BID SPECIFICATION

FOR

HIGH SPEED SINGLE SPINDLE ROUTER

[redacted]

[redacted]
Equipment Engineer
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CONTENTS

1. **SCOPE**

Specification revisions are identified by an asterisk (*) after the Article Number.

This specification provides a standard for the design, performance, fabrication, installation and checkout of a CNC high performance (high-speed) single-spindle 3-axis router cell for stacked flat stock material. The specification lists minimum requirements and is not intended to limit the Supplier's improvements in the design nor performance of the machine.

1.1 The machine shall be designed to automatically stack aluminum sheet stock onto a slave pallet, transfer the stacked flat stock aluminum material to the router hold the pallet and material to the bed of the router, rout and drill the parts, convey the routed stack to an unload station, and return the slave pallet to the load station for reuse.

1.2 The router shall be high performance and include all features necessary to provide a high throughput system including CNC controls, Cell Controller, chip control and collection, automatic tool changer, broken tool detection, and part probing.

1.3 The machine shall have a 3-axis work envelop to accommodate material that is 144 inches (3.5 m) long by 48 inches (1.2 m) wide with a controllable vertical travel of 12 inches.

1.4 The router shall have one spindle with vacuum chip collection and mist cutter lubrication.

1.5* The spindle shall be in the 35-40 horsepower range with a maximum speed range of 27,000 - 30,000 rpm.

1.6 The X and Y – axis maximum feed rate shall be 1,500 ipm. Rapid traverse shall be 2,000 rpm.

1.7 This specification describes a machine having the capability to accurately and efficiently produce parts for the aerospace industry. The articles within describes a machine with appropriate rigidity and high durability with high accuracy, spindle speeds and feed rates for use in producing parts from aerospace aluminum on a 3-shift 5-day per week schedule.

2. APPLICABLE SPECIFICATIONS, CODES AND STANDARDS

The latest revisions 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.

2.1. National Machine Tool Builders Association (NMTBA).

2.2. Aerospace Industrial Association (AIA)

2.3. National Electrical Manufacturer's Association Codes (NEMA).

2.4. National Aerospace Standard (NAS) 938, Machine and Axis and Motion Nomenclature.

2.5. National Aerospace Standard (NAS) 979, Uniform Cutting Tests (Performed at maximum speeds and feeds.)

2.6. National Aerospace Standard (NAS) 958, Uniform Alignment Tests

2.7. ANSI/National Fire Protection Association (NFPA 70 and 79), Electrical Standards for Metalworking Machine Tools.

2.8. Occupational Safety and Health Standards (OSHA), Part 1910, Title 29 of the current Code of Federal Regulations.

2.9. American National Standard for Industrial Robots and Robotic Systems Safety Requirements, ANSI / RIA R15.06-1999; American National Standards Institute, Inc., Approved 21 June 1999

2.10. Environmental Protection Agency (EPA).

2.11. State of Texas, Dallas County and local safety, electrical and fire codes.

2.12. Contractor Compliance Specifications: Customer's Security, Fire Prevention, Safety, Health and Environmental Control Regulations, ESH 060398-003, Rev. 01.

3. TECHNICAL MACHINE REQUIREMENTS

3.1. General Information

3.1.1. The Manufacturer has the choice of the machine's configuration and functional operations except where specifically stated within this specification. The design and general characteristics of the machine are to be detailed in the Manufacturer's Bid Proposal.

3.1.2. The machine shall be capable of "maximum spindle speed and horsepower", high metal removal rate operation, under three shift (24 hour) per day, 5 day per week, production conditions to precise tolerances on work pieces that require three axis positioning and contouring capabilities.

3.1.3. The machine shall be a new existing model of a design that has demonstrated its ability to perform satisfactorily at high production rates during continuous duty operating conditions. Modifications to the Manufacturer's design are permissible if they are accessories or other features needed to meet the minimum requirements of this specification.

3.1.4. Herein the machine's manufacturer may be referred to as the Manufacturer, Supplier or Contractor. The purchaser, or developer of this specification, shall be referred to as the Customer.

3.2 Dimensions and Capabilities

3.2.1. Dimensions and capabilities listed below are the Customer's minimum requirements. All deviations from the listed dimensions and capabilities shall be identified in the Manufacturer's bid proposal, for consideration by the Customer.

3.2.2. Axis Travels shall support a work envelope as follows:

X-Axis	144 inches (3.6 meters)
Y-Axis	48 inches (1.2 meters)
Z-Axis	12 inches (0.3 meter)

3.2.3.	Z-Axis Spindle Nose to Bed	6 inches min. to 15 inches max.
3.2.4.	Spindle Taper	HSK63, or smaller
3.2.5.	Automatic Drawbar	Collet Type
3.2.6.*	Spindle Speed – Maximum RPM	27,000 to 30,000 rpm
3.2.7.	Routing Feedrate, Maximum	Adjustable to 1,500 to 2,000 ipm
3.2.8.	Rapid Traverse, X and Y Axes	2,000 ipm
3.2.9.*	Horsepower, Continuous	35 – 40 Range
3.2.10.	Tool Changer Magazine Capacity	20 Minimum
	Cutting Tool Types	#40 drills to ¾" shank tools
	Cutting Tool Weight (Max)	5 lbs.
	Cutting Tool Length (Max)	3 inches
3.2.11.	Cutter Coolant System	Mist Lubricant (Unist or equivalent)
3.2.12.	Chip Collection	Vacuum

3.2.13.	Bed Type	Vacuum Table (Option)
3.2.14.	Bed Working Height	32 – 36 inches above floor

3.3. Accuracy and Repeatability

3.3.1. The machine shall be capable of the following positioning accuracy and repeatability:

3.3.2. Rise and fall of the spindle nose to work surface, parallel to the X-Axis

Entire Length	±0.0005”

3.3.3. Rise and fall of spindle nose to work surface, parallel to Y-Axis.

Entire Length	±0.0005”

3.3.4. Transverse movement square with longitudinal movement (X-Y squareness).

Per foot	±0.0005”
Overall	0.001” (over all)

3.3.5. Vertical motion square with longitudinal movement (X-Z squareness).

Per foot	±0.0005”
Overall	0.001” (over all)

3.3.6. Vertical motion square with transverse movement (Y-Z squareness).

Per foot	±0.0005
Overall	0.001” (over all)

3.3.7.	Spindle tram, 24” sweep.	All readings within 0.0005” tir
3.3.8.	Spindle face axial runout.	All readings within 0.0002” tir
3.3.9.	Spindle internal runout 12” from face.	All readings within 0.0001” tir

3.3.10. Positioning Accuracy Tolerances
The following positioning accuracy shall be determined with the use of the axis calibration feature and under environmental conditions in which the ambient temperature is stable.

3.3.11. Linear Axes
0.0005”/ft. total band width at 70% of positions
0.0003”/ft. total band width at remaining positions

X-Axis	0.001” overall band width
Y-Axis	0.001” overall band width
Z-Axis	0.001” overall band width

3.3.12. Repeatability

Linear Axes	0.0003”

3.3.13.	Bed Flatness	±0.0008 inches per 10 inches ±0.001 inches tir

3.4. Design Configuration

3.4.1.* This specification describes a numerically controlled three axis router for stacked aluminum with vacuum chip removal, a material handling system and automatic material loader.

3.4.2. The bed shall be elevated so that the work is at waist level of the operator – 32 to 36 inches.

3.4.3.* The machine shall have a vertically mounted Fischer Precision MFW1424, or equivalent, spindle with HSK63 (E or F) taper, or smaller.

3.4.4. The machine shall be designed to minimize transmission of vibrations to the spindle that could degrade the accuracy and high-speed performance of the system.

3.4.5.* The spindle shall provide a minimum of 35 - 40 Hp under continuous duty with a 20% increase in horsepower for the intermittent rating.

3.4.6. The spindle shall be designed to have, as a minimum, a 10,000 hour expected life.

3.4.7. The system shall be provided with a run time meter to monitor hours of run time.

3.4.8. The spindle shall be capable of continuous duty (24 hours per day 5 days per week) at its maximum rpm and full continuous duty horsepower.

3.4.9.* The maximum operating spindle speed shall be between 27,000 – 30,000 rpm for aluminum material. The minimum operating spindle speed shall be adequate for #40 drills.

3.4.10. The spindle shall be the latest design variant.

3.4.11. The spindle shall use hybrid ceramic bearings or more suitable bearings for the intended high-speed machining operation.

3.4.12. The spindle shall be adequately lubricated and cooled to insure proper operation.

3.4.13. A spindle cooling system shall be provided to keep the spindle at the intended operating temperature.

3.4.14. Spindle bearing operating temperature shall be maintained at $\pm$4 degrees Fahrenheit from nominal to minimize spindle growth.

3.4.15. Spindle oil, if used, shall receive 1-micron final filtration after the pump (before entering the spindle).

3.4.16. The spindle oil lubricating system shall be a Trabon system or equivalent.

3.4.17. The lubricating system shall adjust the flow of the spindle lubricant to match the spindle speed so as not to over lubricate the spindle bearings at low rpm's.

3.4.18. The spindle shall have a taper blow off to eliminate contamination.

3.4.19. As the Customer's air pressure fluctuates from between 70 and 90 psig, an air compressor shall be provided with any oil type lubricating system that does not operate with the Customer's air supply to provide all of the air required for the lubrication system.

3.4.20. The spindle shall have a pressure foot to hold the aluminum sheets down during the machining processes without snagging the parts.

3.4.21. The pressure foot shall be made of a non-scoring material to prevent damage to the sheet stock. The pressure foot shall be designed to prevent chips from becoming trapped between the part and the pressure foot to prevent scoring of the routed material.

3.4.22. An additional pressure foot system may be provided to function with the spindle during a tab removal process.

3.4.23.* The router pressure foot shall be designed to have air blowing toward the center opening of the foot where it contacts the material. The orifices shall be a minimum of .060 inches diameter. The intent is to create a positive pressure air flow to minimize the opportunity for chips to get between the material and the pressure foot. There shall also be air orifices in the pressure foot to blow chips from the material where the foot is to come in contact with the material when the foot is lowered onto the material. Air orifices shall also be located around the outside perimeter of the pressure foot to blow away chips the could be run over by the foot. See the included concept sketch on next page.

3.4.24.* Add - If the Customer's air supply is insufficient for proper function of the pressure foot, an auxiliary compressor shall be provided.

3.5. Axis Drives

3.5.1. All axis drives and gearboxes shall be designed for high-speed operation.

3.5.2. Feedrates for X and Y-axes shall be adjustable between 0.1 and the maximum possible for the machine. The maximum linear feedrate shall be a minimum of 1,500 ipm, or as appropriate for high speed operation.

3.5.3. Rapid Traverse shall be 2,000 ipm or higher.

3.5.4. All axis drives shall be AC drives fitted with integrated digital servos (IDS) on the drive motors.

3.5.5. All axis ways shall be protected from dirt and chips by covers.

3.5.6. Dual rack and pinion drives, or linear motors, shall drive longitudinal motion (X-axis), one for each rail. Ball screws may drive all other linear axes.

