with basic instructions for set up, starting, operating, and stopping the heater located near the operator's control panel in such a manner as to be readily visible to the operator during those actions. Verify the operating instructions include all the information needed to operate the heater as intended and warn the user against reasonably foreseeable risks of injury to persons. Verify the heading "OPERATING INSTRUCTIONS" or the equivalent precedes these instructions. Verify the operating instructions explain and describe the location, function and operation of each user-operated control of the heater, safety cautions, and warn against tampering with such devices.

4.12.2 Electrical wiring and fuel system diagrams. Verify the heater has labels depicting the electrical wiring diagram and the fuel system diagram.

4.12.3 User interface component identification labels. Verify the heater has labels identifying major user interface components such as switches, controls, and indicators present near the identified component.

4.12.4 Permanent identification label. Verify the Unique Identification (UID) has the following information: the manufacturer or vendor name or identifying symbol, a distinctive type or model number, a serial number, a contract number, date of manufacture, the firing rate of the burner expressed to the nearest 0.1 gallons per hour, and the grade of fuel.

4.12.5 Safety markings and labels. Verify safety markings and labels are provided identifying potential hazards to personnel and include lifting requirements, hot surface identification of any surface over 120°F, and shock hazards. The contractor shall certify the safety markings comply with ANSI Z535.4. Verify safety labels are not obscured or removed when a barrier or access door is opened or removed. Verify cautionary markings are legible and visible from the position normally assumed by the operator when starting the heater or from the position normally assumed for the specific operation involved. Verify colors of safety critical controls and indicators are yellow for caution and red for danger. Verify a marking intended to inform the user of a risk of fire, electrical shock, or injury is prefixed by a signal word "CAUTION" or "WARNING". Verify the marking is in letters not less than 3/32-inch high and the signal word is more prominent than any other required marking on the heater. Verify the marking contains a statement of the risk involved, for example, "Risk of Electric Shock". Verify the heater is permanently marked to indicate the heater must be disconnected from the battery when cleaning or servicing is performed.

4.13 Durability and materials.

4.13.1 Material deterioration prevention and control. The contractor shall certify the heater is fabricated from compatible materials, inherently corrosion resistant or treated to provide protection against the various forms of corrosion and deterioration that may be encountered in applicable storage and operating environments.

4.13.2 Dissimilar metals. The contractor shall certify dissimilar metals were not used in intimate contact with each other unless protected against galvanic corrosion as defined in MIL-STD-889.

4.13.3 Surface finish. The contractor shall certify that the surface finish applied to the heater is in compliance with MIL-DTL-53072. Examine the heater surface to verify that the heater has a complete, smooth application of Chemical Agent Resistant Coating on all outer surfaces except surfaces exposed to high-temperature flue products. Verify the color of the finish coating is green, tan, or white as specified in 6.2. Any voids in the coating application on the outer surface or failure of the contractor to provide CARC certification shall constitute a failure.

4.13.4 Unpainted surfaces. Examine the unpainted surfaces for deterioration, corrosion or damage. The contractor shall certify interior sheet metal surfaces of the heater, including those behind insulation materiel, were cleaned and treated.

4.13.5 Fastener hardware. The contractor shall certify any and all fasteners used in the design and fabrication of the heater meet the requirements of the applicable ANSI specification and externally threaded fasteners (e.g., bolts) and upset rivet heads meet the requirements of SAE J429. Examine bolt holes for presence of burrs. Examine for presence of sheet metal or self-tapping screws. Verify appropriate means are used for quick opening access required for operating adjustments and Preventive Maintenance Checks and Services (PMCS).

4.13.6 Common parts. Examine the heater for maximum practicable use of interchangeable hardware and fastening devices (bolts, screws, nuts, washers, and similar components) along with a minimum number of types and sizes. The contractor shall certify all fasteners are treated to be corrosion resistant under all environmental conditions specified herein. Examine fasteners for secure installation to prevent inadvertent loosening which may lead to potential foreign object damage.

4.13.7 Gaskets and seals. The contractor shall certify all gaskets, synthetic rubber seals, etc., are suitable for use with fuels specified herein, temperatures from -65 to +300°F, and in all environmental conditions specified herein.

4.13.8 Bearing lubrication. The contractor shall certify bearings are sealed and permanently lubricated for operation in an ambient temperature range of -65F to +250 F.

