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MILITARY SPECIFICATION

MAGNETIC INSPECTION UNITS

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

1. SCOPE

* 1.1 Scope. This specification covers stationary, mobile, and portable equipment suitable for use in the magnetic-particle inspection of items and parts made of magnetic materials.

* 1.2 Classification. The magnetic inspection units shall be of the following types and sizes, as specified (see 6.2).

Type I - (see 6.3)

Type II - Horizontal, wet-method equipment, in which the high-amperage magnetizing current is alternating current (AC) and full-wave rectified current obtained from a 3-phase AC power source.

Type III - Mobile equipment 3000 amperes (amp), 4-wheel, in which the high-amperage magnetizing current is AC and half-wave rectified current obtained from a single-phase AC power source.

Type IV - Portable equipment, 750 amp, in which the high-amperage magnetizing current is AC and half-wave rectified current obtained from single-phase AC power source.

Type V - Mobile equipment, 6000 amp, 4-wheel, in which the high-amperage magnetizing current is AC and full-wave rectified current obtained from a 3-phase AC power source.

* 1.2.1 Sizes. Type II equipment only (based on maximum contact head openings).

26 inches
54 inches
96 inches
144 inches

2. APPLICABLE DOCUMENTS

* 2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of this specification to the extent specified herein.

SPECIFICATIONS

Federal

W-C-596	Connector, Plug, Electrical; Connector, Receptacle, Electrical
QQ-S-766	Steel Plates, Sheets, And Strip-Corrosion Resisting
PPP-B-601	Boxes, Wood, Cleated-Plywood
PPP-B-621	Boxes, Wood, Nailed And Lock-Corner
PPP-B-636	Box, Fiberboard

Military

MIL-C-104	Crates, Wood; Lumber And Plywood Sheathed, Nailed And Bolted
MIL-P-116	Preservation, Methods Of
MIL-D-1000	Drawings, Engineering And Associated Lists
MIL-M-8090	Mobility, Towed Aerospace Ground Equipment, General Requirements For
MIL-L-9909	Light, Ultraviolet, Metals Examining
MIL-C-20696	Cloth, Coated, Nylon, Waterproof

STANDARDS

Military

MIL-STD-129	Marking For Shipment And Storage
MIL-STD-130	Identification Marking Of US Military Property
MIL-STD-1186	Cushioning, Anchoring, Bracing, Blocking, And Waterproofing; With Appropriate Test Methods

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

2.2 Other publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION

NEMA Standard Publications

(Application for copies shall be addressed to National Electrical Manufacturers' Association, 155 East 45th Street, New York NY 10017.)

NATIONAL BOARD OF FIRE UNDERWRITERS' LABORATORIES, INC.

Underwriters Laboratories Standards National Electrical Code

(Copies of publications of the National Board of Fire Underwriters Laboratories, Inc., Standards may be obtained from the Underwriters' Laboratories (upon application), 207 East Ohio Street, Chicago IL 60611; 161 Sixth Avenue, New York NY 10003; 1655 Scott Blvd, Santa Clara CA 95050.)

CONSOLIDATED CLASSIFICATION COMMITTEE

Uniform Freight Classification Rules

(Application for copies of these freight classification rules should be addressed to the Consolidated Classification Committee, 202 Chicago Union Station, Chicago IL 60606.)

3. REQUIREMENTS

3.1 Applicable to all equipment.

3.1.1 Preproduction. This specification makes provision for preproduction testing.

3.1.2 Materials. All materials shall be suitable for the purpose intended.

3.1.3 Finish. All parts shall have a smooth finish free from burrs, flaws, ragged and sharp edges.

3.1.3.1 Corrosion resistant metal parts. All protected metal parts and surfaces that are constructed of corrosion resistant material and on which a protective coating would be detrimental to proper functioning, need not be given protective coatings. All exposed metal parts and surfaces, and all protected metal parts on which a protective coating will not be detrimental to proper functioning shall be treated to satisfy the requirements of this specification.

* 3.1.3.2 Metal finishes. Metal surfaces requiring painting shall be suitably cleaned, primed and finished in accordance with high quality commercial practice. The color shall be as specified by the procuring activity (see 6.2). All ferrous items such as screws, bolts, nuts, washers, etc., shall be either cadmium or zinc plated in accordance with high quality commercial practice.

* 3.1.4 Information supplied with each unit. Detail information necessary for the satisfactory operation and maintenance of the equipment shall be supplied with each unit. A complete set of operating instructions and a parts catalog will be furnished with each unit.

* 3.1.4.1 On type II equipment an arrangement shall be provided for supporting the operating instructions and parts catalog at the rear of the table for display. This display shall not interfere with tail stock or coil movement yet will be readily available and clearly visible to the operator. On type-

III, IV and V equipment a metal chart holder shall be provided to hold the operating instructions and parts catalog. The holder shall be located on the inspection unit in such a manner as not to interfere with its operation.

* 3.1.4.2 Wiring diagram. A wiring diagram shall be supplied, marked with the sizes and electrical characteristics of all circuits and with the identification and the part number of all electrical components of the equipment. On Type II machines, the wiring diagram will be stored in a pocket or data case as specified in 3.2.1. On types III, IV and V machines, the diagram may be included as a part of operating and maintenance instructions as specified in 3.3.3, 3.4.3.5 and 3.5.4, respectively.

* 3.1.5 Electrical systems components. All components, devices, wiring and insulation shall be suitable for voltages, current, and duty characteristics of the circuits in which they are used and shall conform to National Electrical Manufacturers' Association standards as specified by the procuring activity. No wiring, either bare or insulated, shall be exposed except at contact plates and coil terminals on the low-voltage circuit. All control circuit wires shall be suitably identified, corresponding to the wiring diagram. Identification shall be affixed at or near the ends, using adhesive tape or other semi-permanent method.

* 3.1.5.1 Rectifier.

* 3.1.5.1.1 Rectifying agent. Selenium, copper oxide, magnesium copper, or silicon shall be used as the rectifying agent.

* 3.1.5.1.2 Temperature limit. Operating temperature for selenium, copper oxide or magnesium copper shall not exceed 77° Centigrade (C). Operating temperature for silicon shall not exceed 150°C. Ambient temperature is considered 40°C or less.

* 3.1.5.2 Power transformer.

* 3.1.5.2.1 Temperature rise. Allowable temperature rise (above ambient) shall be governed by the class of insulation used in the transformer. Allowable temperature rise for class A shall be 40°C and for class B shall be 70°C. Maximum operating temperature for class A shall be 105°C, for class B, 130°C, higher classes of insulation may be used. For temperature limitation see NEMA Standard.

* 3.1.5.2.2 Dielectric strength. The dielectric strength between high voltage and low voltage windings, and between high voltage winding and core shall be not less than 2500 volts. Dielectric strength between low voltage winding and core shall not be less than 1250 volts (see 4.3.2.3, 4.3.3.3 and 4.3.4.3). (Either AC or Direct Current (DC) dielectric test may be performed.)

* 3.1.5.3 Ammeter(s). The ammeters shall indicate within ±3 percent of the actual amperes at full output.

* 3.1.6 Ratings. Equipment shall conform to the requirements of Table I and shall be capable of developing the maximum rated output at 200/230 volts and 400/460 volts (see 6.2).

* 3.1.7 Interchangeability. All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable. The drawing number requirements of MIL-D-1000 shall govern changes in the manufacturer's part numbers.

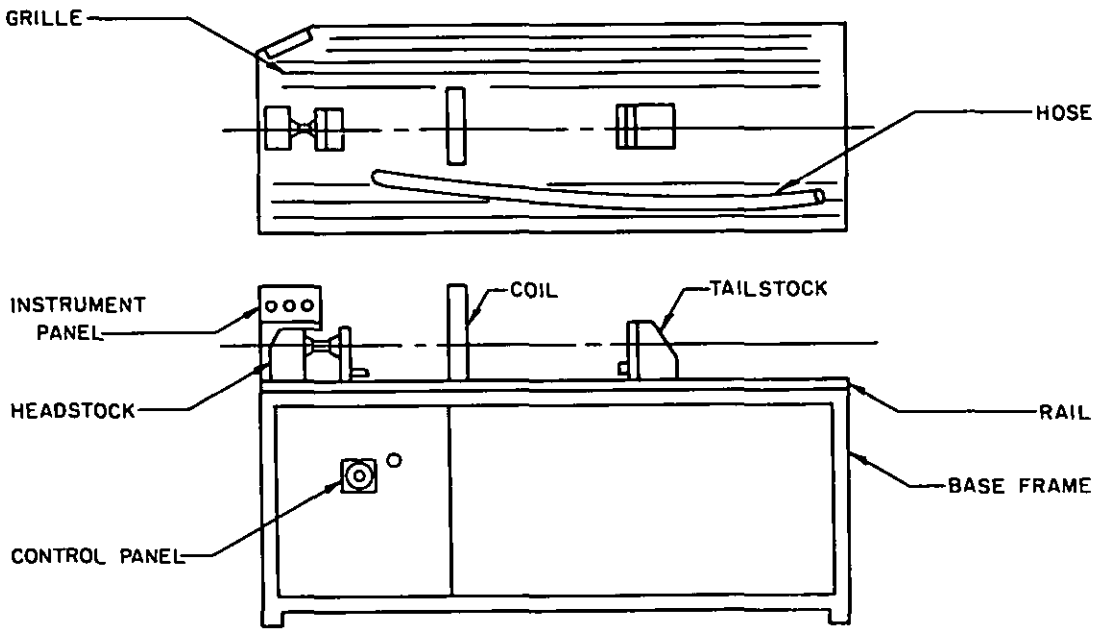
* 3.1.8 Identification of product. Equipment shall have an identification nameplate in accordance with MIL-STD-130. The manufacturer's nameplate shall be attached by self-tapping screws, escutcheon nails, or other mechanical means.