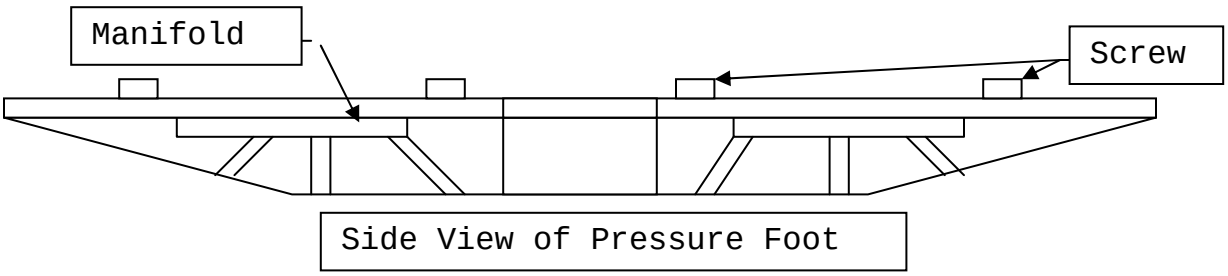
3.5.7. All axis drive motors shall use encoder feedback.

3.5.8. Z-Axis shall be controllable for light milling.

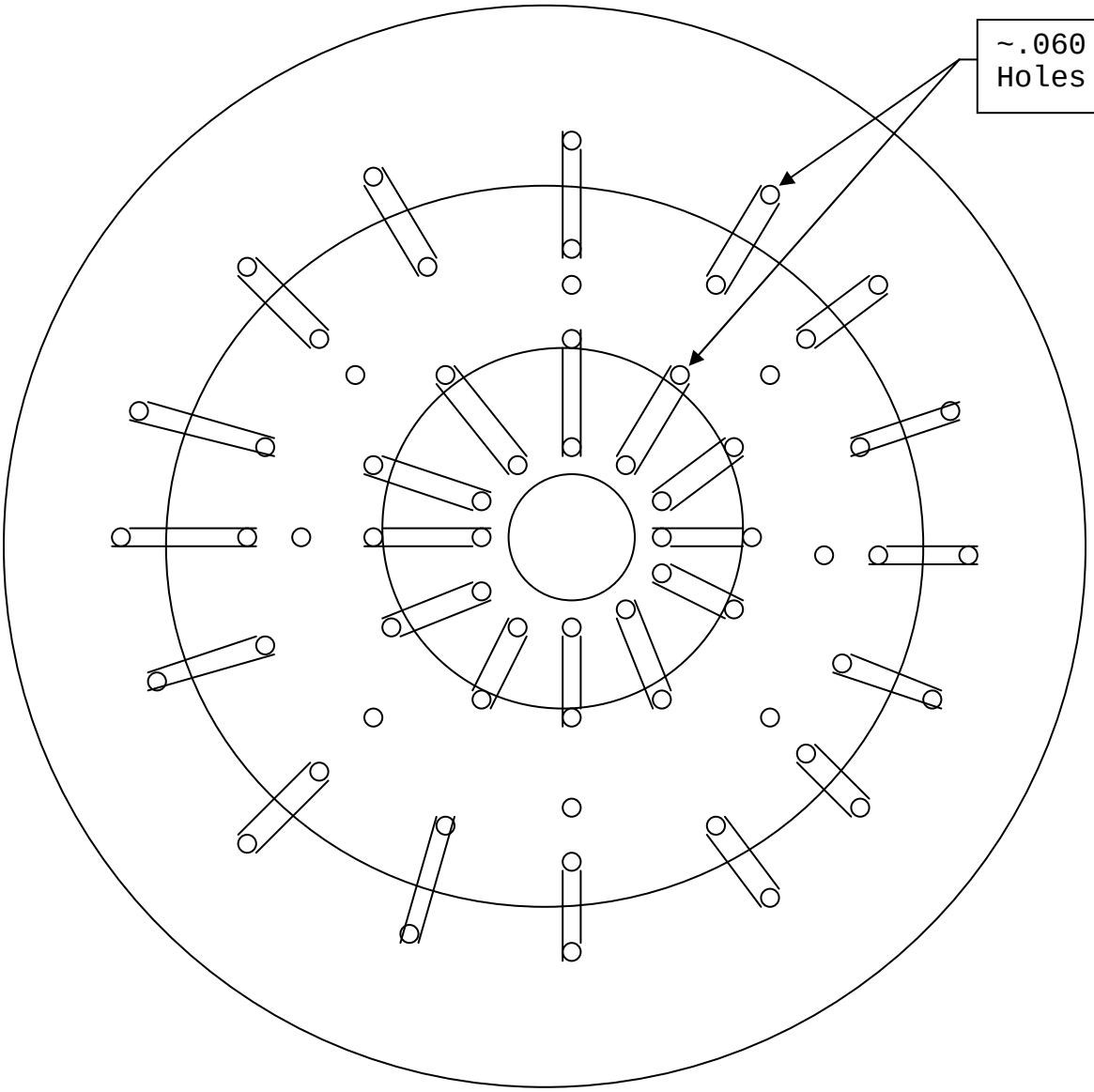
3.5.9 X-Axis shall have anti-backlash drives.

3.5.9. The machine shall have removable, hardened and ground ways on the X and Y-axes for ease of repair or replacement.

3.5.10.



Side View of Pressure Foot



Top View of Pressure Foot

Router Pressure Foot Concept Drawing

3.5.11. The machine's X-axis rails shall be designed such that the ways can be removed and replaced singularly, or in sets, without the need for custom grinding of the ways.

3.5.12. All linear axes shall ride on recirculating anti-friction way bearings. The bearings and ways shall be protected from dirt and chips by seals and way wipers.

3.5.13. All way bearings shall be designed for ease of removal to support maintenance.

3.5.14. X-Axis bearing housing shall be pressurized with air to help prevent contamination by chips, etc.

3.5.15. As an option to the Customer and quoted separately, a spare spindle shall be provided.

3.6. Tool Changer

3.6.1. An automatic tool changer, controlled by the CNC system, shall be provided.

3.6.2. The tool changer shall have a storage magazine for a minimum of 20 cutter assemblies.

3.6.3.* As an option to the Customer and quoted separately, the capacity of the tool magazine may be increased to 40 tools.

3.6.4. Tools shall be stored non-sequentially and searched for in both directions.

3.6.7. The controls shall drive the selector via the shortest route to the selected tool location.

3.6.8. Tool change time shall be 2 seconds or less, tool to tool.

3.7.0. Machine Bed

3.7.1. The machine bed shall be able to support a .500 inch thick stack of aluminum plates 144 inches in the X-axis and 48 inches in the Y-axis.

3.7.2.* The machine's bed shall be high enough to hold the aluminum material at 32 – 36 inches above the floor.

3.7.3.* Delete - The vacuum pump shall provide 29 inches of mercury at a rate adequate enough to meet the needs of the system. The Customer typically uses Ingersoll Rand vacuum pumps.

3.7.4. The machine's bed shall be provided with a mechanism to move the sheet stock onto and off the bed.

3.7.5. The machine's bed shall be provided with a mechanism to position and clamp the stacked material in place for routing and drilling.

3.7.6.* Delete - As an Option to the Customer and quoted separately, the machine's bed shall have a vacuum riser, instead of the shuttle mechanism, fitted to the bed.

3.7.7.* Delete - The surface of the vacuum table shall be machined in a 2-inch square grid pattern for holding the sacrifice wood. The grid pattern shall be sized to cover a 140 x 44 inch area. The vacuum in the grid shall be controllable in 24 inch sections along the X-Axis.

3.7.8.* Delete - A sacrifice wood pallet of medium density pressed wood 1 inch thick shall cover the individual sections of the vacuum riser.

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3.7.9.* Delete - The vacuum riser shall be complete with a high volume pump.

3.7.10.* Delete - The vacuum pump shall be silenced as needed to meet an 80 dba noise limit at 6 feet from the pump.

3.7.11.* Add – A sacrifice board of ¼ inch thick aluminum or Masonite shall be used to support the stack of material through the cell.

3.8. Machine Controls

3.8.1.* The control system for the machine shall be a Fanuc 180i or 160i with the open architecture front end, or equivalent, configured to provide high performance, high accuracy, multi-axis operation. Windows NT is the preferred software operating system.

3.8.2. The machine's control shall have sufficient capability to provide simultaneous motion control at all specified feeds and speeds for all axes and drives of the system plus control all other operating features of the system.

3.8.3. The CNC should utilize the machine's integrated digital servos and the most advanced software available from the Manufacturer.

3.8.4. A digital servo interface shall be provided to use the digital servo feedback system to allow the central processing unit (CPU) of the control to close the servo's position and velocity loops. The CPU will then communicate to the CNC over a high-speed communication line. Analog servo feedback systems are not desirable.

3.8.5. Acceleration/Deceleration (ACC/DEC) shall be based, at least, on a minimum acceleration rate of 0.25g.

3.8.6. ACC and DEC shall be adjustable by the Customer to optimize the machine's performance.

3.8.7. Part program storage, equivalent to 10 gigabytes, shall be provided in the control. The system shall support 600 registerable programs.

3.8.8. The control shall be capable of reading a sixteen (16) digit alphanumeric part program name.

3.8.9. The programs will include an eight (8) digit tool code.

3.8.10. The CNC shall be installed with all necessary I/O's to operate all functions of the machine needed for proper system operation.

3.8.11. The CNC, without operator intervention, will control all machine motions and functions to provide fully automatic, continuous path, high speed drilling, milling and profiling of complex shapes requiring three axis machining.

3.8.12. A CNC error message shall alert the operator of low battery power.

3.8.13. The control system will be provided with protection from the surrounding environment with filters, circulation fans and adequate seals to prevent the entry of foreign matter. Air conditioning for all control and magnetic panels shall be provided as needed.

3.8.14. The control console (CRT and keyboard) will contain all necessary controls for operation of the machine. Operator controls will include cycle start and stop, feed rate override, spindle speed override, block by block control of input data, and tool number display.

3.8.15. Controls shall accept manually inserted positioning data to move each axis in the direction and speed desired, control speed and direction of the spindle, control start, emergency stop, and cutter coolant operations in support of proofing work.

3.8.16. There shall be a modem in the controls that will allow Maintenance personnel to connect, via telephone, the machine's control to the Manufacturer's Service Department to diagnose functional problems that may occur with the machine and its control. The Manufacturer shall state the cost of such service in the bid as an option to the Customer.

3.8.17. Axis calibration will correct repeatable differences between the actual X and Y-axis position and CNC indicated position. Lead screw, rack gearing and feedback device inaccuracies shall be compensated for by axis calibration.

3.8.18. All compensation factors and system parameters shall be provided to the Customer on a Boot Disk to support maintenance activities.

3.8.19. The inch mode shall be the system default mode. If system power is removed, the system shall come up in the inch mode when power is restored.

3.8.20. Cutter length and diameter compensation shall be provided for all milling, drilling and profiling work.

3.8.21. Tool Length Offsets - This feature shall provide tool length offsets up to ±9.9999" (±99.99mm) for drilling and milling.

3.8.22. Cutter Diameter Compensation - This feature shall provide cutter diameter compensation offsets from ± .0001" to ± .1000" (± .001 to 1mm) as a minimum and shall be compatible with the system's look ahead capability of 100 blocks for cutting.

3.8.23. Cutter length and diameter compensation shall be determined on the machine and the compensation values shall be stored in the control.

3.8.24. Although cutters are expected to be provided to the machine from an offline tool setter, a provision to determine cutter length on the machine using a touch pad shall be provided.

3.8.25. The CNC diagnostics shall check the processor, memory, interface and all electrical hardware such as the CRT and keyboard. Ladder logic diagnostic aid format, or its equivalent, shall be provided.

