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MILITARY SPECIFICATION

FURNACES, HEAT-TREATING AND BRAZING, ELECTRIC, CONTROLLED ATMOSPHERE, PUSHER AND CONVEYOR BELT TYPES

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

1. SCOPE

1.1 Scope. This specification covers electrically heated, controlled atmosphere, heat-treating and brazing furnaces of the horizontal pusher and belt conveyor types with operating temperature ranges of 1300°F through 2100°F.

1.2 Classification. This specification covers furnaces of the following types and sizes. The type supplied shall be as specified (see 6.2.1).

1.2.1 Types.

Type I - Manual pusher, full muffle
Type II - Horizontal belt conveyor, full muffle
Type III - Hump belt conveyor, full muffle
Type IV - Horizontal belt conveyor, nonmuffle

1.2.2 Sizes. The size of the furnace supplied shall be as specified (see 3.6 and 6.2.1).

Beneficial comments (recommendations, additions, deletions) and any pertinent data which may be of use in improving this document should be addressed to: Defense Industrial Plant Equipment Center, ATTN: DIPEC-SSM, Memphis, Tennessee 38114-5297, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

AMSC/NA FSC 3424

2. APPLICABLE DOCUMENTS

2.1 Government documents.

2.1.1 Specifications and standards. The following specifications and standards form a part of this specification to the extent specified herein. Unless otherwise specified, the issue of these documents shall be those listed in the issue of the Department of Defense Index of Specifications and Standards (DoDISS) and supplement thereto, cited in the solicitation.

SPECIFICATIONS

MILITARY

MIL-F-3296 - Forges, Furnaces, and Ovens (Exclusive of Space Heating and Cooking), Packaging of.

STANDARDS

FEDERAL

FED-STD-H28 - Screw Thread Standards for Federal Services.

FED-STD-376 - Preferred Metric Units for General Use by the Federal Government.

2.1.2 Other Government documents and publications. The following other Government documents and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues shall be those in effect on the date of the solicitation.

U. S. DEPARTMENT OF LABOR

OSHA 2206 - General Industry, OSHA Safety and Health Standards (29 CFR 1910).

(Application for copies should be addressed to the Superintendent of Documents, Government Printing Office, Washington, DC 20402.)

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

2.2 Other publications. The following document form a part of this specification to the extent specified herein. Unless otherwise specified, the issue of the document which are DoD adopted shall be those listed in the listed in the issue of the DoDISS specified in the solicitation. Unless otherwise specified, the issue of documents not listed in the DoDISS shall be the issue of the non-Government documents which are current on the date of the solicitation.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI/NEMA ICS - Industrial Control and Systems.

ANSI/C96.1 - Temperature Measurement Thermocouples.

(Application for copies should be addressed to the American National Standards Institute, ATTN: Sales Dept., 1430 Broadway, New York, NY 10018.)

AMERICAN SOCIETY FOR TESTING AND MATERIAL (ASTM)

ASTM D 3951 - Standard Practice for Commercial Packaging.

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

AMERICAN GEAR MANUFACTURER'S ASSOCIATION (AGMA)

AGMA 360.02 - Manual for Machine Tool Gearing.

AGMA 390.03 - Gear Classification, Materials and Measuring Methods For Unassembled Gears.

(Application for copies should be addressed to the American Gear Manufacturer's Association, Standards Department, Suite 1000, 1901 North Fort Meyer Drive, Arlington, VA 22209-1695.)

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO 54 - Cylindrical Gears For General Engineering and For Heavy Engineering, Modules and Diametral Pitches of.

ISO R1122 - Gears, Glossary of, Geometrical Definitions.

(Application for copies should be addressed to the International Organization for Standardization, c/o American National Standards Institute, ATTN: Sales Department, 1430 Broadway, New York, NY 10018.)

FACTORY MUTUAL ENGINEERING CORPORATION (FM)

Handbook of Industrial Loss Prevention.

(Application for copies should be addressed to Factory Mutual Engineering Corporation, 1151 Boston - Providence Turnpike, Norwood, MA 02062.)

(Non-Government standards and other publications are normally available from the organizations which prepare or which distribute the documents. These documents also may be available in or through libraries or other informational services.)

2.3 Order of precedence. In the event of a conflict between the text of this specification and the references cited herein (except for associated detail specification, specification sheets or MS standards), the text of this specification shall take precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 First article. When specified (see 6.2.1), a sample shall be subjected to first article inspection (see 4.3 and 6.3).

3.2 Design. The furnace shall be new and one of the manufacturer's current models. The furnace shall be designed for processing the work through the chamber on a horizontal plane, with an opening in the front for loading and in the rear for discharging the workload. The furnaces shall be electrically heated and designed for operation with a manufactured atmosphere.

