

INCH - POUND

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PERFORMANCE SPECIFICATION

HEATER, SPACE - RADIANT, NON-POWERED, LIQUID & SOLID FUEL

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

1. SCOPE

1.1 Scope. This specification covers the performance and acceptance requirements for two non-powered, liquid and solid fuel burning, radiant space heaters, and accessories.

1.2 Classification.

Type I - Space Heater Arctic (SHA), 40,000 BTU

Type II - Space Heater Small (SHS), 20,000 BTU

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.

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, U.S. Army Natick Research, Development, and Engineering Center, Natick, MA 01760-5018 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document, or by letter.

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2.2 Government documents. The following documents form a part of this specification 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).

STANDARDS

DEPARTMENT OF DEFENSE

MIL-STD-810 - Environmental Test Methods and Engineering Guidelines

(Unless otherwise indicated, copies of the above standard are available from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094)

3. REQUIREMENTS

3.1 First article. When specified (see 6.2), a sample shall be subjected to a first article inspection in accordance with 4.2.

3.2 Conformance. When specified (see 6.2), a sample shall be subjected to conformance inspection in accordance with 4.3.

3.3 Materials. The contractor shall select the materials used for fabrication, but the materials shall be capable of meeting all the operational and environmental requirements specified herein.

3.4 Performance requirements. For verification of the following performance requirements, see Table III. The heater, accessories, and materials shall be capable of meeting all the performance requirements herein in all specified environments and climatic categories, including basic climate, basic cold, and severe cold. The heater and accessories shall also be capable of meeting all the specified requirements herein prior and subsequent to all dynamic testing, including transportation, and drop.

3.4.1 Operation. The heater shall operate safely with all specified fuels and under all specified conditions herein with no electrical power. There shall be no exposure of flame during any mode of operation. There shall be no pool of raw liquid fuel in the burner area during operation or in the case of accidental flame loss.

3.4.1.1 Ignition. The heaters shall not require any electrical power for ignition. Ignition shall be accomplished safely in ten minutes or less with the use of a match.

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3.4.1.2 Monitoring. The heaters shall incorporate a sight glass or other means for viewing the entire combustion flame during operation. The heaters shall incorporate a captive cover which can be removed and replaced over the viewing area for black out conditions with out the use of tools. The sight glass shall be quickly replaceable (15 minutes or less) using only common hand tools.

3.4.2 Liquid fuel. The heaters shall be safely operated with all of the fuels listed in Table I at the corresponding environmental conditions. Any cold weather fuel shall be operable in the heaters in temperatures up to 60° F or higher without producing a hazardous condition, premature component wear or loss of efficiency.

TABLE I. Compatible Fuels

Ambient Temperature Range	Military Symbol CONUS	National Stock Number (NSN)
Above +25° F	DF-2	9140-00-286-5294
Above +10° F	DF-1	9140-00-286-5286
Above -60° F	JP-8	9130-00-031-5816
Above -60° F	DFA	9140-00-286-5283

3.4.3 Fuel control. The heaters shall have a fuel control that maintains a constant flow rate to the burner from a gravity feed fuel supply by means of a float actuated valve or similar means. The fuel control shall have a metering knob to control flow rate incrementally and shall have seven settings with five settings between low to high. The fuel control shall have a fuel type selector knob (3 positions maximum), if necessary, which allows the operator to accommodate for varying ambient temperatures and for the different fuels listed in table I. The fuel control shall provide sufficient fuel flow to achieve the full range of required heat outputs corresponding to table II. The fuel control shall be permanently labeled to identify settings and corresponding fuel types. The fuel control shall control fuel flow to the burner to eliminate any possibility of an unsafe overfire condition when operated at the proper settings for the prevailing ambient temperatures and fuel types. The fuel control shall control the firing rate in conjunction with the heaters, such that, smoke levels do not exceed a #4 on the Bacharach smoke scale, on any setting between low and six. The fuel control shall have a heat shield if necessary to prevent excessive warming of the valve and consequent changes in the flow rate to the heater.

3.4.3.1 Fuel control on/off switch. A single on/off switch shall be located on the fuel control and shall start and stop fuel flow to the burner.

3.4.3.2 Fuel filter. The filter shall eliminate foreign particles from obstructing fuel flow. The

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filter shall be located within a protected area on the fuel control and shall be located to allow for 15 minute removal, cleaning and installation of filter element using only common hand tools. The filter shall not require the use of a sealer to obtain a leak free fit. The filter housing shall be of a design that shall not break due to freezing of entrapped water. The filter element shall not rust.

3.4.4 Solid fuel operation. The heater shall be capable of solid fuel (wood or coal) operation. Any components required for solid fuel operation (i.e. grate) shall be packable inside the heater body along with all accessories required for liquid fuel operation and shall be included in the overall weight of the heater. Solid fuel operation shall not degrade subsequent heater performance with liquid fuel, no special PMCS shall be required for conversion from solid to liquid fuel aside from ash removal. Firing rate shall be controllable through manual regulation of combustion air. The solid fuel burning area shall allow for placement of at least .35 cubic feet of solid fuel with an opening large enough to accommodate 16 inch long by 4 inch diameter pieces of wood.

3.4.5 Combustion efficiency. The Type I heater shall have a combustion efficiency greater than 50% when operated 30,000 BTU/hr or higher with liquid fuels. The Type II heater shall have a combustion efficiency greater than 50% when operated at 10,000 BTU/hr or higher.