3.8.26. Omitted

3.8.27. The control software shall minimize (near zero) following error to enable surfaces to be cut as programmed.

3.8.28. The software shall eliminate quadrant crossover "Spikes" on axis reversal.

3.8.29. Sample time of servo velocity feedback and position feed back shall be performed at one millisecond per block or better.

3.8.30. Maximum position feedback pulse rate shall be adequate to enable the machine to operate in coordinated movement at full axis feed rates, even with minimal incremental movements of all axes, such as 0.0001 in. in the linear axes over the full travel of the machine.

3.8.31. The CNC will use multiple 32-bit CPU's and communicate with other components in the controls over a 32-bit bus. Architecture based on 16 - bit CPU and bus is unacceptable. A system based on 64-bit or greater architecture is acceptable.

3.8.32. The Manufacturer's machine interface code will be run in an independent 32 - bit microprocessor.

3.8.33. A dedicated 32 - bit microprocessor shall process part program data. A 64 - bit RISC processor running in parallel with the main processor and the machine tool interface is also acceptable.

3.8.34. Independent axis processors shall run in parallel with other processors to handle the servo sample time at very high rate and simultaneously handle communications with other processors.

3.8.35. Block processing time must be fast enough to ensure that there are no bottlenecks in the control system.

3.8.36. Interpolation rate must be adequate to ensure it does not cause a bottleneck in the system.

3.8.37. DNC communication rate shall be adequate for the machine to be run at maximum speeds and feeds as programs are downloaded from DNC (28,800 baud or faster.)

3.8.38. Automatic Feedrate Override shall allow the CNC to recognize that there is a point in the program, where the path feed rate must be modified to continue to provide acceptable part quality. The control shall automatically adjust the feed rate as needed and then resume speed where appropriate. An error message should be provided to the operator informing of the difficulty.

3.8.39. The controls shall automatically activate Feed Hold in the event the spindle speed drops 5-10% from set speed within 20 milliseconds. Control software shall enable the operator to resume cutting by using Cycle Start.

3.8.40. The controls shall have automatic regrid capability.

3.8.41. Part programs shall be accessible on the system operator's console for maintenance and editing.

3.8.42. The controls shall include a Public Interface capability to permit monitoring the machine’s performance from a PC at a remote location within the Customer’s facility.

3.8.43. The Public Interface capability shall permit real time monitoring of all performance activities of the machine, record the data and generate reports. State all capabilities of the Manufacturer’s Public Interface capability in the quotation.

3.8.44. The CNC shall be installed with all necessary I/O's and shall provide, but not be limited to, the following features:

- Menu driven displays
- Status messages
- Full screen text editor
- Full screen systems status display
- Canned cycle
- Part program storage – 10 gigabytes
- Part program execution from DNC through an Ethernet port.
- Broken Tool Detection
- Tool Path Graphics
- Cutter length and diameter compensation (200 tools)
- Spindle Load Monitoring
- Adaptive Control
- Spare Tool Selection
- Automatic Spindle Orientation

· Tool life monitoring
· Tool Change
· Part Probing
· Pallet Shuttle
· Encoder feedback interface
· Battery backup (5 days) with operator alarm
· Error messages displays
· On line diagnostics
· Manual data inputs
· Absolute and incremental programming
· Jog memory
· Programmable machine interface
· Simultaneous multi - axis machining control
· Automatic EIA/ISO recognition
· Rapid traverse override
· Direct feed rate programming
· Direct spindle speed programming
· Feed rate override (50% to 120% infinitely variable)
· Spindle speed override (0% to maximum RPM in 1% increments)
· Backlash compensation
· Lead screw error compensation
· Workpiece coordinate system
· Sequence number search
· Dry run selection
· Optional stop/optional block skip (quantity 9)
· Sixteen digit alphanumeric program name
· Eight digit tool code (TXXXXXXXX)

3.8.45. The CNC system, without operator intervention, will control all machine motions and functions to provide fully automatic, continuous path, high speed drilling and milling of complex shapes requiring three axis machining geometry. The direction and velocity of all axes will be continuous with zero following error. The CNC system will ensure that all machine functions occur in the proper order and initiate protective action should a fault condition occur.

3.8.46. CNC error messages shall alert the operator of all system malfunctions.

3.8.47. Error messages inform the operator of machine stoppage with explanation at safe points in the part program. The type of stoppage shall depend on the seriousness of the error.

3.8.48. Error messages shall be grouped as to their seriousness. Errors for minor inconveniences will be able to be overridden by the attendant operator until service can be arranged. More serious error messages requiring immediate maintenance service to prevent machine damage must be fixed prior to resetting. Machine failures are most serious and require immediate maintenance support before resetting.

3.8.49. The controls shall have provisions to automatically communicate (via the Customer's Intranet) Machine Failure Alarms in plain English directly to a Customer provided computer (PC or UNIX terminal) in the Customer's Maintenance office via Public Interface, or the Customer's Intranet. The alarm shall indicate the machine's identity, date, time, machine location, alarm code, a narrative description of the alarm, and the classification of maintenance personnel (electrical, mechanical, hydraulic, etc.). All alarm output shall be sorted and logged to enable report writing for record keeping.

3.8.50. A 15" (minimum) color graphics monitor will be used to display all control information including axis position, active block, four buffer blocks, offset tables, MDI entries, modal codes, control status, error messages and defined machine status messages.

3.8.51. All control features must be fully supportive of Mirror Image.

3.8.52. Axis calibration will correct repeatable differences between actual slide position and CNC indicated position. Lead screw, rack gearing and feedback device inaccuracies shall be compensated for by axis calibration.

3.8.53. Absolute/Incremental Input - The control will accept program data in both absolute and incremental forms. The mode will be selected by a preparatory "G" code and may be changed during the part program. Absolute programming will be selected by programming a G90. Incremental programming will be selected by programming a G91. The turn on and reset mode will be G90.

3.8.54. Resolution - The programming resolution for the system will be 0.0001"/0.001mm.

3.8.55. The servo resolution shall be equal to l/4 to l/2 of the programming resolution depending on the feedback device resolution.

3.8.56. End of Block Stop function shall perform all functions of the active block and stop machine motions and new commands without activation of cycle stop. Applicable magnetic relay functions and logic shall also be performed in the CNC system.

3.8.57. IPM/MMPM and V/D (Velocity/Distance) Coding - The basic system shall provide direct IPM/MMPM and V/D coding. Direct IPM/MMPM programming shall be selected by a G94 code (Feed per Minute – Turn On Default). V/D programming shall be selected by a G93 code (1/T Feedrate – Inverse Time). Code G95 shall be Feed per Tooth. Turn on mode shall be G94 (IPM/MMPM).

3.8.58. Velocity shall be in inches per minute and millimeters per minute. Distance shall be the vector distance the axis is to move in inches (or millimeters).

3.8.59. Programming a G00 code shall result in rapid traverse rate. The value shall be preset based on machine's capability.

3.8.60. In the G93 mode, the FRN ("F" code) shall be non-modal and must be programmed in each data block. If omitted in this mode, an Illegal Format Error message shall occur.

3.8.61. IPM/MMPM, G94 - In this mode, the FRN ("F" code) will be expressed directly in inches per minute (millimeters per minute). The format shall be F4.3 in both modes and be modal.

3.8.62. Dwell, G04 - This code shall be non-modal and produce a dwell. The duration shall be defined by the "F" code.

3.8.63. The dwell period shall be defined in seconds and duration of 0.1 seconds (F.1) to 327.67 seconds (F327.67).

3.8.64. The G04 dwell code shall not change the status of any modal conditions of the control. Following the dwell, the operating mode shall revert to the original status.

3.8.65. Switchable Inch/Metric - These codes are to provide the capability to program in metric units if the feedback is in inch units, or to program in inch units if the feedback is in metric units. The inch or metric mode shall be selected by programmed "G" codes. To activate the inch mode, G70 shall be programmed. G71 shall be programmed for the metric mode.

3.8.66. Interface indicators and the state of the discrete signals into and out of the system shall be displayed on the interface indicator modules. The visual indication will expedite checkout and maintenance of the control and machine tool.

3.8.67. The CNC diagnostics shall check the processor, memory, interface and hardware such as the CRT and keyboard. Ladder logic diagnostic aid format, or its equivalent, shall be provided.

3.8.68. The CNC shall have a minimum of nine (9) optional block skip commands and multiple block deletes.

3.8.69. "M" code functions:

3.8.69.1. Program Stop - M00, M02, M30 codes initiate program stop. They stop the spindle(s), coolant, and feed. M03, M04, M07, M13 and M14 are canceled and must be reprogrammed as needed. M30 shall be Put Tool Away, Program Stop.

3.8.69.2. Optional Stop - The M00 code has the same function as M02 except that it is ignored if not enabled by a manual switch on the front control panel. (Switch must be returned to the ON position).

3.8.69.3. End of Program - The M02 code has the same effect as M00 except that it indicates End of Program. Additionally, this code insures that all the active storage registers are cleared, cancels parity check until the first end of block (EOB) is read in the forward direction, and sets up the control logic to begin a new program when the cycle start button is depressed.

3.8.69.4. Spindle On Clockwise - The M03 code commands the spindle to turn in a clockwise direction. Clockwise is considered to be the direction to advance a right hand tap into a workpiece. If coolant flow was subject to an interlock interrupt due to some previous action, it will restart with the M03. M03 cancels M04 and M05. An M00, M01, M02, M04, M05, M06, or M30 cancels M03.

3.8.69.5. Omitted

3.8.69.6. Spindle Off - The M05 code commands the spindle to stop. M05 cancels M03 or M04. Coolant flow interrupts when the spindle stops, but the M07 remains in active storage. Thus a previously commanded coolant flow will resume with the next programmed M03 or M04.

3.8.69.7. Tool Change - The M06 code cancels an M03 and M04. The machine will automatically insert and lock the tool in the spindle. The M06 code will automatically position the spindle for tool changing.

3.8.69.8. Cutter Coolant On - The M07 code turns on the coolant system. (Coolant or cutter lubricant.)

3.8.69.9. Cutter Coolant Off - The M09 code commands off the coolant system.

3.8.69.10. End of Program and Rewind Tape - The M30 code (Put Tool Away, Program Stop) has the same function as M02 except that it also commands a tape rewind to the end of record code before the first end of block. If there is an end of record code between the first end of block and the M30, the tape will rewind to the first end of record code it encounters.

3.8.70. Helical Interpolation shall be provided. State M-Codes in quotation.

3.8.71. In the event of stoppage of the machining process, the control system shall enable the operator to reposition the spindle as needed and then automatically return the spindle to its last Colon Block, safe starting position. As an option to the Customer and quoted separately, the control may be set up to allow the program to restart at a point of the operator's choice.

3.8.72.* A pendant shall be provided with the controls to allow the operator to set up the machining operation as needed.

3.8.73. The pendant shall have a cord reel to automatically retract the cord when the pendant is not in use.

3.8.74. The pendant controls and the control panel shall permit the operator to adjust (Jog-on-the-Fly and set up) the machine for operation and maintenance.

3.8.75.* Omitted

3.8.76. Operating Modes - The following article describes the operating modes and "G" codes. Identify all of the following "G" codes that are <u>not</u> supported under Mirror Image operation.

