

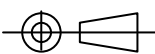
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THIRD ANGLE PROJECTION		CUSTODIAN ENGINEERING MANAGEMENT COMMITTEE	REVISION 2
PROCUREMENT SPECIFICATION NONE		TITLE SPECIFICATION FOR COMPUTERIZED NUMERICAL CONTROL (CNC)	CLASSIFICATION SPECIFICATION DAS995
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1. SCOPE

1.1 Purpose

This specification provides a standard for manufacture, performance, reliability, inspection, and procurement of a Computerized Numerical Control (CNC) System for numerically controlled machine tools. This standard lists minimum requirements and is not intended to limit design advances.

1.2 Classification

CNC Systems for AIA Class III for point-to-point and AIA Class IV for continuous path.

1.3 Intended Use

The control systems described by this specification are intended for use in the aerospace manufacturing industry. Such systems shall provide automatic control of manufacturing equipment and/or processes, including, but not limited to, milling, boring, drilling and turning.

2. APPLICABLE DOCUMENTS

The latest revision of the following specifications, codes and standards are included as a portion of this specification. Detail requirements listed in this specification shall override any contradictory portions of the following specifications, codes and standards, except OSHA or other safety codes in which case the contradiction is to be shown to the customer.

State and Local Safety and Electrical Codes

Government Standards

29 CFR 1910 Occupational Safety and Health Standards (OSHA Act 1970)

TechAmerica

EIA-RS-281-B Electrical and Construction Standards for Numerical Machine Control

EIA-408 Interface between Numerical Control Equipment and Data Terminal Equipment Employing Parallel Binary Data Interchange

Copies can be obtained from TechAmerica, 601 Pennsylvania Avenue NW, North Building, Suite 600, Washington, D.C. 20004. www.techamerica.org

Telecommunications Industry Association

TIA-232-F Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange

TIA-422-B Electrical Characteristics of Balanced Voltage Digital Interface Circuits

Copies can be obtained from TIA, 1320 N. Courthouse Rd., Suite 200, Arlington, VA 22201. www.tiaonline.org

American National Standards Institute (ANSI)

ANSI X3.9 Programming Language FORTRAN

ANSI X3.J7 APT Language and APT CL File Format and Content

Copies can be obtained from the American National Standards Institute, 25 West 43rd Street, New York, NY 10036. www.ansi.org

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Aerospace Industries Association

NAS938	Machine Axis and Motion Nomenclature
NAS955	Interchangeable Tape Standards, Variable Block Format, Contouring and Contouring/Positioning Numerically Controlled Equipment
NAS968	Interchangeable Digital Magnetic Tape Standards, Variable Block, Word Address Format, Contouring and Contouring/Positioning Equipment
NAS972	Glossary of Manufacturing Equipment Terms
NAS979	Uniform Cutting Tests, NAS Series Metal Cutting Equipment Specifications
NAS993	Direct Numerical Control System

Copies can be obtained from the Aerospace Industries Association, 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209. www.aia-aerospace.org

National Fire Protection Association

NFPA 70	National Electrical Code
NFPA 79	Electrical Standard for Industrial Machinery (3.4.7) (3.5)

Copies can be obtained from NFPA, 1 Batterymarch Park, Quincy, MA 02169. www.nfpa.org

3. REQUIREMENTS

The supplier has the choice of configuration and the functional operation of the control system except where specifically stated in this specification. The CNC shall be of the latest design technology and shall include a minicomputer or micro-computer(s) in conjunction with all necessary equipment for controlling simultaneous motions and auxiliary operations for as many axes of motion as specified and operations at maximum specified feed rates. Exceptions to this specification shall be documented by the manufacturer.

3.1 Hardware

- 3.1.1 The CNC on retrofit applications shall provide for the use of the customer's existing hardware including servomotors and transducers that are in good working condition. If compatibility does not exist, CNC manufacturer shall advise.
- 3.1.2 The CNC shall be of modular, expandable design so that only minor modification to the hardware should be required to integrate new features.
- 3.1.3 The machine control system shall have automatic bi-directional tape search and rewind.
- 3.1.4 Any peripheral or any other input shall not inhibit machine performance. The CNC computer or microprocessor data handling speed shall be such that all data transmission elements can be handled without inhibitions.
- 3.1.5 The system shall have the capability of storing a minimum of _____ feet (customer to specify) of equivalent punched tape.
 - 3.1.5.1 The internal capacity of the CNC shall be expandable by the addition of modular memory elements.
- 3.1.6 The CNC shall recognize and perform control functions as specified by the customer (See Appendix A).
- 3.1.7 Where the computer is an integral part of the servoloop, failure of the computer shall stop the machine tool.