* 3.1.9 Workmanship. The equipment shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to freedom from blemishes, defects, burrs, alignment of parts and tightness of assembly.

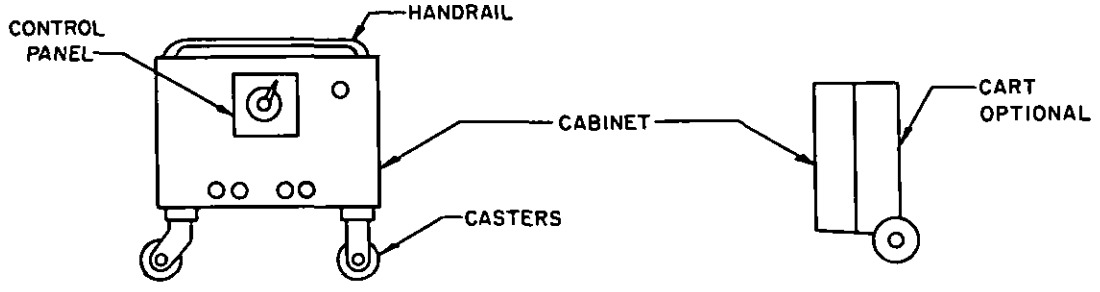
* TABLE I - Dimensional and Electrical Capacities

Sizes (Contact Head Opening)	Rated Maximum Output, Amperes			
	Type II	Type III	Type IV	Type V
(Inches)				
26	2,000			
54	5,000			
96	6,000			
144	6,000			
		3,000	750	6,000

* 3.2 Additional requirements applicable to type II equipment. The complete unit shall consist of a magnetizing power pack and the inspection processing station mounted in a base frame of metal construction. The equipment is essentially a table upon which are mounted the components for circular and longitudinal magnetization of parts (see Figure 1), and providing facilities for applying the inspection medium to the parts. The magnetizing devices shall include a fixed headstock, a movable tailstock, and a coil. The tailstock and coil shall be installed on common rail(s). A hose and lever operated nozzle shall be provided to apply the inspection medium to parts being inspected. A slatted wooden grille shall cover the table area otherwise open to the tank below. An instrument panel shall be provided above table level. The base frame shall incorporate a pump agitated, built-in tank or reservoir for the inspection medium, and contain the electrical components. The left front panel shall serve as the control panel. The units shall be constructed so that the workpiece may be located either by over-head handling equipment or by a conveyer system, as specified by the procuring activity (see 6.2). The over-all length of the unit shall be not greater than the contact head maximum opening plus

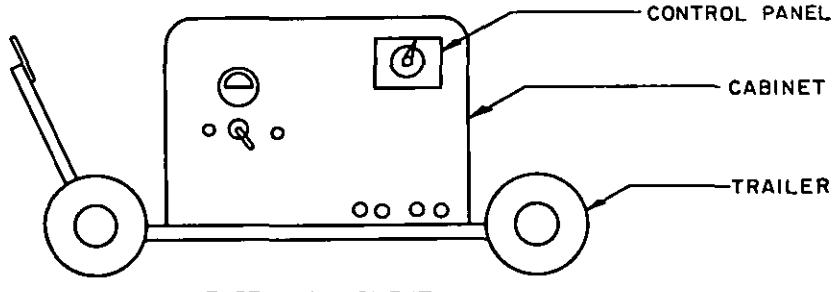


TYPE II EQUIPMENT



TYPE III EQUIPMENT

TYPE IV EQUIPMENT



TYPE V EQUIPMENT

FIGURE 1.

24 inches. The width shall be 24 to 26 inches for the 26 and 54 inch sizes, and 30 to 36 inches for the 96 and 144 inch sizes. The rail height shall be from 35 to 40 inches.

* 3.2.1 Frame. The frame shall be sufficiently sturdy to withstand the loads specified in 3.2.5.3. The sides of the frame shall be completely enclosed with the back panels ventilated. Panels affording access to lubrication or drain fittings, fuses, and timers shall be hinged. A metal pocket or data case shall be installed inside the machine enclosure on the inside of a hinged panel.

3.2.2 Storage tank. The unit shall contain a storage tank for the suspension, covered by a grille, with splash panels extending approximately 2 inches above the level of the grilles all around the tank. The storage tank shall extend the full length of the processing area and the approximate width of the unit. The sides shall slope not less than 45 degrees to the horizontal. The storage tank shall be fabricated from stainless steel conforming to QQ-S-766, Class 304.

3.2.2.1 Grille or grating. The top of the tank shall be covered between the front edge and rail(s) and the back edge and rail(s) by a readily removable grille. The grille shall be constructed of longitudinal, horizontal, hardwood slats, not less than 3/4 by 2 inches in cross section, with the 2 inch face vertical. These slats shall be suitably spaced and assembled together to form sections. A screen, not larger than 1/4 inch mesh, shall be provided and installed under the entire length and width of the grille.

3.2.2.2 Sump. One or more sumps for pump suction reservoir, shall be located in the bottom of the tank vee. No part of the sump shall extend above any part of the tank.

3.2.2.3 Sump screen. A screen of No. 10 mesh, or finer, shall be provided to exclude foreign particles in the suspension from entering the sump. The screen shall be easily removed for cleaning without removing any fasteners and by removing only a relatively small portion of the grille. It shall not be adversely affected by corrosion or other deterioration from water or mineral oils.

3.2.2.4 Drain hose. A flexible drain hose shall be supplied to allow drainage of the inspection medium from the tank and circulating system of the equipment. A drain cock to which the hose may be connected shall be installed in the equipment in a location which will allow draining of the entire tank and circulating system.

3.2.3 Suspension circulating system. Means shall be provided for applying the inspection medium, consisting of a suspension of ferromagnetic particles in a vehicle, to the parts or areas thereof when properly located at the inspection station. This system shall be constructed of material which is not unduly affected by either corrosion or other deterioration from water or mineral oils or by interaction with other components of the system.

3.2.3.1 Circulating pump. The circulating pump shall be entirely suitable for handling a suspension of ferromagnetic particles in the vehicles which form this inspection medium. It shall be electric-motor driven, compact, and easily accessible. The design of the pump shall preclude its building up a pressure in excess of 12 pounds per square inch (psi) at the hose discharge and shall preclude stalling or damage from grit, chips, et cetera. The pump shall be self-draining or shall be provided with an external drain cock.

3.2.3.2 Pump motor. The pump motor shall operate satisfactorily without excessive temperature rise, and shall be provided with suitable protection against overload and short circuit.

3.2.3.3 Hose(s). Suitable oil-resistant flexible hose(s) shall be provided of adequate length to deliver the fluid suspension from the pump to any location in the working area. The hose shall have threaded fittings to attach to the pump discharge line at a location inside the front edge of the unit and a nonmagnetic metal nozzle with a lever-type hand valve at the discharge end.

3.2.4 Agitation system. Means shall be provided for maintaining the ferromagnetic particles in suspension. The system shall be so designed that the pump discharge is connected to a flow-distribution device which discharges the inspection medium directly toward the sump with sufficient velocity that particles are kept in suspension and do not settle out in the tank. Agitation shall be sufficiently vigorous that positive motion of the bath toward the sump can be felt by placing one's hand at any location near the bottom of the tank between the agitator inlet and the sump. Except for the sump screen and the distributor, there shall be no fittings which might interfere with proper agitation. The distributor shall clear the tank sides by not less than 1/2 inch and shall be easily removable for cleaning and repair. This sytem shall be constructed of materials which are not unduly affected by either corrosion or other deterioration from water or mineral oils or by interaction with other components of the system.

3.2.5 Clamping device. A fixed headstock and movable tailstock shall be provided with a clamping device for supporting and providing electrical contact, when required, with the work.

* 3.2.5.1 Headstock. The headstock shall be fixed and shall be located on the table to the left of the operator. It shall support and guide a horizontal plunger shaft which supports the vertical contact plate assembly. Clamping of the work between contact plate assemblies may be accomplished by means of an air cylinder attached to the plunger assembly of the headstock. The air system shall be designed to operate from an external source supplying air at a line pressure of 90 + 20 psi or 90 - 30 psi. The cylinder shall be double acting with the direction of travel controlled by a solenoid valve, which is in turn controlled by a foot switch connected to the equipment through a flexible cord. Clamping forces shall be continuously adjustable between limits of 10 to 300 pounds maximum. The piston rod shall be not less than 1 inch in diameter. Piston speed shall be controllable. A moisture filter and pressure gage shall be installed in the feed line to the cylinder. An automatic lubricator shall provide positive lubrication to the cylinder.

* 3.2.5.1.1 Contact plate units. The headstock contact plate unit shall consist of a suitable metal backing plate, a 3/16 inch or more copper contact plate, and a 1/4 inch or more lead contact plate. The contact plates shall be completely insulated from the backing plate. Tailstock contact plate assembly shall consist of a 3/16 inch or more copper plate and a 1/4 inch or more lead plate properly grounded and mounted on a suitable structure. The headstock contact plate assembly shall be securely mounted to the plunger, and tailstock contact plate assembly securely mounted to tailstock body. The lead plates shall be secured by a single screw at top center, the lower edge being retained behind the contact assembly plate shelf. Electrical connections to the headstock and tailstock contact plates shall be two 4/0 extra-flexible copper cables or equivalent copper cables of equal or greater cross sectional area of copper. Each contact plate shall be equipped with a shelf, and a removable "V" type support. The center of pressure of contact plates shall correspond to the centerline of the magnetizing coil ± 1 inch. (Changeable for the various size coils designated in Table V).

