

PART – B

UPGRADATION & RETROFITTING OF CNC SYSTEM IN PINES MACHINE INSTALLED IN BAY-1B, BUILDING-1

Sl. No.	Description	BHEL Remarks	Vendor to Specify deviation if any
1.	The scope of work involves UPGRADATION & RETROFITTING OF CNC SYSTEM IN PINES MACHINE AND PROVE OUT.		
2.	Details of existing machine: Type: CNC tube bending machine Supplier: M/s. Pines, USA. Model: CNC – 150 Purpose of the machine: Making Single or Multiple bends of straight tubes into different profiles from 0deg. To 179.99 deg.		
3.	Details of job (pipe) parameters • Outer dia. 31.8 to 76.1mm max. • Thickness 12mm max. • Length 5mtrs. max. Grades of steel tubes: carbon steel, alloy steel (specifically P91, T91), stainless steel, Inconel.		
4.	DESCRIPTION OF <u>EXISTING</u> CNC SYSTEM: - The input devices machine control unit and display unit all together forming a part of an Industrial PC with following features: a) Windows operating system b) Custom in-built CNC software used to control operations c) Motion control cards embedded in motherboard for processing the analog and digital I/O signals. 1.1. INPUT DEVICES The touchscreen display unit (Pro-face XYCOM 5015T/R2, with CPU Pro face XYCOM 1547) of Industrial PC acting as input device. USB connected keyboard and mouse facility is also available for operating touchscreen based software. In addition, some operator I/P commands through push button operation in operator pendants are present.		

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	There are two operator pendants. One pendant contains CPU of industrial PC, HMI touchscreen display and Push buttons (Off/On remote, enable motion, motor start, cycle stop, emergency stop). The other pendant contains only push buttons (enable, forward, cycle stop, emergency stop, load, collet close), 1.2. MACHINE CONTROL UNIT All the controlling action is done by tube bending software TS2000 (developed by Pines Ltd., Machine OEM) and motion control cards (DCX_PCI300 - H). In addition to this, one master PLC (YASKAWA MP2300) and pressure die dedicated PLC (Delta PLC RMC75E-XXN) is present in separate electric control panel for handling Analog/Digital I/O signals between field elements and Industrial PC. 1.3. DRIVE SYSTEMS Of the 8 axes, four Axis movements are having motorised control and four are hydraulically operated. The motorised operation is achieved through the use of servo motors and servo drives. Hydraulic actuators/cylinders operated through valves govern the hydraulic operations. 1.4. OTHER FEEDBACK ELEMENTS Refer clause (5.0/6.0) 1.5. DISPLAY UNIT The touchscreen display (Industrial PC) forms part of display unit (PROFACE).		
5.	Existing Machine Axes and Controls: Axis 1: X Axis Carriage The carriage unit serves as machine tool for X axis cross travel movement of job with the help of driving unit viz.		

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	Drive mechanism: Servo motor driven. Servo Motor details: Make – YASKAWA, Model: SGMPH-08A1E41D, Sigma 2, 0.75 kW, 200 VAC, 3,000 RPM (rated speed), 5,000 RPM (max speed), Flange Mount type with inbuilt ABSOLUTE encoder (16bit resolution), constant torque 2.39 Nm, 7.1Nm (Peak) Yaskawa make Servo drive (Yaskawa SGDS-08A12A). External feedback: Nil. Axis 2: Y Axis Carriage The carriage unit serves as machine tool for Y axis long travel movement of job with the help of driving unit viz. Yaskawa make Servo motor SGMGH-30DCA61, Sigma 2, 3.0 kW ,400 VAC, 1500 RPM (rated speed), 3000 RPM (max speed), Flange Mount type with inbuilt INCREMENTAL encoder (17bit resolution), constant torque 18.6 Nm, 45.1Nm (Peak) Yaskawa make Servo drive (Yaskawa SGD H-30DE) SIGMA II SGD H Series, 3KW, 400V, 3PH., 8.8A (Constant), 28A (PEAK), 2/2 Analog I/O and 7/3 Digital I/O with Dynamic braking. servo control mode, encoder feedback and frequency response of 40HZ. External feedback: Nil. Axis 3: X Axis Clamp Die The clamp die unit serves as machine tool for clamping the job in X direction (horizontal clamping) with the help of driving unit. There are two driving units, viz. Servo motor driven for positioning the axis up to commanded position & Hydraulic driven for exerting the clamping pressure during bending. Strain gauges are used. Yaskawa make Servo motor SGMPH-04A1E41D, Sigma 2, 0.4 kW ,200 VAC, 3000 RPM (rated speed), 5000 RPM (max speed), Flange Mount type with ABSOLUTE encoder (16bit resolution), constant torque 1.27 Nm, 3.82Nm (Peak).		