3.2.1 Type I. Type I furnaces shall be of the horizontal, straight-through design. The furnace shall be designed for hand pushing of work from a loading stand into a purge chamber, a heating chamber, a cooling chamber and removed through a rear door onto a runout table. Design and construction of the furnace shall be such that the complete work cycle will be accomplished in a protective atmosphere. Type I furnaces shall have a full muffle and unless otherwise specified (see 6.2.1), shall be designed for operation with an endothermic type of atmosphere (see 6.6).

3.2.2 Type II. Type II furnaces shall be of the horizontal, straight-through, continuous belt conveyor design. The furnace shall be designed for loading of work on a conveyor belt, in which the work will move through a purge chamber, heating chamber, and cooling chamber in a protective atmosphere and be removed from the belt at the rear of the furnace. Type II furnaces shall have full muffle and unless otherwise specified (see 6.2.1), shall be designed for operation with an endothermic type of atmosphere (see 6.5).

3.2.3 Type III. Type III furnaces shall be of the hump conveyor belt design. Furnaces of this type shall be designed primarily for use with hydrogen atmosphere. The heating chamber hearth shall be elevated above the top of the charge and discharge openings with the purge and cooling chambers arranged on an incline approximately 12 degrees off a horizontal plane with the heating chamber level.

3.2.4 Type IV. Type IV furnaces shall be of the horizontal, straight-through, continuous belt conveyor design. The furnace shall be designed for loading of work on a conveyor belt, in which the work will move through a purge chamber, heating chamber, and cooling chamber in a protective atmosphere and be removed from the belt at the rear of the furnace. Type IV furnaces shall be furnished without a muffle and shall be designed for operation with an endothermic type of atmosphere.

3.2.5 Measurement systems. Unless otherwise specified, either the U.S. Customary System of Units (US) or the International System of Units (SI) shall be used in the design and construction of the furnace. When only one system of measurement is acceptable, the particular system required shall be as specified (see 6.2.1). In this specification, all measurements,

dimensions, sizes, and capacities are given in US units. These measurements may be converted to SI units through the use of the conversion factors and methods specified in FED-STD-376.

3.2.5.1 Dual calibrations. When specified (see 6.2.1), measuring and indicating devices shall be graduated in both the US and the SI System of Measurements.

3.2.6 Material. All material used in the fabrication of the furnace shall be of the quality necessary to produce a furnace to meet the requirements described herein. Materials that are exposed to the atmosphere of the heating chamber shall be compatible with the type of atmosphere to be used in the furnace.

3.2.7 Reclaimed materials. The furnace may contain reclaimed materials provided such materials will not jeopardize the furnace's intended use and performance. The reclaimed materials shall have been reprocessed, remanufactured, or recycled in a manner which will restore them to the same chemical composition and physical properties as the materials originally selected for use on the furnace.

3.2.8 Energy efficiency. The furnace and its applicable components that directly consume energy in normal operation shall be designed and constructed for the highest degree of energy efficiency as governed by the latest developments available within the Industry.

3.2.9 Lubrication. Means shall be provided to insure adequate lubrication for all moving parts. Recirculating lubrication systems shall include a filter which is cleanable or replaceable. Each lubricant reservoir shall have means for determining fluid level. All oil holes, grease fittings, and filler caps shall be accessible.

3.2.10 Safety and health requirements. Covers, guards, or other safety devices shall be provided for all parts of the furnace that present safety hazards. The safety devices shall not interfere with the operation of the furnace. The safety devices shall prevent unintentional contact with the guarded part, and shall be removable to facilitate inspection, maintenance, and repair of the parts. All parts, components, mechanisms, and assemblies furnished on the furnace, whether or not specifically required herein, shall comply with all of the requirements of OSHA 2206 that are applicable to the furnace itself. The safety systems of the furnace shall conform to the requirements of "FM Handbook of Industrial Loss Prevention". Additional safety and health requirements shall be as specified (see 6.2.1 and 6.4).

3.2.11 Mercury restriction. The furnace shall not contain mercury or mercury compounds nor be exposed to free mercury during manufacture.

3.2.12 Asbestos restriction. Asbestos and materials containing asbestos shall not be used on or in the furnace.

3.2.13 Interchangeability. All parts shall be manufactured to definite dimensions and tolerances that will permit installation of replacement parts without modification of the part or furnace.

3.2.14 Accessibility. All parts subject to wear, breakage, or distortion and all parts which require periodic lubrication or maintenance shall be accessible for adjustment, replacement, and lubricant as applicable.

3.3 Construction. The furnace shall be constructed of parts which are new, without defects, and free of repairs. The structure shall be capable of withstanding all forces encountered during operation of the furnace at its maximum rating and capacity without permanent distortion.