3.4.6 Smoke readings. The smoke reading of the heaters shall not be greater than a No. 4 on the Bacharach smoke scale when the heater is operated between 20,000 BTU/Hr and 40,000 BTU/Hr for the Type I and 8,000-20,000 BTU/hr for the Type II with any fuel listed in Table I.

3.4.7 Heat output. The heaters shall provide the BTU outputs at the corresponding ambient temperatures listed in table II while operating inside a tent.

TABLE II Heat Output Requirements

Ambient temp (F)	Fuel	Output Type I (low, max)	Output Type II (low, max)	Output Type I (high, min)	Output Type II (High, min)
40	DF2	18,000 BTU/Hr	5,000 BTU/Hr	30,000 BTU/Hr	15,000 BTU/Hr
40	JP8	18,000 BTU/Hr	5,000 BTU/Hr	30,000 BTU/Hr	15,000 BTU/Hr
10	DF1,JP8	18,000 BTU/Hr	5,000 BTU/Hr	35,000 BTU/Hr	15,000 BTU/Hr
-25	JP8,DFA	23,000 BTU/Hr	10,000 BTU/Hr	40,000 BTU/Hr	20,000 BTU/Hr
-60	JP8,DFA	23,000 BTU/Hr	10,000 BTU/Hr	40,000 BTU/Hr	20,000 BTU/Hr

3.4.8 Automatic fuel shut off capability. Fuel flow shall stop entering the combustion area during accidental flame loss. Fuel flow shall also not enter the combustion area if a full inverted fuel can is connected to the heater with the fuel control in the on position. At no time shall there

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be a puddle of raw fuel inside the burner area.

3.4.9 Fuel lines and fittings. A gravity feed fuel supply line shall be supplied and shall be easily connected and disconnected to the heater fuel control and gravity feed adapter (NSN 7240-21-911-8834). The gravity feed adapter uses a Parker female hose coupler part number B20-5BP, which the fuel supply line shall mate with. The gravity feed fuel supply line shall not leak fuel when disconnected from the fuel control while connected to a full inverted 5 gallon fuel can. The fuel line from the fuel control to the combustion area shall be easily connected for operation with cold weather gloves. Fuel lines, fittings, and controls shall be sufficiently isolated from the combustion chamber and high heat areas to prevent being adversely affected from heat. Fittings shall not leak and shall be compatible with all fuels and environmental extremes specified herein.

3.4.10 Gaskets and seals. All gaskets, seals, etc., shall be suitable for use with specified fuels under all climatic categories specified herein.

3.4.11 Exhaust pipe. The exhaust pipe shall be nestable to be stowed inside the heater body. Each section shall be permanently numbered sequentially corresponding to order of assembly. The diameter of the exhaust pipe shall be sized to fit through the 5 inch diameter stove pipe opening on the 5 and 10 Man Arctic Tents for the Type I heaters and the Soldier Crew Tent (SCT) for the Type II heaters. The exhaust pipe shall be no higher than 140 inches when assembled onto the Type I heater and no higher than 105 inches on the Type II heater. The exhaust pipe seams shall be permanent and shall not require operator assembly. The heater exhaust gases shall be discharged vertically to exit through the stove pipe opening on the tents. The exhaust pipe shall include a stack cap with guy lines to secure pipe in high winds and to prevent down drafts. The exhaust pipe and stack cap exterior shall have a surface finish that reduces reflective glare.

3.4.12 Tilt during operation. The heater shall operate at 5 degrees tilted in any direction without causing a safety hazard or performance degradation.

3.4.13 Accessories. The heaters shall include the following accessories as required to meet this performance specification: Exhaust pipe assembly, fuel control, plastic gravity feed adapter kit NSN 7240-21-912-7162, fuel can stand NSN 7240-01-318-5222, gravity fuel feed hose, overflow hose, stack cap, solid fuel burning components, manual, and burner cleaning device. All accessories, except the fuel can stand, shall be storable inside each heater body.

3.4.14 Spare parts. The heaters shall include a fuel line mender fitting with clamps and a spare sight glass.

3.5 Physical characteristics.

3.5.1 Weight. The weight of the heater without accessories shall be less than 40 pounds for

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the Type I and less than 20 pounds for the Type II. The heater and all accessories when stowed inside the heater body, shall not exceed 60 pounds for Type I and 38 pounds for Type II.

3.5.2 Volume. The outside dimensions of the heater shall not exceed 3 cubic feet for the Type I and 2 cubic feet for the Type II when in the packed for storage or transport configuration. The overall height of the heater body, excluding exhaust pipe, shall be 19 inches or less for the Type I and 17 inches or less for the Type II.

3.5.3 Fasteners. All external fasteners used shall be captive, limiting loss in snow or dark conditions.

3.5.4 Bottom surface. Both heaters shall have provisions to allow for operation on a snow packed surface without degrading performance or safety. Both heaters shall have provisions to reduce sliding when operated on a packed snow or ice surface and shall have provisions to prevent tearing of fabric tent floors.

3.6 Interface requirements.

3.6.1 Tent interface. The Type I shall be operable inside the 5 and 10 Man Arctic tents (NSN 8340-01-026-6095 and NSN 8340-01-059-4075) and the Type II shall be operable inside the Soldier Crew Tent (SCT) (NSN 8340-01-359-1481). Fuel shall be routed to the heater from outside the tent using the 5 gallon fuel can (NSN 7240-01-337-5269), gravity feed adapter (NSN 7240-21-912-7162), fuel can stand (NSN 7240-01-318-5222) and the gravity feed fuel supply line. The fuel shall be located a minimum of 4 feet from the tent wall. Special consideration shall be given to the heater shape and location of exhaust pipe and controls 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. The exhaust pipe shall be secured by guylines from the stack cap to ground stakes or the sidewalls of the tent.