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	Yaskawa make Servo drive SGDS-04A12A 1PH. 200V AC I/P 50-60Hz, 4.7A Input, 3PH. 0-230VAC O/P, 0-300HZ., 2.8A, 400W for moving the clamp die / (Clamping Unit) before clamping. Axis 4: B Axis collet rotation The collet unit serves as machine tool for rotation of job with the help of driving unit viz. Yaskawa make Servo motor SGMGH-44DCA61, Sigma 2, 4.4 kW, 400 VAC, 1500 RPM (rated speed), 3000 RPM (max speed), Flange Mount type with inbuilt INCREMENTAL encoder (17bit resolution), constant torque 28.4 Nm, 71.1Nm (Peak). Yaskawa make Servo drive SGD5-50DE SIGMA II SGD5 Series, 5KW, 400V, 3PH., 14.9A (Constant), 16.5A (PEAK), 2/2 Analog I/O and 7/3 Digital I/O with Dynamic braking. servo control mode, encoder feedback and frequency response of 40HZ. Axis 5: Pressure Die movement in x direction The pressure die unit is for moving the job in crosswise (X axis) just before booster operation with the help of driving unit viz. Hydraulic cylinders actuated through Servo valve (Woodward 27G50F-9F02-999) along with Pressure sensor in both ends, IFM PN2221(Head End) and LENZ LZTA3M4N11N (Rear End) for feedback. Axis 6: Bending arm movement The bending arm unit serves as machine tool for bending operation of job with the help of driving unit viz. Hydraulic cylinders actuated through Proportional Valve (Bosch Rexroth BAT 0811404305) along with position encoder (ACCU-CODER by Encoder Products Co. Ltd Part#725I-4-S-1000-R2-H5-1-S-1-SX-N-N) for feedback (1000CPR). Axis 7: Booster Arm movement The booster die unit serves as machine tool for booster operation of job (providing tangential bending torque) with the help of driving unit viz. Hydraulic cylinders actuated through Hydraulic operation involving Proportional Valve (Bosch Rexroth		

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	BAT 0811404305) along with position encoder (ACCU-CODER by Encoder Products Co. Ltd Part#725I-4-S-1000-R2-H5-1-S-1-SX-N-N) for feedback (1000CPR). Note:- (The given machine supports Two additional axis movements, viz. Tube support and Booster clamp, but booster clamp is presently disabled due to no operation requirement)		
6.	Details of Hydraulic System: Hydraulic power pack (capacity, pump / motor details) Lincoln motors make, 22.4kW, 50Hz, 3Ph., 1475rpm -- Two No's Recirculation pump motor, 50Hz, 1.49kW, 1440rpm, 3Ph.		
7.	Details of Other Critical Feedback Elements: a. Pressure transducer details. – IFM make, PN2221, 4-20mA o/p, LENZ LZAT. b. Any other special / critical feedback elements. X Axis Clamp Die Pressure Transmitter CPA-3 (SS)X, Cylinder Position Sensor for bending arm NJ2-D-US 1.750-V93 PEPPERL+FUCHS		
8.	SCOPE OF SUPPLY		
8.1.	Latest CNC system functionally equivalent to the existing CNC system & suitable for Pipe bending application. The make of the CNC system shall be Siemens, Fanuc, Fagor, Pines, Yaskawa, Fuji Electric. Note: 1. The CNC system being offered shall be available in the market for next 10 years and spares/service support shall be available for the next 15 years. 2. All features available in the old CNC system of the machine shall be made available in the new CNC being offered. 3. Service support shall be available in India. Details of the service centre facility available in India to be indicated.		
8.2.	Latest PLC system in place of the existing PLC system mentioned in Clause 4.0. The make of the PLC system shall be Mitsubishi / ABB / Siemen / Yaskawa / Delta / Allen Bradley		
8.3.	A latest industrial / conventional desktop PC with 18” touch screen type monitor for the operator to view / edit process parameters and wireless keyboard and mouse. It shall be compatible to the new CNC / PLC system. The industrial / conventional PC shall have the following features:		