3.2.5.1.2 Contact plate shelf. The shelf shall be suitably supported phenolic sheet, not less than 1/2 by 1-1/2 by 6 inches, with the 1-1/2 inch side horizontal.

3.2.5.1.3 V-notched shelf. The shelf shall be suitably supported phenolic sheet not less than 1 inch thick and of such design as to support parts up to 6 inches in diameter. It shall be readily mounted on or demounted from the flat shelf without the use of tools.

3.2.5.2 Tailstock. The tailstock shall be movable to any position on the horizontal guide rail(s) extending the full length of the unit. The tailstock shall be handcrank operated through a gear to afford easy movement in both directions. A positive lock shall be provided to hold the tailstock in a fixed position.

3.2.5.3 Rail(s). The rail(s) shall be metal and shall provide for coil and tailstock traverse. The rail(s) shall be sufficiently sturdy to accommodate a static load equal to 1,500 pounds, concentrated over an area equivalent to the tailstock base at any point along the rail(s) with a deflection not greater than 1/4 inch for machine sizes of 96 inches, or less, and not greater than 1/2 inch for larger sizes.

3.2.6 Electrical system.

* 3.2.6.1 The equipment shall be designed to operate from either a 200/230 volt or 400/460 volt, 3 phase 50/60 cycle power source. Dual-voltage components shall be provided to permit changeover from 200/230 to 400/460 volts, or vice versa, without replacement of components other than fuses or overload relay heater elements. Initial connections shall be as specified and so indicated on the nameplate (see 6.2).

3.2.6.1.1 High voltage AC connections. A suitable junction box shall be provided on the rear of the equipment at the left hand end to which the high voltage, AC power lines may be connected. A suitable grounding lug shall be provided in the junction box to permit grounding of the equipment.

* 3.2.6.2 Magnetizing current. The magnetizing current shall be high amperage, low voltage as specified in 3.1.6 (see 4.3.2.1). A surge feature shall be provided allowing maximum current application for brief period, then dropping the current to a lower value depending on the variable current control setting. The DC current shall be obtained from a 3-phase source by full wave rectification of all phases using dry plate or semiconductor diode rectifier. The power-pack components shall be of sufficient capacity to insure the performance required by Tables I and II (see 3.1.6 and 3.2.6.11).

* 3.2.6.3 Transformers. The transformers shall be suitable for continuous operation at currents which are 20 percent of the currents drawn from the transformers when the equipment is delivering its full rated output. Current control shall be provided by a variable current control (30 or more points) in conjunction with transformer(s) which vary the voltage applied to the primary of the power transformer(s).

* 3.2.6.3.1 Magnetizing current control. A variable current control shall be provided to regulate the high-amperage current. The control shall be mounted under the table, suitably enclosed for protection, with a control knob of nonconducting material on outside left front, accessible to the operator. The magnetization current shall be controllable (30 or more steps) from 10 percent to 100 percent of full rated power.

* 3.2.6.4 Main contactor and relays. The main contactor shall be a magnetic switch placed in the incoming high-voltage lines of the autotransformer and when actuated along with other controls, shall cause the high-amperage rectified current or AC current to flow. It shall be actuated through suitable relay(s) by a push-button or switch mounted on the front of the equipment accessible to the operator, or by the switch on the contact prod. The DC magnetizing circuit controls shall be connected in such a manner that the magnetizing current will be broken at the peak value and preclude any demagnetizing effects from the collapse of the field of the power transformer primary. Except for contact prod use, the relay(s) shall be such as to limit the time for which this high-amperage circuit may be energized by one operation of the control button, regardless of how long the button is depressed. This time shall be adjustable down to 1/4 second. For contact prod use, the relay(s) shall be such as to permit the high-amperage circuit to remain energized for the length of time the switch on the contact prod is energized regardless of the adjustment of time to which the high-amperage circuit is set for operation by the control button. However, a device(s) shall be provided which limits the time the high-amperage circuit may remain energized when the switch on the contact prod is energized to prevent damage to the equipment. This device(s) shall be such as to allow the high-amperage circuit to remain energized for a shorter time when maximum current is flowing than when currents less than maximum current are flowing, in such a manner as to permit operation at approximately the duty cycles specified in Table II (see 3.2.6.11).

3.2.6.4.1 Remote-control-cable receptacle. This receptacle shall be suitable for connection of the plug on the control cable of the contact prod. When the plug is connected in the receptacle the switch on the contact prod shall function as specified in 3.2.6.4. The receptacle shall be of twist-lock type or of equivalent locking type.

* 3.2.6.5 Control panel. The left-hand front panel shall serve as a dead-front electrical control panel. Controls and switches shall be conveniently arranged, and shall be identified with legible nameplates in accordance with their designation on the wiring diagram. The following controls should be mounted on the control panel:

a. Line pilot light.

b. Variable current control (30 or more points).

c. Pump switch.

d. Magnetizing current pushbutton switch(es).

e. "Contacts" - "Coil" transfer switch.

f. Remote control cable receptacle.

g. 110-volt AC receptacle.

h. Surge selector control.

3.2.6.5.1 Transfer switch. The transfer switch shall enable the operator to connect the high-amperage circuit to the coil mounted on the equipment or to the contact plate assemblies. The switch shall remain in the selected "Coil" or "Contacts" positions.

* 3.2.6.6 Magnetizing current switches. The magnetizing current shall be actuated by pushbutton switch(es). The size 96 inch and size 144 inch equipment shall be provided with two magnetizing current push button switches approximately evenly spaced on the front of the equipment.

* 3.2.6.7 Longitudinal magnetizing coil. The coil used for longitudinal magnetization shall be energized by low-voltage, high-amperage current. The coil shall be mounted on the rail(s), shall permit easy movement along the rail(s) and shall be capable of being locked in any position on the rails. Current shall be supplied to the coil through No. 4/0 extra-flexible cables attached to rigid bus bars extending from the coil horizontally toward the rear of the table. The coil shall have an opening large enough to clear the contact plate assembly, and when not in use, shall be capable of resting at the extreme left in order that the contact plate assembly on the headstock will extend beyond the face of the coil. The length through the window opening shall not exceed 5 inches. The opening of the coil shall exceed a diameter corresponding to the specified coil size by at least 1/4 inch. The coil shall carry a current such that the ampere turns for all sized coils shall be at least 15,000 for type II equipment. A 12 inch coil shall be supplied except that the procuring activity may specify as an alternate, a 16 or 20 inch coil for 54 inch equipment; or a 16, 20 or 25 inch coil for 96 or 144 inch equipment. A 10 inch coil shall be supplied with the 26 inch equipment, except that the procuring activity may specify as an alternative an 8 inch coil (see 6.2).

* 3.2.6.8 Control circuit transformer. A transformer shall be provided to supply 110 volts AC for the control circuits, receptacle, pilot lights, et cetera. The transformer shall be of the type in which the 110-volt winding is conductively isolated from the primary winding. The capacity of the transformer shall be such as to permit operation of the equipment at the rated output specified in Table I, and shall allow for an additional load up to 450 volt-amperes to be drawn continuously from the 110-volt, AC receptacle.

* 3.2.6.8.1 Fuses. Suitable cartridge-type fuses shall be provided to protect the 110-volt, AC circuit.

* 3.2.6.8.2 AC receptacle. A standard 10-ampere, plug-type receptacle furnishing 110-volts AC shall be located on the control panel to permit connection of an auxiliary device requiring up to 450 watts input.

* 3.2.6.9 Instrument panel. A dead-front electrical instrument panel shall be mounted in a vertical position, above the grille, at the extreme left end and at the rear of the equipment. The position of the panel shall be such that the operator can observe readings of instruments from his operating positions. No part of the panel shall extend to the right of the headstock. Full protection shall be provided by a sheet metal box with a removable back. The instrument panel and box assembly shall be mounted on vertical standards of sufficient length. Instruments and controls shall be symmetrically arranged and identified with legible nameplates in accordance with their designation on the wiring diagram. Wires to instrument panel shall be contained within the instrument panel and box assembly standards. The instrument panel shall contain the magnetizing current ammeters, pilot light, and other instruments as appropriate.

* 3.2.6.9.1 Ammeters magnetizing current. The ammeters for the magnetizing current shall be dual range, 0 to 1200 amp and 1000 to the maximum output which the equipment is designed to deliver. The AC ammeter shall indicate AC root mean square (rms) amperes and the DC ammeter shall indicate DC (full-wave rectified AC) magnetizing amperes.

* 3.2.6.9.2 Pilot lamps. Jewel pilot lamps shall be provided. One red lamp shall be "on" to indicate line switch is closed, and one green lamp shall be "on" to indicate when magnetizing current is on. Pilot lamps shall be a type which permits easy removal of the jewel cap from the front of the mounting panel in order that the bulb may be easily replaced.