3.6.2 Operation with the thermo-electric fan. The heater shall accommodate placement of the thermo-electric fan unit (see figure 1 of Appendix B), so that it is positioned to direct air downward. The heater shall have a surface which provides clearance for the fan shroud. An indented area shall be provided for placement of the base of the fan, the area shall be flat to provide sufficient heat transfer to the fan base.

3.7 Reliability/maintainability.

3.7.1 Mean Time Between Essential Function Failure (MTBEFF)/Maintenance Ratio(MR). The heaters shall meet a quantitative reliability requirement MTBEFF of 615 hours. The heater essential functions are heating air sufficient to maintain a minimum 50° F temperature inside a tent having 170 to 220 square feet of floor area (Type I) and 80-120 square feet of floor area (Type II), and circulating heated air in the tent without the use of external power (using the thermo-

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electric fan). 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. The heater maintainability requirement is a total unit, direct support (DS), general support (GS) MR which shall not to exceed 0.0016 maintenance man-hour per operating hour, not including preventive maintenance checks and services (PMCS).

3.7.2 Field serviceability. Periodic cleaning of the fuel control filter element and burner area shall be accomplished within the operational environment by MOS nonspecific personnel wearing anticontact gloves NSN 8415-00-227-1220 within 15 minutes. There shall be no requirement for special tools, liquid sealants or additional materials to remove and replace filter or burner elements for service. The sight glass shall be replaceable within 15 minutes with out the use of special tools. Fielding shall have no impact on the manpower or personnel structure. Spare parts shall be installed for field maintenance to - 60° F.

3.7.3 Common test equipment. There shall be no new system specific test, measurement, and diagnostic equipment, or special tools to repair or maintain the heater. The heater shall be capable of complete disassembly and reassembled using common hand tools.

3.7.4 Preventive maintenance checks and services (PMCS). The heater fuel lines and burner shall be designed in such a manner to allow for operator inspection without disconnection from the tent. A PMCS shall be performed before and after operation and shall not exceed 10 minutes time to accomplish. The minimum PMCS items to be checked during any climatic condition specified in this performance specification during day light or dark using a flash light, shall be secure connections of the gravity fuel supply, fuel lines, snow or ice coverage or blockage of external components, fuel leaks, exhaust obstructions, burner and general condition to permit operation.

3.8 Environmental conditions.

3.8.1 Storage. The heater and accessories shall remain operable and show no signs of impairment due to storage at 155° F for 4 hours daily.

3.8.2 Basic climate operation. The heater and accessories shall be operable in temperatures of +60° F to 0° F. Heat outputs shall be in accordance with Table II.

3.8.3 Basic cold operation. The heater and accessories shall be operable in temperatures of -5 F to -25° F. Heat outputs shall be in accordance with Table II.

3.8.4 Severe cold climate operation. The heater and accessories shall be operable and maintainable in temperatures down to -60° F. Heat outputs shall be in accordance with Table II.

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3.8.5 Severe cold manipulation. The heater shall be compatible with temperatures of -60° F allowing unpacking, set up for operation in the respective tents, and stowage of all accessories within the heater body. Fuel hose and hose couplers shall remain flexible and operational.

3.8.6 High altitude. The heaters shall operate safely at a minimum of 60% rated capacity when operated at altitudes of 10,000 feet above sea level. The heater shall display no signs of backfiring, sputtering or pulsing at high altitude.

3.9 Transportability. The heaters shall be of sufficient durability to be transportable in the High Mobility Multipurpose Wheeled Vehicle (HMMWV), heavy-HMMWV, the Commercial Utility Cargo Vehicle (CUCV), and standard Army cargo trucks (2 1/2 to 5 ton) and all standard Army cargo trailers having a 1/4 to 1 1/2 ton capacity. The heaters shall also be transportable on a fully loaded AKIO sled. Type II heater shall be transportable in armored combat vehicles. The heaters shall also be of sufficient durability to survive an accidental drop from any of the vehicles.

3.10 Identification and marking.

3.10.1 Labels/tags. The heaters shall have an instruction plate permanently attached in an immediately obvious location which provides warnings, start up and shut down procedures, operating procedures, and safety cautions. The fuel control and heater lettering shall be permanent for the life of the item. Controls shall not obscure labels. Labels shall be located in a consistent manner throughout the system. Labels shall be printed in capitals. All letters shall be black except for when using a black background the letters shall be white. Letter size and width shall be sufficient to be easily read from a distance of six feet in day light or with the aid of a flashlight. Access panels if used shall be labeled identifying the component protected inside. If the Type I weighs more than 35 lbs it shall be labeled TWO PERSON LIFT.

3.11 Interchangeability.

3.11.1 Replacement parts. All replacement parts shall be physically interchangeable without the need for special modification or loss of performance. Parts shall be interchangeable on all production buys under the same contract. All replacement parts shall meet the requirements specified within this performance specification. Where possible replacement parts shall be interchangeable through use of standard fastening and mounting hardware requiring no special tools.

3.12 Safety.

3.12.1 Operational safety. The heater and its components shall perform in all modes of operation in a safe manner. All equipment shall include fail safe features for safety of personnel

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during installation, operation, maintenance, and repair activities. The heater configuration shall eliminate the possibility of improper assembly of components (i.e. burner assembly, fuel control) which may lead to a hazardous condition.