4.13.9 Metal fabrication. Examine metal used in fabrication for presence of kinks and sharp edges. Verify sharp bends and corners are square and true and fabricated to minimize surfaces that would trap contaminants or decontaminants. Verify all bends are made by controlled means to ensure uniformity of size and shape.

4.13.10 Welding and brazing. The contractor shall certify all welding is in accordance with AWS D1.1, AWS D1.2, as applicable. The contractor shall provide certification that each welder or welding operator is certified in accordance with AWS D1.1, AWS D1.2, AWS B2.1, as applicable. Certification shall be made available for review by the contracting officer or designated representative. The contractor shall certify brazing of steels, copper alloys and nickel conforms to AWS B2.2 and during the brazing operation, care was exercised to protect all components from deformation and damage, and heavy beads and fillets of braze material were avoided.

4.13.11 Severe climate manipulation. Perform a severe cold manipulation and component replacement test. Cold soak the heater with all accessories to -60°F. After component temperature stabilization remove battery then re-install, replace igniter, then the flame sensor using spares included in the accessories bag. Connect the heater fuel line to the external fuel source and heater. Repack all components to the transportation configuration. Perform this test cycle 3 times. Any evidence of damage to wires, components and accessories or any inability to manipulate components while wearing the appropriate cold weather clothing shall constitute a test failure.

4.13.12 Electrical wiring. The contractor shall certify that the heater is in compliance with the National Fire Protection Association, National Electric Code, Standard 70. Verify wire numbering or color coding is used to the maximum extent to aid in following wiring diagrams and troubleshooting electrical problems. Verify electrical wiring is supplied as removable harnesses for ease of replacement. Verify a wiring diagram is present on the heater. Examine the heater to determine whether wiring is secured with mechanical clamps and the wiring does not hinder maintenance functions. Verify wires are routed so that they do not contact sharp corners, are not pinched between components, and strain relief is provided. Verify wire ties are used to make wiring look neat and professional and excess wire tie ends are cut off close and straight. Failure of the contractor to certify that the heater design is in conformance with the above industry requirements and standards, or evidence of loose, misrouted, or pinched wiring shall constitute a design failure.

4.13.13 Electrical connectors. Verify electrical connections are of a quick disconnect type wherever feasible. Verify connectors of the same shell size are not in adjacent locations. If connectors of the same shell size are in close proximity, verify differences in the keying arrangements are used. Verify multi-contact connectors, including printed circuit assembly connections, are keyed, polarized, or of a contact configuration to prevent improper connection.

4.14 Reliability, maintainability, and serviceability.

4.14.1 Mean Time Between Essential Function Failure MTBEFF. In order to demonstrate an 80% lower confidence level with a threshold (T) 1150-hour MTBEFF, the total test length for the allowed number of essential function failures (EFF) is detailed in the table below:

TABLE. III EFF vs. Total Test Length

EFF Allowed	Total Test Length (hours)
0	1850
1	3443
2	4920
3	6342
4	7729
5	9091
6	10,346
7	11,767
8	13,086

As an example, three heaters shall each be placed on a reliability test for a minimum of 2114 hours each for a total of 6342 hours collectively. There shall be no more than three chargeable essential function failures (cumulative).

Fuel type for the test shall be divided equally between DF-2 and JP-8. A 55-gallon drum shall be used for the fuel source and refilled as needed. Measure burner smoke spot and combustion efficiency during the start, at each 100-hour interval (±10-hours), and once during the last start cycle at the conclusion of this test for each unit operated.

4.14.2 Maintenance Ratio. During RAM testing, record and time all maintenance procedures performed. A maintenance ratio greater than a threshold (T) 0.013 maintenance man-hours per operating hour, for any maintenance, other than PCMS shall constitute a failure. Preventive maintenance checks and services performed by the operator in 20 minutes or less are excluded.

4.14.3 Preventative Maintenance Checks and Services PMCS. Configure the heater for operation. Perform a walk around inspection. Inspect the fuel filter for water or dirt contamination and clean if necessary; fuel supply connections; exhaust stack connection; secure connection of ducts; secure connection of control box and CO monitor; snow or ice blockage; inspect for fuel leaks and general condition to permit operation. A thorough examination shall not exceed 20 minutes. No panels or covers shall be removed or opened to gain visual access.

4.14.4 Endurance. Determine heater endurance during RAM testing. Any malfunction before 2,000 hours of operation that precludes further operation of the heater and which causes a repair that is costly enough to justify scrapping major components shall constitute a failure.

