Bhabha Atomic Research Centre, Nuclear Recycle Board

Technical Specification – Shearing Machine

TECHNICAL SPECIFICATIONS

FOR

SHEARING MACHINES

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1.0 SCOPE:

The scope of supply includes design, preparation of design & shop drawings, identification & procurement of all raw material including bought out components, manufacture, shop assembly, testing of 3 Nos. of 37/19 pins Shearing Machines at the supplier’s works, packing, safe transportation, installation and commissioning of the machines at NRB site, Tarapur. Detailed scope of the supply is as follows:

- Shearing Machines in SS construction for cutting 37&19 pins fuel bundles: 3 Nos.
- Set of standby modules & spares as per Para-13 of this specification: 1 Set.
- Set of tools & tackles: 3 Sets.
- Set of supports, spacers, weld pads & fasteners: 3 Sets.
- Installation & commissioning of Shearing Machines at NRB site, Tarapur: 3 Nos.

The following aspects shall be adequately addressed while submitting their techno-commercial offer for the design, manufacture & supply of Shearing Machines for cutting 37/19 pins spent fuel bundles:

- The Shearing Machines shall be designed and manufactured considering the design basis, layout & other clauses described in this document.
- Design details & other information provided under Para-4 are for Shearing Machines for cutting 19 pins spent fuel bundles & shall be considered only as guidelines. The supplier shall work out design details, prepare GA layouts, design drawings, shop drawings and other details for new machines for cutting both types of spent fuel bundles i.e. 37 & 19 pins spent fuel bundles.
- Operational feedback from the existing Shearing Machine is enumerated under clause 4.9 of Para-4 & shall be taken care during design of new machines.
- The bidders shall consider the development of application programme for PLC programming & SCADA development for each machine while preparing their techno-commercial bid.
- One No. of licensed version of PLC programming software with simulator features and One No. of SCADA – Licensed version with unlimited tags & reporting features shall be considered for all three machines while preparing their techno-commercial bid.
- One No. of Laptop with latest configuration and 15” LCD monitor loaded with licensed Windows Professional operating system shall be supplied along with all three machines for software maintenance works.
- The bidders shall consider quantity & make of all bought out components as per Annexure-2 of this specification while preparing their techno-commercial bid. Wherever choices are available, BARC has preference for first choice of the make.
- Submission of ONE set of approved design report giving the design criteria, features, design calculations considering load & sizing of the components and all relevant design data concerning each component of the machine.
- Submission of FOUR sets of approved as-built drawings (assembly & part drawings) in blue print as well as in electronic form (soft copy), Quality Assurance Programme (QAP), Quality Assurance (QA) document and Operation & Maintenance (O&M) manual along with each machine.
• The supplier shall provide training to BARC Staff for proper operation and maintenance of the machines.
• The manufacturing of three machines shall be met in two phases:
  **Phase-I:** Design, preparation of design & shop drawings, identification & procurement of all raw material including bought out components, manufacture, shop assembly, extensive testing at supplier’s end, packing, safe transportation, installation, testing and commissioning at NRB site, Tarapur – **First Machine.**
  First machine shall be tested extensively for 2000 cycles at Component Testing Facility (CTF), Tarapur with simulated dummy bundles to ascertain remote handling & maintenance aspects as qualification criteria for approval for manufacturing of remaining two units.
  **Phase-II:** Modifications in the design, if required, preparation of shop drawings, manufacture, shop assembly, testing at supplier’s works, packing, safe transportation, installation, testing & commissioning at NRB site, Tarapur – **Second & Third Machines.**

• Minor changes/modifications in the design limiting to the tune of 5% of the cost of first unit shall be undertaken by the supplier during the feedback from testing of first unit. The major modifications beyond 5% shall be carried out by the supplier after negotiations/mutually agreed terms & conditions.

2.0 DESIGN BASIS: The Shearing Machines shall be designed on the following basis:

2.1 General:
2.1.1 The Shearing Machines shall be designed on multiple cutting concept to chop one 37 pins & one 19 pins spent fuel bundle into 11 pieces respectively in one stroke. Details of simulated 37 & 19 pins dummy bundles are provided under Para-4.
2.1.2 The Shearing Machines shall be designed for a cutting force of **630 Te.**
2.1.3 The machines shall be capable of handling dismantled bundles (one or two pins dismantled). However suitable provision shall be made to mount a retrieval system to retrieve fuel bundles in case it fails during operation.
2.1.4 The machines shall accommodate 5 nos. of either 37 pins spent fuel bundles (Ø102 x 495 mm long) or 19 pins spent fuel bundles (Ø82 x 495 mm long) in one batch.
2.1.5 The systems/ sub-systems/ components of each machine shall have state of the art modular design
2.1.6 The machines shall be designed to operate either in inch (manual) mode or once (semi-auto) mode or continuous (auto) mode.
2.1.7 Minimum rate of cutting shall be 1 bundle /min. Provision for cooling the components in case of temperature rise should be provided. Total cycle time for cutting 5 nos. of 37/19 pins spent fuel bundles shall be around 5 min.
2.1.8 The length of cut pieces shall be around 50 mm.
2.1.9 Material of construction for in cell components of each machine shall be compatible to corrosive nitric acid vapors & high radiation field.
2.1.10 The non-metallic components shall be able to with stand radiation dose rate of $10^4$ R/hr & cumulative dose of $10^5$ R (100 MR).
2.1.11 All in-cell components of the machine shall be suitably designed to facilitate easy
decontamination.
2.1.12 Groove sizes for O-rings/ Gaskets (wherever required such as shear cover, distributor
lid, main distributor door etc) shall be made uniform to the extent possible.
2.1.13 Linear position transducer in addition to reed switch or limit switch/GO switch in
addition to reed switch shall be used for position sensing of all pneumatic cylinders.
2.1.14 O&M manual shall elaborate the procedure for assessing the conditions of tools &
components during preventive maintenance.