* 3.2.6.10 Optional demagnetizing facilities. Demagnetizing facilities shall be built into the equipment, except for size 26 or 54 inch equipment the unit may be supplied separately (see 6.2). When built into the 26 or 54 inch equipment, the overall length of the unit may exceed the length specified in 3.2 by 30 inches. When furnished as separate units and shipped in separate containers, each container shall be identified as specified in MIL-STD-129. Demagnetizing current shall be high amperage low voltage reversing DC and AC decrement (selectable by the operator). Decrements shall be 30 points or more. The maximum demagnetizing current shall be sufficient to demagnetize parts magnetized by the outputs specified in Table I. The pushbutton switch for the automatic demagnetizing cycle shall, when momentarily depressed, initiate the

automatic demagnetizing cycle. When the demagnetizing cycle has been completed, the cycle shall stop automatically. The equipment shall be arranged to allow the demagnetizing current to flow either through the contact heads or mounted coil as controlled by the transfer switch relay. The demagnetizing cycle shall be so designed that the demagnetization current can be started at any value from 10 percent to 100 percent of machine rating. At least the following shall be located on the demagnetizing control panel:

a. Demagnetizing switch "start" button.

b. "Contacts" - "Coil" transfer switch and demagnetizing pilot light.

c. Current control knob and indicating dial.

d. AC/DC selector switch.

* 3.2.6.11 Duty cycle. Equipment shall be capable of operating at the duty cycles specified in Table II without damage to any of the components.

* TABLE II - Duty Cycles of Type II and Type V Equipment

Period which magnetizing current is "on"	Period which magnetizing current is "off"	Allowable percent of maximum rated magnetizing current
10 seconds	3 minutes	40 percent
5 seconds	4 minutes	100 percent

* 3.2.7 Accessories. The following accessory items shall be included with each type II magnetic inspection unit:

a. Contactor block with connectors.

b. Two 15 foot No. 4/0 cables with connectors on both ends.

c. Two 10 foot No. 2/0 cables with No. 4/0 connectors on both ends.

d. Contact prods, one pair, with No. 4/0 connectors.

e. Two contact clamps with No. 4/0 connectors.

f. One pound fluorescent dry concentrates.

g. 100 cubic centimeter centrifuge tube.

h. Centrifuge tube stand.

i. Hose brush.

j. Drain hose.

k. Copper rod, 1 inch diameter by 18 inches long.

l. Residual field indicator.

m. Canopy - black light inspection.

n. Black light.

3.2.7.1 Contactor block. The main body of the contactor block shall be of nonconducting material, approximately 12 inches long. It shall be equipped with a connector at each end to connect to the auxiliary cables, such as to insure that the placing of the block, with auxiliary cables attached between contact plate assemblies, will provide good electrical contact between contact plate assemblies and auxiliary cables.

3.2.7.2 Auxiliary cables. Auxiliary cables shall consist of No. 4/0 extra-flexible insulated cable conductors, each 15 feet long, and No. 2/0 extra-flexible insulated conductors each 10 feet long. Each conductor shall have a connector on each end, and shall have a suitable heavy-duty oil-resisting insulation.

* 3.2.7.3 Cable connectors. The contactor block, contact prods, contact clamps, No. 4/0 cables, and No. 2/0 cables shall all be equipped with 4/0 connectors which permit the interconnection of these components. The connectors shall not be the male-female type, but shall be a type which permits the connection of any two connectors. The connectors shall be readily connected, locked or separated, regardless of temperature, without the use of fasteners or tools. Connectors on cables shall be so insulated that when two cables are joined, no current-carrying part shall be exposed. Connectors shall be connected to the conductors by mechanical means.

3.2.7.4 Contact prods. Contact prods shall consist of two prods suitable for use with the equipment in circular magnetization of parts by passing current through the parts. The prods shall be designed to be held, one in each hand, by the operator. The prods shall be equipped with connectors to allow connection of the auxiliary cables to supply current to the prods. One of the prods shall be equipped with a suitable switch, control cable, at least 20 feet long, and plug for connection to the remote control cable receptacle on the equipment, to allow the operator to control the flow of magnetizing current while holding the prods.

3.2.7.5 Contact clamps. Contact clamps shall consist of two spring loaded clamps, suitable for use with the equipment in circular magnetization of parts by passing current through the parts. The clamps shall be suitable for clamping to parts from 1-1/4 inches to 2-1/2 inches thick. The clamps shall have insulated handles and shall be equipped with connectors to allow connection of the auxiliary cables to the current supply.

* 3.2.7.6 Fluorescent dry concentrates. The fluorescent dry concentrates of ferromagnetic particles, when mixed in suitable proportions with specified vehicle, will form a mixture suitable for use in magnetic-particle inspection operations.

* 3.2.7.7 Centrifuge tube and stand. A 100 milliliter centrifuge tube and suitable stand shall be provided. The centrifuge tube shall be entirely suitable for determining the relative concentration of ferromagnetic particles in the inspection medium. The stand shall be such that readings can be made without removal of the centrifuge tube.

3.2.7.8 Hose brush. A brush shall be supplied which is suitable for cleaning accumulated ferromagnetic particles and foreign material from the inside of the hose(s) used to apply the inspection medium.

3.2.7.9 Copper rod. A copper rod, 1 inch in diameter and 18 inches long, shall be provided with the equipment for use in checking the magnetizing current through the contact heads.

3.2.7.10 Residual field indicator. The indicator shall be a pocket size magnetometer suitable for exploring parts to obtain comparative readings of appreciable magnetic poles.

* 3.2.7.11 Canopy. The canopy shall consist of a steel frame, and fabric conforming to MIL-C-20696, type II, class 3 or 4. The canopy shall form an enclosure and shall fold back to facilitate the entry of personnel, and the entry of parts from an overhead position. The edges shall overlap at least 4 inches to preclude the entrance of outside light.

* 3.2.7.12 Black lights. The black lights which are employed to fluoresce the inspection medium shall be built according to MIL-L-9909. The line cord shall be at least 8 feet long. The light shall be supported on adjustable swivel brackets which shall permit the lights to be directed or aimed toward the part to be inspected. Unless otherwise specified, the lights shall be readily demountable from the adjustable brackets without removing any fasteners or fixtures.

* 3.2.8 Additional control devices. Additional control devices as listed below shall be provided:

a. Air-pressure regulating valve.

b. Air-pressure gage.

c. Headstock speed control valve.

d. Headstock control foot switch and receptacle.

e. Hose pressure regulating cock.

f. Lever type hand valve.

The controls shall be conveniently located.

* 3.2.9 Optional equipment. Special equipment, designed for the inspection of specific materials or parts of special design, shall conform in general to performance requirements and applicable portions of this specification (see 6.2).

* 3.2.9.1 Optional headstock and tailstock. When specified by the procuring activity, all of the optional headstock and tailstock equipment listed below shall be provided in place of the headstock and tailstock specified above. The optional headstock and tailstock components shall not be provided individually.

* 3.2.9.2 Optional headstock. The headstock shall be fixed and shall be located on the table to the left of the operator. It shall support and guide a horizontal plunger shaft which supports the vertical contact plate assembly. A spring shall hold the plunger assembly in normal extended position. A limit switch installed on the headstock shall stop the movement of the tailstock toward the headstock when the plunger spring is compressed by a predetermined force, adjustable from 30 to 100 pounds ± 10 pounds, as work is moved by the travel of the tailstock.

* 3.2.9.3 Optional tailstock. The tailstock shall be movable to any position on horizontal guide rails extending the full length of the unit. The tailstock shall be actuated by means of a self-contained electric motor enclosed within a protective splashproof cover and suitably ventilated. The speed of traverse of the tailstock shall be between 85 to 110 inches per minute.

* 3.2.9.4 Optional tailstock motor unit. The tailstock motor shall be in accordance with NEMA Standard and shall be of sufficient horse-power to perform to the requirements of this specification. The motor shall be of the split-phase induction type and shall have a worm-geared reduction drive or a unit with similar power.

* 3.2.9.5 Optional tailstock motor forward-reverse switch(es). The tailstock motor forward-reverse switch(es) shall be either the double-throw momentary type, spring loaded to the center ("Off") position, or a rotary type with pointer operating knob automatically returning to vertical "Off" position. The motion of the tailstock shall be in the same direction as the switch is actuated or in the direction of the pointer. Motion of the tailstock shall be in the direction of pointer with the pointer automatically returning to vertical "Off" position. All sizes of equipment shall have one switch on the control panel. Size 96-inch equipment shall have one additional switch on the front near the right end of the equipment. Size 144-inch equipment shall have two additional switches evenly spaced on the front of the equipment.

* 3.2.9.6 Optional tailstock limit switch. A limit switch shall be provided to limit the movement of the tailstock away from the headstock to any predetermined point.

* 3.2.9.7 Optional fixtures for propeller blade inspection. When specified by the procuring activity, fixtures to permit the inspection of aircraft propeller blades shall be provided. These fixtures shall be securely fastened to the headstock and tailstock contact assemblies, replacing only the lead plates. Upon removing the fixtures, the lead plates shall be secured as specified in 3.2.5.1.1. The fixtures shall consist of a headstock fixture to accept the shank of the propeller, and a tailstock fixture to accept the blade tip. The fixtures shall be so designed that the centerline of the blade is the same as center of pressure of the contact plates ±1/2 inch. The headstock fixture shall incorporate a nonferrous vee shelf extending out from the fixture contact plate at least 2-1/4 inches. The contact surface of the headstock fixture shall be faced with a 1/4 inch thick lead plate. The shelf shall be vertically screw adjustable, by means of a knob, in order that blade shanks ranging in diameter from 3 to 8 inches can be accommodated. The tailstock fixture shall accept either rounded or square tipped blades, up to any width which the equipment will accommodate, and up to 2 inches thick at the tip. The fixture shall open in the manner of a hinge, shall provide for securely clamping the blade tip, and shall not require removal of fasteners or the use of tools for operation. Integral with the upper portion of the hinge shall be a screw adjustable, self-aligning, nonrotatable pressure pad, at least 1-1/2 inches by 3-1/2 inches to accommodate thicknesses varying from 1/4 inch to 2 inches. The lower portion of the hinge shall incorporate a fixed pad at least 1-1/2 inches by 5 inches. The entire hinge assembly shall permit rotation of the propeller blade for inspection while clamped. The pads shall be faced with suitable copper-braid pads, secured other than on the face by screws. These fixtures, when installed, shall not reduce the maximum contact head opening by more than 8 inches.