4.14.5 Field serviceability. Verify the heater is easily maintainable. Examine for maximum use of modular components. Verify standard parts are used whenever practicable and mission critical items, such as the burner, are most accessible. Verify sufficient and reasonable accessibility is afforded for cleaning, inspection, repair and replacement of all critical heater components. Verify high failure rate items are accessible for replacement without moving or removing non-failed items. Verify the heater requires the use of only those tools in the general mechanics kit specified in Supply Catalog SC 5180 90 CL N26. Verify Test, Measurement, and Diagnostic Equipment (TMDE) required for maintenance currently exists in the DoD supply system. Time the removal and replacement of each of the following: the flame sensor, igniter, fuel filter, battery fuses and battery. Use the spares included in the accessories bag except for the battery, which shall be reinstalled. Inability to remove and replace each component within 15 minutes shall constitute a test failure. Remove and replace circulation fan(s) or blower(s), failure to remove and replace within 30 minutes shall constitute a failure. After each component removal and replacement the heater shall be returned to the operational configuration. Repack/stow all components to the transportation configuration. Perform this test cycle 3 times. After completion perform a functionally check of the heater.

4.14.6 Design for maintenance. Verify the heater is designed for ease of maintenance with general purpose tools (common hand tools) and equipment normally available commercially. Verify the heater is capable of being operated and maintained by personnel wearing arctic clothing and nuclear, biological, and chemical (NBC) warfare defense protective ensemble. Verify, where practical, parts and components are located or positioned for rapid and simple

inspection and recognition of excessive wear or potential failure and standard parts are used whenever practicable. Verify cam lock latches are used for access panels and oversized captive screws are used whenever possible. Verify no small removable screws are used on field serviceable components.

4.14.7 Error proof design. Verify the heater is designed to preclude improper assembly or installation and to prevent the interchange of items of a same or similar form that are not in fact functionally interchangeable. Verify physical measures are taken to prohibit improper mounting of units or components and to facilitate the identification, orientation, and alignment of cables and connectors.

4.14.8 Operational clearance. Verify the heater is designed to allow operation, servicing, and maintenance at low ambient temperatures convenient to personnel wearing arctic clothing and chemical warfare gear. Examine the heater for intricate locking devices, controls, and fasteners that can easily be over-torqued by personnel lacking feeling through cold weather/chemical warfare clothing. Verify covers and plates that must be removed for component adjustment/operation are equipped with fasteners that can be easily operated using cold weather/chemical warfare clothing.

4.14.9 Scheduled maintenance. Determine the required scheduled maintenance during RAM testing. Examine the technical manual. Verify scheduled maintenance is not required more frequently than each 750 hours of operation as a threshold (T) and 1,500 hours as an objective (O). Verify scheduled maintenance is not at any level higher than operational.

4.15 Spares, accessories, and tools.

4.15.1 On-board spares. Verify the heater is equipped with the following on-board spares: the igniter, fuel filter/strainer element, flame sensor, fuses, fuse caps and any other recommended components. Verify spares are located within a secure area with the heater or inside an accessories bag when specified.

4.15.2 Accessories. Verify the following accessories are included with the heater: two breathable air ducts, remote control panel, control panel connection cable, remote CO monitor, fuel hose for external fuel operation, battery charging adapter, exhaust stack with rain cap, accessories storage bag, quick start instructions, and a technical manual compact disc. Verify all accessories that are not stored on-board the heater fit in the accessories bag.

4.15.3 Tools. Verify tool(s) required to remove or replace any on-board spare parts are included and stowed within the heater or in the accessories bag.

4.15.4 Accessories bag. Verify an accessories bag is provided to house any accessories, spares, or tools that are not stored on-board. Verify the accessories bag is rugged and the hand holds provide uniform load distribution.

4.16 Electromagnetic Environmental Effects.

4.16.1 Electromagnetic Interference (EMI) Radiated. Conduct the radiated emissions test per MIL-STD-461E, Method RE102, radiated emissions (ground applications), electric field, in the 10 kHz to 18 GHz range. Electric field emissions radiated from the heater or any

interconnecting cables in excess of those shown in MIL-STD- 461E, Method RE102, radiated emissions (ground applications), electric field, 10 kHz to 18 GHZ shall constitute a failure.