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- 3.1.8 The system shall provide for feed rate & spindle speed override from 0% to 120%. Provision shall be made to permit inhibiting this function.
- 3.1.9 A convenient means of reloading all CNC software shall be provided. The manufacturer shall state the method and time required for reloading.
- 3.1.10 There shall be provisions for manual input of data. However, adequate means shall be provided to ensure against unauthorized data editing.
- 3.1.11 The CNC shall be of digital and analog circuits using general industry recognized solid state devices for controlling the position and operation of a machine tool.
- 3.1.12 The CNC shall include all of the following components:
- a. Control electronics consisting of all hardware to interface the machine to the CNC.
 - b. Machine interface electronics which will integrate the machine tool servos, control valves, limit switches, etc.
 - c. System to include indicator modules for all inputs/outputs, AC/DC.
 - d. CRT display.
- 3.1.13 The control panel shall include the following function switches:
- a. Power on/off
 - b. Auto/manual selection
 - c. Machine control reset
 - d. Cycle start/stop
 - e. Emergency stop
 - f. Axis sign select
 - g. Manual motion controls
 - h. Spindle(s) control(s)
 - i. Coolant on/off
 - j. Machine drive system on/off
 - k. Feed rate override
 - l. Reader controls
- 3.1.14 The control shall provide for the following indicator displays:
- a. Axis overtravel
 - b. Machine drive system failures
 - c. Spindle failures
 - d. Reader status
 - e. Servo error
 - f. Position displays, sequence display
 - g. Following error

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- 3.1.15 The supplier shall provide appropriate controls and indicators/displays for customer options such as:
- a. DNC
 - b. Part program edit
 - c. Peripherals
- 3.1.16 Computers and peripherals shall be replaceable.
- 3.1.17 Where the system or peripheral device builder's part number is used for identification, a reference to equivalent industry standards shall be provided.
- 3.1.18 Additional hardware/software minimum requirements are listed in Appendix A.
- 3.2 Software
- 3.2.1 The supplier shall have the responsibility for providing all software necessary for a complete, operational CNC system, including an appropriate post processor (Ref. Appendix C).
- 3.2.2 The CNC supplier shall provide all relay logic functions in the form of programmable machine dependent logic complete with a software package priced separately.
- 3.2.3 The system shall be designed to detect improper entry of part program data and inhibit such entry.
- 3.2.4 Data shall be checked on a character by character basis (parity checks) on entry.
- 3.2.5 The CNC shall have the capability of accepting data in either inch and/or metric format with no loss of accuracy.
- 3.2.6 The CNC shall have linear and circular interpolation with no quadrant limitation, plus helical or parabolic if specified.
- 3.2.7 The system shall have the capability of producing right and left-handed parts from the same part program (mirror image).
- 3.2.8 The system shall be capable of suppressing leading and/or trailing zeros from dimension words.
- 3.2.8.1 The system shall provide for decimal point display.
- 3.2.9 Control function codes shall conform to NAS955.
- 3.2.10 System axis designation shall conform to NAS938.
- 3.2.11 Systems shall be designed so that "stop" can be programmed as desired for such purposes as inspection, spindle speed change, etc. (optional stop).
- 3.2.12 Provisions shall be made for restarting at other than programmed "stop" (i.e. sequence numbers or other part program reference points) and automatically positioning the machine slides to the restart coordinates.
- 3.2.12.1 The CNC shall be capable of displaying current machining operation codes (i.e. use typical codes).
- 3.2.13 It shall be possible to resume the automatic cycle after a manual interruption (e.g. slide hold) without loss of information or position.
- 3.2.14 A full floating zero reference system singular (or multiple as may be required for multiple set up type machine) for all axis movements shall be provided to allow the location of a set point anywhere on the work mounting surface.

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- 3.2.15 The CNC shall have the capability (via software) to compensate for inaccuracies in axis drive devices (e.g., leadscrew/ballscrew errors).
- 3.2.16 Loss of synchronization for any reason, including excess servo following error, shall stop the machine tool. The loss of synchronization as well as the particular axis involved shall be indicated by appropriate signals.
- 3.2.17 There shall be provisions for manual input of data, however, adequate means shall be provided to ensure against unauthorized data editing.
- 3.2.18 CNC shall provide for customer's option (e.g., part program edit, part program identification checking and sequence search).
- 3.2.19 The CNC shall have the capability to collect the machine status information specified in Appendix B.
- 3.2.20 The CNC software shall have fixture offset capability to facilitate fixture setup (compensate for fixture misalignment).
- 3.2.21 CNC computer operating software will be provided.
- 3.2.22 The control shall accept data per NAS955.
- 3.2.23 CNC software that accepts the customer's existing part programs (emulate customer's existing controls) shall be supplied (Customer option).
- 3.2.24 CNC shall accept part program data in absolute and incremental form. Selection shall be by part program control. The preparatory code required to select the desired mode of operation shall be per NAS955.
- 3.2.25 Maximum departure distance shall be at least ± 999.9999 inches (Customer option).
- 3.2.26 Feed rate and spindle speed coding shall be per NAS955.
- 3.2.27 The control shall provide the maximum programmable axis velocity.
- 3.2.28 The CNC software shall be modular so that major subsections can be easily altered with minimum change to the remaining modules.
- 3.2.29 The supplier shall provide system maintenance programs to automatically diagnose the control system to the major component level (e.g., circuit board, data input device, etc.) and identify the faulty components with suitable indicators.
- 3.2.30 The supplier shall provide a storage map of the computer.
- 3.2.31 All CNC software shall be provided in source language with appropriate detailed documentation (flow charts, general description and source listings).
- 3.2.32 The supplier shall be responsible to diagnose and correct any errors in the supplied software during the warranty period.
- 3.2.33 When multiple part programs are stored, they shall be capable of running in any order selected. Execution of the selected part program shall not require operator intervention or action other than selecting the program and starting the cycle.
- 3.2.34 Software in identical control systems shall be interchangeable with the exception of those items which are unique to a specific machine tool.
- 3.2.35 CL Data Option (Ref. Appendix D).

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3.3 DNC Interface (Customer Option)

- 3.3.1 The CNC shall have the capability of receiving part program data from Customer's DNC system, and shall be capable of distinguishing between production and tryout files if identifying data is provided by the DNC system.
- 3.3.2 The CNC shall have the capability of maintaining the equivalent of _____ feet (Customer to specify) minimum of Machine Coded Data (MCD) at all times. The operation shall be transparent to all users and other machining operations. Furthermore, this operation shall require no intervention from the machine tool operators.
- 3.3.3 The CNC shall have the capability of requesting the next _____ feet (Customer to specify) of MCD and verifying completeness of downloaded operation before the machining process on that operation can begin.
- 3.3.4 The CNC shall verify the completeness of each downloaded operation, bracketed by a pair of O-codes or an O-code paired with the end of program mark, before any machining can be performed.
- 3.3.5 The CNC shall be capable of recovering from CNC/DNC transmission error, power failure, and other error conditions. Part program transmission shall be re-initiated from the last good O-code received.
- 3.3.6 The CNC shall be capable of supporting the display and entry of all DNC transaction screen formats defined in the system.
- 3.3.7 The CNC shall be capable of supporting the display of edit part program functions during editing operations.
- 3.3.8 The CNC shall be capable of displaying the part program number (tool number) throughout the machining operation.
- 3.3.9 The CNC shall be capable of transmitting, at customer specified rates, all status and management information data, as identified in Appendix B. The transmission rate shall be implemented as a variable for possible future modification.
- 3.3.10 The CNC shall be capable of transmitting all CNC diagnostic monitor messages to the DNC system.
- 3.3.11 The CNC shall be capable of transmitting all manual entries to the DNC system.
- 3.3.12 The CNC shall be capable of accepting the CNC executive and diagnostic software from the DNC system.
- 3.3.13 All existing CNC capabilities shall be retained in the CNC local operating environment (non-DNC environment).
- 3.3.14 The DNC/CNC interface shall be provided with means of isolating faults. Diagnostic and testing programs shall be provided to test the performance of the DNC/CNC link.
- 3.3.15 The supplier shall provide a list of additional hardware required to meet the conditions of the described DNC interface.
- 3.3.16 The CNC system shall be capable of storing & displaying shop instructions. The manufacturer shall specify the limitations.

3.4 Construction

- 3.4.1 All primary operator's control buttons, switches, levers, meters and regulating devices shall be grouped and mounted in a location affording the operator (when in his normal established work position) maximum visibility of the controls, indicators, machine, tooling and work. Location of the controls to be provided at time of quote. All controls should be plainly and unambiguously labeled with permanent labels.
- 3.4.2 Location of the tape reader shall be such that it is visible and readily accessible from the operator's position.

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