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	• RAM / Hard disk capacity • Operating system. • Graphical interface card. • USB / Ethernet / RS 232 ports. • Remote diagnosis feature		
8.4.	Soft starter for switching on/off 22.4kW Hydraulic Motor. For recirculation pump DOL starter can be used.		
8.5.	One safety sensor (Eg. Sick unit) as an alarm indication to trip the system and alert the user for preventing the human entry during bending operation.		
8.6.	Latest AC Servo motors to replace the existing servo motors mentioned in clause 4.0. The make shall be of Siemens / Fanuc / Mitsubishi / Yaskawa / ABB / Fagor.		
8.7.	Latest AC servo drives for the newly supplied AC servo motors. The make shall be Siemens / Fanuc / Mitsubishi / Yaskawa / ABB / Allen Bradley		
8.8.	New external encoders for the axes to replace the existing external encoders as mentioned in clause 4.0. The new encoders shall be compatible to the new CNC / PLC system to be supplied. The make of the encoders shall be Encoder Products / Heidenhein / Fanuc / Siemens / Fagor.		
8.9.	New pressure transducers to replace the existing pressure transducers mentioned in clause 4.0. The pressure transducers shall operate on 24V DC and shall have features like, pressure display mounted on the transducer, functional / programmable keys on the transducer, option to program the measuring range / switching point, 2 programmable outputs (1 may be for digital switching and another may be for 4-20 mA analog output). The new transducer shall be compatible to the new PLC / CNC system supplied.		
8.10.	Other feedback elements such as limit switches, pressure switches to replace the existing feedback elements in the machine.		
8.11.	Machine control panel to accommodate items such as the PLC, CNC system (if reqd. as per design), servo drives, switchgears, SMPS, transformer etc. The panel shall have the following features: • IP 54 protection. • Shall be at a height of min. 1 mtr. From the ground level.		

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	• Shall include all the switchgears, relays, etc. required for the complete operation of the machine. • Shall be in fully wired up condition with the interconnection of all the components installed in the panel. • Pocket arrangement at the door inside the panel, for storage of documents. • Suitable lighting arrangement in all compartments.		
8.12.	Suitable capacity Refrigerant type Air conditioner unit for the machine control panel. The make shall be Rittal, Werner finley,		
8.13.	Main Operator pendant (portable) with rotating wheel in all four corners to accommodate the touch screen type monitor described in clause 3.0. The pendant shall have the following features: • Shall be similar in construction to the existing one. • Shall have IP 54 protection. • Other features: a) Inbuilt AC for cooling b) Wireless keyboard and wireless mouse c) A 230Volt, 5 amps, 3 pin, flush type switched socket shall be provided in the operator pendant. d) Four no's of external USB 3.0 ports on the operator console for connecting keyboard, mouse and spares. e) The console LCD display shall be touchscreen based and should have suitable communication ports for projecting the display to external PC or printing. f) The cable length from the main panel should not be less than 15mtrs.		
8.14.	A mini (portable) operator pendant similar to the existing operator pendant in the machine. The switches / keys in the existing pendant shall be available in this mini operator pendant also.		
8.15.	Mounting brackets / flanges, couplings, fittings etc. required for fixing / interfacing the newly supplied items such as servo motors, encoders, pressure transducers, etc. in the existing machine.		
8.16.	Spare hard disk (for the one used in the newly supplied Industrial desktop) with loaded Ghost image of the commissioned machine after retrofitting.		

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8.17.	A standard laptop PC of latest version for trouble shooting, up loading, down loading and editing the CNC system / PLC parameters, machine parameters, axis parameters. The PC shall have standard features such as PCMCIA, USB, Ethernet ports, DVD(R/W), licensed Windows (Latest Professional OS). The make of the laptop shall be hp/dell. The laptop shall have the capability / features to use it in place of the new HMI system described in clause 8.3, in case of its failure.		
8.18.	Licensed OEM PLC software for the new PLC system supplied, for programming, editing, uploading / downloading the PLC program along with the supply of necessary hardware interface cables, connectors.		
8.19.	Licensed CNC software for programming, editing, uploading / downloading is to be supplied with necessary hardware interface cables, connectors.		
8.20.	Power, control and communication cables required to connect the newly supplied items as listed in the previous clauses as well as for the items available / retained in the machine. The cables shall be of reputed make like Igus/Lapp or any other make acceptable to BHEL.		
8.21.	Cable drag chain / cable trays. For the newly laid cables.		
8.22.	Lubrication system to replace the existing lubrication system Lincoln make QLS401. Make: Lincoln. Supply of new lube line tubes with suitable end fitting /adapters / ferrule for replacement of all existing lube lines.		
9.	SCOPE OF WORK:		
9.1.	Dismantling of all the old items such as servo motors, drives, machine control panel, pendants, lubrication system etc. to install the newly supplied items as mentioned in Scope of supply.		
9.2.	Erection & Commissioning of new CNC & PLC system.		
9.3.	Erection & Commissioning of new Servo motors / servo drives.		
9.4.	Erection & Commissioning of Industrial / desktop PC.		
9.5.	Erection & commissioning of all the field elements such as external encoders, pressure transducers, pressure switches, limit switches, etc.		
9.6.	Erection & Commissioning of Machine control panel, Main and mini operator pendants.		
9.7.	Erection & Commissioning of lubrication system.		