3.3.1 Castings and forgings. All castings and forgings shall be free from defects such as scale and mismatching. Processes such as welding, peening, plugging, or filling with solders or pastes shall not be used on castings or forgings to reclaim any defective components for use on the furnace. Such processes may be used only for enhancing surface finish and appearance.

3.3.2 Welding, brazing, or soldering. Welding, brazing, or soldering shall be employed only where specified in the original design. None of these processes shall be employed as a repair measure for any defective part.

3.3.3 Fastening devices. All screws, pins, bolts, and other fasteners shall be installed in a manner to prevent change of tightness. Fastening devices subject to removal or adjustment shall not be swaged, peened, staked, or otherwise permanently installed.

3.3.4 Surfaces. All surfaces shall be clean and free of sand, dirt, fins, sprues, flash, scale, flux, and other harmful or extraneous materials. All edges shall be either rounded or beveled unless sharpness is required to perform a necessary function. Except as otherwise specified herein, the condition and finish of all surfaces shall be in accordance with the manufacturer's commercial practice.

3.3.5 Painting. The furnaces shall be primed and painted with heat resisting paint in accordance with the manufacturer's commercial practice.

3.3.6 Threads. All threaded parts used on the furnace and its related attachments and accessories shall conform to FED-STD-H28.

3.3.7 Gears. All gears and pinions used in the furnace or its components, shall be properly selected for the intended application and fabricated to either English (USA) standards per AGMA 390.03 and AGMA 360.02 or Metric (SI) standards per the International Organization for Standardization, ISO-112, ISO-54, and FED-STD-376.

3.4 Electrical equipment. The furnaces shall be furnished complete with all motors, controls, relays, signal lights, and switches prewired where possible for operation upon connection to source of power. Each furnace shall draw all electrical power from a single source power supply fed through a fused safety disconnect switch. All electrical equipment shall conform to Standard ICS 1.

3.4.1 Power supply. Unless otherwise specified (see 6.2.1), the furnace shall be designed to operate on 230/460 volts, 60-Hz, 3-phase power supply and wired for the 460-volt operation.

3.4.2 Motors. Motors shall be continuous duty, dual voltage, 230/460 volts and have ball or roller bearings. Motors rated in excess of 1/2 horsepower shall operate on the same voltage and phase required for the furnace.

3.5 Performance. Each furnace shall be capable of operating continuously with maximum loads through the temperature range of 1300°F to 2100°F. Unless otherwise specified (see 6.2.1), maximum loads or production rate shall be as specified in tables herein for each type and size furnace.

3.5.1 Temperature uniformity. The type I furnace, when operating with production loads and the heating chamber temperature stabilized, the temperature variation form chamber control point to any other point within the heating chamber effective working area shall vary not more than 20°F. The type II, III and type IV furnace, when operating with production loads and the heating chamber temperature stabilized, the temperature shall vary not more than 20°F across the width of the belt in the effective working area of the chamber. The effective working area of the chamber may be defined as up to 20 percent less than the actual heating chamber length. Each furnace shall be capable of maintaining the temperature uniformity specified, at any desired temperature control point within its operating range, with any size load up to maximum production rate.

3.6 Sizes. The size of the furnace shall be as specified (see 6.2.1) and should be selected from the sizes listed in tables herein for the type furnace required. If a chamber size different from the dimensions listed in tables herein is required, the chamber dimensions, cooling chamber length and number of zones, KW input and production rate shall be as specified.

3.7 Components and systems. Principal component parts of the furnace shall consist of the shell, hearth, refractory, muffle, purge chamber, doors, atmosphere curtain, cooling system, heating elements, conveyor system, thermocouples and instruments.

3.7.1 Shell. The outer shell of the furnace heating chamber shall be a welded fabrication of steel plate, not less than 3/16 inch in thickness, properly reinforced and braced with steel angle and shapes. The shell of nonmuffled furnaces shall be gas-tight constructed, with all joints and seams continuously welded, except openings required for repair or rebuild,

TABLE I. Sizes and capacities.

Size	Type I - Manual pusher, full muffle design						
	Heating Chamber Inside Dimensions, inches			Cooling Chamber		Electrical Input, K.W.	Production rate at 2100°F
	Width	Height	Length	Length, Inches	Number of zones		Lbs/Hr.
30	6	5	18	60	1	30	50
38	8	6	20	60	1	38	75
45	10	8	24	96	2	45	125
56	12	8	36	144	2	56	150
70	15	10	42	168	3	70	250
80	18	12	42	168	3	80	300

Requirements are not less than those shown.

Table II. Sizes and capacities.