4.16.2 Nuclear, Biological Chemical (NBC) compatibility. Verify the heater is Chemical Agent Resistant coating (CARC) painted. As an objective, (O), verify two soldiers in full NBC-protective ensembles can set up the heater for operation, operate the heater, and perform unit maintenance. Verify the heater is NBC survivable, is hardened against the effects of chemical agents and decontaminants, and can be decontaminated to negligible risk levels.

4.17 Environmental requirements.

4.17.1 Basic climate operations. The basic climate operation test shall be run in accordance with MIL-STD 810, Method 502.5, Procedure II-Operation. Set up the heater for operation. Provide temperatures of 40°F (+/- 2) to operate heater. Use fuels as specified in Table I. Perform heat capacity test of Appendix B. Values not meeting the requirements of 3.17.1 shall constitute a failure.

4.17.2 Basic cold climate operation. The basic cold operation test shall be run in accordance with MIL-STD 810, Method 502.5, Procedure II-Operation. Set up the heater for operation. Provide temperatures of -25°F (+/- 2) to operate heater. Use fuels as specified in Table I. Perform heat capacity test of Appendix B. Values not meeting the requirements of 3.17.2 shall constitute a failure.

4.17.3 Severe cold climate operation. The severe cold climate operation test shall be run in accordance with MIL-STD 810, Method 502.5, Procedure II-Operation. Set up the heater for operation. Provide a Threshold (T) temperature of -40°F (+/- 2) to start the heater, then, bring test chamber temperature down to -60°F while operating. Provide an Objective (O) temperature of -60°F (+/- 2) and NATO assist to start the heater, then, maintain the test chamber temperature at -60°F while operating. Use fuels as specified in Table I. Perform heat capacity test of Appendix B. Values not meeting the requirement of 3.17.3 shall constitute a failure.

4.17.4 High altitude. Conduct test in accordance with MIL-STD 810, Method 500.5, Procedure II-Operation. Provide a field site that is 5,000 feet altitude minimum for operational checkouts. Operate heater for a minimum of one hour. Perform smoke spot test within five minutes after burner ignition and again before shut down. There shall be no operator adjustments required for altitude compensation for proper operation. Perform indicated efficiency test. Any degradation in performance as demonstrated by the efficiency test and smoke test, failure of the battery to charge within 60 minutes or failure of the heater to operate shall constitute a failure. Provide a field site that is 10,000 feet altitude minimum for operational checkouts. Operate heater for a minimum of one hour. Perform smoke spot test within five minutes after burner ignition and again before shut down. There shall be no operator adjustments required for altitude compensation for proper operation. Perform indicated efficiency test and measure heat output. Verify heat output is derated 15%. Degradation in performance below the requirement of 3.17.4 as demonstrated by the efficiency test, smoke test, failure of the battery to charge within 60 minutes or failure of the heater to operate shall constitute a failure.

4.17.5 Inclined operation. Start the heater. Verify the heater operates normally at a 15 degree tilt on all four sides without fuel leakage or damage to components from external fuel source or

a half-full fuel tank. Spillage of fuel or the inability of the heater to operate normally during any tilt tests shall constitute failure.

4.17.6 Salt fog. A heater with accessories shall be tested IAW the requirements and conditions set forth in MIL-STD-810, Method 509.5. Provide 24 hours of salt fog exposure, followed by 24 hours of dry out. Repeat with 24 hours of salt fog and 24 hours of dry out. Use a 5% (±1%) salt solution concentration. Operate the heater per the Minimum Run Cycle Test of 4.18 prior to testing to ensure it is operational. Expose the heater set up in its normal operating mode. Upon completion of the testing, perform a visual check of all the heater components, for evidence of peeling, blistering paint, possible electrical shorts or impairment due to salt deposits, evidence of deterioration, clogging or binding of moving parts, or change in tolerance limits of any internal or external parts which could prevent the unit from meeting operational and maintainability requirements. Minor oxidation, which can easily be removed, on exposed fasteners and hardware is permissible, provided performance of the part is not adversely affected. Operate the heater per the Minimum Run Cycle Test of 4.18. Failure to remain operational after salt fog testing shall constitute a test failure.