3.8.77. A table summarizing some of the "G" Codes is shown below:

G00 - Positioning Mode (Modal)
G01 - Linear Interpolation (Modal)
G02 - Circular Interpolation CW (Modal)
G03 - Circular Interpolation CCW (Modal)
G04 - Dwell F3.2 Up to 327.67 Seconds (Non-Modal)
G17 - Circular Interpolation XY Plane
G18 - Circular Interpolation ZX Plane
G19 - Circular Interpolation YX Plane
G40 - Cutter Diameter Compensation Off
G41 - Cutter Diameter Compensation Left of Part
G42 - Cutter Diameter Compensation Cutter Right of Part
G68 - Fixed Probe – Measure Tool Length
G69 – Fixed Probe – Check Tool Length
G70 - Inch (Modal) (All Axes)
G71 - Metric (modal) (all axes)
G80 - Cancel Canned Cycles G81-G89
G81-G89 - Canned Cycles
G90 - Absolute (modal)
G91 - Incremental (modal)
G92 – Position Set
G93 - V/D (modal) F4.3 inch, F4.3 metric
G94 - IPM/MMPM (modal) F4.3 inch, F4.3 metric
G98 - Machine Coordinate Programming (non Modal)
G99 – Position Set Cancel G98
Input Format:
Inch: N4, G02, X±3.4, Y±3.4, Z±3.4, W±3.4, A4.3, C4.3, I3.4, J3.4, F4.3, M2#.
Metric: N4, G02, X±5.3, Y±5.3, Z±5.3, W±5.3, A4.3, C4.3, I4.3, J4.3, F4.3, M2#.
= End of Block
A plus (+) sign is assumed if no sign is programmed.

3.9. Post Processor

3.9.1. The Manufacturer shall provide sufficient documentation and support to enable the Customer to write a post processor for the system.

3.10. DNC Communication

3.10.1. There shall be a dedicated RJ45 port and Ethernet Card on the main control computer for a DNC interface.

3.10.2. The port will be capable of transferring ASCII files, binary files, and equipment status information in either direction over the communication link with the Customer’s DNC computer.

3.10.3. The port will provide error checking on data being transferred and will have retransmission capabilities. The Customer shall provide the cable interface

3.10.4. The purpose of the port is to permit:

- · Parts program downloading
- · Data table downloading
- · Executive software uploading and downloading
- · Diagnostic software uploading and downloading
- · Graphic (CATIA) data downloading
- · Real-time status information uploading
- · Cutter Offset downloading

3.10.5. The CNC and DNC interface shall enable programs to be run directly from the DNC System without the need for an intermediate program.

3.11. Machine Control Panel

3.11.1. The operator's control panel shall include the following features and controls (minimum) and all controls shall be clearly labeled and mounted in a single console:

- · Power On - illuminated button
- · Power Off
- · Emergency Stop Button (pan head button)
- · Cycle - Run and Test Setup
- · Mirror Image Z-Axis Inversion
- · Monitor - Color 15 inch
- · Floppy Disk Unit (3.5", 1.44 MB)
- · CD Drive
- · Placard identification for all controls, pushbuttons, displays and indicators

3.11.2. The control panel shall be designed to provide an ergonomically acceptable presentation of controls and monitors to the operator.

3.11.3. The pendant shall have a display and controls capable to enable the operator to control all functions of the machine.

3.12. Control Monitoring Systems

3.12.1. The following conditions, as well as those conditions identified by the Manufacturer for machine control, shall be monitored and visual and audio messages provided:

3.12.2 Message only:

- · R.P.M. (5 digits)
- · High/Low Air Supply Pressure
- · Feed Limit
- · Low Spindle Oil
- · Low Lubrication Oil
- · Chip Collector Vacuum Pressure Low
- · Low Cutter Lubricant Level
- · Spindle Not At Speed
- · Spindle At Speed

3.12.3. Machine Cycle Hold with Message:
- · Axis Over-Travel Limit (minor)
- · Broken Cutter Detected
- · Low Hydraulic Pressure
- · Low Lubrication Air Pressure
- · Axis Motor Over Temperature
- · Spindle / Bearing Over Temperature
- · Axis Drive Fault
- · Chip Conveyor Jammed
- · Chip Enclosure Door Open
- · Spindle Speed 10% Low (Feed Hold)

3.12.4. Machine Emergency Stop, Message and Alarm:
- · Axis Over-Travel Limit (extreme)
- · Loss of Vacuum
- · Loss of Coolant/Lubricant
- · Tool Changer Malfunction
- · Loss of Hydraulic Pressure
- · Loss of Spindle Oil Pressure
- · Spindle Overload

3.13. Cell Controller

3.13.1. The Router Cell shall, if necessary, be controlled by a master computer located in a Customer provided control room. The computer may be a HP UNIX based system, or equivalent.

3.13.2. All remote terminals shall be UNIX, or host computer compatible, terminals. The system shall at a minimum support Tektronix X-Terminals and “Exceed” X-Terminal emulation software.

3.13.2.1. The Customer can provide the Tektronix UNIX X-Terminals for the cell.

3.13.3. There shall be a remote terminal at the operator’s unload up station.

3.13.3.1. An additional terminal in the Maintenance office shall provide cell status and maintenance required reporting to the Customer’s Maintenance department. Communication to the Maintenance office may be done via a web interface that can be used by Netscape or Internet Explorer browser on the Customer’s network.

3.13.4. The master computer shall include a 17 inch color monitor, (2) nine Gigabyte hard drives, a 3.5 inch floppy drive, a CD drive of at least 28 spin capacity, mouse (with scroll wheel if supported) and sufficient memory (at least 2 Gb) to support UNIX.

3.13.4.1. The cell controller shall be able to support a minimum of seven (7) simultaneous remote X-terminal connections.

3.13.4.2. The Cell controller shall include the UNIX version of Netscape Internet Explorer web browser and be able to link to the Customer’s corporate web server. The cell controller software shall run on the latest version of HP operating system and have the ability to operate on new releases of HP operating software.

3.13.4.3. The Tektronix UNIX remote terminals, provided by the Customer, shall have the same capabilities as the cell controller except that they will have 512 megabytes of memory.

3.13.5. The master cell control computer shall receive production schedules and part programs from the Customer's legacy system. Part programs, or nested programs, shall be down loaded to the machine controls by the cell controller using Sybase, or Oracle, which also directs all other cell activities for proper system function.

3.13.6. The master cell computer shall support the following functions:

3.13.6.1. Production Order Management – Production orders shall be identified by Order Number, Part Number, Quantity, Date Required, and Optional Priorities. The function shall track the quantity of parts machined against the Order Quantity.

3.13.6.2. Production Priority Scheduling – Priority scheduling shall be accomplished automatically based on the assigned priority of the order and delivery date. The cell control operator shall have the ability to adjust the priority of an order to speed its completion.

3.13.6.3. Work Setting Station Select – The cell controller shall select the work set up station to which a pallet is to be delivered.

3.13.6.4. Nesting software (Sys-Tech or equivalent) shall be provided to nest parts on the material.

3.13.6.5. The nesting software shall have the ability to efficiently use the material and to orient parts by grain if needed.

3.13.6.6. Multiple Parts per Nest – The system shall support multiple parts per pallet in Customer's nest.

3.13.6.7. Graphical User Interface – A graphical user interface shall enable the cell operators to direct cell activities and check the status the machines, tools and equipment quickly.

3.13.6.8. Multiple Cell Management – This feature enables one cell controller to manage multiple cells.

3.13.6.9. Tool and Part Images – Tool and part images can be developed to assist in fixture loading. A tool presetter window shall allow viewing of functional tool images for specification verification. Images shall be accepted in PCX, TIFF, GIF and BMP files along with text.

3.13.6.10. Tool Management – Tool management shall notify the cell operator of lacking or deficient tool requirements, automatic tool changer load status, schedules work and tools, interfaces with the tool presetter for cutter offset data, and informs the operator as to which machines are equipped to run parts.

3.13.6.11. Tool In/Out – Color graphics shall signify information about tool life, tool usage, and tool availability.

3.13.6.12. NC Program Management – This feature receives and stores the NC programs, distributes the programs to the machines and updates the resident programs in storage.

3.13.6.13. Preventive Maintenance Management – The controller shall schedule the machines for preventive maintenance and alert the operators when equipment is due for PM.

3.13.6.14. Graphs and Reports – The control shall provide standard graphs and reports on Equipment Utilization, Production Results, Tool Shortage, Individual Tool Data, Functional Tool Data, Pallet Data, Fixture Data and other report. The control shall have the reports and graphs resident in the computer. The Sybase, or Oracle, database shall allow the user to connect to another PC using any database package for generation of custom reports and graphs.

3.13.6.15. On-Line Help – The master computer shall have, resident in storage, the Operator manual and the Maintenance manual including drawings and parts list with the original manufacturer's component part numbers for quick reference by shop personnel. The operator and maintenance information shall be upgraded as needed to keep the information current during times of maintenance by the system's Manufacturer's personnel or by down loading from the Manufacturer's maintenance computer.

3.13.6.16. Manufacturer's Maintenance and Support – The Manufacturer shall provide software support and upgrade for the machine and the control system for a period of three years following Final Acceptance of the high speed machining cell. Thereafter, software maintenance shall be renewable on a yearly contract basis. Computer equipment declared unsupported by the original manufacturer shall be replaced at no cost to the Customer during the three year support period.

3.13.6.17. Statistical Process Control Reporting – The master computer shall provide standard x-bar, Run and Range real-time, dynamic SPC charts per feature using probe data from the machines. The SPC function shall be configurable by Part Feature, Limit Values and Actions per limit violations and Numbers of Points.

3.13.6.18. Machine Alarm Reporting – The machine controls shall alert the operators of all alarms. The alarms shall be ranked in order of severity.

. Minor problem alarms, not requiring immediate attention, can be overridden by the operator and addressed later.

. Important problem alarms that need be addressed immediately by the operator only must be rectified before the restarting the program.

. Machine or system failures requiring Maintenance support before proceeding with the program.

3.13.6.19. The machine controls shall communicate Maintenance alarm messages to the cell controller. The cell controller shall have provisions to communicate the Maintenance Alarm messages, in plain English, directly to a computer (possibly a UNIX terminal Customer provided) in the Customer's Maintenance office, a narrative description of the alarm, the classification of serviceman required (Electrical, Mechanical, etc.), the machine's identification, the machine's location, and the date and time of the failure. The alarms reported to Maintenance office terminal shall be sorted and logged to enable report writing for record keeping.

3.13.7. The master controller shall be able to easily take one or more machines off line for maintenance and for manual operation for part program proofing.

3.14. <u>Tab Removal Capability</u>

3.14.1.* A capability to separate the parts from the sheets by removing the tabs attaching the parts to the sheet stock shall be provided.

3.14.2.* The tab removal capability shall be a function of the router spindle.

3.14.3. A pressure foot shall hold the material and parts in place while the tabs that connect the parts to the sheets are removed.

3.14.3. The pressure foot must provide sufficient force to the parts to prevent them from moving during the tab removal process.

3.14.4. When the tab is removed, the pressure foot shall release the parts and material and proceed to the next tab.

3.14.5.* The separate tab removal spindle, if provided, shall be aligned to the router spindle within ±.0005 inches in the X and Y Axes.

3.14.6. Positioning accuracy of the axis drives for the tab removal spindle shall be in accordance with the router spindle.

3.15. Part Probing

3.15.1.* As an Option to the Customer and quoted separately, a Renishaw MP10, or equivalent, probe shall provide part-probing capability. The probe shall be provided in an appropriate tool holder.