Size	Type II - Horizontal conveyor, full muffle design						
	Heating Chamber Inside Dimensions, inches			Cooling Chamber		Electrical Input, K.W.	Production rate at 2050°F
	Width	Height	Length	Length, Inches	Number of zones		Lbs/Hr.
15	3	2	36	108	2	15	20
20	4	2	36	108	2	20	30
25	6	2	48	144	2	25	60
30	8	3	54	162	3	30	90
50	10	4	60	180	3	50	125
59	12	6	72	216	3	59	180
60	12	6	63	240	3	60	180
61	18	6	63	240	3	61	180

Requirements are not less than those shown.

TABLE I. Sizes and capacities.

Size	Type III - Horizontal hump belt, full muffle design						
	Heating Chamber Inside Dimensions, inches			Cooling Chamber		Electrical Input, K.W.	Production rate at 2050°F
	Belt Width	Height	Length	Length, Inches	Number of zones		Lbs/Hr.
20	3	3	36	108	2	20	25
25	5	3	48	144	2	25	50
30	7	4	54	162	3	30	79
50	9	5	60	180	3	50	112
60	11	6	72	216	3	60	165
75	12	6	45	216	3	75	165
100	18	13	72	232	4	100	280

Requirements are not less than those shown.

Table II. Sizes and capacities.

Size	Type IV - Horizontal conveyor, full muffle design						
	Heating Chamber Inside Dimensions, inches			Cooling Chamber Length, Feet	Cooling Water Number of 60°F rise (GPH)	Electrical Input, K.W.	Production rate at 2050°F
	Width	Height	Lenght				Lbs/Hr.
42	8	7	60	15	125	42	140
62	12	11	60	15	185	60	210
90	12	11	96	24	295	90	280
75	18	11	60	15	275	75	250
125	18	11	96	24	440	125	420
175	18	11	132	33	665	175	530
160	24	11	96	24	590	160	560
195	24	11	132	33	890	195	710
200	30	11	96	24	740	200	700
250	30	11	132	33	1100	250	885
230	36	11	96	24	890	230	840
270	36	11	132	33	1330	270	1068

Requirements are not less than those shown.

which shall have gaskets and bolts. End plates shall be so designed and of such material and construction that warping will be prevented. Muffled furnaces shall be designed with removable roofs, or other means provided for replacing the muffle with minimum disturbance to insulation. Furnaces with removable roofs shall be provided with lifting eyes permanently secured to the furnace. Atmosphere and thermocouple openings shall be provided with gas tight seals.

3.7.2 Hearth. The hearth plates shall be constructed of material that will readily conduct heat to the interior of the furnace, and prevent distortion and atmosphere contamination. The hearth shall be designed to prevent buckling and warping and permit maximum heat transfer and uniform temperature through the heating chamber and through not less than first cooling section. The hearth plates shall be easily removed and replaced and designed to allow unrestricted movement for expansion and contraction.

3.7.3 Insulation. The heating chamber lining shall consist of suitable refractory brick, insulating block or ceramic fiber insulation selected to minimize atmosphere contamination, resist abrasion and spalling, backed up with insulating block or preformed insulation. If ceramic fiber insulation is used, the fiber material shall be compatible with the atmosphere that will be used in the chamber and insulation techniques and hardware shall conform with the recommendations of the fiber material manufacturer. Overall thickness and quality of the furnace lining shall be such that the outside surface temperature of the furnace will not exceed 100°F above ambient air at maximum operating temperature. When motor is used, it should be of the same basic material as the units being cemented together. Powdered, shredded, or granular insulation shall not be used for insulation purposes. Type I, II, and III furnaces shall have full muffle heating chambers.

3.7.4 Muffle. Muffles shall be designed to minimize thermal shock, prevent warping and distortion, and shall be capable of operating continuously with an internal chamber temperature of 2100°F. Muffles shall be fabricated or cast from an alloy containing 48 percent nickel and 28 percent chromium. The muffles shall extend from the outside of each heating chamber opening, through the heating chamber. Muffles shall be secured at one end and means provided at the opposite end for expansion and contraction. The muffle inside dimensions shall be not less than the rectangular dimensions specified for the size furnace required.

3.7.5 Purge chamber. Purge chambers shall be designed and constructed of material to prevent warping. The chambers shall be fully insulated and gastight constructed. The outside surface temperature shall not exceed the outside surface temperature of the heating chamber. The inside length of the purge chamber of the type I furnace shall be as specified (see 6.2.1). The inside length of the purge chamber for the conveyor furnace shall be sufficient to minimize atmosphere contamination and losses. Each chamber shall be provided with sufficient atmosphere inlets and exhaust outlets.