4.17.7 Wind and rain. A heater with accessories will be tested IAW MIL-STD- 810, Method 506.5, Procedure I – Blowing Rain. Operate the heater per the Minimum Run Cycle Test of 4.18 prior to testing to ensure it is operational. Provide 4 in/hr of rain along with 40 mph winds for 30 minutes with the heater in each of the following two configurations: (a) the storage configuration and (b) the operational configuration. After each of the two test exposure configurations, the heater shall be checked for water penetration. After completion of wind/rain testing, operate the heater per the Minimum Run Cycle Test of 4.18. Failure to remain operational after wind/rain testing shall constitute a test failure. Any signs of water penetration, which may cause component degradation or prohibit safe operation of the heater, shall constitute a failure. Failure of the heater to operate in the wind/rain shall constitute a test failure.

4.17.8 Icing and freezing. A heater with accessories will be tested in accordance with MIL-STD-810, Method 521.3 covered in a 6 mm thick coating of ice glaze. Operate the heater per the Minimum Run Cycle Test of 4.18 prior to testing to ensure it is operational. Place the heater in the test chamber and cover in a 6 mm thick coat of ice. Clear the air intakes of ice and operate heater per Minimum Run Cycle Test of 4.18. Failure of the heater to remain operational after the icing and freezing test shall constitute a test failure.

4.17.9 Sand and dust. Test for operation and storage in a blowing sand and dust environment per MIL-STD-810, Method 510.5, Procedure I – Blowing Dust and Procedure II – Blowing Sand. Set up the heater outside a tent in operating configuration. Operate the heater per the Minimum Run Cycle Test of 4.18 prior to the dust test. Conduct the Blowing Dust Test at an ambient temperature of 90°F, under 30% relative humidity and an air velocity of 1750 ft/min. Conduct the test using red china clay as defined in MIL-STD-810 at a concentration of 0.3 +/- 0.2 g/ft3. Expose each of four sides for 90 minutes to the blowing dust for a 6-hour total duration. Operate the heater per the Minimum Run Cycle Test of 4.18. Conduct the Blowing Sand Test at an ambient temperature of 90°F, under 30% relative humidity and an air velocity of 3540 ft/min. Use sand particle size as specified in the MIL-STD-810 at a concentration of 0.005 g/ft3. Expose each of the four sides of the heater for a 90-minute duration. Operate the heater per the Minimum Run Cycle Test of 4.18. Inspect the heater for evidence of erosion and abrasion of surfaces, penetration of seals, and degradation of electrical circuits, obstruction /

clogging of openings or filters, and interference of moving parts. Failure of the heater to operate after sand and/or dust test shall constitute a failure.

4.17.10 Storage. Subject heater to testing IAW MIL-STD- 810, Method 501.5, Procedure I - Storage. Operate the heater per the Minimum Run Cycle Test of 4.18 prior to the high temperature storage test. Bring chamber air temperature up to 155°F (±3°F) and 75% relative humidity (±5%), once these conditions are attained, hold for a 4-hour storage period. Remove the heater and perform functionality check per 4.18, Minimum Run Cycle Test. Failure of the heater to operate due to damage during storage testing shall constitute a test failure.

4.17.11 Vibration. Test heater per MIL-STD-810, Method 514.5, Procedure I – General Vibration – Transportation, Restrained Cargo. Operate the heater prior to the vibration test per the Minimum Run Cycle Test of 4.18. Place the heater in the transportation configuration on the vibration fixture and secure the heater to the fixture using approved tie-down devices. Test the heater per Category 4, Restrained Cargo, Composite Wheeled Vehicle, Annex C – Figure 514.5C-3 for a 40-minute duration per axis. Visually inspect the heater after each axis tested. At the conclusion of the last axis, operate the heater per the Minimum Run Cycle Test of 4.18. Place the heater in the transportation configuration on the vibration fixture and secure the heater to the fixture using approved tie-down devices. Test the heater per Category 4, Restrained Cargo, Two Wheeled Trailer, Annex C – Figure 514.5C-2 for a duration of 32 minute per axis. Visually inspect the heater after each axis tested. At the end of vibration testing operate the heater per the Minimum Run Cycle Test of 4.18. Damage to the heater that affects safe operation or failure of the heater to operate shall constitute test failure.