3.12.2 Breathable air. Products of combustion shall remain separated from the breathable heated air. Heated air inside the 5 and 10 Man Arctic tents and Soldier Crew Tent shall be within the American Conference of Governmental Hygienists (ACGIH) 8-hour Threshold Limit Values-Time Weighted Average (TLV-TWA) for carbon dioxide, nitrogen dioxide, carbon monoxide, formaldehyde and ammonia.

3.12.3 Sharp edges. Non-functional sharp edges and projections shall be eliminated.

3.12.4 Noise. Noise levels, as measured from 3 feet from the heater, shall not exceed 60 db.

3.13 Human factors engineering

3.13.1 Lifting. The heaters shall be transportable by two people wearing cold weather gear.

3.13.2 Personnel clothing. The heaters shall be easily operated by personnel attired in clothing appropriate for all intended user environments.

3.13.3 Set up. The heater shall be capable of being assembled for operation in 20 minutes or less, and disassembled and repacked for storage by two people in 15 minutes or less in any climatic category specified herein.

4. VERIFICATION

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

- a. First article inspection (see 4.2).
- b. Conformance inspection (see 4.3).

4.2 First article inspection. When a first article inspection is required (see 3.1 and 6.2), the heater shall undergo the tests and examinations outlined in Table III. Sampling for first article inspection shall be as specified in the contract or purchase order.

4.3 Conformance inspection. Conformance inspections shall be conducted according to the tests specified in Table III. Sampling for conformance inspection shall be as specified in the contract or purchase order (see 3.3 and 6.2).

4.3.1 End item examination. Each heater shall be examined for the requirements specified in

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table III. 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. This element of inspection shall encompass all visual examination and dimensional measurements. Non-compliance with any specified requirement, absence of components, or presence of one or more defects shall constitute cause for rejection.

4.3.2 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.

4.3.3 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.

TABLE III Requirement and Verification Outline

Requirement	Requirement paragraph	Verification paragraph	First article inspection	Conformance inspection	End item examination
Operation	3.4.1	4.4.1	X	X	
Ignition	3.4.1.1	4.4.1.1	X	X	
Monitoring	3.4.1.2	4.4.1.2	X	X	
Liquid fuel	3.4.2	4.4.2	X	X	
Fuel control	3.4.3	4.4.3	X	X	
On/Off switch	3.4.3.1	4.4.3.1	X	X	
Fuel filter	3.4.3.2	4.4.3.2	X	X	
Solid fuel operation	3.4.4	4.4.4	X		
Combustion efficiency	3.4.5	4.4.5	X		
Smoke readings	3.4.6	4.4.6	X		
Heat output	3.4.7	4.4.7	X		
Automatic shut-off capability	3.4.8	4.4.8	X		
Fuel lines	3.4.9	4.4.9	X		
Gaskets and seals	3.4.10	4.4.10	X	X	
Exhaust pipe	3.4.11	4.4.11	X	X	
Tilt during operation	3.4.12	4.4.12	X		
Accessories	3.4.13	4.4.13	X	X	X
Spare parts	3.4.14	4.4.14	X		X
Weight	3.5.1	4.5.1	X	X	
Volume	3.5.2	4.5.2	X	X	
Fasteners	3.5.3	4.5.3	X	X	
Bottom surface	3.5.4	4.5.4	X	X	X
Tent interface	3.6.1	4.6.1	X		
Operation with thermo-electric fan	3.6.2	4.6.2	X		
MTBEFF/MR	3.7.1	4.7.1	X		
Field serviceability	3.7.2	4.7.2	X		
Common test equipment	3.7.3	4.7.3	X	X	

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PMCS	3.7.4	4.7.4	X		
Operator/maintenance manual	3.7.5	4.7.5	X	X	X
Storage	3.8.1	4.8.1	X		
Basic climate operation	3.8.2	4.8.2	X		
Basic cold operation	3.8.3	4.8.3	X	X	
Severe cold climate operation	3.8.4	4.8.4	X		
Severe cold manipulation	3.8.5	4.8.5	X		
Transportability	3.9	4.9	X		
Loose cargo		4.9.1	X		
Drop		4.9.2	X		
Labels/tags	3.10.1	4.10.1	X	X	
Replacement parts	3.11.1	4.11.1	X		
Operational safety	3.12.1	4.12.1	X	X	
Breathable air	3.12.2	4.12.2	X	X	
Sharp edges/moving parts	3.12.3	4.12.3	X	X	X
Noise	3.12.4	4.12.4	X	X	
Lifting	3.13.1	4.13.1	X		
Personnel clothing	3.13.2	4.13.2	X		
Set up	3.13.3	4.13.3	X		

4.4 Tests and examinations.

4.4.1 Operation. Verify safe operation during all performance and reliability testing specified herein. Any use of electrical power, failure to operate with specified fuels, exposure of flame or exposure of raw fuel shall constitute a failure.

4.4.1.1 Ignition. Observe heater on start. Failure to start using a match as an ignition source, and failure of the heater to be operating within specified smoke and efficiency readings within 10 minutes after lighting under any environmental condition specified herein, shall constitute a failure.

4.4.1.2 Monitoring. Observe the heater during operation. Absence of a sight glass shall constitute a failure. Absence of a captive cover for the sightglass shall constitute a failure. Inability to view entire flame through the sightglass shall constitute a failure. Verify 15 minute removal and replacement during field serviceability 4.7.2.