3.7.6 Doors.

3.7.6.1 Type I. Type I furnaces shall be furnished with cast iron, inclined type doors at both the loading and discharge openings of the furnace. The doors shall be designed so that their weight holds them firmly against a machined metal end-plate providing an effective metal to metal seal. The doors shall be self-relieving in the event of excessive internal pressure, manually operated and provided with suitable counterweights. When specified (see 6.2.1), in addition to the inclined doors, type I furnaces shall be provided with air operated, refractory insulated, internal doors located in the throat of the furnace at each end of the heating chamber.

3.7.6.2 Type II, type III, and type IV. Conveyor type furnaces shall be provided with metal adjustable, or top hinged, free swinging doors at each opening. Type IV furnaces with belt widths of 18 inches and wider shall have refractory inner doors located at each end of the heating chamber.

3.7.7 Atmosphere curtains. The type III and type IV furnaces shall be provided with a sufficient number of atmosphere curtains located inside the charge and discharge openings to minimize the loss of atmosphere.

3.7.8 Flame curtain (type I). When specified (see 6.2.1), type I furnaces shall be provided with gas-air flame curtains for each door opening. The flame curtain shall operate automatically by limit switches through solenoid valves to protect the atmosphere when the doors are opened.

3.7.9 Cooling system. Each furnace shall be equipped with a water-jacketed cooling chamber. Number of zones and minimum over-all length of the cooling chamber shall be as specified in the tables herein. Multiple zone automatic water temperature controls shall be provided with direct reading thermometers on each individual zone. The cooling system shall be capable of cooling the production rate of the furnace from 2100°F to 250°F The cooling system shall be of the recirculating type and shall not require the continuous input and discharge of cooling water from the main water supply.

3.7.10 Heating elements. Unless otherwise specified (see 6.2.1), the furnaces shall be heated by silicon carbide rod type elements. A multiple tap transformer having not less than 7 taps shall be provided for changing voltage. An ammeter shall be provided to detect change in resistance of the elements. The power density on the elements shall not exceed 50 watts per square inch of radiation surface. The elements shall be removable and replaceable without disassembling the furnace or removing any refractory or insulation.

3.7.11 Conveyor system (type II, type III, and type Iv). The conveyor belt shall be driven from the charge end of the furnace by a variable speed drive system. Belt speed shall be adjustable form 2 inches to 20 inches travel per minute. The drive drum shall be covered with rubber or similar material and equipped with a pinch roller mechanism and automatic slack takeup system. Sufficient exposed belt area shall be provided at each end

of the furnace to facilitate loading and unloading. Loading and unloading level of conveyor shall be between 38 and 44 inches above floor level. Type III furnaces shall be provided with rollers in the purge chamber or an escalator system to minimize belt tension on the upward incline. The belt of each furnace shall be supported through the return travel.

3.7.11.1 Conveyor belt. Unless otherwise specified (see 6.2.1), the type II, type III and type IV furnaces shall be provided with woven wire mesh alloy belts. The belts shall be of wire cloth construction, with 1/2-inch center-to-center mesh, 12 gauge, 25 percent chrome and 20 percent nickel steel wire. The belt shall be capable of continuous operation in furnace temperatures of 2100°F with a workload of not less than 7 pounds per square foot of surface belt area. The width of the belt shall be not less than the width specified for the chamber.

3.7.12 Thermocouples. Chromel-alumel type thermocouples conforming to ANS C96.1 shall be used as the temperature sensing device for each instrument. The thermocouples shall be protected from the contamination of the furnace gases by protective tubes. Thermocouple lead wires shall be not less than 25 feet in length and of the same material as the thermocouples, or of a material having the same thermoelectric characteristics at a thermocouple head temperature between 0 degrees and 250°F.

3.7.13 Instruments. Each furnace shall be provided with a single temperature indicating-recording-controller type instrument with an accuracy of 0.50 percent of full scale reading. The instrument shall provide the operating characteristics, control functions and tolerances specified in 3.7.13 through 3.7.13.3. Solid-state design shall be employed where possible. The instruments shall be marked to indicate the particular type of thermocouple for which its calibrated. Automatic reference junction compensation shall be provided in all instruments using thermocouples as the primary temperature sensing element. When specified (see 6.2.1), all instruments shall be of the digital readout design and the recorder shall be of the print-out design.

3.7.13.1 Microprocessor. When specified (see 6.2.1), the furnace control system shall incorporate a microprocessor digital programmable/controller to provide maximum control flexibility within the limitations of the furnace's designed capability. The microprocessor shall provide for not less than 50 read/write programmable segments of random access memory and input into the system shall be by manual data input (MDI) through a keyboard and magnetic tape cassette.