3.15.9. Part probing will be performed under numerical control to check critical dimensions, verify setup and check cutter performance.

3.15.9. A Probe Calibration device shall be provided in the work area of the bed that is accessible to the probe without limiting the machining process range. The calibration device shall enable the machine to calibrate itself and the probe prior to performing machining and part inspection.

3.15.9. The probe shall be complete with four (4) 5 mm/0.020 inch diameter ruby ball tipped straight shank ceramic styli. Two (2) shall be 50mm long and two (2) shall be 100mm long.

3.15.9. The probe shall be provided in a protective carrying /storage case with probe identification on the case. The case may be made of plastic, wood or metal.

3.15.9. The probe shall be mounted in a tool holder and shall communicate to the machine by inductive transmission or optics.

3.15.9. The probe shall sense in the ±X, ±Y, and +Z directions.

3.15.9. Stylus Overtravel shall be a minimum of 17.5° in X and Y directions and 8 mm (0.31 inches) in the Z direction.

3.15.9. The probe shall have Uni-Directional Repeatability of Max 2-Sigma (2s) value: Repeatability of 1.0μm (40μ inch) shall be valid for a test velocity of 480mm/min (1.57ft/min) at the stylus tip.

3.15.10.* Delete - As an Option to the Customer and quoted separately, a non-contact vision system for part perimeter inspection shall be quoted. The vision system shall provide the same or better accuracy required of the contact probe. The Supplier shall describe the operation of the vision inspection as part of the bid response.

3.16. Broken Tool Detection

3.16.1. A mechanical or laser type broken tool detection system (Renishaw or equivalent) shall be provided to determine if a tool may have broken (with breakage of .020 inches or more) during the routing, drilling and milling processes.

3.16.2. The Broken Tool Detection capability shall determine whether or not the cutting tool is the expected length after its use.

3.16.3. Torque Controlled Machining shall be provided, but will not be the only determining factor for Broken Tool Detection.

3.16.4. Should a tool be determined to be broken the control shall stop the machining process, present the tool to the operator for appropriate action, and notify the operator of the broken tool.

3.16.5. The control shall go into a hold condition until the operator has examined the cutter and the workpiece, and has taken the appropriate action to return to the machine to production.

3.16.6. If the tool is confirmed to be broken and the operator has determined that the workpiece does not have to be replaced, a replacement tool shall be selected and the control shall back up in the program to a block selected by the operator to resume cutting.

3.17. Cutter Lubrication System

3.17.1. The machine shall be provided with an “almost dry” cutter lubricating system. The system shall use the Customer’s water based coolant or other lubricant more suitable for high speed, nearly dry machining.

3.17.2. The cutter lubrication system shall spray a minute amount of lubricant on the cutter to facilitate the cutting process. Chips generated shall be essentially free of the lubricating/cooling liquid.

3.17.3. A point of generation chip enclosure (shroud) around the cutting tool shall contain chips and direct them to the chip collector.

3.17.4. The nozzle of the cutter lubrication system shall penetrate the shroud to apply lubricant to the cutter.

3.17.5. The chips shall be collected by a vacuum chip collection system and deposited into the Customer’s chip collection container.

3.18 Vacuum Chip Collection

3.18.1. A vacuum chip collection system shall collect chips through a shroud around the cutter.

3.18.2. The vacuum chip collection system shall be manufactured by Donaldson / Torit, Kirk and Blum, Mayfran, or equivalent.

3.18.2.1.* Add – The dust collector, as well as the rest of the components of the cell, must fit within the physical constraints of the Customer’s facility. Columns are two feet in diameter and on 25 foot centers. The ceiling height is 13 feet.

3.18.3. The vacuum chip collection system shall have a shroud type chip containment device surrounding the cutting tool for point of generation control of the chips.

3.18.4. The chip collection system shall be a minimum of 96% efficient in collection of the chips.

3.15.3. The chips shall be collected, separated by a cyclonic separator and deposited in the Customer's chip container. The container shall have a volume of approximately 4 cubic feet.

3.18.6.* Delete - As a separately priced Option to the Customer, a boom mounted vacuum hose, normally OFF, shall be used to remove chips from and around the surface of the machine's bed when the spindle is not turning. Operation of the vacuum chip pick up hose shall be controlled by shutting off the flow of air through the chip shield; thereby enabling flow through the pick up hose.

3.18.7.* Delete - If a separate table for parts removal is acquired, the auxiliary hose shall be used at the unload table during machine operation.

3.18.8.* All flexible vacuum hoses shall be made of a durable abrasion resistant material. The pick up hose shall have a three inch nozzle and, as a minimum, a 4 inch diameter hose for removal of chips that may have been missed by the point of generation chip shield.

3.18.9. All components of the vacuum system shall be appropriately grounded to prevent the generation of sparks by static electricity.

3.18.10. The vacuum system's pump shall be surrounded by a noise reducing structure, if necessary, to lower the system's noise level to 80 dba.

3.18.11. The vacuum system shall have alarms to alert the operator of system malfunctions.

3.18.12. As the vacuum chip collection will collect aluminum and wood chips all efforts shall be made to minimize the possibility of dust explosion.

3.18.13. The vacuum to the chip collection shroud shall have provisions for cut off, via the CNC program, to prevent lifting the routed parts after each tab is removed.

3.19. <u>Automatic Material Loader</u>

3.19.1.* As part of the cell, a system that will automatically load sheet metal onto the bed of the machine shall be provided.

3.19.1.1.* A system to automatically load an aluminum or a wooden "sacrifice" board onto the load station shall be provided onto which the sheets shall be placed by the material loader.

3.19.2.* The sacrifice board will be provided by the operator via a non-powered conveyor at the side of the load station.

3.19.3. The loader is expected to remove individual sheets from a box stationed before the load station via a vacuum lifter, transport he sheets to a load station, and build the stack of sheet metal on top of a sacrifice board.

3.19.4. The intent of the autoloader is to automatically load the material for the router without operator intervention.

3.19.5.* Once the stacked material is ready, the cell controller shall control the automatic loading of the router. Then the router shall begin the planned routing activities.

3.19.6. Operation of the automatic (robotic) material loader shall be controlled by the cell controller.

3.19.7.* Add - The Customer may choose to run sheet stock smaller than 4 x 12 feet. All of the material in the box will be the same size.

3.19.8.* Add - The vacuum cups shall be configured so that the array of vacuum cups can be activated for stacks of material that are 2 x 4 and 4 x 4 feet in size.

3.19.9.* Add – The smaller sized material sheets shall be provided to the robotic loader in a box with a common corner of the stacks matching one corner of the full sheets. The common corner shall be the forward left hand corner.

3.19.10.* Add - The Customer envisions an array of vacuum cups that is four cups wide by eight cups long.

3.19.11.* Add - The material lifter shall lift one corner of the sheet of material and an air nozzle shall blow a stream of air at the lifted corner to help separate the sheets. Then the lifter shall continue the lift the sheet.

3.19.12.* Add – A Bar Code Reader at the common corner of the stacks of material shall be provided for the cell controller to identify the material to be loaded and compare the material present with the material expected.

3.19.12.1.* Add - The bar code reader shall read bar codes on the first sheet and the last sheet of material in the stack to determine the stack is correct. Any discrepancy from the planned material and quantity shall cause an alarm message to alert the cell operator to the situation and put the cell into a Hold condition. After the operator takes appropriate action, the cell shall resume operation.

3.19.13.* Add - The cell control shall have the ability to be reconfigured to enable the cell to:

3.19.13.1.* Add - Verify the proper material and quantity of sheets has been loaded that meets the planned material for the nest, and

3.19.13.2.* Add - Identify the material type and quantity of sheets to enable the cell controller to call up the appropriate planned nest for the material to be provided to the router.

3.19.14. Add – The cell controller shall have a canned cycle that will advance the stacked material through to the unload station in the event the stack is inappropriate and must be purged from the system.

3.20. Load Station

3.20.1. The router cell shall be configured with a separate station for loading the sacrifice board and sheet aluminum.

3.20.1.1.* Add - The cell controller shall cause the sacrifice board to be loaded onto the load station from the return conveyor.

3.20.1.2.* Add – The cell controller shall then cause the Robotic Material Loader to load material onto the sacrifice board.

3.20.2.* The stacked sacrifice board and sheet aluminum shall be automatically conveyed to the bed of the router when the routed material is transferred to the unload station.

3.20.2.1.* Add – The routed stack shall only move to the unload station when the operator indicates the station is ready by pressing on and holding two palm buttons.

3.20.3. The stacked material shall be positioned on the bed of the router and clamped in place by hydraulic clamps the come up from below the bed of the router.

3.20.4. The clamps shall hold the material in place during the routing process.

3.20.5.* Add - There shall be sufficient clamps to hold the previously stated stack sizes. A minimum of two clamps per side shall hold the stacks in place.

3.21. Unload Station

3.21.1.* A station to unload parts and scrap shall be provided after the router where the cell operator can remove the routed parts from the work surface and remove the sacrifice board.

3.21.2.* The operator shall return the sacrifice board to the load station of the cell for reuse on a roller conveyor or equivalent apparatus.

3.21.3. The routed stack of aluminum shall be automatically, under the direction of the cell controller, conveyed to the unload station.

3.22. Conveyors

3.22.1.* A means shall be provided to convey the stacked material from the load station to the router and from the router to the unload station.

3.22.2. The stacked material transport system shall be directed by the cell controller.

3.20.3. The stacked material shall be positioned on the bed of the machine and clamped in place.

3.22.4.* A non-powered conveyor shall be provided to help the operator move the sacrifice board from the unload station to the load station.

3.22.4.1.* At the unload station, a gate shall be provided to permit shop personnel access around the unload station and to the router. The gate shall provide three to four feet of clearance to the unload station.

3.22.5. The sacrifice board conveyor shall be routed around the rear of the router and not interfere with machine operation, or chip removal.

3.22.6. A method of automatically loading the sacrifice board onto the bed of the load station and positioning it for loading shall be provided.