4.4.2 Liquid fuel. Verify fuel compatibility during environmental climate testing of 4.8.2, 4.8.3, and 4.8.4.

4.4.3 Fuel control. Determine adequacy of the fuel control during environmental climate

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testing of 4.8.2, 4.8.3, and 4.8.4. Operate the heaters at the low setting and at each setting up to and including the HI setting. Measure heat output as outline in Appendix A for each setting. Failure of the flow rate and heat output to incrementally increase shall constitute a test failure. Measure the smoke level per Appendix A at setting 5 and setting 2 during the climatic tests of 4.8.2, 4.8.3, and 4.8.4. Any smoke readings greater than #4 shall constitute a failure. Presence of an unsafe overfire condition during testing as evidenced by black smoke exiting the exhaust stack, pulsing, sputtering or backfiring of the heater or excessive sooting shall constitute a failure. Absence of fuel type labeling with corresponding fuel type settings shall constitute a failure. During test of 4.8.2, measure flow rate to the heater at setting 5 after 1 hour of operation and record. After one more hour of operation at a constant ambient temperature with the tent doors closed and at a fuel control setting of five, measure the flow rate to the heater. An increase greater than 10% over the previous reading shall constitute a failure.

4.4.3.1 Fuel control on/off switch. Connect a buret in-line with the gravity feed fuel supply line. After the heater has been operating for a minimum of 10 minutes, turn the on/off switch to the off position and observe flow rate in the buret. Failure of fuel flow to stop immediately upon activation of the off switch shall constitute a failure.

4.4.3.2 Fuel filter. Observe filter condition after reliability testing. Any rusting of filter or heater shut downs related to particles by-passing the fuel filter shall constitute a failure. Verify 15 minute removal, cleaning and replacement during field serviceability testing 4.7.2.

4.4.4 Solid fuel operation. Visually inspect the heater for solid fuel burning components stored inside heater body along with liquid fuel components. Operate the heater with wood or coal for a minimum of 8 hours. Inability to operate on wood or coal, presence of any hazardous condition due to solid fuel operation or inability to regulate flame through control of combustion air intake shall constitute a failure. Verify the solid fuel burning area meets the wood capacity and dimensional requirements of 3.4.4.

4.4.5 Combustion efficiency. During environmental testing of 4.8.2, 4.8.3 and 4.8.4, after durability testing, every 24 hours during reliability testing, and as required, measure efficiency per procedure outlined in Appendix A. Any readings lower than 50% while the Type I heater is operating at 30,000 BTU/Hr or higher, or when the Type II heater is operating at 10,000 BTU/Hr or higher shall constitute a test failure.

4.4.6 Smoke readings. During environmental testing of 4.8.2, 4.8.3 and 4.8.4, after durability testing, and every 24 hours during reliability testing, measure smoke readings per procedure outlined in Appendix A. Any readings greater than a #4 during any required firing rate shall constitute a failure.

4.4.7 Heat output. See 4.8.2, 4.8.3, and 4.8.4.

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4.4.8 Automatic fuel shut off capability. Configure the heater for operation with a full 5 gallon inverted fuel can and with the on/off switch in the off position. Turn the fuel control to the on position. Any fuel flow entering the combustion area or any puddling of fuel in the burner area shall constitute a failure.

4.4.9 Fuel lines and fittings. During reliability testing per 4.7.1, visually inspect fuel lines every 100 hours and at the end of the test. Any signs of heat damage or degradation shall constitute a test failure. Disconnect gravity feed fuel supply line from the fuel control with a full inverted fuel can attached to the other end, any leakage of fuel from the fuel line shall constitute a failure. Determine that the gravity feed fuel supply line mates with the standard gravity feed adapter during severe cold weather manipulation per 4.8.5 and the fuel source is the standard five gallon fuel can during reliability testing per 4.7.1. Inability of the fuel line to mate with the standard gravity feed adapter and the heater to operate with the standard 5 gallon fuel can as a fuel source shall constitute a failure. Inability of any fuel lines or fittings to provide positive connections with no fuel leakage during any environmental condition specified herein shall constitute a failure.

4.4.10 Gaskets and seals. Visually inspect gaskets and seals during reliability testing per 4.7.1 every 100 hours and at the end of testing. Any signs of degradation or lose of performance shall constitute a test failure.

4.4.11 Exhaust pipe. Inspect heater during operation and verify that the exhaust pipe passes through the opening in the required tent for each heater. Verify that the pipe fits inside the heater body with accessories for transport and storage. Verify the presence of an exhaust pipe cap with guy lines or other means to keep exhaust pipe from blowing off in windy conditions. Verify the exhaust pipe fits properly with no exhaust leaks.

4.4.12 Tilt during operation. Operate the heater. After the heater has stabilized tilt the heater 5 degrees and operate for a minimum of 15 minutes. Failure of the heater to continue normal safe operation shall constitute a failure. Perform this test on all four sides.

4.4.13 Accessories. Inspect for the exhaust pipe and cap, (plastic) gravity feed adapter kit, fuel feed hose, burner cleaning device, overflow hose, fuel control, technical manual, fuel can stand, and solid fuel burning components. Absence of any items required for operation shall constitute a failure. Failure to store all required accessories for solid and liquid fuel operation inside the heater body, except the fuel can stand, shall constitute a failure.

4.4.14 Spare parts. Inspect heater for a captive fuel line mender fitting and clamps and a spare sight glass.

4.5 Physical Characteristics.

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4.5.1 Weight. Weigh the heater without accessories. Any weight readings exceeding the requirements of 3.5.1 shall constitute a failure.

4.5.2 Volume. Measure the outside envelope dimensions of the heater. Any measurements greater than the requirements listed in 3.5.2 shall constitute a failure.