3.7.13.2 Temperature recorder. The temperature recorder shall be of the strip chart, self-balancing type. The recorder shall include a safety switch operated from the front of the instrument that may be positioned above set point to shut off heat under excess temperature condition. The instrument shall also be provided with a thermocouple upscale device which will act through the safety system to shut off the heat source to the furnace in the event of thermocouple failure. Unless otherwise specified, the

calibrated chart width shall be not less than 6 inches, and the chart length shall be not less than 80 feet to the roll. The chart speed shall be one-inch per hour. The chart mechanism shall be furnished in a dust proof housing with a glass door that permits full view of chart width and not less than 7 inches of chart length. When required, the chart width shall be not less than 9 or 12 inches, as specified (see 6.2.1), and the chart length shall be 120 feet to the roll.

3.7.13.3 Temperature controller. The temperature controller shall be of proportioning, automatic, controlling type. The controller shall be capable of maintaining the set control temperature of the furnace heating chamber with a deviation of not greater than $\pm 2^{\circ}F$.

3.7.13.4 Temperature indicator. The temperature indicator scale of the instrument shall be approximately the same length as the temperature recorder chart width. The calibrated scale range shall be at least $100^{\circ}F$ above the maximum temperature of the furnace. The increments between successive temperature marks shall not be greater than $20^{\circ}F$, with the spacing of numbered marks not greater than $400^{\circ}F$. The control indicator shall be provided with two pointers. One pointer shall be adjustable to the desired control chamber temperature, and one pointer shall indicate the actual chamber temperature.

3.7.13.5 Excess temperature control. When specified (see 6.2.1), the furnace shall be provided with an excess temperature controller. The excess temperature control instrument and circuit shall be independent of the furnace control system. The instrument shall function to shut off the heat source to the furnace when the over-temperature control point is reached. In case the furnace is shut down by the excess temperature control system, the system shall sound an audible alarm, and the furnace shall remain off until started manually. Calibrated accuracy shall be within one percent of full scale reading.

3.7.13.6 Instrument panel. Floor mounted instrument panels shall be provided for mounting all instruments and accessory controls. The panels shall conform to NEMA Standard ICS-1. All ventilated openings shall be designed to prevent entrance of any deleterious substance. Signal lights shall be provided to indicate the furnace cycle performance. The panels shall provide flush or semi-flush mounting of all instruments.

3.8 Atmosphere generator. When specified (see 6.2.1), the furnace shall be furnished with protective atmosphere generator, complete with all necessary piping, control and safety equipment. Type of atmosphere, size of generator (CFH) and dew point requirements shall be as specified.

3.9 Loading and unloading platforms. When specified (see 6.2.1), loading and unloading platforms shall be furnished. Design and dimensions shall be as specified.

3.10 Power pusher. When specified (see 6.2.1), a power pusher mechanism shall be provided for use on the charge end of the type I furnace. Design and performance requirements shall be as specified.

3.11 Trays and fixtures. When specified (see 6.2.1), work trays and fixtures shall be furnished. Design and dimensions shall be as specified.

3.11.1 Nameplate. Unless otherwise specified (see 6.2.1), a nameplate shall be securely attached to each furnace. The nameplate shall contain the information listed below. If the furnace is a special model, the model designation shall include the model of the basic standard furnace and a suffix identified in the manufacturer's permanent records. The captions listed may be shortened or abbreviated, provided the entry for each caption is clear as to its identity.

Nomenclature
Manufacturer's name
Manufacturer's model designation
Manufacturer's serial number
Power input characteristics and ratings
Heating chamber, inside dimensions
Belt width, when applicable
Operating temperature range (°F)
Compatible atmosphere
Date of manufacturer
Contract Number or Order Number
National Stock Number or Plant Equipment Code
U S

3.12 Technical data. When technical data is required it shall be furnished in accordance with the requirements of the contract. All technical data furnished shall be written in the English language.

3.13 Workmanship. Workmanship of the furnace and accessories shall be of a quality equal to that of the manufacturer's commercial equipment of the type specified herein.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the contractor is responsible for the performance of all inspection requirements specified herein. Except as otherwise specified in the contract or purchase order, 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 inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Responsibility for compliance. All items must meet all requirements of sections 3 and 5. The inspections set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all products or supplies submitted to the Government for acceptance comply with all requirements of the contact. Sampling in quality conformance does not authroize submission of known defective material, either indicated or actual, nor does it commit the Government to acceptance of defective material.

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

a. First article inspection (see 4.4).

b. Quality conformance inspection (see 4.5).

4.3. Inspection conditions. Unless otherwise specified herein, all inspections, tests, and examinations shall be performed in the manufacturer's designated indoor test area under the ambient temperature, the relative humidity, and the air pressure existing inside the building at the time the inspections, tests, and examinations are performed.

4.4 First article inspection. When a first article inspection is required, it shall be applied to the first article submitted in accordance with 3.1. Unless otherwise specified (see 6.2.1), first article inspection shall consist of the examination in 4.6 and all tests in 4.7. Failure of the item to pass the first article examination and all tests shall be cause for rejection.