4.17.12 Shock. Subject a heater with accessories to drop testing IAW MIL-STD-810, Method 516.5, Procedure IV. Visually check all contents of the heater and perform the Minimum Run Cycle Test of 4.18 prior to the drop test. Suspend the heater in the transportation configuration by a drop hook such that the desired bottom corner is 24 inches from the impact surface. The drop hook shall be triggered allowing the heater to fall freely to the drop surface. See Table 516.5-VI Transit drop test, Note B. The drop surface shall be a 2-inch thick plywood surface backed by concrete. Drop on each bottom corner for a total of four drops. Drop straight down (base of heater shall be horizontal) for a fifth drop. Upon completion of the drop testing, perform a visual check of all heater components and a functional check of the heater per the Minimum Run Cycle Test 4.18. Any component damage, which prevents the heater from operating after drop testing, or any damage on the heater or accessories, which may lead to unsafe operation, shall constitute a failure.

4.18 Minimum run cycle. Operate the heater for a sufficient amount of time to verify that the heater exhibits battery “Charged” on the remote display. Measure and record fuel flow rate, indicated BTU output, smoke number, combustion efficiency, excess air, CO2, and flue temperature.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or purchase order (see 6.2). When actual packaging of material is to be performed by DOD personnel, these personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the

Military Departments System Command. Packaging data retrieval is available from the managing Military Departments or Defense Agency's automated packaging files, CD-ROM products, or by contracting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory)

6.1 Intended use. The SHC 90K is military unique in that it is required to circulate heated air without external electrical power, operate on logistical fuels, interface with military tents and shelters, and operate down to –60°F. There are no commercial items that can satisfy these requirements. The SHC 90K with accessories is intended to heat personnel and equipment housed in the TEMPER, GP tents and MGPTS shelters. It provides approximately 90 KBTU of circulated heated air without the use of external electrical power.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.
b. Operators manual requirements
c. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.3).
d. When a first article is required (see 3.1.).
e. Color of heater required (see 3.13.3).
f.. When tent wall modification kit is required (see 3.11.6)
g.. Sampling plan size for first article and conformance test (see 4.1.1 and 4.1.2).
h. End item examination requirements
i. Packaging requirements (see 5.1).
j. Wheel requirements (see 3.11.4.5)

6.3 Subject term (key word) listing.

Multi-fuel
Tent heating

6.4 Color or SHC. Colors approximating the following color chip number of FED-STD-595 have been used to satisfy the requirement of 3.4.18:

Color required	Color chip No.
Green 383	34094
Tan 686	33446
White (aircraft)	37875

6.5 Corrosion preventive paint. The use of MIL-P-53022 or MIL-P-53030 as a first coat, then top coating all surfaces with a Chemical Agent Resisting Coating (CARC) conforming to MIL-C-46168 or MIL-C-53039 has been found to satisfy the requirement of 3.13.3.

6.6 Technical manuals. The requirement for technical manuals should be considered when this specification is applied on a contract. If technical manuals are required, specifications and

standards that have been cleared and listed in DoD 5010.12-L, Acquisition Management Systems and Data Requirements Control List (AMSDL) must be listed on a separate Contract Data Requirements List (DD Form 1423), which is included as an exhibit to the contract. The technical manuals must be acquired under separate contract line item in the contract.

6.7 Verification alternatives. Contracting documents should provide guidance to offerers regarding the submission of alternatives to specified verification methods.

6.8 First article. When requiring a first article, contracting documents should provide specific guidance to offerers. This guidance should cover whether the first article is a first article sample, a first production item, or the number of test items. These documents should also include specific instructions regarding arrangements for examinations, approval of first article results, and disposition of first articles. Pre-solicitation documents should provide government waiver rights for first article inspection to bidders offering a previously acquired or tested product. Bidders offering such products that wish to rely on previous testing must furnish evidence with the bid that prior government approval is appropriate for the pending contract.

6.9 Conformance inspection. During acquisition, contracting documents should indicate the designated frequency of conformance tests listed in Table II based on risk assessment for the procurement. Some of these risk factors include contractor past performance, government schedules and budget, product material and design maturity, manufacturing equipment and processes applied, labor skill and training, and uniformity of measuring processes and techniques.

APPENDIX A
ASHRAE Performance Test Procedure

A.1 SCOPE

A.1.1 Scope. This appendix details the ASHRAE procedures for air discharge rate, heating capacity, and measured efficiency; and is a mandatory part of this specification.

A.2 APPLICABLE DOCUMENTS.