4.5.3 Fasteners. Perform the field serviceability test per 4.7.2. Any non-captive fasteners needed to attach covers or access panels for PMCS or maintenance shall constitute a test failure.

4.5.4 Bottom surface. Inspect bottom of heater for unrounded and sharp edges on feet or corners which may cut into tent floor fabric. Inspect heater for a solid bottom, shield, or other means to protect burner and prevent performance degradation in the event the heater were to sink in snow. Inspect the heater bottom for padded feet, or other means to prevent slippage on a packed snow or ice surface.

4.6 Interface requirements.

4.6.1 Tent interface. Configure the Type I heater in the 10 Man Arctic tent or the 5 Man Arctic tent. Configure the Type II heater in the SCT. Observe the heater while operated in this configuration, any signs of tent fabric damage due to heat shall constitute a failure.

4.6.2 Thermo-electric fan interface. Place the thermo-electric fan on the heater designated location during operation. Failure of the TEF to fit evenly on the heater designated surface and direct heated air downward shall constitute a failure.

4.7 Reliability/maintainability.

4.7.1 MTBEFF/Maintenance ratio. Four heaters shall each be placed on a reliability test for a minimum of 461 hours each for a total of 1844 hours collective. Testing shall be conducted at 30° F or colder and the heaters shall be at a setting to maintain a minimum of 50° F inside the tent. There shall be no more than one chargeable essential function failure (cumulative). Fuel type used for test shall be divided equally among DF-2, JP-8, DF-A. The GFE furnished plastic five gallon can shall be used for the fuel source and refilled as needed. Perform burner smoke spot, during the start and each 100 hour interval (\pm 10 hours) and once during the last start cycle at the conclusion of this test for each unit operated. A maintenance ratio greater than .0016 maintenance man-hour per operating hour for any maintenance other than PMCS shall constitute a test failure.

4.7.2 Field serviceability. Stabilize the heater in accordance with 4.8.2 basic climate, having the heater in an operational configuration. Time the removal of the burner assembly. Inability to remove and replace the burner within 15 minutes shall constitute a test failure. Time the removal and replacement of the fuel control filter. Inability for the operator to remove and replace the fuel filter using only common hand tools in less than 15 minutes shall constitute a failure. Remove and replace

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sight glass, inability to remove and replace sight glass using only common hand tools in less than 15 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 functional check of the heater.

4.7.3 Common test equipment. Inspect the heater and maintenance manual. Any requirement for the use of any special hand tools or test equipment shall constitute a failure.

4.7.4 Preventive maintenance checks and services (PMCS). Configure the heater for 4.6.1 tent operation. Perform a walk around inspection of the heater and tent, verify a secure fuel control connection, the gravity fuel supply for proper connection, fuel leaks, and general operating condition. A thorough examination shall not exceed 10 minutes. No panels or covers shall be removed or opened to gain visual access.

4.8 Environmental conditions.

4.8.1 Storage. Subject one heater to storage testing. Bring chamber air temperature up to 155° F (± 3) and 75% relative humidity (± 5), once these conditions are attained, hold for a 4 hour storage period. Remove the heater and perform functionally check. Failure of the heater to operate due to damage with stained during storage testing shall constitute a test failure.

4.8.2 Basic climate operation. Stabilize climatic chamber ambient air temperature at 40° F (± 2) to operate heater. Cold soak heater, accessories and fuel. Set up heater per 4.6.1. Use fuels specified (see Table II). Perform indicated efficiency, smoke test and heat output test per Appendix A. Failure of the Type I heater to operate at 18 KBTU maximum at the low setting and 30 KBTU minimum at the high setting within acceptable smoke and efficiency levels shall constitute a failure. Failure of the Type II heater to operate at 5 KBTU/Hr maximum at the low setting and 15 KBTU/Hr minimum at the high setting within acceptable smoke and efficiency levels shall constitute a failure.

4.8.3 Basic cold operation. Stabilize climatic chamber air temperature at -25° F (± 2) to operate heater. Cold soak heater, accessories and fuel. Set up per 4.6.1. Use fuels specified (see Table II). Perform indicated efficiency, smoke test and heat output test per Appendix A. Inability of the Type I heater to provide a minimum of 40 KBTU with acceptable smoke and efficiency levels shall constitute a test failure. Inability of the Type II heater to provide a minimum of 20 KBTU within acceptable smoke and efficiency levels shall constitute a failure.

4.8.4 Severe cold climate operation. Stabilize climatic chamber air temperature at -60° F (± 2). Set up heater per 4.6.1. Perform indicated efficiency, smoke test and heat output test per Appendix A. Use fuels specified (see Table II). Inability of the Type I heater to provide a minimum of 40 KBTU within acceptable smoke and efficiency levels shall constitute a test failure. Inability of the Type II heater to provide a minimum of 20 KBTU within acceptable smoke and efficiency levels

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shall constitute a failure.

4.8.5 Severe cold manipulation. Perform a severe cold manipulation and component replacement test. Cold soak the heater and accessories to -60° F for a minimum of 4 hours. After component temperature stabilization unpack the heater, connect all fuel lines and set up for operation. Repack all components inside the heater body. Perform this test cycle 3 times. Operate heater at -60° F. Any evidence of damage to fuel lines, fittings, components and accessories or any inability to manipulate components while wearing the appropriate cold weather clothing shall constitute a test failure.

4.8.6 High altitude. Provide a field site which is 10,000 feet Above Sea Level (ASL) minimum or simulate conditions at 10,000 feet ASL for operational checkouts. Operate heater for a minimum of one hour. Perform smoke spot per Appendix A within 10 minutes after starting and again before shut down. Perform indicated efficiency test per Appendix A and measure fuel flow. Heat output less than 60% rated capacity, unacceptable smoke readings, heater pulsing, or sputtering, shall constitute a failure.

