MIL-C-45596B
28 October, 1983
SUPERSEDING
MIL-C-45596A
30 March 1973

MILITARY SPECIFICATION

CLEANING SYSTEM, SONIC ENERGY

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

1. SCOPE

1.1 Scope. This specification covers a sonic energy cleaning system incorporating cleaning, rinsing, and drying facilities for use with aqueous detergent solutions.

2. APPLICABLE DOCUMENTS

* 2.1 Government documents.

* 2.1.1 Specifications, standards, and handbooks. Unless otherwise specified, the following specifications, standards, and handbooks of the issue listed in that issue of the Department of Defense Index of Specifications and Standards (DODISS) specified in the solicitation form a part of this specification to the extent specified herein.

SPECIFICATIONS

FEDERAL

O-A-548	- Antifreeze/Coolant, Engine, Ethylene Glycol, Inhibited, Concentrated
CC-M-1807	- Motor, Alternating Current, Fractional and Integral Horsepower (500 HP and Smaller)
TT-P-636	- Primer Coating, Alkyd, Wood and Ferrous Metal
PPP-B-636	- Box, Shipping, Fiberboard
PPP-C-843	- Cushioning Material, Cellulosic
PPP-T-60	- Tape, Packaging, Waterproof

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Commander, US Army Armament, Munitions and Chemical Command, ATTN: DRSMC-LEE-S (R), Rock Island, IL 61299 by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

FSC 4940

MILITARY

MIL-P-116 - Preservation, Methods of
MIL-P-130 - Paper, Wrapping, Laminated and Creped
MIL-T-152 - Treatment, Moisture and Fungus Resistant, Of Communications, Electronic, and Associated Electrical Equipment
MIL-T-152 - Treatment, Moisture and Fungus Resistant, of Communications, Electronic, and Associated Electrical Equipment
MIL-H-775 - Hose, Hose Assemblies; Rubber, Plastic, Fabric, or Metal (Including Tubing, Fittings, Nozzles, and Strainers): Packaging of
MIL-E-16298 - Electric Machines Having Rotating Parts and Associated Repair Parts: Packaging Of
MIL-I-24092 - Insulating Varnish, Electrical, Impregnating, Solvent Containing
MIL-C-52950 - Crate, Wood, Open and Covered

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards For Federal Services

MILITARY

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-129 - Marking for Shipment and Storage
MIL-STD-130 - Identification Marking of US Military Property
MIL-STD-889 - Dissimilar Metals
MIL-STD-1186 - Cushioning, Anchoring, Bracing, Blocking, and Waterproofing; With Appropriate Test Methods

2.1.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein.

Publications

FCC TITLE47 - Part 18 Industrial, Medical, and Heating Equipment

(Copies of specifications, standards, handbooks, drawings, and publications required by manufacturers in connection with specific acquisition functions should be obtained from the contracting activity or as directed by the contracting officer.)

2.2 Other publications. The following document(s) form a part of this specification to the extent specified herein. The issues of the documents which are indicated as DOD adopted shall be the issue listed in the current DODISS and the supplement thereto, if applicable.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

Electrical Standards

(Application for copies should be addressed to the National Electrical Manufacturer's Association, 155 East 44th Street, New York, NY 10017.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D3951-82 - Standard Practice for Commercial Packaging

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.)

(Industry association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.)

* 2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein, the text of this specification shall take precedence.

3. REQUIREMENTS

* 3.1 First article. When specified (see 6.2), the contractor shall furnish one complete sonic energy cleaning system for first article inspection. The first article may be either a preproduction model or an initial production item which conforms to the requirements of this specification. In either case, the approved first article and the production items shall be identical and in accordance with the terms of the contract. Approval of the first article shall not relieve the contractor of the responsibility to furnish equipment in accordance with the requirements of this specification.

* 3.2 Design. The system shall be a complete sonic energy cleaning system consisting of: an electronic generator and cleaner, a rinser, and a dryer. All electrical and mechanical parts necessary to produce a system meeting the requirements specified shall be housed within a single cabinet or cabinets, not exceeding three cabinet units. All electrical and mechanical parts shall be accessible from the front of the cabinet or cabinets, for adjustments, repair, or replacement. In no event shall any part be used where the requirements exceed the component manufactures rating for that part.

* 3.2.1 Maintainability. The equipment shall be designed so that one repair technician shall be able to repair the cleaning system in no more than 2.5 hours.

* 3.2.2 Electrical power requirements. Unless otherwise specified (see 6.2), the cleaning system shall operate from a 230 volt $\pm$ ten percent, single phase, 60 hertz (Hz) electrical power source.

3.2.3 Safety provisions. The cleaning system shall be provided with safety devices for all parts that could present safety hazards. Protection against electric shock shall be incorporated. All front access panels and doors shall be

furnished with electrical interlocks to remove power from the cabinets while panels or doors are open. When required (see 6.2), special safety devices shall be as specified by the procuring activity.

* 3.2.4 Lubrication. All bearings (except sealed-for-life type), mating gears, and sliding parts shall be provided with standard means for lubrication. Oil holes, grease fittings, and filler caps shall be accessible. Lubrication reservoirs, if applicable, shall have means for checking levels.

* 3.2.5 Interchangeability. All replaceable parts shall be designed and manufactured to such standards as shall permit replacement and adjustment without the need for modification of the parts or the cleaning system.

* 3.2.6 Threads. All threads shall conform to FED-STD-H28 and the applicable Detailed Standard section referenced therein.

* 3.2.7 Anti-siphon provisions. Incoming water lines shall have adequate anti-siphon provisions to prevent water supply contamination.

* 3.3 Material. Materials not specifically designated herein or in the contract shall be of a quality commensurate with commercial practice within the producing industry. When dissimilar metals are used in contact with each other, suitable protection against galvanic corrosion shall be applied in accordance with MIL-STD-889.

* 3.3.1 Reclaimed materials. The contractor is encouraged to use reclaimed materials for fabricating new parts without jeopardizing the chemical and physical properties, design integrity, and intent of the materials originally selected or specified. The reclaimed materials shall have been reprocessed, remanufactured, or recycled in a manner that shall restore them to the same chemical composition and physical properties as the materials originally selected for use. It shall not be permissible to use reclaimed parts as is, or rebuilt from scrap or other used equipment.

* 3.4 Construction. The cleaning system shall be complete so that, when installed, it can be used for all operations specified herein. All surfaces of all parts shall be cleaned and free of extraneous materials. External surfaces shall be smooth and free of sharp edges. All bolts, pins, screws, and similar locking parts shall be installed with means to prevent loss of tightness. All parts subject to removal or adjustment shall not be permanently deformed.

* 3.4.1 Castings and forgings. Castings shall be free from blowholes, porosity, hard spots, shrinkage defects, cracks, and other visible defects. Forgings shall be free from scale, inclusions, cold shuts, mismatching, and other visible defects that could affect structural strength. Physical and chemical properties of the castings and forgings shall be adequate to meet the performance requirements specified herein.

* 3.4.2 Welding, brazing, and soldering. Welding, brazing, and soldering shall be of a quality which shall sustain the performance requirements of the welded, brazed, or soldered part. These operations, however, shall not be employed as repair measures for defective parts.

3.4.3 Electrical construction. Electrical components, including starters, relays, switches, wiring, and their enclosures, shall conform to and be located in accordance with applicable NEMA Electrical Standards, except as specified herein.

* 3.4.3.1 Electrical connections. Connections of conductors and terminal parts shall be of the screw, pressure, or solder type. When soldered connections are used the connections shall be mechanically secured before soldering. In solid state applications, where connections cannot be mechanically secured, the connections shall be soldered to maintain proper electrical continuity. Rosin base fluxes only shall be used in soldering operations. Connections to screw type terminals shall be mechanically secured, with means to prevent loss of tightness.

* 3.5 Performance and product characteristics. The cleaning system, when properly connected to the appropriate water and electrical sources, shall provide complete facilities for sonic energy cleaning, spray and immersion rinsing, and hot air drying. The entire cleaning system shall be capable of continuous operation for at least 520 hours, without damage or malfunction, and with not more than eight percent degradation of cleaning effectiveness. After 520 continuous hours of operation, not more than one hour shall be required for the operator to restore the cleaning system to original effectiveness. The average repair time after 520 continuous hours of operation shall not exceed one hour for each additional 40 hours of operation, with no one repair requiring more than 2.5 hours to complete (see 3.2.1).

3.5.1 Operating temperatures. The cleaning system shall withstand without damage, and shall meet the requirements of 3.5, while being subjected to ambient temperatures of +35° Fahrenheit (F) to +38°F and +115° to +120°F and the temperature range between those limits.

3.5.2 Storage temperatures. The cleaning system shall withstand without damage, and shall meet the requirements of 3.5, when stabilized at a temperature of +70° to +90°F after having been subjected to:

(a) A temperature of -60° to -65°F for a period of 72 hours.
(b) A cycle of temperatures, starting with the cleaning system stabilized at +85° to +95°F, followed by five hours of steady increase to +150° to +155°F, four hours at +150° to +155°F, and five hours of steady decrease to +70° to +90°F.

3.5.3 Humidity conditions. The cleaning system shall withstand without damage and shall meet the requirements of 3.5:

(a) After having been subjected to 20 hours exposure to a relative humidity of 93 to 97 percent at an air temperature of +75° to +77°F, air movement and radiation negligible.
(b) After having been subjected to four hours exposure to a relative humidity of 5 to 10 percent at an air temperature of +100° to +115°F, air movement and radiation negligible.

3.5.4 Circuits. When all wiring of the electrical system is completely installed, there shall be no short circuits or faulty grounds. Each circuit shall be capable of withstanding at least ten percent overvoltage.

* 3.5.5 Federal communications commisson approval (FCC). The cleaning equipment shall be type approved as required by FCC Title 47-Part-18-subpart C, 18.71 to 18.84.

3.6 Details of components.

3.6.1 Cabinets. Cabinets shall be of all metal construction. The exterior, excluding the top and the chamber cover, shall be fabricated of steel of sufficient strength to meet the specified system requirements. The frame and base shall be sufficiently strong and rigid to withstand stresses of normal operation and transportation by fork lift trucks. Each corner of the base shall have a leveling device with not less than one inch of adjustment. The top shall be fabricated of stainless steel having sufficient strength to meet the specified system requirements. The top shall have nondrip edges. All chamber covers shall be of double pan construction of not less than 22 gage stainless steel. Covers shall be hinged at the back, with stainless steel hinges, and shall be furnished with holding devices or shall go far enough past the center of gravity point when in the fully open position to preclude accidental closing. A sufficient number of access panels or doors shall be provided to assure access to all components within the cabinets. A control panel shall be provided on each cabinet for mounting operating controls. All operating controls shall be identified by permanent, legible markings. All cabinets shall be uniform in exterior dimensions which shall not exceed 36 inches by 36 inches by 108 inches for a single cabinet or 36 inches by 36 inches by 36 inches for the three cabinet unit, these dimensions do not include the control panels. A recessed toe space not less than three inches high by three inches deep shall be provided at the bottom of each cabinet. A recessed toe space not less than three inches high by three inches deep shall be provided at the bottom of the front of each cabinet.

3.6.2 Electronic generator and cleaner. The sonic energy electronic generator and cleaner shall be housed within a cabinet. Sonic energy shall be distributed at uniform intensity throughout the cleaning chamber so that cleaning can be accomplished in all areas within the chamber and at all levels. Intensity at all points in any maximum activity layer (on an essentially horizontal plane) shall be such that no point shall be more than five percent below the average intensity in the same maximum activity layer. Cleaning effectiveness shall be such that the cleaner is capable of passing the cleaning effectiveness test of 4.6.6.6. Frequency shall be not less than 18 and not more than 28 kilohertz (kHz). A manually operated electrical power input control, that shall permit operation with the chamber cover in any position, shall be mounted on the control panel. Overcurrent protection shall be provided. All reset controls and fuses shall be mounted in accessible locations on the control panel.

3.6.2.1 Generator. Unless otherwise specified (see 6.2), the generator power output shall not average less than 1,500 watts when connected to a matched transducer load. The generator shall be continuous duty rated. It shall energize the transducers at their design resonant frequency within $\pm$ one kHz. Manual tuning shall not be required to compensate for changes in resonant frequency caused by variations in chamber loading or liquid level. Variations in chamber loading or liquid level shall not cause frequency to shift more than $\pm$ five percent or power output to drop more than ten percent. Means shall be provided to automatically shut off the generator in the event of low liquid level (less than 2.5 inches) in the cleaning chamber.

3.6.2.2 Cleaning chamber. The cleaning chamber shall have unobstructed inside dimensions not less than 25 inches long, 18 inches wide, and 14 inches deep. The chamber shall be constructed of 316 L stainless steel and shall have sufficient strength and rigidity to meet the specified system requirements. Inlet fitting(s) and valve(s) shall be provided for filling the chamber. A drain connection and valve shall be provided for draining the chamber. The inlet and outlet valve controls shall be mounted on the control panel or located on the front exterior of the cabinet. The long axis of the cleaning chamber shall be parallel to the front of the cabinet. The cleaning chamber and the attached transducers shall be capable of withstanding, without breakage, deformation of the outside surface of the chamber bottom, or impairment of function, an impact force equal to that of a five pound solid steel ball dropped a vertical distance of 16 inches to the inside surface of the chamber bottom.

3.6.2.3 Transducers. The transducers shall be securely attached to the outside bottom of the cleaning chamber. They shall be capable of continuous operation at temperatures up to, and including, +255°F. The transducers shall be fabricated, selected, and installed to withstand the impact testing specified herein. They shall have no characteristics which would limit the duty cycle or reduce the operational life or capability of the cleaning system.

*3.6.2.4 Recirculating system. A recirculating system, connected to the cleaning chamber, shall be provided to filter and recirculate the cleaning solution used in the cleaning chamber. It shall be comprised of an electric motor driven pump, a filter, and connective plumbing. The flow rate shall be not less than five gallons per minute (gpm) with a clean filter element installed. Manual control of the recirculating system shall be provided by controls mounted on the control panel. The recirculating pump shall be made inoperative (locked out) if the sonics are activated. Means shall be provided to automatically shut off the recirculating pump and the solution heater in the event of low liquid level (less than 2.5 inches) in the cleaning chamber. All parts of the recirculating system subject to contact with the cleaning solution shall be corrosion resistant or treated to be corrosion resistant.

* 3.6.2.4.1 Pump. The recirculating pump and its drive motor shall be continuous duty rated. The pump drive motor shall be furnished with automatic reset thermal overload protection and shall conform to CC-M-1807, as applicable.

3.6.2.4.2 Filter. The filter and filter element shall not pass particles more than 20 microns in size, and shall permit removal and replacement of the filter element without draining the recirculating system or the cleaning chamber. The filter shall permit the use of standard commercially available filter elements capable of being repeatedly removed, cleaned, and reinstalled. Means shall be provided to automatically shut off the recirculating pump and the cleaning solution heater in the event the filter element becomes clogged. A visual indicator shall be provided to indicate the need for filter element cleaning or replacement.

3.6.2.5 Temperature control. A thermostatically controlled electric heater shall be provided that shall permit the cleaning solution temperature to be adjusted from 100 + 10°F to not less than +200°F. Solution temperature shall be maintained at the thermostat control setting within ±10°F independent of any sonic heating effects. The thermostat control shall be mounted on the control panel.

* 3.6.2.6 Timer. Unless otherwise specified (see 6.2), a 0 to 5 minute minimum range automatic reset timer, graduated in 15 second increments, shall be provided to automatically control cleaning time. It shall be interlocked with a cover actuated switch that shall start the automatic cleaning cycle when the cleaning chamber cover is closed, and shall interrupt the cycle when the cover is opened. A timer by-pass shall be provided to allow operation of the cleaner without timer. The timer shall be mounted on the control panel.

3.6.3 Rinser. A rinser, housed in a cabinet, shall be provided for spray rinsing and immersion rinsing of cleaned parts.

* 3.6.3.1 Spray rinse. The spray rinse shall provide a flow rate of not less than 13 gpm with not more than 40 pound force per square inch gage (psig) water pressure at the inlet connectors to the cabinet (either cleaner, or rinse). The spray pattern shall completely cover the working area of the rinse chamber. A cover actuated valve shall be provided to start the spray rinse when the rinse chamber cover is closed and to interrupt the rinse when the cover is opened. In addition, means shall be provided to start and stop the spray rinse while the cover is closed or opened.

3.6.3.2 Immersion rinse. A control, mounted on the control panel, shall be provided to shut off the spray rinse and to permit the rinser to be used as an immersion rinse. Manual control for filling and draining the rinse chamber shall be provided.

* 3.6.3.3 Rinse chamber. The rinse chamber shall be fabricated of stainless steel. Unobstructed inside dimensions shall be not less than 25 inches long, 18 inches wide, and 14 inches deep. The rinse chamber shall be furnished with standard fittings for connecting to water supply lines, a drain with a removable stainless steel screen strainer, and a drain valve. The drain shall be of sufficient size to accommodate the maximum spray rinse water flow. An overflow drain shall be provided near the top of the chamber. A removable rack, constructed of stainless steel, shall be provided to support a parts basket not less than 1 inch and not more than 2 inches above the chamber bottom. The long axis of the chamber shall be parallel to the front of the cabinet.

3.6.4 Dryer. A hot air drying system for drying cleaned and rinsed parts shall be housed within a cabinet. All intake air shall be filtered through a filter element capable of being removed, cleaned, and reinstalled. A blower shall provide maximum air flow of not less than 300 cubic feet per minute (cfm) through the drying chamber. A thermostatically controlled heater shall permit drying air temperature to be adjusted from ambient to not less than +200°F at rated air flow. Drying air temperature shall be maintained at the thermostat control setting within ±10°F. The thermostat control shall be mounted on the control panel. Means shall be provided to preclude the heater being turned on without the blower in operation and to automatically shut off the heater if the blower fails during operation. The drying air shall be exhausted from the cabinet through a duct on the back of the cabinet. A control to energize and deenergize the blower and heater circuits shall be mounted on the control panel. Overcurrent protection shall be provided. All reset controls and fuses shall be mounted on the control panel.

3.6.4.1 Drying chamber. The drying chamber shall be fabricated of stainless steel, and be not less than 25 inches long, 18 inches wide, and 14 inches deep. The long axis of the drying chamber shall be parallel to the front of the cabinet. A cover actuated switch shall be provided to remove power from the blower and heater while the cover is open.

* 3.6.5 Motors. Electric motors shall be induction squirrel-cage type conforming to CC-M-1807 with class B insulation and continuous duty rating.

* 3.6.6 Parts basket. Unless otherwise specified (see 6.2), three rigidly constructed parts baskets, fabricated of 316 L stainless steel screen wire, shall be provided with each sonic energy cleaning system. Outside length and width of the parts basket shall be 1 to 1.5 inches less than the corresponding inside dimensions (unobstructed) of the smallest chamber. Depth of the parts basket shall be not less than five inches and not more than seven inches.

* 3.7 Fungus control. When specified (see 6.2), electrical components and circuit elements shall be treated for fungus resistance in accordance with type II requirements of MIL-T-152, except that the statement of treatment is not required. Windings of electric motors shall be given two impregnating coats of varnish conforming to the requirements of MIL-I-24092, type M, class 130 through class 220 (manufacturer's option).

* 3.8 Painting. Unless otherwise specified (see 6.2), painting and finishing of the cleaning system shall be in accordance with standard commercial practice provided the following minimum criteria are met or exceeded: all surfaces to be painted shall be clean and be free of all foreign matter detrimental to painting and at least one coat of primer and one coat of enamel, or equivalent, applied.

* 3.9 Identification marking. The cleaning system shall be marked for identification in accordance with MIL-STD-130 and, unless otherwise specified (see 6.2), shall include the National Stock Number.

* 3.10 Workmanship. Standards of workmanship shall assure that the cleaning system shall have the stability and efficient operating characteristics found in standard commercial items and as specified in section 3 herein.

4. QUALITY ASSURANCE PROVISIONS

* 4.1 Responsibility for inspection. Unless otherwise specified in the contract, the contractor is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other facilities suitable for the performance of the inspection requirements specified herein, unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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

(a) First article inspection (see 4.3).
(b) Quality conformance inspection (see 4.4).

* 4.3 First article inspection. First article inspection shall be applied to the preproduction model or initial production item (see 3.1). Unless otherwise specified (see 6.2), first article inspection shall consist of the examination in 4.5 and all tests under 4.6. Failure of the first article to pass the examination or any of the tests shall be cause for rejection.

* 4.4 Quality conformance inspection. Unless otherwise specified (see 6.2), quality conformance inspection shall be applied to production items offered for acceptance under the contract. Unless otherwise specified (see 6.2), quality conformance inspection shall consist of (a) through (i) below. Failure of any unit to pass an examination or test shall be cause for rejection of the unit.

(a) Product examination (see 4.5).
(b) Functional test (see 4.6.1).
(c) Circuit test (see 4.6.5).
(d) Generator test (see 4.6.6.1).
(e) Uniform cavitation intensity test (see 4.6.6.5).
(f) Cleaning efficiency test (see 4.6.6.6).
(g) Rinser test (see 4.6.7).
(h) Air temperature control test (see 4.6.8.2).
(i) Packaging inspection (see 4.7).

* 4.4.1 Sampling. When required (see 6.2), sampling for quality conformance inspection shall be in accordance with MIL-STD-105 at the Inspection Level and Acceptable Quality Level (AQL) specified in the contract. For packaging inspection, special inspection level S-4 and an Acceptable Quality Level (AQL) of 4.0 percent defective shall be used.

4.5 Product examination. Each complete cleaning system shall be visually examined to determine compliance with Section 3 requirements.

4.6 Tests. All instruments used in testing cleaning systems, including watt-meters, and weighing devices, shall be accurate within one percent.

4.6.1 Functional test. The cleaning chamber shall be filled to within 3 to 4 inches of the top with tap water and the generator shall be energized. The liquid in the cleaning chamber shall be observed for cold boiling action (degassing) to indicate presence of sonic energy in the cleaning chamber. Proper operation of all controls, switches, pumps, motors, indicator lights, gages, timers, heaters, blowers, and temperature controls of the cleaning system shall be verified. There shall be no evidence of fractures, loose connections, leaks, or malfunctions in any part of the cleaning system.

4.6.2 Operating temperature tests.

4.6.2.1 High operating temperature test. The cleaning system, after being in an ambient air temperature of +115° to +120°F until stabilized, and while at that temperature, shall be tested in accordance with 4.6.1 (see 3.5.1).

4.6.2.2 Low operating temperature test. The cleaning system, after being in an ambient air temperature of +35° to +38°F until stabilized, and while at that temperature, shall be tested in accordance with 4.6.1 (see 3.5.1).

4.6.3 Storage tests.

4.6.3.1 Low temperature storage test. All liquid shall be removed from the cleaning system, and the unit shall be subjected to a temperature of -60° to -65°F for a period of 72 hours. At the end of this time, the cleaning system shall be removed and allowed to stabilize at an air temperature of +70° to +90°F. The cleaning system shall then be inspected for evidence of damage and tested in accordance with 4.6.1 (see 3.5.2).

4.6.3.2 High temperature storage test. The cleaning system shall be subjected to a cycle of temperatures, starting at +85° to +95°F, followed by five hours of steady increase to +150° to 155°F, four hours at +150° to +155°F, and five hours of steady decrease to +70° to +90°F. The cleaning system shall then be inspected for evidence of damage and tested in accordance with 4.6.1 (see 3.5.2).

4.6.4 Humidity test. The cleaning system shall be subjected to 20 hours exposure at a relative humidity of 93 to 97 percent in an air temperature of +73° to +77°F, air movement and radiation negligible. While at this condition, the cleaning system shall be tested in accordance with 4.6.1 (see 3.5.3). Following the above, the cleaning system shall be subjected to four hours exposure at a relative humidity of 5 to 10 percent, in an air temperature of +110° to +115°F, air movement and radiation negligible. While at this condition, the cleaning system shall be tested in accordance with 4.6.1 (see 3.5.3).

4.6.5 Circuit test. Electrical circuits of the cleaning system shall be tested for electrical continuity, short circuits, and faulty grounds. Each circuit shall withstand an overvoltage of at least ten percent without any evidence of damage or breakdown (see 3.5.4).

4.6.6 Cleaner tests.

4.6.6.1 Generator test. The cleaning chamber shall be filled to within 3 to 4 inches of the top with water. A frequency counter and a wattmeter shall be connected to the output of the sonic energy generator. After a 30 minute warm up period, the frequency and power output of the generator shall be measured and recorded. Maximum average power output shall be as specified in 3.6.2.1. The liquid level shall be reduced by one inch decrements until no more than three inches of liquid remain in the cleaning chamber. Frequency and power output of the generator at each decremental liquid level shall be measured and recorded. The frequency shift shall not exceed $\pm$ five percent and the power output shall not drop more than ten percent. After the foregoing measurements are complete, the liquid level shall be lowered to two inches. The generator shall then automatically shut off (see 3.6.2.1).

4.6.6.2 Recirculation test. The cleaning chamber shall be filled to within 3 to 4 inches of the top with water. A new or cleaned filter element shall be installed. The recirculating system shall be put into operation and the flow rate shall be measured. Flow rate shall be not less than five gpm. The solution heater shall be energized and the liquid flow shall be impeded to simulate a clogged filter element. Automatic shut off of the recirculating pump and the cleaning solution heater shall be verified. Indication of the need for filter element replacement or cleaning shall be apparent (see 3.6.2.4 and 3.6.2.4.2).

4.6.6.3 Temperature control test. With the cleaning chamber filled to within 3 to 4 inches of the top with water and with the recirculating system operating, the cleaning solution heater shall be energized. The thermostat control shall be set at +100°F. The liquid temperature shall be monitored. After the liquid temperature stabilizes, the temperature shall be monitored for one hour to verify that the temperature control shall maintain the liquid temperature at the control setting within ±10°F. This test shall be repeated at thermostat control settings of +140°F and ±200°F. The capability of the heater to raise the temperature of the cleaning solution to at least +200°F shall be verified (see 3.6.2.5).

4.6.6.4 Low liquid level test. With the recirculating pump and the cleaning solution heater operating, the liquid shall be drained from the cleaning chamber. Automatic shut off of the recirculating pump and the cleaning solution heater shall be verified (see 3.6.2.4).

* 4.6.6.5 Uniform cavitation intensity test. A Cavitation Intensity Meter or equivalent test method shall be utilized in this test. The cleaning chamber shall be filled to within 3 to 4 inches of the top with water. The cleaner shall be operated at maximum power for a 30 minute preliminary period. During the preliminary period, the cavitation meter shall be used to explore cavitation intensity in the cleaning chamber along a vertical axis in order to locate the zones of maximum activity. The maximum activity zone (on an essentially horizontal plane) nearest the surface of the liquid shall be located, and the distance of the probe tip from the chamber bottom shall be noted. All measurements in this test shall be made at the same distance from the chamber bottom. At the end of the 30 minute preliminary period, cavitation meter readings shall be taken in accordance with placement of transducers.

4.6.6.6 Cleaning effectiveness test. The following test shall be conducted to evaluate the cleaning effectiveness of the sonic energy cleaner.

Materials required:

(a) Ceramic rings, 12 each, approximate size 1.625 inch outside diameter, 1.125 inch inside diameter, 0.125 inch thick. Each ring shall be indelibly marked with a number for identification.
(b) Graphite rods approximately 3.5 inches long by 0.375 inch in diameter.
(c) Detergent, Swen Sonics DIRL-LUM 603, or equal.
(d) Weighing apparatus, having accuracy within ±0.1 milligram.

Procedure:

(a) The ceramic rings shall be ultrasonically cleaned for a period of five minutes in a water-detergent solution, consisting of two ounces of detergent per gallon of water, heated to +140° ±10°F. The rings shall then be oven-dried for 15 minutes at +200° ±3°F. Each cleaned and dried ring shall be identified, weighed, and the weight recorded.

(b) Each cleaned and dried ring shall be thoroughly coated on both sides, using a graphite rod under at least four pounds of pressure. Remove glaze from the graphite rod after coating each ring, using a 240 emery cloth. The coated rings shall be oven-dried 15 minutes at +200° ±3°F. Each coated and dried ring shall be identified, weighed, and the weight recorded.

(c) The weight of each ring recorded in step (a) and the weight of the same ring recorded in step (b) shall be compared. The difference will be the weight of the graphite coating and shall be so recorded for each ring.

(d) The cleaning chamber shall be filled to within 3 to 4 inches of the top with water-detergent solution, two ounces of detergent per gallon of water. The cleaning chamber heater shall be turned on and sonically activated, degassed 30 minutes, and heated to 140° ±10°F. The coated and dried rings shall be placed uniformly in the parts basket. With the cleaner deactivated, the parts basket containing the coated and dried rings shall be placed in the cleaning chamber so that it rests on the bottom of the chamber. The cleaner shall be activated for one minute, then deactivated. The rings shall be removed from the cleaning chamber, oven-dried 15 minutes at +200°F ±3°F, individually weighed, and the weight recorded for each identified ring.

(e) The weight of each ring recorded in step (a) and the weight of the same ring recorded in step (d) shall be compared. The difference will be the weight of the graphite coating remaining on the ring after one minute of cleaning and shall be so recorded for each ring.

(f) The weight of graphite coating remaining on each ring after one minute of cleaning, recorded in step (e), shall not exceed 50 percent of the graphite coating recorded in step (c).

(g) This test shall be repeated with the rings supported at the 50 percent solution level.

4.6.6.6.1 Loaded cleaning effectiveness test. To indicate cleaning capability under loaded conditions, the cleaning efficiency test in 4.6.6.6 shall be conducted at the 50 percent solution level with 30 pounds of steel or stainless steel blocks approximately one inch by one inch by one to four inches in size evenly distributed over the bottom of the cleaning chamber.

4.6.6.7 Impact test. This test shall be conducted with no liquid in the cleaning chamber. The cleaning chamber shall be subjected to three impact shocks, of the force specified in 3.6.2.2, delivered to the diaphragm to which the transducers are attached. The impacts shall be accomplished by dropping a solid steel ball to the inside surface of the chamber bottom. The cleaning chamber shall evidence no breakage or deformation of the outside surface of the chamber bottom. The transducers shall evidence no breakage, damage, or separation from the cleaning chamber. The cleaning chamber shall be filled to within 3 to 4 inches of the top with cleaning solution and the cleaner tested for cleaning efficiency in accordance with 4.6.6.6. There shall be no reduction in cleaning efficiency.

4.6.7 Rinser test. The rinser shall be connected to a suitable water supply. With 40 psig input water pressure, the spray rinse shall be put into operation. The spray rinse operation shall be observed to verify that the entire working area of the rinsing chamber is covered by the spray. Water flow through the rinser shall be measured. Water flow shall be not less than 13 gpm. Proper operation of the cover actuated valve shall be checked by opening and closing the rinsing chamber cover to verify that the spray rinse cycle is started when the cover is closed and interrupted when the cover is opened. Capability of the rinser to permit starting and stopping the spray rinse with the cover closed and with it open shall be verified (see 3.6.3.1).

4.6.8 Drying tests.

4.6.8.1 Air flow test. A clean filter element shall be installed in the dryer. The blower shall be put into operation, and maximum air flow through the drying chamber shall be measured. Maximum air flow shall be not less than 300 cubic feet per minute (cfm) (see 3.6.4).

4.6.8.2 Air temperature control test. With air flow through the drying chamber at not less than 300 cfm, the thermostat control shall be set at +100°F and air temperature inside the drying chamber shall be monitored. After a five minute warm-up period, air temperature inside the drying chamber shall not deviate from the control setting by more than ±10°F. The test shall be repeated at thermostat control settings of +140°F and +200°F. Failure of the blower shall be simulated and automatic shut-off of the heater shall be verified (see 3.6.4).

4.6.9 Endurance test. The cleaner and the dryer shall be operated continuously for not less than 520 hours. The cleaning chamber shall contain water at operating level throughout the test. Solution temperature shall be maintained at not less than +200°F. Air temperature inside the drying chamber shall be maintained at not less than +200°F with an air flow through the drying chamber of not less than 300 cfm. Upon completion of 520 hours of continuous operation, the dryer shall be examined for evidence of damage or malfunction. The cleaning efficiency test (see 4.6.6.6) of the cleaner shall be repeated, results noted, and compared with the results of the cleaning efficiency test performed earlier. Degradation of cleaning efficiency shall not exceed eight percent (see 3.5).

* 4.6.9.1 Product Performance. At the completion of the endurance test (4.6.9) the system shall be returned to the original effectiveness level 4.6.6.6 within one hour. After 520 hours of continuous operation, the average repair time shall not exceed one hour, and no one repair shall exceed 2.5 hours to complete.

4.7 Packaging inspection. Packaging inspection shall be conducted before and after packaging to determine compliance with the requirements of Section 5.

5. PACKAGING

* 5.1 Disassembly. The cleaning system may be disassembled to the extent necessary to assure that all surfaces requiring a preservative are accessible for processing, to assure minimum cube for packing, and to permit reassembly without special skills or tools. Disassembly, when applicable, shall be as specified in MIL-STD-1186.

* 5.2 Preservation. Preservation shall be Level A or Industrial, as specified (see 6.2).

5.2.1 Level A.

* 5.2.1 Cleaning. Cleaning shall be in accordance with any applicable process of MIL-P-116.

* 5.2.1.2 Drying. Drying shall be in accordance with any applicable procedure of MIL-P-116.

* 5.2.1.3 Preservative application. Unpainted metal surfaces and surfaces exposed by disassembly shall be coated with type P-1 preservative of MIL-P-116. The entire water system shall be flushed with a solution consisting of 40 percent ethylene glycol of O-A-548, type 1, and 60 percent clean water. Interior surfaces of pipes, hoses, tubes, etc. shall be thoroughly drained.

* 5.2.1.4 Openings. Openings, inlets, and outlets shall be provided with means for closure or shall be sealed with type IV tape of PPP-T-60.

* 5.2.1.5 Unit packs. The generator-cleaner, the rinser, and the drier shall be individually unit packed in accordance with method I of MIL-P-116. To protect the finished surfaces of the cabinets, cover the surfaces with paper conforming to MIL-P-130 and secure with tape conforming to PPP-T-60, type optional.

* 5.2.1.5.1 Electrical equipment. Electric motors shall be preserved and packaged in accordance with level A requirements of MIL-E-16298 and the applicable subparagraph(s) for assembled machines. Electric switch boxes shall be sealed, and loose ends of power cords shall be covered with type IV tape of PPP-T-60.

* 5.2.1.5.2 Hose, tubing, and fittings. Hose, tubing, and fittings shall be packaged in accordance with level A requirements of MIL-H-775.

5.2.1.5.3 Drive belts. Drive belts shall be removed from the equipment or released from tension. The faces or grooves of all ferrous metal pulleys shall be coated with a rust-inhibitor primer conforming to TT-P-636. Belts removed from the equipment shall be packaged in accordance with method III of MIL-P-116.

5.2.1.5.4 Control panels. Control panels shall be cushioned to prevent damage to the item or container. Cushioning material shall be in accordance with the requirements of PPP-C-843, type II. Cushioning material shall be secured with type IV tape of PPP-T-60.

* 5.2.1.6 Consolidated packaging. Packaged disassembled components, publications, and accessories shall be cushioned and packaged in one or more containers conforming to type CF, class weather resistant, of PPP-B-636.

* 5.2.2 Industrial. The cleaning systems shall be preserved and packaged as specified in ASTM D3951-82.

* 5.3 Packing. Packing shall be Level A or Industrial, as specified (see 6.2).

5.3.1 Level A. Cleaning systems, including major components and consolidated packages, shall be packed in type V, style B, covered crates of MIL-C-52950. Blocking, bracing, anchoring, and cushioning shall be as specified in the crate specification and in MIL-STD-1186.

* 5.3.2 Industrial. Industrial packing of the cleaning systems shall be as specified in ASTM D3951-82.

* 5.4 Marking. Marking shall be Level A or Industrial, as specified (see 6.2).

* 5.4.1 Level A marking. Level A marking shall be as specified in MIL-STD-129.

* 5.4.2 Industrial marking. Industrial marking shall be as specified in ASTM D3951-82.

6. NOTES.

6.1 Intended use. The sonic energy cleaning system covered by this specification is intended for use in base shops to clean, rinse, and dry components, assemblies, and batches of small parts.

6.2 Acquisition requirements. Acquisition documents should specify the following:

(a) Title, number, and date of this specification.
(b) First article when required (see 3.1).
(c) Electrical power requirements if different (see 3.2.2).
(d) Special safety devices when required (see 3.2.3).
(e) Generator power output if different (see 3.6.2.1).
(f) Timer if different (see 3.6.2.6).
(g) Parts basket if different (see 3.6.6).
(h) Fungus treatment when required (see 3.7).
(i) Painting and finishing if different (see 3.8).
(j) Identification marking if different (see 3.9).
(k) First article inspection if different (see 4.3).
(l) Quality conformance inspection if different (see 4.4).
(m) Sampling when required (see 4.4.1).
(n) Level of preservation, packing, and marking required (see 5.2, 5.3, and 5.4).

6.3 Contract data requirements. Required technical data such as operator's manuals, parts lists, and other instructions for operation and maintenance, as identified on a numbered DD Form 1664, should be specified on a DD Form 1423 incorporated in the contract.

6.4 Safety and health determination. In order that equipment integrated into the user's operational environment will comply with OSHA limitation and control of noise levels, radiation, electromagnetic emissions, noxious vapors, heat, etc., as applicable, specific requirements concerning those points of operations, and other health and safety requirements should be specified by the user.

6.5 Changes from previous issue. The margins of this specification are marked with an asterisk to indicate where changes (additions, modifications, corrections, deletions) from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and suppliers are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the previous issue.

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Air Force - 99

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Army - AV

Preparing activity:

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Project No. 4940-0450

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