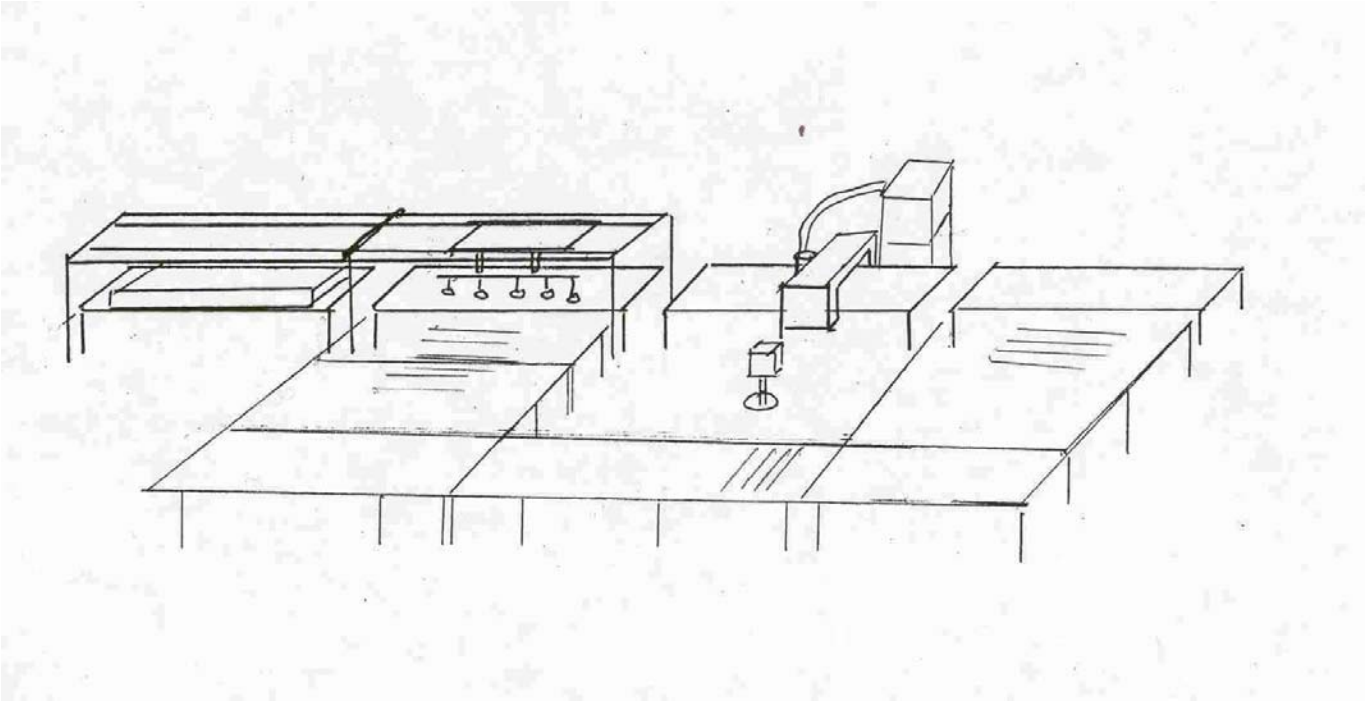
3.22.7.* Sacrifice boards are expected to be able to be reused three times on a side. A means of flipping over the boards shall be provided near the load station. The manufacturer shall describe the flip over system in the bid response.

3.22.8.* Add - The operation of the board flipper shall be under the control of the operator.

3.22.9.* Boards that are no longer usable shall be positioned such that they can be removed from the conveyor and stacked on a disposal dolly adjacent to the conveyor. A stack of replacement sacrifice boards shall be located adjacent to the conveyor for loading onto the conveyor. The operator shall manually remove the sacrifice board from the conveyor and replace it with a fresh board.

3.22.10.* Delete - The cell controller shall keep track of the usage of the sacrifice boards and inform the operator of the need to replace a board.

3.22.11.* Add – See concept drawing of the cell below.



4.0 ELECTRICAL REQUIREMENTS

4.1. All electrical equipment and installation shall be in accordance with latest revision of the National Machine Tool Builders Association Standards, the National Electrical Code, State and Local Code, and Customer's Standards.

4.2. Power supply shall be from a single power source of 480 volt ±10%, 3 phase, 60 Hz.

4.3. The main disconnecting device shall be a thermal-magnetic molded case circuit breaker meeting the requirements of Federal Specification W-C-375B, with an Underwriter Laboratory approved interrupting rating of at least 35,000 RMS symmetrical amperes. Ampacity at the breaker shall be not less than 115% of full load requirements.

4.4. The main disconnects shall be a single padlockable unit that disconnects the motors and controller from all non-grounded supply conductors and shall be designed so that no pole can be operated independently.

4.5. All control circuits shall be 24 VDC and 120 VAC 60 Hz derived from a single electrical power supply through appropriate control isolation transformers with secondary overload protection, line filters and power line conditioners.

4.6. Manufacturer will provide all transformers required to convert voltages from the 480 volt power source.

4.7. Electrical components shall be protected from damage due to power surges, transients, power failures, etc.

4.8. All encoders, electronic scales and sensors shall be protected from oil, cutting fluid, chip, and etc. contamination.

4.9. Components sensitive to vibration, electromagnetic noise and static discharge shall be protected.

4.10. All relays rated at less than 120 VAC shall be of the sealed plug-in type.

4.11. Alternating Current (AC) motors, 1/2 Hp or greater, shall be operated on 480V ±10%, 60Hz, 3 phase power.

4.12. Fractional horsepower motors under 1/2 Hp may be operated from a 120V single phase 60 Hz supply derived from the basic power supplied, provided no interference results.

4.13. Motors 50 Hp or greater, shall be supplied with full voltage across the line starters.

4.14. All motors between 1 and 125 Hp shall be energy efficient type, Gould E-Plus or equivalent and meet NEMA Test Standard MG 1-12.53a.

4.15. All motors shall be provided with thermal overload protection in all ungrounded legs, short circuit protection, and magnetic starters.

4.16. All motors shall be protected from contamination, shall be of the anti-friction type, and shall be totally enclosed fan cooled (TEFC).

4.17. Axis drive motors shall be brushless DC or AC. Digital drives are acceptable.

4.18. All motors shall provide ample power to drive their respective components. Under normal conditions, no motor shall operate at overload.

4.19. Door interlocks shall be provided on control cabinets to protect from incoming high voltage where required.

4.20. All fractional horsepower motors shall contain lifetime lubricated sealed bearings.

4.21. Overload relays shall be supplied with all motors with an interlock to actuate the cycle stop in event of motor stoppage.

4.22. On equipment wiring diagrams, the same number and/or symbol shall not be used more than once in identifying wires and terminals of different circuits. Only one number and/or symbol shall be used to identify a wire. The wire number shall not change where crossing a terminal strip.

4.23. Equipment wiring will include a unique identification number on both ends of each length of wire. If a wire crosses a terminal, the wire leaving that terminal will carry the same unique identification number on both ends as the incoming wire.

4.24. All electrical controls, unless specifically excluded, including the across-the-line disconnect switch, push buttons, indicating lights, controls, CRT, keyboard, switches, fuses, etc. shall be enclosed in a floor supported dust tight cabinet(s) rated NEMA 12 or better.

4.25. All items shall be completely wired to terminal strips within the cabinet(s), ready and identified for interconnecting field wiring between components.

4.26. The function of each control, alarm or indicator, etc. shall be clearly identified as to its function and operation on the exterior of the panel.

4.27. The control panels shall be filtered, and air conditioned as required, to insure reliable system performance.

4.28. Conduit threads cut on the job shall be coated with a conductive galvanized material as soon as possible. Any rust shall be removed prior to coating.

4.29. All above ground conduit shall be intermediate metal conduit (IMC) or galvanized rigid steel (GRC). All conduit, fittings, connectors, conduit bodies, etc, shall be threaded.

4.30. At motors, solenoids, and similar equipment where flexibility is necessary or where vibration may occur, 12 in. minimum and 36 in. maximum lengths of liquid-tight flexible metal conduit (Sealtite) may be used. Sealtite shall be the type that incorporates an integral copper bonding strip, such as Anaconda type U.A., or type O.R.-H. Sealtite may be used where vibration or component removal is an issue.

4.31. Terminations at knockouts shall be lock-nutted inside and outside and capped with an insulated bushing. The insulated bushing shall be of metal construction on conduit of 2-1/2 in. or larger.

4.32. The use of reducing washers, or "Chinese Money", in junction boxes is not permitted on equipment in the Customer's facility.

4.33. All temporary wiring and extension cords shall be provided with a ground fault interrupter for protection of personnel or the Contractor shall meet the requirements of the N.E.C. Article 305. The Contractor shall furnish proof of compliance and test results to Customer. An additional copy of the written procedure, proof of compliance, and test results shall be conspicuously posted at the project site. The Contractor shall remove all temporary wiring and extension cords on completion of the job.

4.34. Three feet minimum working space shall be provided in front of all electrical wireways, junction boxes, switch boxes, control and equipment consoles and all access doors and panels.

5.0. HYDRAULIC AND PNEUMATIC REQUIREMENTS

5.1. All hydraulic and pneumatic systems, herein referred to as Hydraulic Systems, shall conform to NMTBA Standards. The hydraulic system shall be complete, including all pumps, valves, filters, dryers, piping, cylinders, pressure controls, gages and other parts and shall be sufficient capacity to give satisfactory service under operating pressures and flow volume.

5.2. All components of hydraulic systems, including seals, packing, O-rings, etc. shall be compatible for use with regular petroleum base hydraulic fluids.

5.3. The hydraulic system, including machine tool components, shall be inspected for cleanliness before and after flushing. Flushing blocks shall be provided with the machine and used to bypass control valves during flushing. The Manufacturer will certify that the hydraulic system is clean of foreign objects to 3 microns prior to initial operation and checkout.

5.4. The hydraulic system operating pressure shall not exceed 85% of pump rating for continuous machine operating at maximum tonnage ratings.

5.5. Hydraulic hoses, where installed, shall be routed and supported in a manner that will prevent excessive stretching, flexing, whipping, vibration, or rubbing.

5.6. Hydraulic hoses shall be Airco, 2-ply, 3000 psi, hoses with Airco double nut fittings.

5.7. All gages will read in dual scale, metric and English (Pascal and psi).

5.8. All hydraulic and pneumatic cylinders will be constructed as separate and readily removable units.

5.9. Over-temperature thermal switches, alarms and lights for each hydraulic pump and gearbox shall be provided to alert the operator to an over-temperature condition and shut the system down automatically.

5.10. The hydraulic fluid reservoir shall be equipped with a low level alarm system to automatically shut down the affected pump motor.

5.11. Hydraulic fluid reservoirs will be equipped with a fluid level/thermometer sight glass for visual inspection of hydraulic fluid status.

5.12. All hydraulic fill points will be readily accessible without necessity for machine disassembly.

5.13. All air used in pneumatic powered systems shall receive 100% filtration to 10 microns. The Manufacturer will supply all filters and dryers, appropriately sized, to protect all pneumatic equipment and to insure proper operation and reliability.

5.14. All hydraulic fluid used in hydraulic powered systems shall receive 100% filtration from 10 to 25 microns on the pressure side. The Manufacturer will supply filters to protect all hydraulic equipment and pass the maximum required fluid flow for specified machine performance.

5.15. All lubricants, hydraulic fluids, and coolants required to start-up operation and the Manufacturer will provide acceptance testing of the machine system.

5.16. All filters shall be installed outside the machine's structure and located so as to permit easy access for service.

5.17. The hydraulic pump system and reservoir shall be set on a tray to contain any leakage and direct the leakage away from the coolant system.

5.18. Reservoirs greater than 100 gallons hydraulic oil capacity shall have a remote “Emergency Power Off” pushbutton located at or near the operator station and wherever else needed.

5.19. All hydraulic pumps, reservoirs and other regulating and valve components shall have double containment where possible to prevent leaking oil from accumulating on the machine, workpiece, coolant and floor. Double containment shall be interpreted to mean a tank or any other device specifically intended to collect and contain the leaking oil.

6.0. LUBRICATION

6.1. The machine shall be provided with automatic lubrication at all points requiring lubrication.

6.2. Suitable instructions in the form of manuals, charts, and/or plates shall be furnished at time of delivery of equipment. Instructions shall contain all pertinent lubricating information required to insure maximum efficiency and continued accuracy of all component parts and accessories. The instructions shall clearly show the points to be lubricated, types and grades of lubricants recommended, and the frequency of application.

6.3. Points of lubrication, and lubrication fill, on the machine shall be clearly indicated with instructions for type, amount and frequency of recommended lubrication stated on a legend posted on the machine.

6.4. Points of lubrication will be readily accessible without necessity for machine disassembly.

6.5. Cycling of the machine shall actuate automatic lubrication of all sliding and rotating parts (excluding motors or pumps equipped with non-additive pack seal bearings). Such lubrication shall be adequate for the purpose but not excessive.

6.6. All ball screws and rack and pinions shall have provisions for automatic periodic lubrication.

6.7. All points of machine adjustment (independent of machine cycling) shall have provisions for periodic lubrication.

6.8. Any lubrication system incorporated with this equipment shall not contribute to any possible contamination of the part, the environment, or the cutting fluid (if any). The system shall have provisions to collect leakage wherever gaskets are located.

6.9. All lubricants containing silicone are prohibited from use with this equipment.

6.10. Spindle lubrication shall be appropriate for high-speed operation and have a reservoir capable of supporting the spindle for ten days of three-shift operation.

6.11. Any oil for oil lubricated spindles shall be filtered to 1 micron after the pump and before entering the spindle.

6.12. Excess spindle oil shall be collected so as not to drip on the workpiece or floor.

7.0. SAFETY

7.1. The machine and all related accessory equipment provided with the machine shall comply with the applicable Department of Labor "Occupational Safety and Health Standards" (OSHA). Safety features shall include, but not be limited to the following:

7.2. The machine shall be equipped with energy isolating devices on all power sources. A Lockout/Tagout capability shall be provided on all energy isolating devices, in accordance with OSHA approved procedures, to ensure the energy isolating device and the equipment cannot be operated until the Lockout/Tagout device is removed.

7.3. The machine system shall be fully equipped with automatically operated safety devices and guards to protect the operator from injury. In addition to mechanical and electrical safeguards, the location and functioning of controls shall provide maximum protection against injury caused by operator error in manipulating controls.

7.4. Any machine surfaces intended specifically or implied to be a walkway or step shall be finished with permanent non-slip surfaces.

7.5. Safe lifting attachment points (lift lugs, lift rings) shall be provided for erection and maintenance purposes for machine subassemblies and accessories.

7.6. All operator primary control buttons, switches, gages, 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 machine, tooling, and work area.

7.7. Pneumatic - All airline filter and lubricator bowls shall be provided with bowl guards.

7.8. An Emergency Stop button shall be provided to stop all machine functions. Emergency Stop button(s) shall be furnished at all normal operating positions.

7.9. The electrical circuits shall be fully interlocked to prevent injury to personnel or damage to the machine or workpiece.

7.10. Any machine operation shall not exceed a noise level of 80 dba at the operator's station and 6 feet from the machine when the noise level is measured on the A-scale of a standard sound meter at slow response setting.

7.11. Manufacturer's installation personnel shall comply with all Customer Security, Fire Prevention, Safety, Health and Environmental Control Regulations when on Customer's premises. The document shall be provided after issuance of Purchase Order, or as required by the Contractor.

7.12. Essential safety operating instructions shall identify safety and health hazards associated with the equipment and the procedures and practices necessary for safe operation.

7.13. The Contractor, or Subcontractor, shall supply all safety equipment for their personnel.

7.14. All extension cords shall meet OSHA requirements and shall be in good condition.

7.15. Damaged or improperly modified or repaired extension cords shall not be permitted on site.

7.16. Flexible cords and cables shall be protected from damage by sharp corners, protrusions, or pinch points.

7.17. A ground fault interrupter shall be provided for all extension cords and temporary wiring.

8.0. **INTERCHANGEABILITY**

8.1. All replaceable parts shall be manufactured to definite standards for tolerance and finish in order that any such part may be field-installed without further machining or fitting. All parts shall be permanently and legibly marked with the original manufacturer's part number, where practical.

8.2. Parts of assemblies that require "fitting" for proper assembly in the field are not desirable. If provided, they must be identified and separately listed in the Parts Manual.

8.3. Field wired hardware must be identified and separately listed in the system's documentation. All drawings must be modified to reflect changes and describe the machine as built.

9.0. PAINT AND/OR FINISH

9.1. Exterior surfaces of the machine(s) and peripheral equipment not otherwise finished or plated and for which a painted surface is suitable, shall be cleaned to bare metal and prepared with one or more coats of primer having good adhesion and rust resisting properties. Castings shall include a filler, smoothly finished and sealed.

9.2. Metal shall be primed with one coat of Glid-Guard Enamel Primer, Glidden No. 5251/5252, or equal. Applied film thickness shall be 2.5 mils wet; 1.5 mils dry.

9.3. Finish coat shall be one or more coats of Glidden Enamel No. 5250, or equal. Applied film thickness shall be 5.0 mils wet; 2.0 mils dry. Basic color shall be stated at time of purchase.

9.4. OSHA safety colors shall be used for marking physical hazards per OSHA Standard 1910.144.

9.4.1. Emergency stop bars, buttons, or switches shall be Glidden Safety Red (EC-57), or equal in color.

9.4.2. Physical hazards that may cut, crush, shock or otherwise injure shall be Glidden Safety Orange (EC-61) or equal in color.

9.4.3. Paint a stripe of appropriate size of alternating Glidden Safety Yellow (EC-69) and Gloss Black (FSC No. 17038) to draw attention to those stationary portions of machines and their accessories which by shape or location present a hazard of bumping against, tripping over, etc.

9.4.4. Moving parts (cranks, hand wheels, spindle carrier, etc.) shall be Glidden Safety Yellow (EC-69) or equal in color.

9.4.5. Electrical boxes, panels, consoles, etc. Glidden Safety Blue (EC-92) shall be or equal in color.

9.5. Customer will furnish color chips upon request.

10.0. INSPECTION AND ACCEPTANCE OF EQUIPMENT

10.1. The Manufacturer shall, with a Customer representative present, inspect and test the completed system at the Manufacturer's facility prior to shipment and at the Customer's facility after installation to demonstrate designed operating capabilities and compliance with this specification. The Manufacturer shall furnish verified and certified test results to the Customer on both hard copy and machine readable media, such as a disk.

10.2. The acceptance tests will include all applicable NAS 979 and 985 cutting and alignment tests. The cutting tests shall be run at the maximum speeds and feeds of the machine with appropriate cutters.

10.3. The Manufacturer shall submit an acceptance plan, in book form, for Customer approval and concurrence no less than 60 days prior to Factory Testing. The Customer Approved Acceptance Test Book shall demonstrate compliance to all specifications and capabilities of the equipment as purchased. The Customer may include special Customer developed performance tests with the Manufacturer's stated tests for further confirmation of performance and compliance.

10.4. The Manufacturer shall demonstrate the performance of the machine, the clamping, and the Post Processor by producing one sample of each of the three right and left hand parts submitted by the Customer. The Customer shall provide the extrusion material, cutters, and tool holders.

10.5. Should the Customer elect not to witness Factory Acceptance testing at the Manufacturer's plant, the Manufacturer shall inspect and test the system using procedures outlined in the Customer approved test manual. The Manufacturer shall furnish to the Customer verified and certified test results on both hard copy and machine readable media such as a computer floppy disk for Customer Acceptance and Approval to Ship.

10.6. The equipment shall be deemed "Acceptable for Shipment" by the Customer after demonstration of compliance to the specifications and successful operation at the Manufacturer's facility. The Customer shall grant acceptance for Shipment in writing. The equipment shall not be shipped to the Customer without written authorization by the Customer.

10.7. The Manufacturer will provide all programs, tools, tool holders, fixtures, materials, and inspection equipment for all of the Manufacturer's acceptance tests at the factory and at the installation site. The Customer shall be responsible for all peculiar items needed to support Customer developed tests.

10.7.1. Peculiar test equipment for Customer approved acceptance tests, not available at Customer's facility, shall be identified and quoted separately as an option to the Customer.

10.8. The machine shall demonstrate a minimum run time before failure, equivalent to 12 hours of operations, for warranty purposes.

10.9. All Customer approved acceptance tests shall be rerun at the Customers facility.

10.10. The Customer shall grant final Acceptance of the equipment in writing after successful demonstration of compliance to all requirements of the Purchase Specification at the Customer's facility.

10.11. The Customer will provide final payment for the machine after Final Acceptance and the Manufacturer meets all conditions of the Purchase Order.

11.0. OPERATING AND INSTALLATION DATA

11.1. Prints and Drawings

11.1.1. The Manufacturer shall furnish three (3) reproducible Computer Aided Design (CAD) drawings of the data required in each of the following paragraphs within thirty days after receipt of purchase order or as needed by the Customer. The manufacturer shall also furnish one set of the CAD drawings on Compact Disk (CD) at final acceptance.

11.1.2. Utility requirements and scaled drawings showing plan view, front elevation, and end elevation; major dimensions consisting of all work clearances, maintenance clearances, overall height, width and length dimensions shall be furnished with the response to this RFQ, unless otherwise specified. Peripheral equipment, such as control cabinets, shall also be dimensioned and their relationship to the machine established.

11.1.3. Certified foundation and/or installation drawings shall be furnished 30 days after the Purchase Order issuance date, or as required by the Customer. These drawings shall show the location and sizes of all services, outline of floor area required to clear all machine motions, total net weight, and major individual component weights. Drawings shall also show bolt layout and the purpose of each bolt, soil bearing loads to which foundation shown was designed, isolation requirements, purpose of any and all pits, and maximum allowable weight on the work mounting surface.

11.2. Manuals and Documentation

11.2.1. Manufacturer shall provide, 30 days prior to factory acceptance, three sets of the following manuals for the system, as accepted and as installed. The manuals shall also be provided on CD for Final Acceptance:

11.3. Maintenance Manuals

11.3.1. Three bound Maintenance manuals, including sectional drawings showing all machine components together with the original Manufacturer's part name and identification number, which shall contain the following:

11.3.2. A useful, factual table of contents.

11.3.3. A section stating the equipment utilities requirement for optimum performance.

11.3.4. A Maintenance section to provide service personnel with a schedule of periodic preventive maintenance operations and detailed instructions on how to perform the maintenance. Predicted mean time between failure ***with*** preventive maintenance and ***without*** preventive maintenance shall be provided with quotation.

11.3.5. Component and detail drawings, to ANSI or NMTBA Standards, of all subsystems to facilitate maintenance disassembly, repair and reassembly.

11.3.6. Parts list section (Bill of Materials) containing a complete Parts List showing the original part Manufacturer's name and part number. The Customer will purchase replacement part locally.

11.3.7. Suggested Spare Parts List denoting critical spare parts and long lead parts that are recommended by the Manufacturer to be purchased to ensure reliable machine performance. The Spare Parts List may be provided as a separate document from the Service Manual.

11.3.8. Fault isolation diagnostics, such as fault sequence relays, to supplement wiring diagrams and schematics.

11.3.9. A description of the functional operation necessary to provide backup information for fault isolation.

11.3.10. A list of special (unique) tools and test equipment needed for adequate maintenance of the system.

11.3.11. Theory of operation for each functional module in the system.

11.3.12. Complete electrical, schematic, logic, block, and functional diagrams to NFPA Standards.

11.3.13. Circuit module descriptions and card drawings with part identification for maintenance.

11.3.14. User's information, flow charts, setup procedures, and timing diagrams for maintenance.

11.3.15. Circuit Drawing section to contain block diagrams and circuit drawings of the wiring, including wire and terminal numbers at test points.

11.3.16. A complete list of all motors showing horsepower, amperage, voltage, speed, cycles, and the original manufacturer's name and model number.

11.4. Operator's Manual

11.4.1. Three bound Operator's manuals that shall contain the following:

11.4.2. A useful, factual table of contents.

11.4.3. An Introduction section to describe the use of the manual and explain the principles of operation of the equipment, complete with block diagrams to show how the subassemblies interrelate.

11.4.4. A Machine Operation section containing step-by-step instructions on the operation of the equipment and trouble shooting of error messages.

11.4.5. Description of operator’s procedures for emergency conditions.

11.5. Programmer's Manual

11.5.1. Three bound Programmer's manuals that shall contain the following:

11.5.2. Documentation of all applicable software for the machine controls system, including program listings, source code input language statements, assembled object coding, diagnostics listing, program flow charts, and programmer's instruction manual. The programmer's manual shall contain I/O data for programming and feed rates, auxiliary functions, and all axis motions of the machine.

11.5.3. A description of all routines in the system shall be provided. A hierarchical structure diagram of the software system showing the relationship of all routines in the system and the structure of the overlays of all modules is required.

11.5.4. For all software provided, the Manufacturer shall be responsible for updating and maintenance of the software unless modified by the Customer. The Manufacturer shall not have access or rights to software portions modified by the Customer. The Manufacturer will retain rights to resale of the software provided. The Manufacturer shall furnish the Customer with all required software licenses for full support of the system at no additional Customer cost.

11.6. Manual Requirements

11.6.1. Manuals shall be constructed as follows:

11.6.2. Pages shall be 8-1/2 x 11 inches with foldout pages no larger than 11 x 24 inches. Size requirements do not apply to foldout drawings. Pages shall be sequentially numbered.

11.6.3. Each manual shall be a standard loose leaf, three-ring binder with a hard back, or a good quality stiff spiral bound book.

11.6.4. Each volume of a set of manuals shall be labeled and sequentially numbered.

11.7. Documentation

11.7.1. Certified copies of machine response data, including tolerances obtainable, the maximum increments of acceleration and deceleration and the minimum interval needed to change direction at varying speeds as functions of tolerance and machine performance shall be provided from acceptance runoff data. The data shall be provided in notebook form.

11.7.2. The Manufacturer shall furnish, at equipment delivery, three copies of "As Delivered" construction drawings, to aid in maintenance.

11.7.3. The Manufacturer shall furnish a milestone chart, two weeks after acceptance of Purchase Order, showing the manufacturing schedule for the equipment. The chart shall be measured in weeks and shall include the various milestones for the project such as start/complete for design, fabrication, factory checkout, ship, installation or installation supervision, acceptance checkout, and training. A more detailed schedule may be requested at the Customer's discretion.

12.0. INSTRUCTION AND TRAINING

12.1. As an option to the Customer and quoted separately, the Manufacturer will provide instruction and training for Customer operating, maintenance, skills training, and programming personnel as follows:

12.2. Operator Training

12.2.1. Instruction in the methods and techniques, using the Operator's manual, for up to six Customer's employees, required for proper operation of the system.

12.2.2. Training shall be adequate to permit the employees to operate the system in manual, shop programmed, and automatic modes.

12.2.3. Manufacturer shall state duration of the proposed training session and provide an outline for the course with quotation.

12.3. Programmer Training

12.3.1. Instruction in the methods and techniques, using the shop floor Programmer's manual, for six Customer's employees, required for development of part programs and modification of system programs.

12.3.2. Training shall be adequate to permit the Customer's personnel to create programs in the automatic and manual modes.

12.3.3. Manufacturer shall state duration of the proposed training session and provide an outline for the course with bid response.

12.4. Maintenance Training

12.4.1. Instruction in the methods and techniques, using the Maintenance manual and system drawings, for four employees (two mechanical and two electrical), required for proper maintenance techniques of the entire operation system.

12.4.2. Training shall be adequate to permit the Customer's maintenance personnel to repair all features of the system's operating and control equipment.

12.4.3. The Manufacturer shall state duration of the proposed training session and provide an outline for the course with quotation.

12.5. Training General

12.5.1. Instructors, for all subjects, must be thoroughly familiar with their subject matter so as to perform on a stand alone basis and answer trainee's questions.

12.5.2. All training will be performed at the Customer's facility during Customer's normal working hours (7:18 a.m. to 3:48 p.m.).

12.5.3. Customer will have the option to video record all training for future reference.

13.0. PRESERVATION AND PACKING

13.1. Unless otherwise specified, preservation and packing shall be in accordance with the following:

13.2. Packing Instructions

13.2.1. For shipment within the continental United States, equipment shall be packed, crated, or skidded so as to ensure acceptance by common or other carrier for safe transportation, at lowest rate, to point of delivery. All loose parts, attachments, and accessories shall be suitably boxed. Whenever practical, smaller boxes shall be secured inside the skid, crate, or box containing the equipment. In all cases, the equipment shall be preserved in accordance with best commercial practice and adequately protected from contamination and physical damage in transit.

13.2.2. Skidding and preparation of shipment shall be in accordance with pamphlet No. 21, "Rules Regulating the Preparation and Safe Loading of Machinery in Closed Cars and Protection of Equipment", and/or Part 2 of Section 4, entitled, "Loading of Machinery on Open Top Cars". This is contained in "Rules Governing the Loading of Commodities on Open Top Cars" published by the Association of American Railroads, 59 East Van Buren Street, Chicago, Illinois.

13.2.3. System controls shall be shipped by van of the type specially equipped to transport electronic equipment.

13.3. Shipping Instructions

13.3.1. Complete information concerning the gross weight, size, quantity of shipping units or crates, and the contents of each shall be forwarded to the Customer no later than the time of shipment.

13.3.2. Each shipping unit or crate shall be clearly, legibly, and permanently marked to show destination, Manufacturer's order number, Customer's order number, gross weight, and unit or crates in shipment (e.g., 1 of 6, etc.).

13.3.3. The accessories included on the order shall not be shipped prior to the basic unit.

14.0 MANUFACTURER'S RESPONSIBILITY

14.1. General

14.1.1. The Manufacturer shall be responsible for the design, manufacture, performance, reliability, packaging, transportation, and installation of the equipment and control system, its

subsystems and components as defined in this specification, whether or not such items are of his design and manufacture. This responsibility shall include technical direction during installation and maintenance assistance for the duration of the warranty period.

14.1.2. The Manufacturer agrees that all components shall be replaceable or have an acceptable substitute that shall be available for a minimum of 10 years from the date of acceptance by the Customer.

14.1.3. During any installation and checkout activities the Manufacturer will comply with the Customer's "Contractor's Compliance Specifications" Document #ESH 060398-003, Rev 01.

14.2. Installation

14.2.1. The Manufacturer shall provide installation supervision, satisfactory to the Customer, capable of committing the supplier, on site, at all times during the installation. The Manufacturer's representative shall be on site until testing, acceptance, and training are complete. The Manufacturer shall state a weekly fee for additional factory representation in the bid proposal. This fee shall be used to terminate or extend services at the Customer's option.

14.2.2. The Manufacturer shall furnish (via written letter no later than 2 weeks prior to personnel arrival at the Customer's facility) the names, Social Security Numbers, and titles of all personnel involved in the installation of the equipment to enable the Customer to provide contractor personnel badges.

14.3. Turnkey Installation

14.3.1. The Manufacturer shall provide Turnkey Installation of the equipment.

14.3.2. Turnkey Installation means the Manufacturer shall provide all equipment, labor, tools, slings, fork trucks, attachments, cranes, and lifts that the Manufacturer requires to receive, unload, and move said equipment to the installation site.

14.3.3. The Manufacturer shall furnish all material, cribs, equipment, and labor necessary for all rigging and assembly tasks for the equipment during the installation.

14.3.4. The Manufacturer shall furnish, erect, and remove upon project completion any temporary crib required for storage of Manufacturer's materials, equipment, and tools. The Customer shall provide a location for the temporary crib.

14.3.5. Steel wheeled dollies or facsimile will not be used to support the equipment during transport of the machine within the Customer's facility to the installation site.

14.3.5. The Manufacturer shall be responsible for removal and disposal of all packaging, shipping and installation material not provided by the Customer.

14.4. Liability Insurance

14.4.1. The attached "Addendum G212 to Purchase Orders - Insurance", outlines mandatory terms and conditions of insurance requirements. *Compliance to each applicable item is mandatory.*

14.5. Warranty

14.5.1. The Manufacturer shall warrant all items supplied in compliance with this specification and the terms of purchase to be free from defects in materials and workmanship. The warranty

shall be for a period of 12 months from the day of equipment Final Acceptance. The Customer shall notify the Manufacturer, in writing, of the acceptance date.

14.5.2. The Manufacturer shall repair or replace all items found defective at no charge in accordance with the provisions of the warranty. Warranty coverage includes all parts, materials, freight, and service labor. The Manufacturer shall have sole responsibility for dispensation of defective items.

14.5.3. Failure of a subsystem or component that has not yet demonstrated its ability to perform as specified or achieves minimum run time before failure shall cause the start date for the warranty for the subsystem or component to start over.

14.5.4. Once the equipment and control system have achieved the quoted performance and minimum run time before failure, if specified, the warranty shall not be extended because of any subsequent failure.

14.5.5. The failure of a subsystem or component shall be covered by the equipment and control system warranty until such time as the total system has demonstrated its quoted reliability.

14.5.6. The Manufacturer shall agree that availability of replacement parts and qualified field service personnel, on an as required basis in response to a service request by the Customer during the warranty period, shall not exceed a 24-hour period.

14.5.7. Replacement spindles shall carry a separate warranty of one year from the date of installation and startup.

15.0 CUSTOMER FURNISHED ITEMS

15.1. The concrete foundation, as approved by Manufacturer.

15.2. Water, temperature varies from 45° to 90°F.

15.3. Electricity (480v, 3ph, 60 Hz) through wiring installed from source to fusible disconnect or circuit breaker (supplied by Manufacturer).

15.4. Plant compressed air at 70 - 90 psi from source to pressure regulator (supplied by Manufacturer).

15.5. Ambient air at 85°F.

15.7. Deionized water - 10 Micro Mhos.

15.8. Laser interferometer for alignment and positioning tests at Customer's facility.

16.0. CONDITIONS OF BID

16.1. The Customer’s Equipment Engineer is the Technical Project Manager for the project. He has the sole responsibility over the execution of, and/or the deviation from, all technical and schedule elements of this specification. The Equipment Engineer shall preside over all meetings between the Customer and the Manufacturer regarding this specification.

16.2. Bidder Shall:

16.2.1. State "Compliance," "Equivalence," or "Non-compliance" (with explanation) to each item of this machine specification. Non-applicable specifications shall be so indicated.

16.2.2. Quote total price, including base price and all requested features and options, on a separate Price Information Page.

16.2.3. State installation and checkout costs required, if turnkey, as separate items on the Price Information Page.

16.2.4. State fabrication time to ship date and installation time as separate items on the Price Information Page.

16.2.5. State total weight of system and components and state FOB location on the Price Information Page.

16.2.6. List and quote individual price of all optional supervision, equipment features, and training requested in this specification, or otherwise available, in a separate "Option" section.

16.2.7. Provide information on design including drawings, sketches, schematics (electrical, etc.) and descriptions adequate to permit evaluation and comparison of bids by the Customer in a separate "Design" section.

16.2.8. State all utility and energy requirements for the system in the "Design" section.

16.2.9. Provide installation information including foundation, pad and utility requirements in a separate "Installation Requirements" section.

16.2.10. List and price recommended spare parts on a separate Spare Parts page.