4.9 Transportability. Assess the ability to be carried by the required vehicles by inspection of the maximum dimensions of the heater and accessories with vehicle cargo storage area dimensions. Inability to transport the heaters and accessories with any of the vehicles listed in 3.9 shall constitute a failure.

4.9.1 Loose Cargo Test. The heater shall be subject to loose cargo testing IAW the requirements and conditions set forth in MIL-STD-810, Method 514.4, Category 3, Procedure III.

(1) Visually check all contents and functionally check the heater.

(2) Place the heater on a tester using fences and a plywood bed configured IAW MIL-STD-810. The package tester speed shall be 300 ± 2 RPM. Total test time of 45 minutes shall be divided into the four major loading configurations by stopping the test and rotating the heater 90 degrees and continuing the test as needed.

(3) Upon completion of the 45 minutes of testing, perform a visual and a functional check of the heater and components.

Any component damage which prevents the heater from operating after loose cargo testing or any damage on the heater or accessories which may lead to unsafe operation shall constitute a test failure.

4.9.2 Drop test. The heater shall be subject to drop testing as follows:

(1) Visually check all contents and functionally check the heater.

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(2) Suspend the heater by a drop hook such that the desired edge, corner or face is 24 inches from the impact surface. The drop hook shall be triggered allowing the heater to free fall to the drop surface.

(3) The drop surface shall be a packed dirt surface.

(4) A total of seven drops to the following orientations: each bottom corner, the bottom, fuel inlet side bottom edge.

(5) Upon completion of the drop testing, perform a visual and operational check.

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 test failure.

4.10 Identification and marking.

4.10.1 Labels/tags. Any signs of labels wearing out from normal usage during reliability testing of 4.7.1 shall constitute a test failure. Omission of any of the required labels shall constitute a failure.

4.11 Interchangeability.

4.11.1 Replacement parts. The contractor shall certify that all parts of the heater are interchangeable with like parts of different heater units furnished under the same contract.

4.12 Safety.

4.12.1 Operational safety. Observe test records and performance of all test and inspections within this performance specification. Inspect heater system documentation for adequacy of safety information. Presence of any hazards, injury to personnel or damage to equipment or property resulting from testing shall constitute a failure. Evaluate assembly and installation of heater components for potential hazards, presence of any possible misalignment of components which could occur during assembly (i.e. improperly mounted fuel control) shall constitute a failure.

4.12.2 Breathable air. Test for, at a minimum, carbon dioxide, carbon monoxide, ammonia, nitrogen dioxide and formaldehyde while the heater is set up in the tent per 3.6.1. The heaters shall operate for a minimum of 8 hours in each tent and all doors shall be closed during testing with no one entering the tent during the test. Any readings above the TLV-TWA as established by the ACGIH shall constitute a failure.

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4.12.3 Sharp edges. Visually inspect the heater. Presence of any non-functional sharp edges shall constitute a failure.

4.12.4 Noise. Operate the heater at the high fire rate. Measure sound levels at a 3 foot distance around the outside of the heater on four sides and the top. Any readings in excess of 60 db shall constitute a failure.

4.13 Human factors engineering.

4.13.1 Lifting. Verify the Type I heater can be lifted and moved by two 80th percentile soldiers a distance of 100 feet and lifted to a height of 60 inches. Verify the Type I heater can be lifted and moved by one 80th percentile soldier a distance of 100 feet and lifted to a height of 60 inches.

4.13.2 Personnel clothing. Verify during test of 4.8.5.

4.13.3 Set up. Configure the Type I heater in the 10 Man Arctic tent or the 5 Man Arctic tent. Configure the Type II heater in the SCT. Set up shall be conducted by no more than two people. Unpack and install fuel lines, gravity feed adapter, exhaust pipe and guy lines and tripod with fuel can. Average set up times greater than 20 minutes for each heater shall constitute a failure. Repack each heater for storage. Disassembly times greater than 15 minutes for each heater shall constitute a failure.

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 Type I heater with accessories is intended to heat personnel and equipment housed in the 5 and 10 Man Arctic tents and similarly sized shelters. The Type II heater with accessories is intended to heat personnel and equipment housed in the Soldier Crew Tent and similarly sized shelters. The heaters provide radiant heat and circulated heated air with the use of the thermo-electric fan with out the use of external electrical power. The heaters can be safely operated

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on the following fuels: DF-1, DF-2, DF-A, and JP-8 and wood and coal.

6.2 Acquisition requirements. Acquisition documents should specify the following:

- a. Title, number, and date of this specification.
- b. Issue of DoDISS to be cited in the solicitation, and if required, the specific issue of individual documents referenced (see 2.2).
- c. When a first article is required (see 3.1.).
- d. Sampling plan for first article and conformance test (see 4.2 and 4.3).
- e. Packaging requirements (see 5.1).

6.3 Subject term (key word) listing.

Tent heating
Diesel, JP-8, Wood, Coal

6.4 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 should be acquired under separate contract line item in the contract.

6.5 Verification alternatives. Contracting documents should provide guidance to offerors regarding the submission of alternatives to specified verification methods (see 4.3.3).

6.6 First article. When requiring a first article, contracting documents should provide specific guidance to offerors. This guidance should cover whether the first article is a first article sample, a first production item, and 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 who wish to rely on previous testing must furnish evidence with the bid that prior government approval is appropriate for the pending contract.