4.5 Quality conformance inspection. Quality conformance inspection shall be applied to each item prior to being offered for acceptance under the contract. Unless otherwise specified (see 6.2.1), quality conformance inspection shall consist of the examination in 4.6, the test in 4.7.1, and the inspection in 4.8. Failure of the item to pass the examination, the test, or inspection shall be cause for rejection.

4.6 Examination. The furnace and equipment shall be examined for design, dimensions, construction, materials, components, electrical equipment, safety conformance, and workmanship to determine compliance with the requirements of this specification.

4.7 Tests. All tests shall be conducted at an ambient temperature of 77°F ±18°F. Test instruments and sensing elements, used to perform the test specified for the furnace and the instruments should have been checked against a standard potentiometer type instrument and calibrated thermocouple of known accuracy, within the previous six months to read accurately within ±2°F.

4.7.1 Instrument test. Indicating and recording instruments shall be tested by impressing various predetermined voltages, simulating thermocouple outputs for different furnace temperatures to terminals where normally the thermocouples would be connected. These tests shall be made in accordance with, and results checked against, standards established in ANSI C96.1.

4.7.2 Circuit test. Each circuit of the electrical system shall be tested for dielectric strength, continuity, short circuits, and faulty grounds, in accordance with the requirements of NEMA Standard ICS-1.

4.7.3 Performance tests (type I). The pusher furnace selected for preproduction test shall be prepared for operation, and operated in accordance with the manufacturer's handbook of instructions until equilibrium has been established at a work chamber temperature of 2100°F. The furnace shall then be operated for a period of 2 hours with production charges of iron or steel processed through the furnace. Each charge shall equal approximately 1-3 of production rate specified for the furnace. During the second hour of production the furnace shall process a quantity of iron or steel equal to not less than the production rate specified for the size furnace under test. The material shall be heated to a temperature of 2100°F $\pm$10°F, and cooled to a temperature not greater than 250°F. The temperature of the material entering the furnace shall be 77°F $\pm$18°F.

4.7.4 Temperature uniformity test (type I). The furnace shall be operated under production conditions with charges of iron or steel equivalent to not less than 80 percent of maximum load, and a chamber temperature survey shall be performed to determine conformance with 3.5.1. Not less than 9 test thermocouples shall be used, with one thermocouple located in each corner of the effective heating zone and one located with 3 inches of the instrument control thermocouple. For furnaces with chamber heating space of 10 cubic feet or less, the temperature survey may be performed with a minimum of 3 thermocouples with one each located at the front, middle and rear of the effective heating zone. The survey shall be performed under equalibrium conditions at minimum and maximum temperature range of the furnace. Temperature readings shall be continuously recorded, or taken at not greater than 5 minute intervals for not less than 30 minutes, and the maximum temperature variation of all points under test shall not exceed 20°F. With the temperature stabilized at maximum temperature, the outside surface temperature shall be checked at random locations, and shall not exceed the limit specified in 3.7.3.

4.7.5 Performance test (type II, type III and type IV). The type II, type III, or type IV furnaces selected for first article test shall be prepared for operation, and operated in accordance with the manufacturer's handbook of instructions until equilibrium has been established at a work chamber temperature of 2100°F. The furnace shall then be operated in continuous production for 2 hours, with a load on the conveyor belt equivalent to 7 pounds for each square foot of working belt surface. During the first hour of production the belt speed shall be checked, and any necessary instrument, thermostat, and belt adjustments made prior to production test.

The conveyor belt shall have constant velocity (within ±5 percent) at any preset speed between 2 and 20 inches travel per minute. During the second hour of production the furnace shall process a quantity of iron or steel equal to at least the production requirements specified for the size furnace under test. The material shall be heated to a temperature of 2050°F ±10°F and cooled to a temperature not greater than 250°F. The temperature of the change entering the furnace shall be 77°F ±18°F.

4.7.6 Temperature uniformity test (type II, type III, and type IV furnaces). The conveyor furnace shall be operated as specified in 4.7.5 and the exact test performed except only 4 thermocouples shall be used with one placed in each corner of the effective heating zone. The temperature variation across the width of the belt or across the width of the chamber shall not exceed 20°F. The outside surface temperature shall be tested at random locations and shall not exceed the limit specified in 3.7.3.

4.8 Packaging inspection. Packaging of each item shall be inspected to determine compliance with the requirements of section 5.

5. PACKAGING

5.1 Packaging, packing, marking. Unless otherwise specified, packaging, packing, and marking shall be in accordance with ASTM D 3951. When specified preservation, packing, and marking shall be in accordance with specification MIL-F-3296. Level of preservation and packing shall be as specified (see 6.2.1).