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9.8.	Laying & termination of all the power, control & communication cables.		
9.9.	Erection & Commissioning of the new cable drag chain system.		
9.10.	Earthing of all the system.		
9.11.	Interconnection of all the electrical / mechanical / hydraulic system.		
9.12.	Performance prove out of the machine after retrofitting:		
10.	DOCUMENTATION		
10.1.	Supply of THREE sets of hard copies & 1 set of soft copy in CD / Pen drive of the following documents in English along with the system: • Programming, Commissioning, troubleshooting manuals and parameter list of the CNC, PLC & Servo system. • Interface wiring drawings, circuit diagrams for the new panels, bought out items including part number • Complete Functional manual of the new system. • Other catalogues / manual of electrical / mechanical system.		
10.2.	TRAINING of BHEL operators on machine functioning & operation for min. two days after successful prove out of the machine at BHEL - Trichy. Also training has to be imparted for BHEL Maintenance persons on Machine maintenance and programming aspects of CNC, PLC and drives for min. two days at BHEL – Trichy.		
11.	GENERAL FEATURES AND CONDITIONS		
11.1.	The vendor is advised to visit the BHEL works to study the existing machine and discuss with the maintenance executive before quoting for the offer.		
11.2.	Only 3-Phase 3-wire supply will be provided by BHEL at their works.		
11.3.	The rating and type number of all the motors and other components selected shall be indicated in the offer and the technical leaflet showing the parameters and dimensional details shall be enclosed.		
11.4.	All the existing INTERLOCK features to be retained.		
11.5.	Control panel, Operator pedestal and Push button control station shall confirm to the IS / BS/ EN / Indian electricity Regulations from safety aspects. The panels shall be of indoor floor mounting type of 1.6mm/ 2mm sheet steel with necessary gasket for the non-load bearing/ load bearing sheets with necessary MS angles/ sections		

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	includes the suitable size "EYE bolts for lifting. It shall undergo full degreasing, de-rusting, phosphating treatment process before painting with red oxide and two coats of Siemens / Apple green enamel paints outside and white enamel painting inside for better visibility.		
11.6.	All control elements like contactor, relay, push buttons, MCCB, MCB, MPCB, Proximity switches and limit switches shall be M/s. Siemens / L&T / Telemecanique / Technik make only (with DIN rail mounting).		
11.7.	All the control wires shall be M/s. Igus or Lapp makes only All Power cables shall be of reputed make accepted to BHEL.		
11.8.	All the control and power wiring from control panel to field elements shall be protected with suitable sizes of PVC sheathed flexible metal hoses and ducts.		
11.9.	MAKE OF THE BOUGHT OUT ITEMS "Makes of all bought out items shall be as follows unless otherwise specified elsewhere 1. ALL COUPLINGS WITH GUARDS: SKF/FENNER/HYDAX 2. HYDRAULIC FITTINGS: PARKER/SWAGELOC/HYLOC" 3. CONTACTORS: SIEMENS/L&T/SCHENIEDER/TELEMECHANIC 4.PUSH BUTTONS AND SELECTOR SWITCHES: SIEMENS / TELEMECHANIC 5. TEMPERATURE GAUGE: WIKA/ WARRE/ REXROTH/ EATON VICKERS 6. SERVO MOTOR: SIEMENS/ MISTIBUSHI/YASKAWA/FANUC 7. PU TUBES & ONE TOUCH FITTINGS: FESTO/ SMC /PARKER 8. PRESSURE GAUGE: REXROTH/WIKA/WAREE/PARKER ANY OTHER MAKES RECOMMENDED BY THE SUPPLIER SHALL BE APPROVED BY BHEL ENGINEERS BEFORE MANUFACTURING		
11.10.	The proposed electrical circuit diagram, component lay out, panel drawings with dimension, Bill of Materials, Mechanical drawings and other details for mechanical items such as machined bracket, gear boxes, coupling arrangements shall be submitted to BHEL officials for approval before starting manufacturing. Supplier shall submit these details for approval to BHEL engineers within 2 months from the date of PO/LOI.		
11.11.	All the materials as per scope of supply shall be offered for Stage/Final inspection at supplier's works before dispatch. Recommended to call for pre-dispatch inspection by atleast one week in advance.		

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11.12.	Before dismantling the existing wiring & drive, the vendor should check and record the performance of the machine.		
11.13.	Supplier shall quote for materials supply and erection work separately.		
11.14.	The vendor shall give guarantee for trouble free operation for the period of one year after commissioning of the machine.		
12.	PACKING: Sea worthy & rigid packing for all items of complete machine and all accessories and other supplied items to avoid any damage/loss in transit. When machine is dispatched in trailers, all small loose items shall be suitably packed in boxes.		
13.	DELIVERY: Supply: - Delivery shall not exceed 4 months from the date of Purchase Order. Erection, Commissioning and Prove out: - This shall not exceed 1 month from the date of Delivery.		
14.	GUARANTEE: 12 months from the date of commissioning or 18 months from the date of despatch of material whichever is earlier,		