6.7 Recycled, recovered or environmentally preferable materials. Recycled, recovered or environmentally preferable materials should be used to the maximum extent possible, provided the materials meet or exceed the operational, environmental and maintenance requirements specified herein and promote economically advantageous life cycle costs.

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Custodians:

Army - GL
Navy - YD1
Air Force - 99

Preparing activity:

Army - GL

Review activities

Army - MD1, QM1
Navy - MC
Air Force - 84
DLA-CS

(Project 4520-0399)

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APPENDIX A Performance Test Procedures

A.1 SCOPE

A.1.1 Scope. This appendix details the performance testing procedures for measuring indicated combustion efficiency, heat output, and burner smoke spot; and is a mandatory part of this specification.

A.2 PROCEDURE

A.2.1 Heater test set up. For all performance testing, the following minimum conditions apply:

a. The heater shall be set up in the normal operating configuration with the correct length of exhaust pipe and on a level surface inside the proper tent.

b. A sampling hole (approximately 1/4" dia) shall be drilled in the exhaust pipe below the point where the exhaust pipe exits the tent roof. The draft shall be natural with out the use of any mechanical draft inducer.

c. Connect a 100ml buret in-line with the fuel supply line to measure fuel flow. An Alltech Associates, Inc. 100cc flowmeter stock # 4045 or equal is sufficient for this test.

A.2.2 Combustion efficiency test. The heaters shall be operated for a minimum of 15 minutes at the required setting before taking readings. The following readings shall be taken consecutively within five minutes:

a. Measure flue gas temperature at the sampling hole, a thermometer capable of measuring up to 1300 F shall be used.

b. Measure air temperature immediately around the combustion air intake area of the heater.

c. Measure the CO₂ % from the sampling hole using a Bacharach CO₂ indicator, Part No. 11-7032.

Use the following formula for determining the combustion efficiency:

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$$E = 1 - \frac{3171 + 2.69T_s + \frac{216.2 + .77}{CO_2}(T_s - T_i) - 5.38T_i}{HHV}$$

E = Combustion efficiency (%/100)

TS = Stack temperature (Degrees C)

TI = Combustion air inlet temperature (Degrees C)

CO₂ = Carbon dioxide (%)

HHV = High heat value (joules/gram) (from fuel certification)

A.2.3 Heat output.

$$\text{Heat output (BTU/Hr)} = F \times P \times (\text{HHV}/1055) \times E \times 60$$

F = Fuel flow rate (ml/min)

P = Fuel density (gm/ml) (DF-2 = .852 gm/ml)

HHV = High heat value (DF-2 = 45166 joule/gram)

E = Combustion efficiency (from A.2.2)

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

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APPENDIX B
Figures

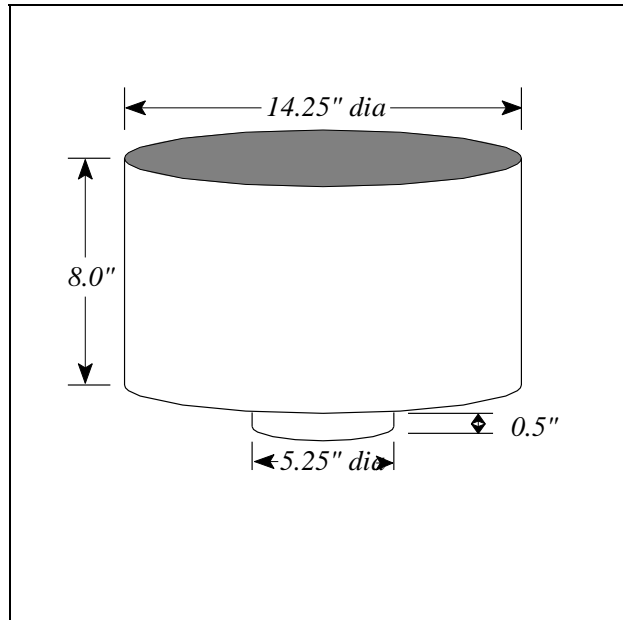


Figure 1. Thermo-Electric Fan (TEF)

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INSTRUCTIONS

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2. The submitter of this form must complete blocks 4, 5, 6, and 7.
3. The preparing activity must provide a reply within 30 days from receipt of the form.

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I RECOMMEND A CHANGE:

1. DOCUMENT NUMBER
MIL-PRF-44494

2. DOCUMENT DATE (YYMMDD)
970205

3. DOCUMENT TITLE HEATER, SPACE - RADIANT, NON-POWERED, LIQUID AND SOLID FUEL

4. NATURE OF CHANGE *(Identify paragraph number and include proposed rewrite, if possible. Attach extra sheets as needed.)*

5. REASON FOR RECOMMENDATION

6. SUBMITTER

a. NAME *(Last, First, Middle Initial)*

b. ORGANIZATION

c. ADDRESS *(Include Zip Code)*

d. TELEPHONE *(Include Area Code)*
(1) Commercial
(2) AUTOVON
(if applicable)

7. DATE SUBMITTED
(YYMMDD)

8. PREPARING ACTIVITY

a. NAME

U.S. ARMY NATICK RD&E CENTER

b. TELEPHONE *Include Area Code)*

(1) Commercial
508-233-5175

(2) AUTOVON
256-5175

c. ADDRESS *(Include Zip Code)*

COMMANDER, U.S. ARMY NATICK RD&E CENTER
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Natick, MA 01760-5018

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5203 Leesburg Pike, Suite 1403, Falls Church, VA 22401-3466
Telephone (703) 756-2340 AUTOVON 289-2340