6. NOTES

6.1 Intended use.

6.1.1 Type I. Type I furnaces are intended primarily for use with controlled atmosphere for heat treatment of stainless, high carbon or other air hardening type steels, and for silver or copper brazing, metal bonding, sintering and annealing processes.

6.1.2 Type II. Type II furnaces are intended for such processes as brazing, sintering, annealing and air hardening of steels with a controlled atmosphere.

6.1.3 Type III. Type III furnaces are intended for heat treatment and brazing processes using hydrogen atmosphere.

6.2 Ordering data.

6.2.1 Acquisition requirements. Acquisition documents should specify the following:

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

b. Type and size furnace required (see 1.2 and 3.6). (If chamber dimensions different from those listed in tables are required, specify chamber width, height and length, cooling chamber characteristics, power input and production.

c. First article approval, if required (see 3.1).

d. Type of atmosphere the furnace will use, if other than endothermic. type I and II only (see 3.2.1, 3.2.2 and 6.6).

e. If measuring and indicating devices are required to be graduated in a specific measurement system (US or SI), state required system (see 3.2.5).

f. Dual calibrations (US and SI), if required (see 3.2.5.1).

g. Specify exceptions and safety and health requirements (see 3.2.10 and 6.4).

h. Power supply, if different (see 3.4.1).

i. Production rate, if different (see 3.5).

j. Purge chamber length in inches (type I furnace only), (see 3.7.5).

k. Internal doors, if required (type I furnace only) (see 3.7.6.1).

l. Flame curtain, if required (type I furnace only) (see 3.7.8).

m. Heating elements, if different (see 3.7.10).

n. Conveyor belt, if different (see 3.7.11.1).

o. Digital readout instruments, if required (see 3.7.13).

p. Microprocessor when required (see 3.7.13.1).

q. Recorder chart width, if different (specify width required) (see 3.7.13.2).

r. Excess temperature controller, if required (see 3.7.13.5).

s. Atmosphere generator, if required (see 3.8).

t. Loading and unloading platforms, if required (see 3.9).

u. Power pusher, if required (see 3.10).

v. Trays and fixtures if required (see 3.11).

w. Nameplate, if different (see 3.11.1).

x. First article inspection, if different (see 4.3).

y. Quality conformance inspection, if different (see 4.4).

z. Preservation, packaging, and packing requirements (see 5.1).

6.2.2 Contract data requirements. Required technical data such as, operator's manuals, parts lists, wiring diagrams, foundation and anchor bolt plans and acceptance test reports should be specified on a DD Form 1423, Contract Data Requirements List, incorporated into the contract.

6.3 First article. When first article inspection is required, the item to be tested should be the first item offered for acceptance under the contract. The contracting officer should include specific instructions in acquisition documents regarding arrangements for examination, test, and approval of the first article.

6.4 Safety and health requirements. Paragraph 3.2.10 requires compliance only with those OSHA requirements that concern the furnace itself. It does not require compliance with those OSHA requirements that concern "the furnace in its operating environment" such as noise levels, radiation levels electromagnetic emissions, noxious vapors, air contaminants, and heat. Since OSHA limits the total hazard level of these hazards in the environment (and does not limit the hazard level of individual furnace in the environment) the procuring activity is advised to analyze the existing hazard levels in the proposed operating environment, and specify additional furnace requirements that will integrate the new furnace into its future operating environment. The furnace shall be equipped with all point-of-operation guarding normally furnished as standard on the manufacturer's commercial furnace supplied to the commercial market. If specific point-of-operation guarding is required, the procuring activity should specify the exact configuration of the guard required, as in most cases, the guard configuration is dependent on the size and configuration of the workpieces. The above, and any other additional safety and health requirements should be specified in detail under 6.2.1.g.

6.5 Atmosphere type. Furnaces designed for operation with one type of atmosphere are not always adaptable or suitable for operation with another type of atmosphere. Some types of atmosphere cause an adverse reaction on certain types of heating elements and insulation. For this reason, it is necessary for the using activity to specify the type of atmosphere that will be used in the furnace, such as endothermic, exothermic, dissociated ammonia, hydrogen or the atmosphere composition by volume.

6.6 Changes from previous issue. Asterisks are not used in this revision to identify changes with respect to the previous issue due to the extensiveness of the changes.

Custodians:
Air Force - 99
Army - AL
Navy - SH

Review Activities:
Air Force - 84
Army - AL
DLA - GS
Navy - SH

User Activities:
Army - AR
Navy - MC

Preparing Activity:
DLA- IP

Project 3424-0107

STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-F-80082B	Furnaces, Heat-Treating and Brazing, Electric, Controlled Atmosphere, Pusher and Conveyor Belt Types

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)*

DD FORM 82 MAR 1426 PREVIOUS EDITION IS OBSOLETE.