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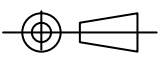
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THIRD ANGLE PROJECTION		CUSTODIAN ENGINEERING MANAGEMENT COMMITTEE	REVISION 4
PROCUREMENT SPECIFICATION NONE	TITLE NUMERICALLY CONTROLLED MACHINING CENTER (COMBINATION DRILLING, BORING, MILLING & TAPPING MACHINES)	CLASSIFICATION SPECIFICATION NAS978	SHEET 1 OF 22

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FED. SUP CLASS
34GPNUMERICALLY CONTROLLED MACHINING CENTER NAS 978
(Combination Drilling, Boring, Milling and Tapping Machines)

1.0 SCOPE

1.1 Purpose

This specification provides a standard for the design, performance requirements, inspection and procurement for combination machines numerically controlled, with work positioning, and tool selection. This is a minimum standard and is not intended to limit or inhibit advanced designs.

1.2 Classification

The machine shall be the following type, and class of N/C control, size and group as ordered by the procuring agency.

1.2.1 Types:

Type I Three-axis machine (X, Y, Z) with 360-station index table. Class IV continuous path control.

Type II Four-axis machine (X, Y, Z and B), the B axis controlling a contouring table. Class IV continuous path control.

Type III Five-axis machine (X, Y, Z, A, and B or C). Class IV continuous path control.

1.2.2 Sizes:

Small - as listed in Table 1

Large - as listed in Table 1

1.3 Intended Use:

The machine described by this specification is intended for use in the aerospace manufacturing industry. Machine is for point-to-point positioning and/or contour milling, drilling, tapping and boring operations in parts and assemblies of aluminum, steel and exotic materials. Preferably, all such operations that are required on a part are to be performed in one setup.

2.0 APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

The latest revision of the following specifications, codes and standards are included as a portion of this specification. Detail requirements of this specification shall preclude any contradictory portions of the following specifications, codes and standards. Verifiable machine tool builders codes and standards from exporting countries may be acceptable as equivalent.

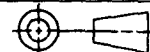
- 2.1 The Joint Industrial Council (JIC) Electrical Standards for General Purpose Machine Tools, EGP-1-67.
- 2.2 The Joint Industrial Council (JIC) Hydraulic and Pneumatic Standards for Industrial Equipment. H-1-1973 and P-1-1975.
- 2.3 The Joint Industrial Council (JIC) Electronic Standard for General Purpose Machine Tools, EL-1-1971.

LIST OF CURRENT SHEETS

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CUSTODIAN MANUFACTURING COMMITTEE

THIRD
ANGLE
PROJECTIONPROCUREMENT
SPECIFICATION

NONE

TITLE

NUMERICALLY CONTROLLED MACHINING CENTER
(Combination Drilling, Boring, Milling & Tapping Machines)

CLASSIFICATION
SPECIFICATION

NAS 978

SHEET 1 OF 21

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- 2.4 The American National Standards Institute (ANSI), B5.1 for T-slots, B5-18 for spindle noses and arbors for milling machines.
- 2.5 The American National Standards Institute (ANSI)/UL-1063-1975, Safety Standard for Machine Tool Wires and Cables.
- 2.6 The American Society of Mechanical Engineers (ASME), Boiler and Pressure Vessel Codes, Section VIII.
- 2.7 National Electrical Code, NFPA 70-1981.
- 2.8 Electrical Standard for Metalworking Machine Tools, NFPA 79-1980.
- 2.9 The Electronic Industries Association (EIA) Standards RS-232, RS-244, RS-274, and RS-281.
- 2.10 National Aerospace Standard (NAS) 938, Machine Axis and Motion Nomenclature.
- 2.11 National Aerospace Standard (NAS) 953, N.C. Systems
- 2.12 National Aerospace Standard (NAS) 995, C.N.C. Systems
- 2.13 National Aerospace Standard (NAS) 943, Interchangeable Perforated Tape Standard.
- 2.14 National Aerospace Standard (NAS) 968, Interchangeable Digital Magnetic Tape Standards.
- 2.15 National Aerospace Standard (NAS) 969, Interchangeable Digital Magnetic Tape Cartridge for Numerically Controlled Machines
- 2.16 National Aerospace Standard (NAS) 955 Interchangeable Perforated Tape Standards -Variable Block Format Contouring and Contouring/Positioning, Numerically Controlled Equipment.
- 2.17 National Aerospace Standard (NAS) 972, Glossary of Manufacturing Equipment Terms.
- 2.18 Occupational Safety and Health Standards, Part 1910 of Chapter XVII of Title 29 of the Code of Federal Regulations.
- 2.19 National Machine Tool Builders Association (NMTBA), Noise Measurement Techniques.
- 2.20 National Machine Tool Builders Association (NMTBA), Definition and Evaluation of Accuracy and Repeatability for Numerically Controlled Machine Tools.

3.0 REQUIREMENTS**3.1 Design**

The dimensions and capacities for the respective types and sizes shall be shown in Section 3.2. The manufacturer has the choice of configuration and the functional operation of the machine except where specifically stated in this specification.

- 3.1.1 The basic design concept shall contain the following elements:
 - 3.1.1.1 One or more spindles to accept cutting tools.
 - 3.1.1.2 One index table for rotating various work surfaces into machining position. Axis of rotation of table to be normal to axis of cutter spindle.
 - 3.1.1.3 Three linear slide motions, normal to each other for maintaining relationships between cutter and work. These motions basically will be parallel or normal to table and spindle axes except for Type III, the 5-axis machine (see 3.1.1.7).
 - 3.1.1.4 A tool magazine for holding a multitude of cutting tools with adapters to fit the machine spindle.
 - 3.1.1.5 Automatic means for transferring tools between spindle and magazine, furnishing the spindle (or spindles) with specific tools for each operation.

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- 3.1.1.6 A pallet shuttle to permit the machine to continue production on one work pallet while operator is unloading and reloading the work on the other. The shuttle exchanges the pallets automatically after completion of work cycle. This pallet shuttle is an optional feature.
- 3.1.1.6.1 Alternately dual work stations may be substituted for pallet shuttle system where pallet part loading is not practical or desirable. All considerations described in 3.8 will apply.
- 3.1.1.7 Type III, the 5-axis machine, has rotational movement for changing the angular relationship between axis of cutter spindle and index table to any angle between and including normal and parallel. This movement may be limited to one quadrant and, according to builder's choice, may swing the work holding means or the spindle head.
- 3.2 Types and sizes, as defined in Section 1.2. The specifications of Table I are minimum requirements and may be exceeded.

MACHINING CENTER
TABLE I

ITEM	SMALL	LARGE
<u>Working Surface</u>		
Minimum Size	18" Dia.	42" Dia.
Alternate	18" x 18"	28" x 36"
<u>Travel (Axis Nomenclature per NAS 938)</u>		
X-Motion	24"	44"
Y-Motion	20"	44"
Z-Motion	16"	32"
A-Motion, Type III Only	90°	90°
B or C-Motion, Type I, II and III	360°	360°
<u>TYPE OF MACHINE</u>	<u>I, II & III</u>	<u>I, II & III</u>
Feed Rate I.P.M.*	0 to 300	0 to 300
Rapid Traverse I.P.M.	300	300
<u>Spindle</u>		
Horsepower (Motor rating)	10	15
Horsepower - Optional	15	25
R.P.M.	20-4000	20-4000
Spindle Nose Type	NAS-970	NAS-970
<u>TYPE OF MACHINE</u>	<u>I, II & III</u>	<u>I, II & III</u>
<u>Tool Changer Capacity</u>		
Tools	24	30
<u>Positioning - Linear</u>		
Resolution per Axis	.0002"	.0002"
Positioning Accuracy	±.0004"/12"	±.0004"/12"
Maximum Accumulation	±.0006"	±.001"
<u>Positioning - Rotary</u>		
Resolution per Axis	1/500,000	1/500,000
	of 1 Rev.	of 1 Rev.
Positioning Accuracy	±10 sec.	±10 Sec.
<u>360-Position Rotary Table Type I</u>		
<u>Machine Only</u>		
Positioned equally spaced within	±10 Sec.	±10 Sec.

*NOTE: Feed rates for rotary axes A, B or C with Class IV control are same as for linear axes when applied to a circle of 100" circumference. Maximum speed 200 IPM, 2 RPM (See NAS 955).

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3.3 Construction

- 3.3.1 The design and manufacture of the specified equipment shall comply with the high standards, material and workmanship associated with heavy duty, precision, industrial machinery. All components shall be constructed for long life under continuous service.
- 3.3.2 The overall design of the machine shall place emphasis on the accessibility, maintainability and reliability of components. Replacement and/or adjustment of these components shall be possible without major machine disassembly.
- 3.3.3 All primary operator control buttons, switches, levers, gages, meters, and regulating devices shall be functionally grouped, permanently identified and mounted in a location(s) affording the operator optimum visibility of the machine tooling and workpiece from his normal position.
- 3.3.4 Safe access shall be provided to the operator to all work and control locations for operation and set-up modes.
- 3.3.5 All mechanical drives (gears, belts, splined shafts) shall be guarded per OSHA standards.
- 3.3.6 Protective covers shall be provided to eliminate the entry of foreign matter into the moving parts of the machine.
- 3.3.7 Adjustable leveling devices and anchor bolts shall either be supplied with the machine or else the requirements for same shall be specified as part of the bid proposal.
- 3.3.8 The equipment shall be delivered complete and ready to operate after being installed and connected to the following availability utilities: Electrical 440V AC $\pm 10\%$, 3 phase, 60 cycle; air, 90 PSI; water, 40 PSI at 70°F max.
- 3.3.9 Safe lifting attach points (lift lugs, lift rings) shall be provided for erection and maintenance purposes for machine sub-assemblies and accessories. Do not use eyebolts.
- 3.3.10 All castings and forgings shall be of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks and any other injurious defects.
- 3.3.11 All welding, brazing and soldering processes shall be performed in accordance with best industrial practices. These processes, including peening and plugging are not to be used on castings or forgings for purposes of retrieving any portion of the equipment unless authorized by purchaser.
- 3.3.12 All welding shall be in accordance with American Welding Society Standards and shall be free of cracks, inclusions, porosity and undercut. All weldments shall be stress relieved and normalized before machining.

3.4 Spindle Head

- 3.4.1 The spindle nose construction is to suit tool holders that are according to the latest revision of NAS 970.
- 3.4.2 Spindle growth due to temperature rise under normal variety of operating conditions is not to change the relative position of the registration surface for tool holders over $\pm .001$ ".
- 3.4.3 Spindle load indicator with 3" diameter dial or equivalent to be located in plain view of operator.
- 3.4.3.1 A horsepower indicator for electrically driven spindles shall be provided.
- 3.4.3.2 For hydraulically driven spindles a differential pressure switch or equivalent shall be included in the system, to stop feed of machine if the pressure differential passes beyond a safe limit. An indicator warning the operator of this condition shall be located in plain view of the operator.

3.5 Tool Magazine

- 3.5.1 The capacities of the tool magazine given in Table I are predicated on tool of a maximum diameter of 2-5/8". It is desirable, but not mandatory, that the magazine be arranged to also accept larger tools occupying, due to their size, several tool spaces.

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- 3.5.2 Upon command, the magazine or an element connected therewith will select and present to the tool changer the tool needed for the next operation. This selection of the correct tool is to take place while the spindle is working with the tool that is to be replaced by the next tool change.
- 3.5.3 The magazine must permit convenient loading and unloading of tool holders during setup.
- 3.5.4 The magazine shall be enclosed in a shroud with access only through latched access doors that are interlocked via use of limit switches stopping all automatic magazine motion but permitting manual manipulation at the tool load station.
- 3.6 Tool Changer
 - 3.6.1 This device will exchange a tool holder and tool from the spindle and return it into the magazine.
 - 3.6.2 The action of the tool changer where initiated shall be fully automatic
 - 3.6.3 The tool changer system shall include a push-button station that shall permit complete step-by-step sequencing of the changer by maintenance personnel.
- 3.7 Tool Coding
 - 3.7.1 The purpose of tool coding is to provide a means for the magazine to select and present to the automatic tool changer the one proper tool for the next tool change.
 - 3.7.2 For machines with pallet changers, the following requirements must be satisfied by the tool coding system.
 - 3.7.2.1 The two pallets of the machine may carry different parts, and the magazine will hold tools for both parts.
 - 3.7.2.2 When the parts require the use of tools, common to both parts, only one such tool need be in the magazine and will serve both parts.
 - 3.7.2.3 Any two parts programmed for the machine independently from each other may be paired on alternate pallets, the only qualification being that the total number of different tools required for the two parts is within the capacity of the magazine.
 - 3.7.2.4 For machines with pallet changers, tool coding shall be capable of differentiating up to 999 tools (three digit system) or up to 99,999 different tools (five digit system) depending upon the coding system used by the manufacturer.
 - 3.7.3 For machines without pallet changers, a fixed number identifying each tool pocket of the magazine will be acceptable.
- 3.8 Pallet Changer (Optional)
 - 3.8.1 Sequence of operation. While machining of work takes place on Pallet "A" mounted to the index table, the operator unloads the previously completed work from Pallet "B" in a load station and reloads it with a new part. After completing this, the operator presses a "Pallet Ready" button. This enables the automatic pallet changer to exchange pallets "A" and "B" immediately after completion of the machining cycle on Pallet "A."
 - 3.8.2 Pallets "A" and "B" may carry work requiring different programs (see 3.7.2.1). These programs may control the machine operation by dual tape readers or multi-part-program storage in solid state memories, floppy discs, or other state-of-the-art techniques. With either scheme, proposed programs identified with each pallet shall be automatically switched during the pallet change.
 - 3.8.3 While a pallet is in the load/unload position, it shall be readily removable from the machine without disturbing any operations being performed on the other pallet in the machining position.
 - 3.8.4 The manufacturer shall have the option to propose different systems involving two or more pallets. Any system offered shall permit easy and safe access to the inactive pallet(s) for loading or unloading while one pallet with a part is in operation.

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