MILITARY SPECIFICATION

MACHINING CENTERS, HORIZONTAL, SINGLE SPINDLE 3 AXIS, SOFTWIRED NUMERICAL CONTROL WITH POSITIONING ROTARY TABLE

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

1. SCOPE

1.1 Scope. This specification covers softwired numerically controlled horizontal, single spindle type machining centers with rotary work table, automatic tool changer and equipment and accessories as specified herein.

1.2 Classification. The horizontal spindle machining center covered by this specification shall be of the following classes and sizes. The specific machining center class and size to be furnished shall be as specified (see 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, Memphis, Tennessee 38114, by using the self-addressed Standardization Document Improvement Proposal (DD Form 1426) appearing at the end of this document or by letter.

Class A - 5 HP

Size	X - Axis Travel	Y - Axis Travel	Z - Travel
1	14 inches (355mm)	9 inches (228mm)	8 inches (203mm)
2	20 inches (508mm)	14 inches (355mm)	14 inches (355mm)

Class B - 10 HP

Size	X - Axis Travel	Y - Axis Travel	Z - Axis Travel
1	20 inches (508mm)	20 inches (508mm)	16 inches (406mm)
2	26 inches (660mm)	22 inches (558mm)	18 inches (457mm)
3	40 inches (1016mm)	30 inches (762mm)	18 inches (457mm)
4	60 inches (1524mm)	36 inches (914mm)	25 inches (635mm)
5	84 inches (2133mm)	36 inches (914mm)	31 inches (787mm)

Class C - 15 HP

Size	X - Axis Travel	Y - Axis Travel	Z - Axis Travel
- i -	24 inches (609mm)	20 inches (508mm)	18 inches (457mm)
2	30 inches (762mm)	24 inches (609mm)	20 inches (508mm)
3	40 inches (1016mm)	32 inches (812mm)	26 inches (660mm)

Class D - 20 HP

Size	X - Axis Travel	Y - Axis Travel	Z - Axis Travel
- i -	43 inches (1092mm)	35 inches (889 mm)	26 inches (66Mm)
2	48 inches (1219mm)	48 inches (1219mm)	26 inches (660mm)

Class E - 30 HP

Size	X - Axis Travel	Y - Axis Travel	Z - Axis Travel
1	40 inches (1016mm)	40 inches (1016mm)	20 inches (508mm)
2	96 inches (2438mm)	60 inches (1524mm)	20 inches (508mm)

?. . APPLICABLE DOCUMENTS

2.1 Issues of documents. 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.

STANDARDS

FEDERAL

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

MILITARY

MIL-M-18058 - Machinery, Metal and Woodworking, packaging of

MIL-STD-461 - Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interferences

(Copies of specifications, standards, drawings, and publications required by contractors 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 the date of invitation for bids or request for proposal shall apply.

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 20492.)

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

B5.1 - T-Slots, Their Bolts, Nuts and Tongues
B5.50 - 'V' Flange Tool Shanks for Machining Centers with Automatic Tool Changers
B11.8 - Construction, Care and Use of Drilling, Milling and Boring Machines, Safety Requirements for the
C113.1 - Electrical Standards for Metalworking Machine Tools (NFPA NO. 79)
Z210.1 - Metric Practice (ASTM-E380)

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

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS

NFPA No. 79 - Electrical Standards for Metalworking Machine Tools

(Application for copies should be addressed to the National Fire Protection Association, 470 Atlantic Avenue, Boston, MA 02110).

ELECTRONIC lNDUSTRIES ASSOCIATION (EIA) STANDARDS

RS-227 - one Inch perforated Tape

RS-232 - Interface between Data Terminal Equipment and Data Communication Equipment Employing Serial Binary Data Interchange

RS-244 - Character Code for Numerical Machine Tool Control Perforated Tape

RS-267 - Axis and Motion Nomenclature for Numerically Controlled Machine Tools

RS-274 - Interchangeable Variable Block Format for Positioning, Contouring, and Contouring/Positioning Numerically Controlled Machines

Rs-281 - Construction Standards - Numerical Machine Tool Control

RS-358 - Subset of American National Standard Code for Information Interchange for Numerical Machine Control Perforated Tape

RS-447 - Operational Command and Data Format for Numerically Controlled Machines

RS-494 - 32 Bit Binary CL Exchange (BCL) Input Format for Numerically Controlled Machines

(Application for copies should be addressed to Electronic Industries Association, Engineering Department, 2001 Eye Street, N.W., Washington, DC 20006.)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) STANDARDS

MG-1 - Motors and Generators

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

NATIONAL STANDARDS ASSOCIATION

NAS-979-Uniform Cutting Tests - NAS Series Metal Cutting Equipment Specifications

(Application for copies should be addressed to the National Standards Association, Inc., 1321 Fourteenth Street, N.W., Washington, D.C. 20005.)

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

3. REQUIREMENTS

3.1 First article. When specified (see 6.2.1), the contractor shall furnish one complete machining center for first article inspection and approval (see 4.2).

3.2 Design. The horizontal machining center shall be new and one of the manufacturer's current models. Its design shall include features and components necessary for maintaining alignment and accomplishing drilling, tapping, milling and boring required herein. The machine shall be of a fixed base type with vertical movements on the column ways. Cross movement may be provided either by movement of the spindle assembly on a column supported saddle, or by movement of the table on saddle ways supported by the bed. Tools, toolholders, and adapters shall be inserted and removed from the spindle by an automatic tool changer with storage magazine. Tool changes, spindle operation, operation of 3 linear axes and one rotary positioning axis, and other operations as specified herein, shall be directed by a softwired numerical control system. The numerical control system shall consist of a softwired numerical control unit, solid state axis drives, electric axis drive motors, solid state electric spindle drive and electric motor, axis feedback devices configured so as to provide a closed loop system and all other hardware and software necessary for numerical control operation of the machine. The machine and its numerical control shall constitute a completely functional system. The machine functions shall be controlled manually by operator control devices, semi-automatically by manual data input devices, and automatically from part program input data. All parts of the machine and system that are subject to wear, breakage, or distortion shall be accessible for adjustment, replacement, and repair.

3.2.1 Measurement systems. Unless otherwise specified, either the U.S. Customary System of Units (US) or the International System of Units (SI) may be used in the design and construction of the machine. When only one system of measurements 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 the U.S. Customary System of Units (US). These measurements may be converted to the International System of Units (SI) through the use of the conversion factors and methods specified in ANSI Z210.1.

3.2.1.1 Measuring and indicating device calibrations. When specified (see 6.2.1), measuring and indicating devices such as feed screw dials, scales, depth stops, carriage stops, dial indicators, pressure gauges, temperature indicators, and all other similar devices shall be graduated in the specified system (US or SI) of measurement. Regardless of the measurement system used, all measuring and indicating devices on the machine shall be graduated in the same system.

3.2.1.2 Dual calibrations. When specified (see 6.2.1), measuring and indicating devices shall be graduated in both the US and SI System of Measurements. When a dual US and SI system is furnished, both feed dials shall have independent zero adjustments and both dials shall be calibrated in such a manner that the last dial graduation progresses into and is continuous with the first dial graduation as the dial is rotated through the zero position.

3.2.2 Reclaimed materials. The machining center shall contain reclaimed materials to the maximum extent possible without jeopardizing its intended use and performance. The reclaimed materials shall have been either reprocessed, remanufactured, or recycled in a manner which restores them to the same chemical composition and physical properties as the materials originally selected for use on the machine.

3.2.3 Operating controls. All operating controls necessary for manual and tape operation of the machine shall be mounted on either a control console or pendant stand clearly identified to facilitate its use. Voltage and current meters, indicator lights, and all other operational control aids shall be arranged and mounted convenient to and in full view of the operator. An emergency stop switch shall be furnished on the control station,

3.2.4 Safety and health requirements. Covers, guards, and other safety devices shall be provided for all parts of the machining center that present safety hazards. The safety devices shall not interfere with operation of the machine. 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 machine parts, components, mechanisms, and assemblies furnished on the machine, whether or not specifically required herein, shall comply with all of the requirements of "OSHA Safety and Health Standards (29 CFR 1910), General Industry" that are applicable to the machine itself. In addition, the machine shall comply with all requirements of ANSI B11.8 that are designated therein as the responsibility of the machine manufacturer. In the event of conflict between the requirements of OSHA and the ANSI Standards, the requirements of OSHA shall apply. Additional safety and health requirements shall be as specified (see 6.2.1).

3.3 Construction. The machining center 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 machine to its maximum rating and capacity without permanent distortion.

3.3.1 Castings and forgings. All castings and forgings shall be free of scale and mismatching. No process such as welding, peening, plugging, or filling with solder or paste shall be used for reclaiming any defective part.

3.3.2 Welding, brazing, or soldering. Welding, brazing, or soldering shall be employed only where specified in the original design. None of these operations 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 that prevents change of tightness. Those subject to either removal or adjustment shall not be swaged, peened, staked or otherwise permanently installed.

3.3.4 Surfaces. All surfaces shall be cleaned 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. Unless otherwise specified (see 6.2.1), the machining center shall be painted in accordance with the manufacturer's commercial practice.

3.3.6 Threads. Unless otherwise specified (see 6.2.1), all threaded parts used on the machine and its related attachments and accessories shall conform to FED-STD-H28 and the applicable "Detailed Standard" section referenced therein.

3.3.7 Dials. Unless otherwise specified (see 6.2.1), dials shall be graduated in either the inch or metric (SI unit) system. Graduations to indicate stock removal or tool movement shall be in increments of not more than 0.001 inch or the equivalent on the metric scale. The size of dial faces shall be such that the graduations are easily read. Dial faces shall be permanently and legibly engraved, stamped, or etched and shall have a non-glare finish.

3.3.8 Plates. All words on instruction and indicating plates shall be in the English language. Characters shall be either engraved, etched, embossed, or stamped in boldface on a contrasting background.

3.3.9 Gears. All gears shall he machined from a material suitable for the intended purpose. All gears shall be heat treated by a process that will impart the hardness and toughness that will enable the gear train to transmit full rated torque of the drive motor without gear damage, failure, or premature wear.

3.4 Components. The machine shall consist basically of the following components. Any additional components necessary to the operation of the machine shall be furnished in accordance with manufacturer's standard practice.

3.4.1 Base. The base shall possess the mass, strength, rigidity and other load carrying characteristics necessary for supporting the column, saddle and associated components. The base shall form a foundation for the components supported and shall be sufficiently rigid for maintaining mutual component alignment necessary to maintain the accuracies specified herein. The base shall have bedways that are proportioned to support and accommodate the precision movements of the supported components through the full range of travel. The base shall have either access doors or removable plates for cervicing internal components. Fluid reservoirs shall be either housed within the base or supplied as separate external units. The base

shall have means for leveling and securing the machine to a mounting surface or foundation.

3.4.2 Column. The machine shall be structured with a stationary type column. Slide movement shall be independently driven by solid state servo drives, electric motor and precision ballscrew with recirculating ball nut. Column slides and screws shall be shielded and protected from foreign contamination by either telescoping or curtain type covers and way wipers. Either a brake or a counter balance shall be provided to automatically prevent machining head movement in the event of power loss. Either stops or limit switches at the upper and lower extremes of the column ways shall prevent excessive travel of the machining head. The column shall be arranged to support and accommodate the machining head and spindle drive mechanism. The column shall be of a box-like construction with adequate strength and proportions to sustain, without distortion, all dynamic forces imposed by full load machining operations. The column shall have the degree of static rigidity necessary for maintaining chatter-free and oscillation-free operation at all spindle speed and axes feed rates.

3.4.3 Z axis. In and out movement (Z axis) shall be accomplished by either a sliding table, machining head, or quill. The Z axis shall be independently driven by solid state servo drive, electric motor and precision ballscrew with recirculating ball nut. The Z axis slide shall be secured in place, over the entire travel range, by either servo devices or comparable means as directed by the numerical control unit. The Z axis slides and screws shall be shielded and protected from foreign elements by either telescoping covers or curtain type covers and way wipers.

3.4.4 Spindle assembly. The spindle shall be fixed and held in axial and radial alignment by ball or roller bearings. The spindle shall be mounted in the machining head with its bearings designed and arranged to compensate for thermal expansion. The spindle shall have positive means for accepting, retaining and releasing tools and tool holders inserted by the automatic tool changer and operator. Unless otherwise specified (see 6.2.1), the spindle nose taper shall accept Sizes 24 or 50 “V” flange tool shanks complying with ANSI B5.50. The tool holder shall be held in the spindle by means of a retention knob and automatic drawbar. The spindle shall be driven by a variable speed electric motor. The spindle shall be capable of both clockwise and counterclockwise directions of rotation for accomplishing the full range of spindle speeds specified herein. The spindle shall automatically stop rotation for tool changes. Overload protection shall automatically stop spindle rotation and the motions of all slides upon an overload, and spindle stall. All spindle bearings, gears, shafts, and clutches shall be constantly flooded by temperature controlled lubricating oil to stabilize the machine and control spindle growth due to machine operation or changes in ambient temperature when required to attain and ensure the dimensional accuracy stated within this specification.

3.4.5 Saddle. The saddle shall be supported on horizontal ways. The saddle slide shall be independently driven by solid state servo drive and

electric motor through a precision ball screw with recirculating ball nut. The saddle slide shall be secured in place, over the entire saddle travel range by either servo devices or comparable means as directed by the numerical control unit. Saddle slides and screws shall be shielded and protected from coolant, chips, and other contaminants by either telescoping covers or curtain type covers and way wipers.

3.4.6 Tool changer and storage magazine. The machine shall be equipped with an automatic tool changer and storage magazine with, unless otherwise specified (see 6.2.1), a storage capacity as specified in Table I. Tool change shall be accomplished automatically by a power activated arm which will interchange the tool in the spindle with a tool selected from the tool storage magazine. The magazine shall permit convenient loading and unloading of tool holders during operational setup. Random access tool select ion capability shall be provided. The machine shall have the capability of reusing a tool that has been returned to the storage magazine after a programmed operation. The storage magazine shall be of the closed loop recirculating configuration.

3.4.7 Worktable. Unless otherwise specified (see 6.2.1), the number, size and configuration of T-slots in the tables shall be the manufacturer's standard. The top of the worktable shall be machine finished for a work mounting surface. The table shall have coolant troughs or similar means for draining spent coolant into its reservoir. Edge block locators shall be provided on two adjacent sides of the table. The rotary table shall be capable of the number of positions as specified in Table I controlled by the numerical control unit. The table shall be independently driven by solid state drive and electric motor. The rotary table shall be driven by an anti-backlash gearbox with independent type scales mounted for feedback. The table and all slides shall be provided with an automatic positive means of securing machine components in place to permit accurate cuts under full horsepower, without drifting.

3.4.8 Lubrication. A lubrication system shall be provided which will ensure adequate lubrication for all moving parts. The system shall be automatic with positive metering capability and shall deliver lubricating oil to all ball screws, mating gears, sliding parts, and bearings except sealed-for-life-type. Each lubricant reservoir shall have a means for determining and maintaining fluid level. The lubricant reservoir shall have sufficient capability to operate for a minimum of 80 hours of feed time without being serviced. The lubrication system shall have a device for indicating oil level and a low level pressure warning and protection system to alert the operator and stop spindle and axis motion. Recirculated oil shall be filtered by a cleanable or replaceable type filter. Mechanisms requiring periodic manual lubrication shall be readily accessible for servicing. A recommended preventive maintenance schedule, both electrical and mechanical, shall be provided.

3.4.9 Coolant system. The machine shall be supplied with a complete flood and mist type coolant system with numerically controlled "selection of coolant type and on/off of coolant flow. The system shall have adequate capacity for all types of machining operations for which the machine is designed and shall have means for regulating the flow of flood coolant and for adjusting mist coolant supply as required. All components necessary to make the system completely functional shall be furnished including reservoirs, chip screens, filters, drain troughs, and clean-out plates.

3.4.10 Hydraulic system. The hydraulic system, when supplied, shall be complete with pumps, valves, piping, cylinders, reservoir, and pressure controls. Overpressure protection shall be provided on the high pressure line from the hydraulic pump to prevent damage to components. The system shall include filters to insure delivery of clean fluid. The reservoir shall have a sight gage to indicate the fluid level. The fluid temperature shall be maintained within the proper operating range during all normal operations of the machine. When required, noise level and noise suppression enclosures for stand-alone hydraulic units shall be as specified (see 6.2.1).

3.4.11 Electrical system. Unless otherwise specified (see 6.2.1), the electrical system shall conform to ANSI/NFPA 79. Unless otherwise specified (see 6.2.1), the machine shall operable on both 230 volts and 460 volts , 3 phase, 60 Hz source and shall be initially wired for operation on 460 volts. An identified terminal shall be provided, suitable for connection of a grounding conductor. It shall be possible to operate all electrical equipment on the machine after connection to a single power source. When specified (see 6.2.1), electric noise suppression devices shall be used where applicable.

3.4.11.1 Motors. All motors shall be equipped with ball or roller bearings and have a short time rating of 60 minutes. Motors shall be either AC, 3 phase, 60 Hz or industrial DC motors conforming to NEMA Standard MG1-10-61, paragraph B, equipped with a solid state rectifier. Variable speed DC spindle motors shall develop rated horsepower through at least 90 percent of the range of spindle speeds available from a gear train or direct coupling. Each electric motor shall be a totally enclosed or in a dripproof blower cooled enclosure.

3.4.11.2 Main electrical disconnect. A manually operated fusible disconnect switch or circuit breaker of adequate size to carry the entire electrical load of the equipment shall be provided for connection to the primary power source specified.

3.4.12 Machine ways. The machine ways shall be adequately protected wherever possible to exclude chips, dirt, coolant, and other hazards that may cause damage or result in inaccurate functioning of any members. The machine ways shall be hardened and ground and suitable for the high grade precision numerically controlled machines covered by this specification.

Linear slide movement over the ways shall be supported by either roller packs or non-metallic liners.

3.4.13 Chip conveyor system. Unless otherwise specified (see 6.2.1), a chip conveyor system shall be provided to automatically remove chips from the work area and dumped into a container.

3.4.14 Coolant through the spindle. When specified (see 6.2.1), low pressure coolant through the spindle shall be provided for deep hole drilling or operations where the cutting tool can not be reached with the standard coolant system.

3.4.15 Pallet shuttle system. When specified (see 6.2.1), the machine shall have a pallet shuttle system arranged for the mechanized removal and precise reattachment of worktable tops. Unless otherwise specified (see 6.2.1), the system shall be comprised of a minimum of two duplicate pallets and a workchange mechanism which is functional for automatically transferring a pallet from the machine's work zone area to a workpiece load area while either simultaneously or consecutively transferring and attaching the other pallet in the reverse process. The pallet system shuttle shall be operated by the numerical control for accomplishing automatic pallet change for the execution of both individual and alternate part programs without operator intervention except to start the cycle between programs. The complete automatic programmable pallet change shall be accomplished within 45 seconds. Control shall be included for automatic pallet change, inhibit, and manual cycle. Automatic pallet changes shall be preceeded by an audio type warning signal for a period of not less than five seconds. A pallet change inhibit switch shall be provided in a location readily accessible by an operator who is at the off-line pallet.

3.4.16 Numerical control. The machining center shall have a fully automatic solid state soft-wired, integrated circuit type numerical control. The machine control unit (MCU) shall provide automatic control of machine functions, operating modes, three linear axes feedrate control, positioning control of the rotary table, spindle speed and direction of spindle rotation, and other part program directed functions for machining centers of the type specified herein. Controlled axes be identified in accordance with EIA Standard RS-267. The control shall have linear and circular interpolation and be capable of simultaneous control of three linear axis and positioning control of the rotary table and automatic operation of the pallet shuttle. Control features shall include a programmable interface, buffer storage, fixed cycles, part program storage, part program and buffer edit capability, and control diagnostics. The MCU shall direct machine functions from part program data stored in memory, manually input or directly from the input media specified herein. The control shall initiate a halt or an error signal should a fault condition occur in the control. All necessary executive program routines shall be furnished in the form of one inch eight channel binary coded decimal punched tape or 8 inch flexible disk for controls having volatile memory. The control unit shall conform to EIA Standard RS-281. A line voltage of

+10% from normal shall not adversely affect the numerical control function. The control shall be capable of functioning in ambient temperatures ranging from 50 to 120 degrees F and humidity ranging from 5 percent to 95 percent non-condensing. The control shall automatically shut down when internal operating temperature exceeds safe operating temperature. Control resolution shall be 0.0001 inch or 0.001 mm for each linear axis and not more than 0.001 of a degree for each rotary axis. When binary cutter location (BCL) data is specified (see 6.2.1) the numerical control shall have the necessary hardware and software to perform all geometry dependent functions which are ordinarily performed by the postprocessor.

3.4.16.1. MCU. The MCU shall provide full contouring control of the machines three linear axes and positioning control of the rotary table for performing drilling, tapping, boring, reaming, and contour milling operations by simultaneous movement of each axis.

3.4.16.2 Data input.

3.4.16.2.1 Punched tape data input. Unless otherwise specified (see 6.2.1) the input media for the control shall be one inch, light channel punched tape. The data input format and codes shall comply with EIA Standards RS-274, RS-358 and RS-447 or when specified (see 6.2.1) RS-244 shall apply in lieu of RS-358. The control shall be equipped with a photoelectric tape reader capable of holding, feeding and reading tape prepared in the format specified at a rate not less than 150 characters per second. Unless otherwise specified (see 6.2.1), the tape reader shall be supplied with standard feed and take-up spoolers 5-1/4 inch in diameter. The tape reader shall be housed in a dust free area of the numerical control cabinet and shall be easily accessible for cleaning and tape handling. The control shall have a tape error detection capability to continuously check for the following errors:

a. Odd parity per EIA RS-244
b. Even parity per EIA RS-358
c. Misaligned sprocket holes
d. No sprocket holes

Any of the above errors shall halt machine functions and illuminate an error light or a message on the data display screen to indicate a fault condition.

3.4.16.2.2 Flexible diskette data input. When 32 Bit Binary Cutter Location (BCL) Exchange Input for Numerically Controlled Machines is specified (see 6.2.1), the input media shall be an eight inch flexible diskette recorded in accordance with 3.4.16.2.2.1. The input data format shall comply with EIA Standard RS-494. Functions 10.1, 10.2 and 10.3 of Section 10, EIA-RS-494 shall apply. Manufacturer's providing functions or features that can not be addressed by command codes currently covered by EIA-RS-494 shall apply to the Electronic Industries Association, IE-31 Committee on Numerical Control Systems and Equipment for an extension of

the standard codes to cover the new features or functions. The control shall be equipped with an eight inch flexible diskette reader. The reader shall have the capability to perform a cyclic redundancy check of the input data and be capable of reading not less than 15,000 characters per second.

3.4.16 .2.2.1 Flexible diskette format. When an eight inch flexible disk is specified as the input media to the numerical control it shall be a single density recording on one side using a soft sectored format. The disk shall be divided into 77 distinct locations on the single side disk. Tracks shall be assigned numbers from and trade 76 nearest the center. Tracks 00, 74, 75 and 76 shall not be used. There is an index hole in the jacket and the disk that shall be used for timing functiom when a beam Of light passes through it. Recording shall be accomplished by rotating tie disk inside its jacket exposing the disk at the read/writehead slot cut in tie jacket. Data shall be recorded only on the side of the disk that is exposed to the read/write head. Each track shall be divided into 26 addressable sectors which contain 128 bits. All sectors shall be identified by the file startirq sector nurber with track 00, sector 1, designated as 0. The first part program shall be located at sector lE hexidecimal corresponding to track 1, sector 5. Where two byte numbers are referenced the high order byte shall be recorded first and the low order last. The data stored in a sector is called a record. Track 1, sectors 1 through 4 shall contain the program directory of up to 16 part program names in ASCII. Each file shall be packed on tie disk in the same order as its directory entry. Unused directory entries shall point to the next available sector after the last file and contain the 30 character ASCII space characters. The last sector of each file shall be padded with end of file (EOF) records (8000 0000). Diskette addressing shall comply with the requirements of table IV.

3.4.16.2.3 Manual data input. A manual data input (MDI) unit shall be furnished to permit manual entry of alphabetical, numerical, and special characters necessary for control of all programmable machine functions. The manually input data shall be immediately displayed on the data display to permit data verification. The MDI shall be capable of entering a block of data into memory upon command

3.4.16.3 Data display. A cathode ray tube (CRT) capble of displaying at least 250 characters simultaneously. shall be provided. Unless otherwise specified (see 6.2.1), the display shall, as a minimum, display the following data:

a. Four digit block sequence number
b. Active block of stored! data.
c. Actual position of each axis.
d. Feedrate and override condition.
e. Control and system error messages.

3.4.16.4 Control system modes of operation. The operational modes of the NC control shall include manual, automatic, single block, MDI, sequence number search, and optional stop.

3.4.16.5 Departure control. The maximum departure permitted by a single command in either incremental or absolute mode shall be not less than plus or minus 99.9999 inches or 999.999mm. The control shall be capable of automatically controlling the acceleration and deceleration of the slides. The resolution of slide movement in either direction shall not be more than 0.0001 inch or 0.001mm.

3.4.16.6 Absolute/incremental input. The control shall have absolute/ incremental input capability. This mode shall be selected by a preparatory "G" code which may be switched during the tape program. Not required if BCL input is specified (see 6.2.1).

3.4.16.7 Automatic tape code recognition. The control shall have the capability to automatically recognize and read tape punched with either EIA RS-244 or RS-358 (ASCII) character codes. Not required if CL data input is specified (see 6.2.1).

3.4.16.8 Switchable inch/metric input. The control system shall provide switchable inch/metric input capability.

3.4.16.9 Part program storage. Unless otherwise specified (see 6.2.1) part program storage shall be in either solid state or bubble type memory. The MCU shall be capable of storing in memory the content of, unless otherwise specified (see 6.2.1), not less than 250 feet of postprocessed part-program tape data. Not applicable if BCL data input is specified (see 6.2.1).

3.4.16.10 Standby battery power. Unless otherwise specified (see 6.2.1), standby battery power shall be provided for controls having volatile memory, to hold the memory provided at full load for a period of not less than 70 hours when the primary power source fails.

3.4.16.11 Part program edit. A program edit capability shall be provided to allow block insertion, deletion or modification of any part program in the part program memory. Data related to part program edit shall be input by the manual data input provided on the control panel. Edited program data entered into program memory shall be automatically acted upon, in the sequence designated, whenever the part program is cycled.

3.4.16.12 Feed rate override. A feed rate override control shall be provided to allow manual adjustment of the programmed feed rate from zero to not less than 120 percent of the programmed rate in either continuous adjustment or in steps of not more than 10 percent. The feed rate override control shall have a position that allows return of feed rate to that programmed.

3.4.16.13 Spindle speed override. A spindle speed override shall be provided to allow manual adjustment of spindle speed in either continuous adjustment or in steps of not greater than 10 percent each. The spindle speed override control shall control not less than the range of override percentages between 60% and 120% of programmed speed. The spindle speed override control shall have a position that allows return of speed to that programmed.

3.4.16.14 Sequence number search. The control shall have the capability to permit the operator to search for any desired sequence number.

3.4.16.15 Mirror image. The machine shall be capable of producing either right or left-hand from the same tape data through the inversion of x and y axis. Inversion of each axis shall be by keyboard or switch entry. Mirror image shall not affect the directional sense of manual controls. Reverse settings shall be displayed on the data display.

3.4.16.16 preparatory function (G-Codes). The preparatory function codes of the control shall be in accordance with EIA Standard RS-274. If the BCL data input is specified, codes in EIA-RS-494 shall be applied.

3.4.16.17 Miscellaneous functions (M-Codes). me miscellaneous function codes of the control shall be in accordance with EIA Standard RS-274. If the BCL data input is specified, codes in EIA-RS-494 shall be applied.

3.4.16.18 Block delete. The control shall have a block delete feature to permit by-passing of blocks of programmed data.

3.4.16.19 Buffer storage. The control shall have buffer storage for transferring command data from the tape reader to internal storage without delaying the next incoming command and without interrupting the machine functions. The internal storage shall delay or store multiple blocks of data until required by the controlling devices.

3.4.16.20 Block-by-block read. The control shall have a block-by-block read function to provide for reading information one block at a time.

3.4.16.21 Tool length offsets. The control shall have a tool length offset feature to permit adjustments to the programmed tool length by means of manual data input. The tool length offset feature shall have a range of not less than the following:

a. Inch system ±0.0002" to ±1.0000"
b. Metric system ±0.002mm to ±25.400mm.

3.4.16.22 Cutter compensation. Cutter compensation shall be provided to compensate for cutter diameters differing from those utilized in programing. The cutter compensation shall have a range of not less than the following:

a. Inch system ±0.0002" to ±1.0000"
b. Metric system ±0.002mm to ±25.400mm.

3.4.16.23 Fixture compensation. A fixture compensation feature shall be provided to permit compensation for fixture position errors.

3.4.16.24 Reversal error compensation. Reversal error compensation shall be provided for each axis of motion to compensate for drive gear backlash when slide reversal occurs. A means shall be provided to input new compensation values when required.

3.4.16.25 Axis calibration. Error compensation shall be provided to correct repeatable errors determined to exist due to leadscrew and feedback device inaccuracies. A means shall be provided to input new error compensation values when required.

3.4.16.26 Additional features. Unless otherwise specified (see 6.2.1), the following additional numerical control features shall be provided:

a. Four quandrant programming
b. Incremental and continuous jog for each axis
c. Leading zero suppression or decimal point programming
d. Inches per minute (IPM)/Millimeters Per Minute (MMPM), programming in all modes of operation
e. Tape edit keylock.

3.4.16.27 Operator control panel. Unless otherwise specified (see 6.2.1), the control unit shall have a control panel which provides at least the following control functions: Emergency Stop; Cycle Start; Optional Stop; Mode Selection; Feed Hold; Feedrate Override; Spindle Speed Override; Jog; Jog Direction; and EOB Stop.

3.4.16.27.1 pendant control. When specified (see 6.2.1) a pendant control shall be furnished in lieu of an operator control panel. The pendant control shall be connected to the machine to enable the operator to control machine functions while in a close observation position. Unless otherwise specified (see 6.2.1), the pendant control shall be capable of the same functions as stated for the operator control panel in paragraph 3.4.16.27.

3.4.16.28 Reference zero. The control unit shall have a reference zero to move each axis to a reference limit switch to establish synchronization and reset all registers to zero.

3.4.16.29 Set zero. The control unit shall have a “set zero’* feature to permit the specified axis register to be reset to zero establishing present axis location as zero.

3.4.16.30 Program tryout. The control shall have a program tape tryout feature to permit new part programs to be read through the control without machine motions.

3.4.16.31 Operational software. Operational software shall be resident in the control and shall contain all logic necessary to effectively operate the machine tool. The software shall provide for meaningful diagnostics relating to the utilization of the controls, machine tool, part program, and operator's actions.

3.4.16.31.1 Programmable interface. A software program for accommodating the softwired interface between the numerical control and machine shall be provided as part of the executive program or as a separate program in the form of one inch, eight channel punched tape complying with EIA-RS-244 or eight inch flexible diskette as appropriate for the input media specified (see 6.2.1).

3.4.16.32 Maintenance diagnostics system. Maintenance diagnostics software shall be furnished in either the control as non-volatile memory or in the form of one inch, eight channel punched tape complying with EIA-RS-244 or eight in flexible disk as appropriate for the input media specified(see 6.2.1) to provide for diagnostic checking of the machine control unit. The diagnostic software shall test, exercise, and display failures, at least to board level.

3.4.16.33 Peripheral equipment interface. The control shall be equipped with an interface complying with RS-232.

3.4.16.34 Axis jog. The control panel or pendant shall have manual controls for accomplishing both single and continuous, low and high speed jog movements of the slides for each controlled axis in both the plus and minus direction.

3.4.16.35 Auxiliary functions. Unless otherwise specified (see 6.2.1), the MCU shall respond to the following program commanded auxiliary functions: interpolation, fixed cycles, and dwell. Unless otherwise specified (see 6.2.1), miscellaneous functions shall include program stop, optional program stop, end of program, spindle CW, spindle CCW, spindle off , coolant on-off, tool change, end of program (rewind), and program re-start. System preparatory and miscellaneous functions shall be coded in accordance with EIA RS-274.

3.4.16.36 Canned cycles. The following canned cycles shall be provided:

Drilling
Boring
Tapping

3.4.16.36.1 Macro program cycles. The following flexible macro program cycles shall be provided:

a. Milling
b. Drilling
c. Boring
d. Tapping

3.4.16.37 Tape punch unit. When specified (see 6.2.1), the system shall have a tape punch unit for producing punched tapes from edited programs of stored in data memory. The unit shall have a plug receptacle and circuitry that is compatible with the tape punch output of the system, punching both paper and mylar tapes of dimensions characteristics and code in accordance with 3.4.16.2. The punching speed of the unit shall be not less than 75 characters per second.

3.4.16.38 Postprocessor. When specified (see 6.2.1), the system shall be furnished with a postprocessor program(s) to be utilized in off-line computer assisted preparation of part programs. The postprocessor shall be provided for converting specified programming language (see 6.2.1) to the form and format required to operate the machine tool and control. The postprocessor shall be written for use on the type computer specified (see 6.2.1). Documentation sufficient to implement and utilize the postprocessor shall be provided for computer compatibility verification and validation at least 30 days prior to delivery of the machining center.

3.4.16.39 Graphics software. When specified (see 6.2.1), graphics software shall be provided which will allow communication between the specified (see 6.2.1) user graphics system and the machine control unit.

3.4.17 Standard equipment. Unless otherwise specified (see 6.2.1), the following equipment shall be furnished with the machine:

a. A load meter installed on the machine or MCU console that constantly registers the horsepower load (horsepower units or percent of load) on the spindle rotation drive motor.

b. One set of special wrenches, operating, and repair tools that are normally furnished by the manufacturer.

3.4.18 Optional equipment. The following optional equipment shall be furnished as specified (see 6.2.1):

a. A worklight, conveniently mounted to illuminate the work area, complete with protective shield and on-off switch.

b. An elapsed time indicator of the non-reset type, with digital readout and designed to resist the effects of vibration, voltage fluctuation, temperature change, and humidity. The indicator shall be mounted on the machine in a position visible from the operator's station and be connected to record and accumulate machine operating time to not less than 9999.9 hours.

c. Tools, took holders, and adapters, as specified.

d. Other optional equipment as specified.

3.5 Sizes and capacities. Unless otherwise specified (see 6.2.1). the sizes and capacities of the machining center shall meet the requirements of Table I as applicable for the machine size specified in the contract or order.

3.6 Performance. The machine and numerical control system combination shall be capable of performing as specified herein. In addition, the machine shall be capable for performing drilling, tapping, milling and boring to accomplish the capacities of Table I while meeting the accuracies of Table II.

3.7 Alignment. The machine shall meet the alignment and accuracy tolerances of Table III.

3.8 Electromagnetic interference control. When specified (see 6.2.1), equipment procured under this specification shall comply with the requirements of MIL-STD-461.

TABLE I. SIZES AND CAPACITY

ACTERISTICS	CLASS "A"		CLASS "B"					CLASS "C"			CLASS "D"	
	Size 1	Size 2	Size 1	Size 2	Size 3	Size 4	Size 5	Size 1	Size 2	Size 3	Size 1	Size 2
dle Horsepower	5	5	10	10	10	10	10	15	15	15	20	20
xis Range:												
ravel (in.)	14	20	20	26	40	60	84	24	30	40	43	48
ravel (in.)	9	14	20	22	30	36	36	20	24	32	35	48
ravel (in.)	8	14	16	18	18	25	31	18	20	26	26	26
dle Carrier:												
Speeds	Infinite	Infinite	800	Infinite	1820	Infinite	Infinite	200	800	Infinite	800	800
ge (RPM)	135-4500	0-3600	50-3500	20-3200	20-3000	40-3000	40-3000	4-3000	4-3150	91-3200	20-3300	20-3600
Drives:												
drate-X, Y-(ipm)	.04-80	.1-100	.1-400	.5-150	.5.150	.5-150	.5-150	.1-100	.2-150	.1-400	.2-150	.2-300
drate-Z-(ipm)	.1-160	.1-100	.1-400	.5-150	.5-150	.5-150	.5-150	.1-400	.2-150	.1-400	.2-150	.2-300
id Traverse (ipm)	160	400	400	400	300	300	300	300	400	400	400	300
Change/Storage:												
rage capacity	15	20	24	24	30	40	42	24	30	40	30	42
. Tool Dia. (in.)	3	3	4	4	5	6	8	4-1/4	5-1/2	8	4	8
. Tool Length (in.)	5/8	12	10	16	16	16	16	12	12	16	15	15
. Tool Weight (lbs.)	9	10	30	45	50	50	50	15	26	50	50	50
z. Rotary Table:												
e (in.)	10	14	16	18	20	24	30	16	24	26	20	30
of Positions	3	360	360	360	360	360	360	360	360	360	360	360
drate (RPM)	.04-80	8	4	4	4	4	4	2.5	2.77	4	2.77	2.77
d Cap.	150	1000	1500	1500	2500	2500	3500	1500	2500	3500	2000	3500

Machine size and capacity shall not be less than the stated requirements of the size ordered nor greater than the requirements of the next larger size shown in above table. When the largest size and capacity machine shown in above table is ordered, the size and capacity of the machine offered shall not exceed the stated requirements by more than 10 percent. When a range is shown, the required performance is from the stated minimum or less to the stated maximum or greater.

TABLE II. PERFORMANCE ACCURACY

MACHINING OPERATION	Accuracy (Permissible Tolerance)
Drilling:	
Hole size	±0.005"
Hole depth	±0.005"
Tapping:	
Threaded holes shall be Class III fit in accordance with FED-STD-H28	
Boring and Counterboring:	
Hole location, based on centerline distance of bored holes, 2 holes 18" apart	±0.0015"
Hole size, maximum speed, hole to hole	±0.0005"
Depth of counterbore	±0.0005"
Milling (straight-line):	
Squareness of sides	±0.0015"/FT
Parallelism of opposing sides	±0.0015"/FT
Flatness	±0.001"/FT
Angularity of ramp cuts	±0.0024"/FT
Corner location, deviation from programmed points	±0.001"
Surface finish, maximum roughness	64 RMS
Contouring (circle):	
Roundness	
Diameters measured at 30 degree intervals	±0.003"
Angularity, difference between programmed and actual points of Tangency of circles to straight surfaces	0.001"
Contouring (straight-line):	
Squareness of sides	0.0015"/FT
Angularity of sides	0.0015"/FT

TABLE III. ALIGNMENT AND ACCURACY

COMPONENT CHARACTERISTICS	PERMISSIBLE TOLERANCE
Spindle axial runout	0.0002"TIR
Spindle radial runout:	
1" from spindle nose	0.0005"TIR
8" from spindle nose	0.001"TIR
Spindle centerline to X & Y axis	0.0005"/FT
All linear axis travel square To each other	0.0006"/FT and 0.001"TIR
Key slots/Edge locators parallel with longitudinal axes movement	0.0005"/FT
Key Slots/Edge locators on rotary tables shall be located in relation to the center of rotation within	0.001"TIR
Worktable/Pallet working surface parallel with ZX plane checked at a point 8" from center of rotation at four positions; and 0°, 90°, 180°, and 270° index (16 point check)	0.001"TIR (not to exceed 0.002 when multiple no. furnished)
Worktable working surface rise-fall checked over full range of travel	0.001"/FT
Accuracies over full travel, bi-directional:	
Longitudinal (X-axis)	accuracy ±0.0005" in 30"
	repeatability ±0.0003" in 30"
Vertical (Y-axis)	accuracy ±0.0005" in 30"
	repeatability ±0.0003" in 30"
Traverse (Z-axis)	accuracy ±0.0005" in 30"
	repeatability ±0.0003" in 30"
Contouring table: 360,000 positions	accuracy ±10 sec
	repeatability ±5 sec

TABLE IV. Diskette Addressing

SECTOR ADDRESS	* TRACK	SECTOR* NUMBER	BYTE	USE
0-25	0	All	All	Unused
26-29	1	1-4	0-1	File start sector (Binary)
			2-31	30 character ASCII program name to be defined by user
			32-63	same as 0-31 above for next Part program (file)
			64-95	Same as 32-63 above for next part program
			96-127	Same as 32-63 above for next part program
		5-26	All	APT CL records for NC part programs
30-1897	2-73	All	All	APT CL records for NC part programs
1898-1975	74-76	All	All	Unused

* This numbering corresponds to IBM System 3740 physical format.

3.9 Lubrication chart or plate. Unless otherwise specified (see 6.2.1), a lubrication chart or plate shall be permanently and securely attached to the machine. If a chart is furnished, it shall be placed in a transparent plastic folder or permanently sealed between clear plastic sheets with suitable means for mounting. The following information shall be furnished on the chart or plate.

Points of application
Service interval
Type of lubricant
viscosity

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

Nomenclature
Manufacturer's name
Manufacturer's serial number
Manufacturer's model designation
Number of rotary table positions _____, Number of axes contouring _____
Class, _____ HP spindle motor _____
Size, _____, axis travel (inches) X Y Z
Tool changer cap., _____ tools
Power input (volts, total amps, phases, frequency)
Contract Number or Order Number
National Stock Number, or Plant Equipment Code
Date of manufacture
u s

3.11 Technical data. Data shall be furnished as specified (see 6.2.1).

3.12 Workmanship. Workmanship of the machine and accessories shall be equal to that of the manufacturer's current commercial machines of the type specified herein.

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 when such action is deemed necessary to assure supplies and services conform to prescribed requirements.

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

a. First article inspection (see 4.2.1)
b. Quality conformance inspection (see 4.2.2).

4.2.1 First article inspection. When first article approval is required under 3.1, first article inspection shall be performed. Unless otherwise specified (see 6.2.1), the first article inspection shall comprise the examination in 4.3 and all tests in 4.4. Failure of the item to pass any examination or test shall be cause for disapproval of the first article.

4.2.2 Quality conformance inspection. Each item shall be subjected to quality conformance inspection prior to being offered for acceptance. Unless otherwise specified (see 6.2.1) , quality conformance inspection shall consist of the examination in 4.3, the test in 4.4 and the inspection in 4.5. Failure of the item to pass either any examination, test or inspection shall be cause for rejection.

4.3 Examination. The machine and equipment shall be examined for compliance with the requirements in 3.2 through 3.5 and 3.8 through 3.13.

4.4 Tests. The machine shall be subjected to the following tests. All instruments, tapes, materials, and tools required to perform and evaluate these tests shall be furnished by the supplier. The measuring instruments shall have evidence of calibration traceable to the National Bureau of Standards. The numerical control test tapes and computer printouts used shall become the property of the Government.

4.4.1 Operational test. The machine and its numerical control system shall be operated in accordance with the manufacturer's standard operating test procedure for warm-up and run-off checks. During the warm-up period, proper operation of all manual controls, motors, adjustment mechanisms and accessories shall be verified. After warm-up, the machine shall be cycled continuously under numerical tape control for a period of not less than four hours. This operation shall include tool change, spindle speed and feed rate changes that include the highest, intermediate, and lowest settings of each range, rapid traverse of all slides, simultaneous movement of slides and automatic feed cycles as applicable. The numerical control system shall be further tested to verify proper operation of MDI, program edit, and system diagnostics. Should a malfunction occur, it shall be corrected and the operational test repeated until a full four hours of running time is completed without failure.

4.4.2 Alignment and accuracy test. The machine and its numerical control system shall be tested for conformance with the alignment and accuracy requirements of Table III.

4.4.2.1 Positioning test. Starting at positions other than the extremes of axis travel, two identical movements of each controllable linear axis shall be programmed and executed in each direction. Programmed span shall be not less than 7 inches, and each digit of starting and end point shall be other than zero with respect to reference zero. Feed rate of axis shall be 2 inches per minute. Absolute positioning and positioning repeatability errors shall not exceed the permissible tolerances of Table 111. Similar movements of each linear axis shall be programmed at varied feed rates to test for slide overshoot at accelerated feed rate without programmed deceleration. One pass shall be programmed at feed rates nearest to 10, 20 and 100 percent of maximum linear feed rate, Stops shall be programmed appropriately for inspection of control positioning accuracy. Positioning tests may be part of the same tape as 4.4.1.

4.4.2.2 Overshoot test. Overshoot shall not exceed 0.003 inch at any feed rate up to 20 percent of the maximum. Maximum overshoot shall not exceed 0.005 inch.

4.4.3 Performance accuracy test. While using either *one* or more test setups devised by the supplier, the machine shall be tested to verify its ability to perform machining operations under numerical control for meeting the accuracy tolerances of Table 11. The test piece(s) may be, at the supplier's option, steel, cast iron or aluminum and the tool(s), spindle speed and feed rate for each test shall be selected by the supplier as the most suitable for the particular operation being performed. The test piece(s) shall present a work surface normal to the tool point and approximately centered with reference to the work area in the XY plane. In milling and contouring test, successive cuts may be made inside the outlines of-previous cuts and roughing cuts may be made in the various cuts with excess metal removed as desired to make measurements convenient.

4.4.3.1 Tapping test. Four holes shall be pilot drill and taped at programmed locations, each with finished threads *to* accept 8-32 and 3/4-10 screws, Finished holes shall accept standard 8-32 or 3/4-10 screws freely and threads shall meet Class 3 standards for internal threads as set forth in Handbook H28.

4.4.3.2 Boring test. A minimum of 10 holes shall be pilot drilled, semi-finish bored, and finish bored in a selected pattern covering an area not less than 14 inches in diameter. Four of the holes shall be spaced on 14 inch centers. Different tools shall be used for semi-finish and finish boring operations. Each address shall be to the fourth decimal place with digits other than zero. Finished hole size may range from 1.125 to 2.750 inch. The resulting hole location and hole size shall not exceed the permissible tolerance of Table 11 for boring.

4.4.3.3 Straight-line milling test. The straight line milling test shall be a programmed square or rectangle, not less than 6 inches in length per side with sides parallel to the travel along X and Y axis. Machine angle shall be not less than 2 degrees. The resulting cuts shall be

checked for dimensional accuracy, squareness, parallelism, flatness, angularity, and corner locations to verify the accuracy required in Table 11 for straight-line milling.

4.4.3.4 Circle contouring test. A circle shall be programmed and milled within the outline of the square cut required in 4.4,3.3. The cut shall be made at constant z axis depth of 0.0025 inch and by using the MCU resolution. The resulting cut shall be checked for dimensional accuracy, roundness, surface finish, and angularity to verify the accuracy required in Table II for circle contouring.

4.4.3.5 Straight-line contouring test. Either a square or an equilateral triangle shall be programmed and milled within the circle cut and described by 4.4.3.4 at constant depth of 0.0025 inch. The reference line for one side of the square or triangle shall be 10 to 20 angular degrees canted to the y axis. The resulting cut shall be checked for dimensional accuracy, squareness and angularity to verify the accuracy required in Table II for straight-line contouring.

4.4.3.6 Transverse tilt cutting test. A transverse tilt cutting test shall be performed in accordance with NAS-979 April 1966 Revision 1, 15 January 1969, paragraph 4.3.3.6.

4.4.3.7 Longitudinal tilt cutting test. A longitudinal tilt cutting test shall be performed in accordance with NAS-979 April 1966 Revision 1, 15 January 1969, paragraph 4.3.3.7.

4.4.4 Maximum horsepower test. Using a workpiece of SAE 1020 steel, a straight cut of not less than 12 inches in length shall be made with either a face mill or shell end mill. Diameter of the cutter and spindle speed shall be determined by the supplier to be suitable for making the cut with specified chip load and peripheral cutter speeds. The depth of the cut shall be as required to load the spindle motor to its maximum rated horsepower. Chip load shall be 0.010 $\pm$ 0.01 and peripheral cutter speed shall not exceed 300 feet per minute. The cutting action shall be smooth and even and the finished workpiece shall show no evidence of tool chatter. In addition, there shall be no evidence of overheating of the spindle drive motor or the applicable feed motor.

4.4.5 Test program verification. Unless otherwise specified (see 6.2.1), while using one or more test set-ups devised by the supplier, the machining test program (tape) required under postprocessor validation (see 3.4.16.38), shall be run on the machining center to verify its ability to receive and perform all program functions without malfunction or error. The test piece(s) shall be either steel, cast iron, or aluminum, while the tooling shall be selected by the supplier as the most suitable for the particular operation performed.

4.4.6 Electromagnetic interference control tests. Unless otherwise specified (see 6.2.1), equipment requiring electromagnetic interference control testing shall be tested for compliance with 3.8.

4.5 packaging inspection. packaging shall be inspected to determine compliance with the requirements of Section 5.

5. PACKAGING

5.1 Preservation, packing and marking. Unless otherwise specified (see 6.2.1), preservation, packing and marking shall conform to the requirements of MIL-STD-18058.

6. NOTES

6.1 Intended use. The numerically controlled machines covered by this specification are intended for use in any production shop where drilling, boring, tapping, reaming, and milling operations by numerical control of the machine are required. The machine may be used to produce prototype parts from a taped process or to produce production items repetitively from a proven process, to accuracies within the capabilities of the machine.

6.2 Ordering data.

6.2.1 Procurement requirements. Purchasers should specify their requirements in procurement documents, by entering an appropriate statement identified to each of the following:

a. Title, number, and date of this specification.
b, Class, and size required (see 1.2).
c. First article approval, if required (see 3.1).
d. Measuring system, if different (see 3.2.1)
e. Measuring and indicating device calibration, if required (see 3.2.1.1).
f. Dual calibration, if required (see 3.2.1.2).
g. Specify additional safety and health requirements, if required (see 3.2.4 and 6.3).
h. Painting, if different (see 3.3.5).
i. Threaded parts, if different (see 3.3.6).
j. Dial graduations, if different (see 3.3.7).
k. Specify spindle taper, if different (see 3.4.4.).
1. Specify the desired number of tools, if different (see 3.4.6).
m. Specify the number, size and configuration of T-slots, if different (see 3.4.7).
n. Specify noise level and enlcosure characteristics for stand-alone hydraulic units, if required (see 3.4.10).
0. Electrical noise suppression devices, if required (see 3.4.11).
p* Electrical system, electrical supply, and voltage for initial wiring, if different (see 3.4.11).
q. Chip conveyor system, if different (see 3.4.13).

r. Coolant through the spindle, if required (see 3.4.14).

s. Pallet shuttle system, if required (see 3.4.15).
t. Specify EIA-Rs-244 in lieu of EIA -RS-447 (see 3.4.16.2.1).
u. Tape reader tape reels, if different (see 3.4.16.2.1).
v. Specify CL data input in accordance with EIA-RS-494 optional input is required (see 3.4.16.2.2).
w. Data display, if different (see 3.4.16.3).
x. Specify part program storage capacity, if different (see 3.4.16.9).
y Type memory, if different (see 3.4.16.9).
z* Specify additional NC features, if different (see 3.4.16.26).
aa. Specify operator control panel functions, if different (see 3.4.16.27).
bb . Pendent control in lieu of control panel, if required (see 3.4.16.27.1).
cc, Specify pendent control functions, if different (see 3.4.16.27.1).
dd . Auxiliary and miscellaneous functions, if different (see 3.4.16.35).
ee. Tape punch unit, if required (see 3.4.16.37.
ff. Postprocessor (specify computer name and model, form and format) (see 3.4.16.38).
gg . Graphics software (specify graphics system name and model, form and format), if required (see 3.4.16.39).
gg. " Specify standard equipment, if different (see 3.4.17).
ii. Optional equipment, if required; fully describe (see 3.4.18).
jj. Lubrication chart, if different (see 3.9).
kk . Nameplate, if different (see 4.2.1).
11. First article inspection, if different (see 3.10).
mm. Quality conformance inspection, if different (see 4.2.2.)
nn. Test program verification, if different (see 4.4.5).
oo. Electromagnetic interference control test requirements, if different (see 4.4.6).
PP " Preservation, packaging and marking, if different (see 5.1).

6.2.2 Contract data requirements. Required technical data, such as operators manuals, parts lists, wiring diagrams, certified foundation drawings and other instructions for operation and maintenance as identified on a numbered DD Form 1664 shall be specified on a DD Form 1423 incorporated into the contract.

6.3 Safety and health requirements. Paragraph 3.2.4 requires compliance only with those OSHA requirements that concern the machine itself. It does not require compliance with those OSHA requirements that concern *'the machine in its operating environment" such as noise levels, radiation levels, electromagnetic emissions, noxious vapors, air contaminants, heat, etc. Since OSHA limits the total level of these hazards in the environment (and does not limit the hazard level of individual machines in the environ-

ment) the requesting activity is advised to analyze the existing hazard levels in the proposed operating environment, and specify additional machine requirements that will integrate the new machine into its future operating environment. If specific point-of-operation guarding is required, as in most cases, the guard configuration is dependent on the size and configuration of workplaces. The above, and any other additional safety and health requirements, should be specified in detail (under 6.2.1(g).

6.4 Mercury prohibited. When the use of either mercury or its compounds in the machine and its components and accessories is to be prohibited, procurement documents should include a statement to that effect.

6.5 Asbestos prohibited. When the use of either asbestos or its fibers in the machine accessories is to be prohibited, procurement documents should include a statement to the effect.

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

Review Activities
Army - AL
Navy - SH, AS
Air Force - 99
DLA-GS

Preparing Activity:
DLA-IP

Project Number:
3408-0015

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STANDARDIZATION DOCUMENT IMPROVEMENT PROPOSAL

(See Instructions – Reverse Side)

1. DOCUMENT NUMBER	2. DOCUMENT TITLE
MIL-M-80264	Machining Centers, Horizontal, Single Spindle 3 Axis, Softwired Numerical Control with Positioning Rotary Table

3a. NAME OF SUBMITTING ORGANIZATION

b. ADDRESS *(Street, City, State, ZIP Code)*

4. TYPE OF ORGANIZATION *(Mark one)*

- ☐ VENDOR
- ☐ 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.

MIL-M-80264
AMENDMENT 3
27 October 1986
SUPERSEDING
AMENDMENT 2
8 November 1984

MI LITARY SPECIFICATION

MACHINING CENTERS, HORIZONTAL, SINGLE SPINDLE
3 AXIS, SOFTWIRED NUMERICAL
CONTROL WITH POSITIONING ROTARY TABLE

This amendment forms a part of Military Specification MIL-M-80264 dated 1 May 1984, and approved for use by all Departments and Agencies of the Department of Defense.

PAGE 1

Delete the heading and substitute the following:

MIL-M-60264
1 May 1984
SUPERSEDING
MIL-M-80169
10 July 1973

PAGE 12

3.4.16.2.2, line 5: Delete "Functions 10.1, 10.2 and 10.3 of Section 10, EIA-RS-494 shall apply." and substitute: "Functions 10.1, 10.2, 10.4 10.5, 10.10 and 10.12 of Section 10, EIA-RS-494 shall apply."

PAGE 27

* Paragraph 4.3.3.4, line 3: Delete "0.0025 inch" and substitute "0.5 Inch."

* Paragraph 4.3.3.5, line 3: Delete "0.0025" and substitute "0.5,"

The margins of this amendment are marked with an asterisk to Indicate where changes (additions, modifications, corrections, deletions) from the previous amendment 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 evaluated the requirements of this document based on the emtire content irrespective of the marginal notations. and relationship to the last previous amendment.

Add the following under Review Activiti es:

User Activities:
Army - None
Navy - AS, os
DLA - GS

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

Review activities:
Army - AL
Navy - SH, AS
Air Force - 8 4
DLA - GS

Preparing activity:
DLA - IP

Project (3408-0025)