* 3.3 Additional requirements applicable to type III (mobile) equipment. This type of equipment (see Figure 1) consists of a cabinet, mounted on casters for protability, containing the components to supply current for magnetization and demagnetization of parts. Magnetization and demagnetization of parts shall be accomplished through the use of accessory cables, contact prods, contact clamps and a coil. The inspection medium, either dry magnetic-particle powder, wet magnetic-particle bath, or fluorescent wet magnetic-particle bath, shall be applied by accessories. Instruments and controls shall be mounted on the front of the cabinet. A remote push-button control station, connected to the equipment with a length of electric cord, shall be used to control magnetizing and demagnetizing current. Output connectors for connecting accessory cables shall be provided on the front of the cabinet.

* 3.3.1 Cabinet. The cabinet shall be suitably constructed to contain the powerpack components. It shall be of metal construction, totally enclosed with horizontally louvered panels that provide ventilation and protection against rainfall. The panels shall be readily removable, but requiring a tool such as a screwdriver for removal. Access to fuses and the dual-voltage terminal board shall be by a hinged panel. The top panel shall contain a storage area of at least 3 square feet capable of accommodating 150 pounds of accessories. The cabinet design shall include facilities for lifting by overhead handling equipment and shall provide for a convenient means of hand gripping for ease of movement on the floor. Four heavy-duty nonmetallic tread casters

shall be provided, 2 rigid and 2 swivel, at least 8 inches in diameter, and of rated load-carrying capacity at least 50 percent greater than the operating weight of the equipment.

3.3.2 Powerpack.

* 3.3.2.1 The power pack shall be designed to operate from a single phase 50/60-cycle, AC power source of 200/230 or 400/460 volts. The equipment shall be arranged to permit operation at either voltage by a simple change of electrical connections in the cabinet. It shall be initially connected as specified by the procuring activity (see 6.2).

* 3.3.2.2 High-amperage, low-voltage magnetizing current shall be both AC and half-wave rectified current obtained from single-phase AC available selectively by connection to the output connectors. The half-wave rectified magnetizing current shall be supplied by rectifiers in conjunction with power transformer(s). Current control for both AC and half-wave rectified magnetizing currents shall be provided by means of a variable current control (30 or more points) in conjunction with a transformer which varies the voltage applied to the primary of the power transformer.

3.3.2.3 Transformers. Suitable transformers of sufficient size and capacity shall be furnished. They shall meet the electrical capacity indicated in Table I and Table III, without damage to any of the components. The transformers shall be suitable for continuous operation at a current which is 20 percent of the currents drawn from the transformers when the equipment is delivering its full rated output.

* 3.3.2.4 Control circuit transformers. The control circuit transformer shall meet the requirements of 3.2.6.8.

* 3.3.2.4.1 Fuses. The requirements of 3.2.6.8.1 shall apply.

* 3.3.2.4.2 AC receptacle. The requirements of 3.2.6.8.2 shall apply.

* 3.3.2.5 Main contactor. The main contactor shall be a magnetic switch placed in the high voltage line in the primary circuit of the power transformer and closed by control cable and pushbutton station, or by the switch on the contact prod. The circuit shall be such that the high-amperage current shall flow when "start" button on the remote pushbutton station is pressed and shall continue to flow until the "stop" button on the remote pushbutton station is pressed. The circuit shall also be such that the high-amperage current shall flow whenever the switch on the contact prod is energized.

3.3.2.6 Rectifiers. Suitable rectifiers of sufficient size and capacity for meeting the requirements shown in Table I and Table III, shall be supplied.

TABLE III - Duty Cycles for Type III Equipment

Period which magnetizing current is "on"	Period which magnetizing current is "off"	Allowable percent of maximum rated magnetizing current
2 minutes	5 minutes	40 percent
1 minute	10 minutes	100 percent

* 3.3.2.7 Built-in demagnetizer. Demagnetizing current shall be high amperage low voltage reversing DC and AC decrement. Decrement shall be 30 points or more. The maximum demagnetizing current shall be sufficient to demagnetize parts magnetized by the output specified in Table I. The pushbutton switch for the automatic demagnetizing cycle shall, when momentarily depressed, initiate the automatic demagnetizing cycle. When the demagnetizing cycle has been completed the cycle shall stop automatically. The demagnetizing cycle shall be so designed that the demagnetization current can be started at any value from 10 percent to 100 percent of the machine rating.

* 3.3.2.8 Controls and instruments. Controls and instruments shall be provided as follows:

a. Instrument and control panel:

(1) AC magnetizing current ammeter (dual range 0 to 1200 amp, 1000 to maximum output.)

(2) Half-wave rectified magnetizing current ammeter. (Dual range 0 to 1200 amp, 1000 to maximum output.)

(3) Variable current control (30 or more points).

(4) Magnetizing current pushbutton switch.

(5) Line pilot light.

(6) Magnetizing and demagnetizing current pilot light.

(7) Demagnetizing switch. "Starter" button.

(8) Remote control cable receptacle.

(9) 110 volt, AC, receptacle.

(10) Output terminals.

b. Other controls, conveniently located:

Line disconnect switch.

* 3.3.2.8.1 Variable current control. A variable current control shall be provided to regulate the high amperage current. The control shall be mounted inside the cabinet, with control knob of nonconducting material on the front panel, readily accessible. The control shall have at least 30 or more points. The control shall incorporate a safety device to automatically stop the flow of magnetizing current should the operator change the position of the control while the magnetizing current is on.

* 3.3.2.8.2 Demagnetizing current control. A variable current control shall be used to automatically reduce, in 30 or more decrement, the flow of demagnetizing current. The control shall incorporate a device which will automatically stop it at the end of the demagnetizing cycle. The control knob shall be located on the front panel, and shall be arranged to permit starting of the demagnetizing cycle at any value.

3.3.2.8.3 Remote control cable and push-button station. This shall consist of a suitable start-stop and demagnetizing start push-button station with a suitable 15-foot, or longer flexible insulated cord, to which is attached a plug suitable for connection to the remote control-cable receptacle. The demagnetizing start push button shall be suitably guarded to preclude accidental activation. Provisions shall be made for grounding the pushbutton station when the plug is connected to the receptacle.

3.3.2.8.4 Remote-control-cable extension cord. Remote-control-cable extension shall consist of a plug and receptacle attached to opposite ends of a suitable 20-foot, or longer, flexible insulated cord. The plug shall be suitable for connection to the remote-control-cable receptacle. The receptacle shall permit connection and proper operation of the remote control cable and pushbutton station or the plug on the control cable of the contact prod.

* 3.3.2.8.5 Magnetizing current ammeters. Ammeters shall be provided for AC magnetizing and demagnetizing current and for the half-wave rectified magnetizing current. Ammeters shall be dual range 0 to 1200 amp and 1000 to the maximum output which the equipment is designed to deliver. The AC ammeter shall indicate AC root mean square (rms) amperes. The DC amp shall indicate DC (half-wave rectified AC) magnetizing amperes. (The DC scale shall be calibrated to indicate the average current during the conducting 1/2 cycle.) The ammeters shall be located on the control panel, and they shall be protected from damage by a metal guard.

3.3.2.8.6 Line disconnect switch. A suitable line disconnect switch shall be provided to control the AC power to the equipment. The line disconnect switch shall have a NEMA interrupting rating of at least 15,000 amperes AC.

* 3.3.2.8.7 Dual-voltage terminal board. The dual-voltage terminal board shall be suitable for changing the electrical connections in the equipment to permit operation of the equipment on 200/230 or 400/460 volts AC supply interchangeably, when the voltage of the external power source is either 200/230 or 400/460 volts. The manner in which the connections are made shall be clearly shown on the wiring diagram and on the terminal board proper.

3.3.2.8.7.1 Connections shall be changed by removing nuts or similar fasteners with a tool and rearranging copper connecting pieces on studs. A tag shall be provided on the equipment indicating the voltage for which the equipment is initially connected, and this voltage shall be the voltage of the external power source as specified in the contract or order (see 6.2).

3.3.2.8.8 High voltage AC connections. A suitable, flexible 3-conductor cable at least 30 feet long shall be provided for high-voltage AC connections. The cable shall have heavy-duty oil-resisting outer insulation. One of the conductors of the cable shall be used for grounding and shall be connected to the cabinet of the equipment. At the remote end, the ground conductor shall be identified with a suitable tag. Suitable provision shall be made for storage of the line cable and auxiliary cables when not in use.

* 3.3.3 Accessories. The following devices and items shall accompany each type III inspection unit:

a. Four 15-foot No. 4/0 cables with connectors on both ends (see 3.2.7.2 and 3.2.7.3).

b. Two 10-foot No. 2/0 cables with No. 4/0 connectors on both ends (see 3.2.7.2 and 3.2.7.3).

c. Contact prods, one pair, with No. 4/0 connectors (see 3.2.7.4).

d. Two contact clamps with No. 4/0 connectors (see 3.2.7.5).

e. Remote control cable and push button station.

f. Remote control cable extension.

g. Two powder bulbs.

h. 1 pound black powder.

i. 1 pound red powder.

j. 1 pound grey powder.

k. Residual field indicator (see 3.2.7.10).

l. Operating and maintenance instructions, including wiring diagram.