AMERICAN SOCIETY OF HEATING, REFRIGERATION
AND
AIR CONDITIONING ENGINEERS (ASHRAE)

ASHRAE 41 - Standard Method for Temperature Measurement

(Application for copies should be addressed to American Society of Heating, Refrigeration and Air Conditioning Engineers, 1791 Tullie Circle N.E., Atlanta, GA 30329. The web address is http://www.ashrae.org .)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ASME PTC 19.5 - Application, Part II of Fluid Meters

(Application for copies should be addressed to American Society of Mechanical Engineers, Information Central Orders/Inquiries, P.O. Box 2300, Fairfield, NJ 07007-2300. The web address is http://www.asme.org .)

A.3 PROCEDURE

A.3.1 Air discharge rate.

a. Assemble test setup in accordance with ASHRAE Standard 51. The test chamber shall be insulated so that the calculated heat leakage through the walls of the chamber does not exceed 2% of the capacity of the tested heater.

b. Test heater in both high and low fire rates.

c. The heater under test shall be operated until equilibrium conditions are attained before test data are recorded.

d. Measure the air flow and pressure flow losses in accordance with ASHRAE 51 or ASME PTC 19.5.

e. Measure barometric pressure and temperatures in accordance with ASHRAE 51 and ASHRAE 41.

f. Measure the fuel flow rate.

g. Calculate the air discharge rate (CFM) in accordance with section 9 of ASHRAE Standard 51.

A.3.2 Heating capacity.

a. Use the same setup, data and calculations recorded in A.3.1.

b. Test results shall be corrected to standard conditions using the following properties.

Density	=	0.075 lb. per cubic foot [lbs/ft^3]
Pressure	=	29.92 inches of Mercury [in. Hg]
Temperature	=	68 ^oF

c. Calculate the heating capacity using the following equation:

Heating capacity (BTU/Hr) = 60 x Q x d x C_p x (t_{out} - t_{in})

Q = Air discharge rate [SCFM]

d = 0.075 [lbm/ft^3]. Density of air at standard conditions.

C_p = 0.240 [BTU/lbm dry air-^oF]. Average specific heat of the ventilating air from temperature rise across heater

(t_{out} - t_{in}) = Air temperature rise across heater [^oF]

A.3.3 Measured efficiency.

a. Use the same setup, data, and calculations as recorded in A.3.1 and A.3.2.

b. Calculate an equivalent heat input value (BTU/Hr) based on the energy content of the fuel (from the fuel certification) and the measured flow rate.

c. Calculate the measured efficiency using the following equation:

Measured efficiency (%) = (H / Equivalent heat input) x 100

where H = Heating capacity (BTU/Hr)

APPENDIX B
Indicated Performance Test Procedures

B.1 SCOPE

B.1.1 Scope. This appendix details the procedures for measuring indicated air discharge rate, indicated heating capacity and indicated efficiency, and is a mandatory part of this specification.

B.2 PROCEDURE

B.2.1 Air discharge rate.

a. Test heater in the outside tent configuration, and at high and low firing rates.

b. The heater under test shall be operated until equilibrium conditions are attained before test data are recorded.

c. Measure the air discharge flow speed using a portable vane anemometer and calculate the air discharge rate (CFM), remove any finger guards prior to testing with air ducts. Ambient airflow into the heater shall be 40 to 60 degrees F.

B.2.2 Indicated efficiency.

a. Measure indicated efficiency with a Bacharach Fyrite test kit, P/N 10-5000, Kane-May Ltd. combustion analyzer Model 9003, or equivalent equipment following manufacturer's instructions.

b. Exhaust samples shall be taken no farther than 10 inches from where the exhaust exits the heat exchanger.

B.2.3 Heating capacity.

a. Measure fuel flow into the heater.

b. Calculate an equivalent heat input value (BTU/Hr) based on the energy content of the fuel (manufacturer's certification) and the measured flow rate.

c. Calculate the heating capacity using the following equation:
Heat capacity (BTU/Hr) = (Equivalent heat input x Indicated efficiency) / 100

B.2.4 Burner smoke spot test. At the sampling hole, measure the smoke spot using a Bacharach Fyrite test kit, P/N 10-5000, smoke tester or equivalent meeting ASTM D2156, and compare to the smoke spot scale. The heater shall be operating for a minimum of 15 minutes before taking the smoke sample.

Custodians:

Army - GL
Navy - YD
Air Force - 99

Review activities

Army - MD1, QM1
Navy - MC
Air Force - 35, 84
DLA-CC

Preparing activity:

Army - GL

(Project 4520-2012-001)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil .