MID-RAIL XY SYSTEM SPECIFICATIONS

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I.DESIGN OVERVIEW

The CEJet TECHNOLOGIES Mid-Rail model line is designed to allow the user to enjoy all the benefits of a gantry style waterjet motion system. Additionally, existing systems were observed and problems or concerns with the existing systems were addressed. These items included but are not limited to z-axis stiffness, z-axis load carrying ability, z-axis ability to withstand the damaging environment, dynamic positioning accuracy, stability of the cross axis carriage, ability to support and dynamically position multiple cutting heads simultaneously and consistency of the machines configuration and documentation.

II. STRUCTURE

The structure is an engineered for long life and service to the customer. The beams welded structure is subjected to continuous harmonic vibratory stress relieving during the welding process. This processing produces a structure that is forever stable and will remain so during machining and then when placed into the manufacturing operation environment.

The two side beams are supported separate from the catcher to isolate them from the "breathing" of the catcher. The "breathing" of the catcher is due to the large amounts of energy being introduced to the water in the catcher tank from the waterjet after it performs the cutting process.

The joining of the cross beam to the side beams and the mounting of the side beams to their respective legs includes a centering device which is the key to easy machine setup and alignment. This component coupling system used by the designers of the CEJet machines for many years reduce alignment times from days to hours and even minutes. They also have proven effective in preventing damage to the machine from operator error causing impact to the cross beam.

III. DRIVE SYSTEMS

- The drives for axes four meters and less in length are driven with ball screws. The standard ball screws are twenty five millimeters in diameter and have a 25 millimeter pitch. The drive train is a solid coupled system with no backlash in any coupling of the motor to the lead screw.

- The lead nuts are a dual nut configuration with adjustable preload to assure the best system accuracy possible. The design is made to compensate for small amounts of wear between the lead nut balls and the lead screw and the lead nut balls and the lead nut body. Empirically it has been shown that during the first few hundred hours' operation it is possible to get some physical "wear in" to the grooves where the balls make contact. It is non-discernible to the human eye but can show up as backlash in the drive when testing the system. A simple adjustment of the dual nut assembly will set the load applied to prevent backlash to the correct value as shown in the system Operation and Service manual. This will eliminate any backlash that may occur due to wear from system operation.

- The longitudinal position of all lead screws is maintained using the same bearing design that is used to support and maintain longitudinal position in the most accurate tool and cutter grinding machine spindles. The bearings are match ground at the bearing manufacture's facility for zero end play when properly loaded against one another. They are maintained and sold as a duplex pair of bearings. To support the opposite end of the lead screw we employ a dual bearing configuration as well. However, it is dual to give lateral support and assist in preventing any "whipping" of the lead screw at high RPM. The secondary dual bearings are mounted in a housing which allows their longitudinal movement due to thermal growth and contraction. This also helps to prevent screw whipping caused by column loading due to heat expansion.

- Long lengths of lead screws require lateral support when operated at or above 250 revolutions per minute. To provide the lateral support we have designed a support system which moves with the carriage and minimizes the free length of the lead screw at all times during the operation.

- This system has proven itself over the past twenty two years of operation on systems designed by the American engineering consultants with which we have contracted to assist in our designs.

- The drive motors are digital servo motors employing the state of the art in servo positioning. Because they are digital and have power ratings in excess of the minimum required to drive the axes, the motors will last for many years without adjustment or repair.

- The z-axis when motorized but manually controlled by the operator uses a dc gear motor coupled to an acme type lead screw. By using an acme screw we eliminate the need for a brake on the motor. The acme screw will not back feed and will maintain its vertical position. If a servo driven Z axis is applied to the machine it uses a ball screw type drive which requires a brake because the carriage weight will back feed the screw causing it to fall to the lowest position when the motor is not energized.

IV. CONTROL SYSTEM

- The control system is a hardened CNC control employing the Microsoft Windows XP operating system. Using a hardened system yields a control that is protected from the electrical noise problems often encountered when one uses a standard PC as the control CPU. Yet we are able to take advantage of the broad capabilities and storage capacity of the Windows based system. Windows XP is a time proven operating system which is very stable and so gives the machine very good reliability with little to no down time associated to the CPU.

- The operators interface screen shown in FIGURE 1 is configured for waterjet, is easy to use and displays pertinent information clearly. The system display is available in English and other languages. Manual programming of simple objects can be accomplished thru the edit and MDI functions of the control system. Cutting programs developed with a remote computer can be loaded either by one of two USB ports or the control can be linked into the companies LAN and programs transmitted via a RS232/432 connection on the CPU.

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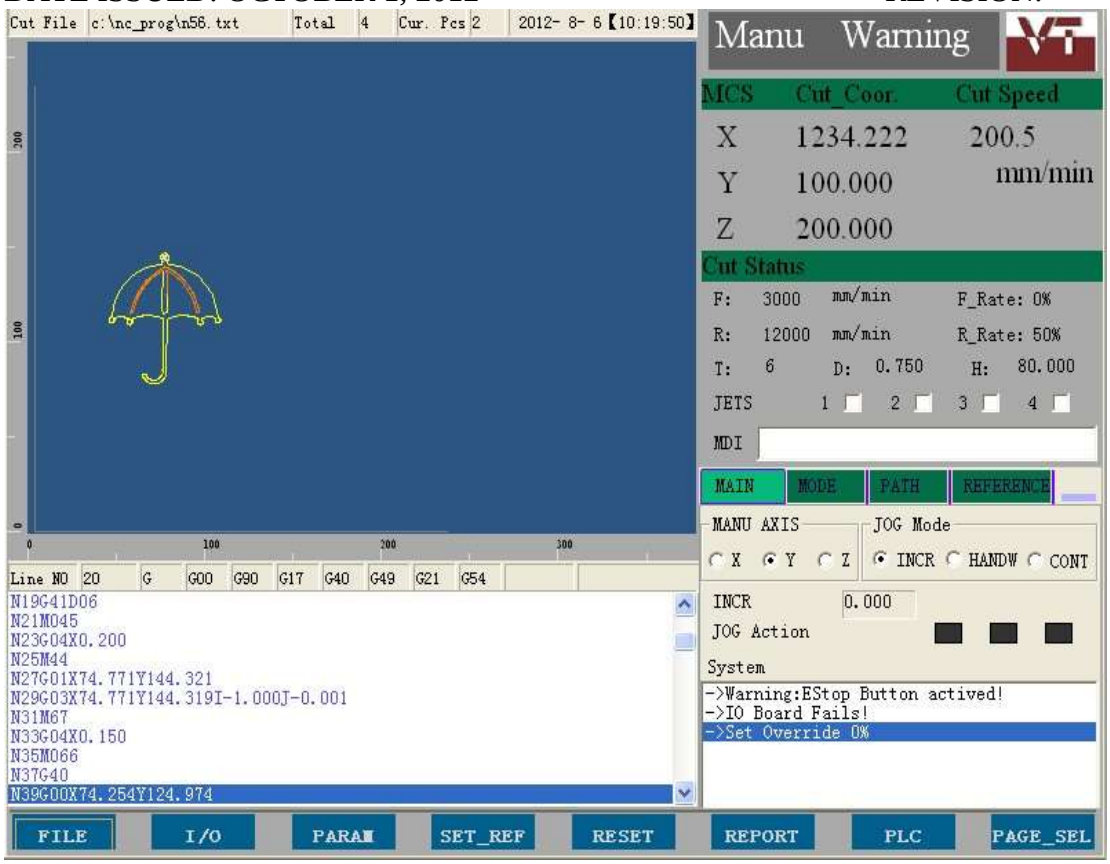

FIGURE 1

- A hand held pendent with motion stop, hand wheel for servo axis movement and an individual up/down switch for systems with a manual Z-axis. The up/down switch for the Z-axis is active in all machine modes, AUTO-MDI-MANUAL. This gives the operator instantaneous control to move the cutting head up or down at any time. The stop motion button when activated stops machine's motion, turns off the outputs for abrasive, waterjet etc and displays a warning on the operators screen. It does NOT cancel the active program. It allows the operator to correct any problem that the button was actuated to avoid, fix the problem and then restart the program by resetting the button and pushing START on the control panel.

The outputs that were active prior to pushing the stop motion button will become active and the motion will start again from where it was stopped.

- The control also has the ability to do mid program start and block retrace to help the operator recover from a problem. If an orifice goes bad and needs to be changed, the operator can stop the program. Move the head to a position where the orifice can be replaced and then restart the program and it will continue on from the position on the table where the operator interrupted the process.

- The cutting head has a manual override switch for each of the functions, waterjet, abrasive and shield. Each switch has three maintained positions, AUTO-OFF-ON. Turning the switch to off during automatic operation will override the automatic function, but returning the switch to AUTO will let the function resume in the auto mode.

Control switches and their function: (see FIGURE 2)

1. EMERGENCY STOP:
   The emergence stop button is hard wired into the drive enable control relay. Actuating the EMERGENCY STOP switch will remove power from all of the system drives and disengage the current cutting program. To resume using the machine one must correct the reason for pushing the EMERGENCY STOP, return the EMERGENCY STOP SWITCH to normal, (out) position and press the E-STOP RESET switch. Now the system is active again but needs to be homed in most emergency stop cases to ensure correct positioning.

2. REFERENCE HOME:
   Used to initiate the homing sequence. Is active only when doing a "cold" start or return from an emergency stop condition. It is inactive once homing has been accomplished.
3. E-STOP RESET:
   When power is first turned on or has been interrupted to the servos it must be reset since the drive enable control relay is wired in an electrical latch configuration. This means if power is interrupted to the power circuit it must be reset in a meaningful manor to assure the safety of the operator and others.
4. POWER:
   Turns CNC screen on, illuminates when ON and initiates startup sequence by illumination E-STOP RESET switch indicates the next step in the startup sequence.
5. MODE SELECT:
   - Auto mode is for running CNC programs.
   - MDI mode is for manual direct input of CNC commands
   - MAN mode is for manual movement of the axes and is the setting for doing the homing sequence.
6. CYCLE START:
   Starts a CNC program either at the beginning or within the program if it has been interrupted by the MOTION STOP switch. It is the only button that starts motion.
7. SINGLE BLOCK:
   When active it is illuminated and pushing the CYCLE START switch will advance the CNC program one block and then stop.
8. CYCLE STOP:

Interrupts the motion at any time in a controlled manor and requires the activation of the CYCLE START switch to resume motion. Acts the same as the stop motion switches on the beam riser end covers and the hand held pendent.

9. FEEDRATE%:
   Overrides the programmed feedrate by percentages of zero to150%. Does not affect the rapid move speed.
10. RAPID %:
    Controls the speed of the moves between cuts. Key feature is being able to prevent a rapid move at the end of a cut. By setting RAPID % to zero the operator can prevent the machine from moving after a cut is finished, this is a great tool for preventing nozzle breakage.
11. JOG TYPE:
    - INCR is a jog which is a certain distance as indicated with the SPEED/INCREMENT switch. Each time JOG switch is actuated plus or minus the cutting head will move the selected direction the amount selected on the SPEED/INCR switch.
    - CONT: Continuous jogging at the speed selected on the SPEED/INCREMENT switch and in the direction the JOG switch indicates. Movement will continue as long as the JOG switch is activated.
12. SPEED/INCREMENT:
    Assigns the incremental jog distance, three to choose from, and the continuous jog speed, LOW, MED, HI.
13. AXIS SELECT:
    Indicates which axis the jog switch will control.

14. JOG:
    Starts the jog movement in the direction indicated as long as the switch is held "ON" continuous jog will keep going. Incremental will only move one increment per each actuation of the jog switch.
15. WATER:
    - ON: Waterjet is on as long as switch is in this position.
    - OFF: Waterjet is off no matter in which mode machine is set.
    - AUTO: Waterjet on/off is controlled by CNC program.
16. ABRASIVE:
    - ON: Abrasive is on as long as switch is in this position.
    - OFF: Abrasive is off no matter in which mode machine is set.
    - AUTO: Abrasive on/off is controlled by CNC program.
17. SHIELD:
    - ON: Shield is on as long as switch is in this position.
    - OFF: Shield is off no matter in which mode machine is set.
    - AUTO: Shield on/off is controlled by CNC program.
18. PIERCE:
    - ON: Pierce pressure is on as long as switch is in this position.
    - OFF: Pierce pressure is off no matter in which mode machine is set.
    - AUTO: Pierce pressure on/off is controlled by CNC program.

19. DRILL:
    - ON: Momentary switch position initiates one cycle of automatic drill spindle.
    - OFF: Auto drill is off no matter in which mode machine is set.
    - AUTO: Auto drill on/off is controlled by CNC program.

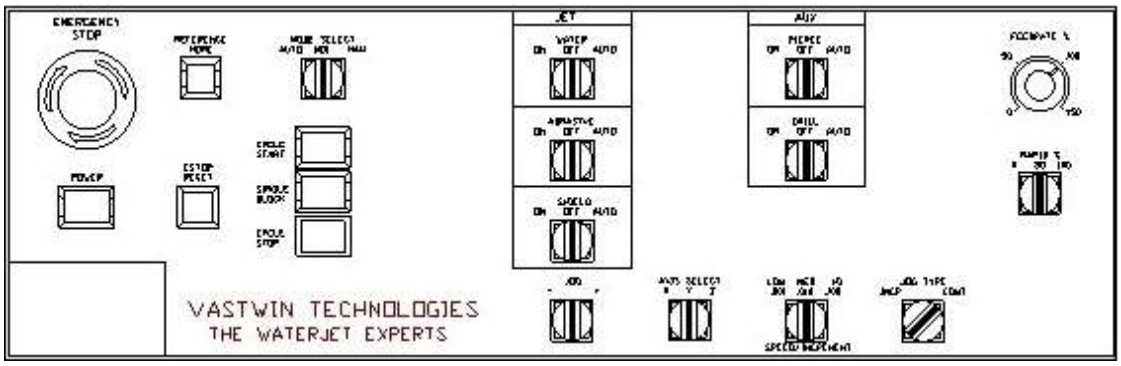

FIGURE 2

V. PROTECTIVE COVERS

All systems of the cutting machine are protected by covers. The abrasivejet cutting environment can be very damaging to equipment if not properly protected. Bellows that have a horizontal section tend to collect abrasive in their folds and have a very short mean time between failures, (MTBF). Flexible wire carriers yield to failure of the rotating joints due to the abrasive. Any part that moves and rubs against itself or another part will tend to wear and fail. Additional damage often occurs to the flexible wire carriers and the large bellows caused by humans leaning on them.

To assure the user of VASTWIN machines gets the longest MTBF of any abrasivejet cutting system we have chosen to eliminate horizontal bellows, design the covers to cover the electrical flexible wire carriers and keep wires when possible inside the covers. We have engineered metal covers capable of supporting the leaning operator. The covered areas are then sealed using a labyrinth of brushes and rubber seals. To further repel dirt and moisture from the mechanical parts each sealed area is equipped with a high volume low pressure fan. Each fan inlet has a replaceable filter to keep the fine dust from entering the mechanical areas and adversely affecting the life of the critical components such as the lead screws and the linear ways. This covering system has proven its ability to provide the desired protection with years of use on hundreds of abrasivejet cutting systems.

VI. SHIPPING

For ease of shipment the cantilevered beam is designed to swivel 90 degrees to be parallel with the X-axis. This greatly reduces the size of the crating and the shipping costs. All overseas shipments will be fully crated or shipped in a dedicated container for multiple machines. When the system is installed the beam is rotated back into the operating position and oriented with dowel pins to be sure critical alignments are retained.

VII. INSTALLATION CUSTOMER REQUIREMENTS

The customer shall be responsible for supplying the necessary floor, (foundation), to support and anchor the machine in place, shop air supply, water supply and electrical power. The customer will be supplied a packet containing the items to be prepared prior to installation. The packet will include such things as a drawing showing the layout of the system, the amount of shop air at what pressure, the electrical power required and the water supply requirements. The layout will indicate where each utility will connect to the machine to enable the customer to stub-off the utilities and be ready for the installation without delays.

VIII. MAINTENANCE

Maintenance is very minimal on the CEJet CNC systems. The machine requires a service procedure at every 2000 hours or six months whichever occurs first. It involves removing various covers. Checking the mechanical drives and ways for cleanliness, lubricating the lead screws and ways, check and adjust dual nut preloads and check preload on the belt-rack. The whole procedure takes about one hour and helps to assure the long life the machine was designed to provide.

IX. HIGH PRESSURE PLUMBING

The high pressure plumbing is routed via a whip to the Z-axis and cutting head. For machines greater than 4 meters in length

The high pressure tubing is contained within the X-axis flexible wire carriers.

X. ABRASIVE SUPPLY ROUTING

Abrasive supply lines are routed through the flexible wire carriers.

XI. PNEUMATIC SYSTEM

The shop air is supplied to the s-axis via the flexible wire carriers.

XII. SYSTEM QUALIFICATION

The complete system is designed and documented CE qualified to meet the requirements per the following documents：

EN1050-1997	RISK ASSESMENT
92/23/EC	PRESSURE EQUIPMENT
ISO-13732-1-2006	HUMAN INTERFACE
ISO-12100-2010	SAFETY OF MACHINERY
EN61000-6-4-2007	EMC

EN60204-1-2006	MACHINERY ELECTRICAL SAFETY
EN349-1993	SAFETY, PINCH POINTS
EN61000-6-2-2005	EMC
EN1037-1995	SAFETY, UNEXPECTED START
ISO/IEC17050-1-2004	DECLARATION OF CONFORMITY
BS-EN-ISO-13850-2006	SAFETY, E-STOPS
BS-EN-ISO-13849-2006	SAFETY, CONTROL SYSTEM
BS-EN-982-1996	SAFETY, HYDRAULICS
BS-EN-953-2009	SAFETY, GUARDS
BS-EN-547-3-1996-A1-2008	SAFETY, HUMAN BODY SIZE
BS-EN-547-2-1996-A1-2008	SAFETY, HUMAN BODY SISE
BS-EN-547-1-1996-A1-2008	SAFETY, HUMAN BODY SIZE
2006/95/EC	LOW VOLTAGE
2006/42/EC	MACHINERY DESIGN
2004/108/EC	EMC
EN-ISO-12100	SAFETY, MACHINE DESIGN

XIII. SPECIFICATIONS

WORK ENVELOPE:

1. 1x1 up to 5 x 5 meters in one meter increments in either axis.
2. Z-axis: 300 mm

CONTOURING CUT SPEED:

1.25~12,700 mm/min (0.05~500 ipm)

DYNAMIC POSITIONING ACCURACY:

Work Envelope up to 5x5 meters: +/-0.127 mm, (+/-0.005 inch)

BI-DIRECTIONAL REPEATABILITY:

0.05 mm, (0.002 inch)