3.3.3.1 Remote-control-cable receptacle. This receptacle shall be suitable for connection of the plug on the remote control cable and the plug on the control cable of the contact prod. When the proper plug is connected in the receptacle, the remote push-button station and the switch on the contact prod shall function as specified in 3.3.2.5.

3.3.3.2 Black powder. Black powder shall consist of black ferromagnetic particles suitable for use in the dry method of magnetic-particle inspection, packed in a suitable container.

3.3.3.3 Red powder. Red powder shall consist of red ferromagnetic particles suitable for use in the dry method of magnetic-particle inspection, packed in a suitable container.

3.3.3.4 Powder bulbs. Powder bulbs shall consist of flexible hand-operated rubber bulbs with perforated metal heads suitable for the application of black and red powder in a dust like or thin coating on flat and vertical surfaces in the dry method of magnetic particle inspection.

* 3.3.4 Optional equipment shall be provided as follows, when specified (see 6.2).

a. Powder blower.

b. Kit for fluorescent magnetic-particle inspection including:

(1) Portable black light, according to MIL-L-9909.

(2) Spare lamp for black light, according to MIL-L-9909.

(3) Two 12 ounce aerosol cans of fluorescent magnetic particles.

3.4 Additional requirements applicable to type IV (portable) equipment.

* 3.4.1 This equipment shall consist of a cabinet containing the components to supply current for magnetization of parts. A suitable arrangement shall be provided to permit lowering through ships' hatches. Carrying handles shall be provided to permit moving the unit by hand. A light-weight, rubber-tired, two-wheeled hand truck shall be provided as an integral or separate part of the magnetizing unit. Magnetization of parts shall be accomplished through the use of accessory cables and prods. Magnetization current shall be controllable (30 or more steps) from 10 percent to 100 percent of full rated power. The inspection medium shall be applied by accessories. Instruments and controls shall be mounted in the cabinet readily visible to the operator. Output connectors shall be No. 4/0 connectors.

3.4.2 Cabinet. Cabinet for the magnetizing unit shall be of metal construction. A removable panel shall be provided for acesss to the interior of the unit. One or more fans shall be incorporated in the unit for cooling power transformer and rectifier.

* 3.4.2.1 Size and weight. The height of the unit including the hand truck shall not exceed 40 inches, the diagonal of the unit shall not exceed 25 inches. The weight of the unit, excluding accessories, shall not exceed 150 pounds.

* 3.4.3 Power pack. The power pack shall be designed to operate on a single phase 50/60 cycle AC power source of 105 to 125 volts. Maximum current required by each unit shall not be greater than 40 amperes (see 4.3.4.1).

* 3.4.3.1 Output. Each unit shall be capable of operating intermittently at 750 magnetizing amperes AC and DC (half-wave rectified AC) when connected to a load of three 10-foot lengths of 2/0 cable (see 4.3.4.2).

TABLE IV - Duty Cycle for Type IV Equipment

Period which magnetizing current is "on"	Period which magnetizing current is "off"	Allowable percent of maximum rated magnetizing current
2 minutes	2 minutes	50 percent
1 minute	2 minutes	100 percent

3.4.3.2 Transformer. Suitable transformers of sufficient size and capacity shall be furnished. They shall meet the electrical capacity indicated in Table I and 3.4.3.1, without damage to any of the components.

3.4.3.3 Rectifier. Suitable rectifiers of sufficient size and capacity to meet the requirements shown in Table I, shall be supplied.

* 3.4.3.4 Controls and instruments. Controls and instruments shall be provided as follows:

a. Instrument and control panel:

(1) AC and DC magnetizing current ammeter.

(2) Line switch.

(3) Pilot lights.

(4) Output terminals.

(5) Remote control cable receptacle.

(6) Variable current control (30 or more points).

* 3.4.3.4.1 Ammeter. The ammeter shall indicate both AC root mean square (rms) amperes and DC (half-wave rectified AC) magnetizing amperes. (The DC scale shall be calibrated to indicate the average current during the conducting 1/2 cycle.

* 3.4.3.4.2 Switches. A line switch shall be mounted on the control panel which shall be integral with magnetizing unit.

3.4.3.4.3 Pilot lights. A red pilot light shall be provided on the control panel to indicate when line switch is closed and a green pilot light to indicate when the on-off relay is energized.

* 3.4.3.5 Accessories. The following devices and items shall accompany each type IV inspection unit:

a. Three 10-foot No. 2/0 cables with No. 4/0 connectors on both ends.

b. Contact prods, one pair, each equipped with No. 4/0 connectors (see 3.2.7.4).

c. Remote control switch with 15 foot cable.

d. Two-wheeled rubber-tired hand truck if not provided as an integral part of the unit (3.4.1).

e. One powder bulb (see 3.3.3.4).

f. 5 pound black powder (see 3.3.3.2).

g. Line cord.

h. Operating and maintenance instructions, including wiring diagram.

* 3.4.3.5.1 Line cord. Unless otherwise specified, twenty feet ± twelve inches of 3 conductor flexible electrical cord in accordance with National Electrical Code type SO, 8 AWG shall be furnished. A 3-pole plug conforming to series D, W-C-596 shall be used for connection to the supply line, and a 3-pole locking type female connector for connection to the unit. The unit shall be furnished with a 3-pole male receptacle for the line cord (see 6.2).

* 3.5 Additional requirements applicable to type V mobile equipment. This type of equipment (see Figure 1) consists of a cabinet, mounted on a trailer for mobility, containing the components to supply current for magnetization and demagnetization of parts. Magnetization and demagnetization of parts shall be accomplished through the use of accessory cables, contact prods, contact clamps and coil. The inspection medium, either dry magnetic-particle powder, wet magnetic-particle bath, or fluorescent wet magnetic-particle bath, shall be applied by accessories. Instruments and controls shall be mounted on the side of the cabinet. A remote push-button controls station, connected to the equipment with a length of electric cord, shall be used to control magnetizing current. Output connectors for connecting accessory cables shall be provided on the instrument and control side of cabinet.

* 3.5.1 Cabinet. The cabinet shall be suitably constructed to contain the powerpack components. It shall be of metal construction totally enclosed with panels that provide for ventilation and protection against rainfall. The panels shall be readily removable, but requiring a tool such as a screwdriver for removal. Access to fuses and the dual-voltage terminal board shall be by a hinged panel. The top panel shall contain a storage area of at least 3 square feet capable of accommodating 150 pounds of accessories. The cabinet design shall include facilities for lifting by overhead handling equipment. The cabinet shall be attached to a 3 or 4 wheel trailer.

* 3.5.2 Trailer. The trailer shall consist of a steel frame with 4 pneumatic tired wheels, two stationary and two capable of being steered. The rated load-carrying capacity shall be at least 50 percent greater than the operating weight of the equipment. The undercarriage to which the wheels are attached shall be so constructed that the cabinet enclosing electrical components is 18 + inches above the floor level. The wheel base shall be sufficiently wide to provide for adequate stability. The trailer shall be steered by means of a towbar with pintle type hitch. The trailer and magnetic particle inspection unit shall meet the type II, group "C" mobility requirements of MIL-M-8090.

* 3.5.3 Powerpack.

* 3.5.3.1 The powerpack shall be designed to operate from a three phase, 50/60 cycle, AC power source of 200/230 or 400/460 volts. Dual-voltage components shall be provided to permit change-over from 200/230 to 400/460 volts, or vice versa, without replacement of components other than fuses or overload relay heater elements. Initial connections shall be as specified and so indicated on the nameplate (see 6.2).

* 3.5.3.2 Magnetizing current. The magnetizing current shall be 6,000 amperes AC and 6,000 amperes DC at low voltage (see 4.3.3). A surge feature shall be provided allowing maximum current application for a brief period then dropping the current to a lower value depending on the variable current control setting. The DC current shall be obtained from a 3 phase source by full wave rectification of all phases using dry plate or semiconductor diode rectifiers. The powerpack components shall be of sufficient capacity to insure the performance required by Tables I and II (see 3.1.6 and 3.2.6.11). Current control shall be provided by means of a variable current control (30 or more points) in conjunction with transformer(s) which vary the voltage applied to the primary of the power transformer(s).

* 3.5.3.3 Transformers. Suitable transformers of sufficient size and capacity shall be furnished. They shall meet the electrical capacity indicated in Tables I and II, without damage to any of the components. The transformers shall be suitable for continuous operation at a current which is 20 percent of the currents drawn from the transformers when the equipment is delivering its full rated output.

* 3.5.3.4 Control circuit transformers. The control circuit transformer shall meet the requirements of 3.2.6.8.

* 3.5.3.4.1 Fuses. The requirements of 3.2.6.8.1 shall apply.

* 3.5.3.4.2 AC receptacle. The requirements of 3.2.6.8.2 shall apply.

* 3.5.3.5 Main contactor. The main contactor shall be a magnetic switch placed in the high voltage line in the primary circuit of the power transformers, and closed by control cable and pushbutton station, or by the switch on the contact prod. The circuit shall be such that the high ampereage current shall flow when "start" button on the remote pushbutton station is pressed and shall continue to flow until the "stop" button on the remote pushbutton station is pressed. The circuit shall also be such that the high amperage current shall flow whenever the switch on the contact prod is energized. A device shall be provided which limits the time the high amperage circuit may remain energized to prevent damage to the equipment. This device(s) shall be such as to allow the high amperage circuit to remain energized for a shorter time when maximum current is flowing than when currents less than maximum current are flowing, in such a manner as to permit operation at approximately the duty cycles specified in Table II (see 3.2.6.11).

* 3.5.3.6 Rectifiers. Suitable rectifiers of sufficient size and capacity for meeting the requirements shown in Tables I and II shall be supplied.

* 3.5.3.7 Built-in demagnetizer. Demagnetizing current shall be high amperage low voltage reversing DC decrement. Decrement shall be 30 points or more. The maximum demagnetizing current shall be sufficient to demagnetize parts magnetized by the output specified in Table I. The pushbutton switch for the automatic demagnetizing cycle shall, when momentarily depressed, initiate the automatic demagnetizing cycle. When the demagnetizing cycle has been completed the cycle shall stop automatically. The demagnetizing cycle shall be so designed that the demagnetization current can be started at any value from 10 percent to 100 percent of the machine rating.

* 3.5.3.8 Controls and instruments. Controls and instruments shall be provided as follows:

a. Instrument and control panel:

(1) AC magnetizing current ammeter (dual range 0 to 1200 amp, 1000 to maximum output).

(2) DC magnetizing current ammeter (dual range 0 to 1200 amp, 1000 to maximum output).

(3) Variable current control (30 or more points).

(4) Magnetizing current pushbutton switch.

(5) Line pilot light.

(6) Magnetizing and demagnetizing current pilot light.

(7) Demagnetizing switch "start" button.

(8) Remote control cable receptacle.

(9) 110 volt, AC, receptacle.

(10) Output terminals.

(11) Surge selector control.

b. Other controls, conveniently located:

Line disconnect switch.

* 3.5.3.8.1 Variable current control. A variable current control shall be provided to regulate the high amperage current. The control shall be mounted inside the cabinet, with control knob of nonconducting material on the front panel, readily accessible. The control shall have at least 30 or more points. The control shall incorporate a safety device to automatically stop the flow of magnetizing current should the operator change the position of the control while the magnetizing current is on.

* 3.5.3.8.2 Demagnetizing current control. A variable current control shall be used to automatically reduce, in 30 or more decrements, the flow of demagnetizing current. The control shall incorporate a device which will automatically stop it at the end of the demagnetizing cycle. The control knob shall be located on the control panel, and shall be arranged to permit starting of the demagnetizing cycle at any value.

* 3.5.3.8.3 Remote control cable and push-button station. This shall consist of a suitable start-stop push-button station with a suitable 15-foot, or longer flexible insulated cord, to which is attached a plug suitable for connection to the remote control-cable receptacle. Provisions shall be made for grounding the push-button station when the plug is connected to the receptacle.

* 3.5.3.8.4 Remote-control-cable extension shall consist of a plug and receptacle attached to opposite ends of a suitable 20-foot, or longer, flexible insulated cord. The plug shall be suitable for connection to the remote-control-cable receptacle. The receptacle shall permit connection and proper operation of the remote control cable and push-button station or the plug on the control cable of the contact prod.

* 3.5.3.8.5 Magnetizing current ammeters. Two ammeters shall be provided, one for AC magnetizing and demagnetizing current, and one for the full-wave rectified magnetizing current. Ammeters shall be dual range 0 to 1200 amperes, 1000 to the maximum output which the equipment is designed to deliver. The AC ammeter shall indicate AC root mean square (rms) amperes and the DC shall indicate DC (full wave rectified AC) magnetizing amperes. The ammeters shall be located on the control panel, and they shall be protected from damage by a metal guard.

* 3.5.3.8.6 Line disconnect switch. A suitable line disconnect switch shall be provided to control the AC power to the equipment. The line disconnect switch shall have a NEMA interrupting rating of at least 15,000 amperes AC.

* 3.5.3.8.7 Dual-voltage terminal board. The dual-voltage terminal board shall be suitable for changing the electrical connections in the equipment to permit operation of the equipment on 200/230 or 400/460 volts AC supply interchangeably, when the voltage of the external power source is either 200/230 or 400/460 volts. The manner in which the connections are made shall be clearly shown on the wiring diagram and on the terminal board proper.

* 3.5.3.8.7.1 Connections shall be changed by removing nuts or similar fasteners with a tool and rearranging copper connecting pieces on studs. A tag shall be provided on the equipment indicating the voltage for which the equipment is initially connected, and this voltage shall be the voltage of the external power source as specified in the contract or order (see 6.2).

* 3.5.3.8.8 High-voltage AC connections. A suitable, flexible 4-conductor cable at least 30 feet long shall be provided for high-voltage AC connections. The cable shall have heavy-duty-oil-resisting outer insulation. One of the conductors of the cable shall be used for grounding and shall be connected to the cabinet of the equipment. At the remote end, the ground conductor shall be identified with a suitable tag. Suitable provision shall be made for storage of the line cable and auxiliary cables when not in use.

* 3.5.4 Accessories. The following devices and items shall accompany each type V inspection unit:

a. Four 15-foot No. 4/0 cables with connectors on both ends (see 3.2.7.2 and 3.2.7.3).

b. Two 15-foot No. 2/0 cables with No. 4/0 connectors on both ends (see 3.2.7.2 and 3.2.7.3).

c. Contact prods, one pair, with No. 4/0 connectors (see 3.2.7.4).

d. Two contact clamps with No. 4/0 connectors (see 3.2.7.5).

e. Remote control cable and push button station.

f. Remote control cable extension.

g. Two powder bulbs.

h. 1 pound black powder.

i. 1 pound red powder.

j. Residual field indicator (see 3.2.7.10).

k. Operating and maintenance instructions, including wiring diagram.

* 3.5.4.1 Remote control cable receptacle. This receptacle shall be suitable for connection of the plug on the remote control cable and the plug on the control cable of the contact prod. When the proper plug is connected in the receptacle, the remote push-button station and the switch on the contact prod shall function as specified in 3.3.2.5.

* 3.5.4.2 Black powder. Black powder shall consist of black ferromagnetic particles suitable for use in the dry method of magnetic-particle inspection, packed in a suitable container.

* 3.5.4.3 Red powder. Red powder shall consist of red ferromagnetic particles suitable for use in the dry method of magnetic-particle inspection, packed in a suitable container.

* 3.5.4.4 Powder bulbs. Powder bulbs shall consist of flexible hand-operated rubber bulbs with perforated metal heads suitable for the application of black and red powder in a dust like or thin coating on flat and vertical surfaces in the dry method of magnetic particle inspection.

* 3.5.5 Optional equipment shall be provided as follows, when specified (see 6.2).

a. Powder blower.

b. Kit for fluorescent magnetic-particle inspection including:

(1) Portable black light, according to MIL-L-9909.

(2) Spare lamps for black light, according to MIL-L-9909.

(3) Two 12 ounce aerosol cans of fluorescent magnetic particles.

4. QUALITY ASSURANCE PROVISIONS

* 4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier 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 Preproduction tests. When specified, preproduction magnetic particle inspection sample unit shall be submitted for testing (see 6.2). The sample unit shall be subjected to all acceptance tests as applicable for each type including examination of product and performance tests. Approval of a sample unit shall have demonstrated the capabilities of the contractor to produce the units under contract and shall not be construed as a waiver of any specified requirement.

4.2.1 Test conditions. Testing of preproduction sample units shall be conducted in normal room temperature and humidity conditions.

4.3 Acceptance "tests." All the following tests shall be classified as acceptance tests. Unless otherwise specified, each magnetic particle inspection unit shall be inspected and tested and test data for each unit shall be identified by serial number. Each unit shall be presented to the Government inspector for verification or acceptance (see 6.2). All test equipment and facilities shall be provided by the contractor.

4.3.1 Examination of product. Each item of inspection equipment shall be inspected to determine compliance with the applicable requirements of this specification not covered by tests.

4.3.2 Type II equipment tests.

* 4.3.2.1 Electrical capacity. A round, solid copper bar, (98 percent International Annealed Copper Standard), 18 inches long and 1 inch in diameter, furnished with the equipment, shall be placed between the head contact plates, with its axis parallel to the centerline, through the center of pressure of the heads. Mechanical contact shall be made by the air cylinder mechanism or by operation of the motorized tailstock controlled by the limit switch. High-amperage current shall pass through the copper bar by depressing the control push-button. With the current control device in the proper position for maximum output the current ammeter indication shall be at least as much as the rated output in Table I. Ammeter(s) shall be checked by means of control instruments traceable to the National Bureau of Standards.

4.3.2.2 Duty cycle. The equipment shall be operated at the duty cycles specified in Table II and shall perform satisfactorily. The maximum temperature rise for the power transformer and rectifier shall be determined after one hour and a half of total duty cycle tests. The maximum temperature rise shall be determined by thermocouples placed at the hottest accessible exterior location.

* 4.3.2.3 Insulation. A dielectric strength test shall be applied for one minute between primary and core and between secondary and core of power transformer and between primary and secondary (see 3.1.5.2.2).

* 4.3.2.4 Demagnetizers shall be operated as specified in 3.2.6.10 and shall perform satisfactorily. The demagnetizer shall be capable of demagnetizing the piece to obtain a reading of less than 2-1/2 divisions on the residual field indicator.

* 4.3.2.5 Performance test. Equipment of each type shall be tested in the manufacturer's plant by using the equipment to inspect magnetic materials of different types which contain known discontinuities of different types in different directions. The equipment shall be tested to see that it performs consistently and satisfactorily when used to inspect by both the continuous and residual methods of inspection, using both longitudinal and circular magnetization. Tests shall be made by personnel experienced in magnetic-particle inspection.

4.3.2.5.1 Type II equipment shall be further checked to see that it is designed to consistently produce satisfactory indications of fine transverse discontinuities near the ends of retentive parts such as hardened pins and bolts. To determine whether suitable magnetizing effect is being produced by the coil for the inspection of this type of part, the following test may be used.

4.3.2.5.1.1 A 1,000-turn air core pickup coil approximately 5/8 inch long made of No. 38 enameled copper wire wound on 1-1/4 inch nonconducting tube shall be placed coaxially and coplanarly in the magnetizing coil. When the field of approximately 15,000 ampere turns is interrupted by the controls of the unit, a pulse of voltage with positive or negative peak must be consistently induced in the test coil. The magnitude of this peak voltage should be equal to or greater than that specified in Table V for the various coil sizes. This shall be determined by connecting the pickup coil directly to a resistive load of 1,000 ohms and measuring the voltage across this load by means of a device having a high input impedance, such as an oscilloscope.

TABLE V - Voltage Induced by Magnetizing Coils

Size of coil	Voltage (peak) reading
12 inches	8 volts
16 inches	6 volts
20 inches	4 volts
25 inches	3 volts

* 4.3.3. Types III and V equipment tests.

* 4.3.3.1 Electrical capacity. Two 15-foot lengths of No. 4/0 cable furnished with the equipment shall be connected in series, and then connected to the output connectors of the equipment. The cables shall be extended straight out from the equipment without any loops, and with the cables parallel and close together. High amperage current shall pass through the cables by depressing the remote control button. With the current control device in the proper position for maximum output, the current indicated by the magnetizing current ammeter shall be at least as much as the rated output in Table I. Two 90-foot lengths of No. 4/0 cable, plus two 10-foot lengths of No. 2/0 cable, plus the contact prods in contact with work at 6-inch spacing, shall be connected to the output connectors of the equipment. The cables shall be extended straight out from the equipment without any loops and with the cables parallel and close together. High-amperage current shall pass through the cables, prods, and work by depressing the remote control button. With the current control device in the proper position for maximum output, the current indicated by the magnetizing current ammeter shall be at least 25 percent of the rated output in Table I. Tests shall be made with AC and DC magnetizing currents. Ammeters shall be checked by means of control instruments which have been calibrated against standards traceable to National Bureau of Standards.

* 4.3.3.2 Duty cycle. The equipment shall meet the requirements of 4.3.2.2 with the exception that the duty cycle shall be as specified in Table III for type III and Table II for type V.

* 4.3.3.3 Insulation. The insulation shall meet the requirements of 4.3.2.3 (see 3.1.5.2.2).

* 4.3.3.4 Demagnetizers shall be operated as specified in 3.3.2.7 for type III and 3.5.3.7 for type V, and perform satisfactorily. The demagnetizer shall be capable of demagnetization of less than 2-1/2 divisions on the residual field indicator.

4.3.3.5 Performance test. The equipment shall meet the requirements of 4.3.2.5.

4.3.4 Type IV equipment tests.

* 4.3.4.1 Electrical capacity. Three 10-foot lengths of 2/0 cable furnished with the equipment shall be connected in series, and then connected to the output connectors of the equipment. The cables shall be extended straight out from the equipment without any loops, and with the cables parallel and close together. With the current control device in the proper position for maximum output, current shall be made to pass through the cables and shall be at least as much as the rated output in Table I. The unit shall be capable of delivering full output at 115 volts.

* 4.3.4.2 Heating. The maximum temperature rise for power transformer and rectifier shall be determined at the end of the "load-on" period, while operating on cycles of 6 minutes "load on" followed by 4 minutes "load off" for 1/2 hour when the unit is operating at 750 magnetizing DC amperes output when connected to a load of three 10-foot lengths of 2/0 cable. Temperature rise of transformer and rectifier shall be determined by thermocouples placed at the hottest accessible exterior location of each.

* 4.3.4.3 Insulation. Test requirements are the same as specified for 4.3.2.3 (see 3.1.5.2.2).

4.3.5 Performance test. The equipment shall meet the requirements of 4.3.2.5.

4.4 Rejection. Units which fail to comply with the requirements specified herein shall be rejected.

* 4.5 Inspection of the preservation, packaging and marking for shipment and storage. Sample items or packs and the inspection of the preservation, packaging, packing and marking for shipment and storage shall be in accordance with the requirements of Section 5, or the documents specified therein.

5. PREPARATION FOR DELIVERY

5.1 Levels of preservation (see 6.2).

5.1.1 Level A. Magnetic particle inspection units shall be cleaned by process C-1 and preserved and packaged in accordance with method IIa, MIL-P-116. The associated cables and cords shall be coiled in and stowed within the dehumidified barrier.

5.1.1.1 Particle dispensers. The particle dispensers shall be packaged in accordance with Method III, MIL-P-116.

5.1.1.2 Magnetic particles. The magnetic particles applicable for shipment with any type inspection unit shall be packaged in fiber-board boxes conforming to PPP-B-636, class 2.

5.1.2 Level C. Cleaning, drying and packaging shall be in accordance with the manufacturer's commercial practice.

5.2 Levels of packing (see 6.2).

5.2.1 Level A. Inspection equipment except type IV equipment shall be preserved as specified in 5.1.1 and shall be packed in exterior-type shipping containers conforming to MIL-C-104.

5.2.1.1 Level A for type IV equipment. When packaged as specified above, type IV inspection equipment shall be packed in a cleated plywood or nailed wood box conforming to PPP-B-601 (overseas type) or PPP-B-621 (class 2), respectively. The boxes shall be modified by the addition of 2 by 4 inch skids and the unit shall be secured through the base and skids. The dispenser and the magnetic power or particles shall be secured within the equipment container.

5.2.2 Level C. Packages which require overpacking for acceptance by the carrier shall be packed in exterior-type shipping containers in a manner that will insure safe transportation at the lowest rate to the point of delivery. Containers shall meet Consolidated Freight Classification Rules or regulations or other common carriers, as applicable to the mode of transportation.

* 5.3 Physical protection. Cushioning, blocking, bracing, and bolting, shall be in accordance with MIL-STD-1186, except that for domestic shipments, waterproofing requirements for cushioning materials and containers shall be waived. Drop tests of MIL-STD-1186 shall be waived when preservation, packaging, and packing of the item is for immediate use or when drop tests of MIL-P-116 are applicable (see 6.2).

* 5.4 Marking for shipment. Interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129.

6. NOTES

6.1 Intended use. Inspection units covered by this specification are intended for use in the magnetic-particle inspection of magnetic materials and parts for surface and sub-surface discontinuities. These units will be used in shop areas where both low or high humidity may exist. These units may be subjected to both high and low temperature and humidities during transportation and storage.

* 6.1.1 Type II self-contained units are intended for production use where 200/230 and 400/460 volt AC, 3 phase, 50/60 cycle is available.

* 6.1.2 Type III, type IV and type V equipments are intended for use for the inspection of parts, assembled or unassembled, in the field or wherever portable/mobile units are required. Type IV units do not contain automatic demagnetization capability and are smaller in size than the type II or V units.

* 6.2 Ordering data. Procurement documents should specify the following:

a. Title, number, and date of this specification.

b. Type and size unit (see 1.2 and 3.1.6).

c. Color of paint (see 3.1.3.2).

d. Loading by overhead handling or conveyor system (see 3.2).

e. Power supply voltage for initial connection for type II units (see 3.2.6.1), type III (see 3.3.2.1 and 3.3.2.8.7.1), and type V (see 3.5.3.1 and 3.5.3.8.7.1).

f. Magnetizing coil diameter for type II units (see 3.2.6.7).

g. Optional built-in demagnetizing facilities for type II units (see 3.2.6.10).

(Built-in or separate demagnetization facilities for size 26 or 54 inch units.)

(AC or reversing DC demagnetizing current.)

h. Optional features and accessories (type II, see 3.2.7 and 3.2.9) (type III, see 3.3.4).

i. Type IV units, length of power cord and type of terminal plug if other than specified (see 3.4.3.5.1).

j. If first article testing is required (see 4.2).

k. If sampling plan is required (see 4.3).

l. Inspection of preservation, packaging and packing (see 4.5).

m. Level of preservation, packaging, and packing (see 5.1 and 5.2).

n. If packing drop test is required (see 5.3).

6.3 Type I units covered horizontal, wet-method equipment in which the high amperage magnetizing current was supplied from storage batteries. There are no current requirements for these units (see 1.2).

6.4 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 contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

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Navy - AS

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Navy - AS

Preparing Activity:
Air Force - 82

Project No. 6635-0039

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE

3a. NAME OF SUBMITTING ORGANIZATION	4. TYPE OF ORGANIZATION *(Mark one)*
	☐ VENDOR
b. ADDRESS *(Street, City, State, ZIP Code)*	☐ USER
	☐ MANUFACTURER
	☐ OTHER *(Specify)*: _____

5. PROBLEM AREAS

a. Paragraph Number and Wording:

b. Recommended Wording:

c. Reason/Rationale for Recommendation:

6. REMARKS

7a. NAME OF SUBMITTER *(Last, First, MI)* – Optional	b. WORK TELEPHONE NUMBER *(Include Area Code)* – Optional
c. MAILING ADDRESS *(Street, City, State, ZIP Code)* – Optional	8. DATE OF SUBMISSION *(YYMMDD)*

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