2.2 Mechanical:
2.2.1 Machine shall be designed considering the following design basis accidents & other
mal operations:
   • Misalignment of fuel bundles inside fuel feed magazine during pushing: In case
     the pins of the fuel bundles are dislodged, the increased pusher torque should be
     sensed & further pushing should be stopped.
   • Retrievability of fuel bundles in postulated stuck scenario shall be considered.
   • Pushing of fuel bundle inside Component Transfer Assembly (CTA) & chopping
     should not be done simultaneous to prevent CTA being crushed by the shear
     blades.
   • Provision for proper guiding of fuel movement in the fuel feed channel & into the
     shear area to avoid flaring in the shear zone.
   • In addition to encoder, mechanical stoppers shall be provided for pusher to restrict
     the end positions.
   • The clearances between each fixed & moving shear blades of the shear module
     should be such that no zircalloy pieces/fines gets stuck in between.
   • The shearing is contained with air draft towards the dissolver to prevent spread of
     contamination & activity.
   • When the fuel bundle is chopped, lot of bearing pads & small zircalloy
     pieces/fines are generated which results in jamming and breakage of blades &/or
     obstruction to fuel pushing inside CTA. Effective way to push them through the
     dissolver should be considered.
2.2.2 There shall be an isolating door between shear & fuel feed channel so that cut pieces
    do not fly in the feed channel.
2.2.3 Fuel feed magazine & CTA tube shall be properly selected for smooth pushing/
    movement of 37/19 pins fuel bundles.
2.2.4 The shear module for cutting 19 pins spent fuel bundles shall be redesigned in order to
    accommodate inside shear housing meant for accommodating shear module for
    cutting 37 pins spent fuel bundles.
2.2.5 Powder accumulation in shearing area should be avoided.
2.2.6 The machine at anytime should not stop due to cut pieces, spacer pads, bearing pads
    & end pieces of the fuel bundle stuck between blades or on the feeding passage.
2.2.7 The existing design of CTA for receiving & placing the fuel bundle between shear
    blades shall be reviewed for effective functioning of CTA. An alternate to CTA for
    receiving & placing the fuel bundles between shear blades shall be looked into.
2.2.8 Liberal slope and direct passage to dissolver shall be provided to avoid accumulation of dust & pieces for example in the shear housing, bottom slope shall be improved for smooth flow of cut pieces & powder generated during chopping towards distributor.

2.2.9 The shear cover shall have wider polycarbonate sheet for better viewing. Also it shall be designed for direct lifting using yoke & thereby provides access to complete shear internals for carrying out any remote operation & maintenance.

2.2.10 The material of construction for shear housing of the machines shall be selected in consultation with the purchaser to take care of high tonnage and material availability & cost. In-cell components/parts pertaining to various systems of SFC shall be made of different grades of SS.

2.2.11 The machine shall operate only if one of the dissolver is open to receive cut pieces. The cut pieces from a pre-set nos. of bundles shall be diverted to each dissolver of the machine.

2.2.12 In distributor housing, side door seating places needs to be improved to prevent accumulation of cut pieces. Provision for washing in & around O-ring grooves/recess shall be made.

2.2.13 The machine shall be designed for achieving a minimum negative pressure up to 100 mm of water as it is connected to dissolver system. Proper gaskets/seals (radiation resistant) shall be used for achieving the vacuum. Judiciously scavenging air shall be injected to ensure flow of dust-laden air towards the dissolver unit.

2.2.14 The systems/ sub-systems/ components of the machine shall withstand the shocks arising due to cutting action on the fuel and shall be rugged enough to have zero failure between two preventive maintenances.

2.2.15 Design shall foresee periodic preventive maintenance to ensure trouble free operation.

2.2.16 The machine shall qualify for SSE level Design Basis Earthquake (0.2g PGA). The necessary Floor Response Spectra (FRS) for the Tarapur site will be provided by BARC for design & analysis of the machine.

2.3 Control, Instrumentation & Electrical System:

2.3.1 PLC based control system & field sensors shall be used for sequential fail-safe operations, feedback sensing, actuation of various actuators etc. Please refer to Para-4 for remote sequential operation employed in existing Shearing Machine. PLC shall have 20-25 extra I/Os for future modifications.

2.3.2 As the machine is operated in a sequence, all the interlocks shall be properly designed for easy approach & rectification.

2.3.3 PLC shall be hot redundant and the system architecture shall be as per attached Sketch-1.

2.3.4 The PLC shall be programmed such that failure or non-functioning of any component/system including encoder shall safely shut down the machine immediately & bring back the operation from the same point after rectification/ replacement of the components.

2.3.5 PLC shall also be programmed for sensing of failure of power supply to actuating devices like solenoid valves.
2.3.6 The PLC shall also take care of the control & safety of the hydraulic circuit incorporating variable displacement pump, hydraulic motor, proportional cum directional control valve, pressure transmitter, feed back sensor etc.

2.3.7 Explicit logic shall be used for I/O assignments. This means all the operations through push buttons/selector switches shall be independent of high/low states.

2.3.8 Complete ladder logic explanation through data flow diagram for PLC shall be supplied.

2.3.9 Functioning of all interlocks, alarms, trips etc shall be checked & verified through soft simulator.

2.3.10 The bidders shall clearly mention the makes of PLC, software & SCADA system in their quotation.

2.3.11 PLC shall have Ethernet connectivity for remote viewing/diagnosis from main control room.

2.3.12 Test mode for individual actuator without sequential run shall be incorporated in the control system.

2.3.13 The control system shall have provision to identify & indicate the fault in case the machine stops.

2.3.14 In addition to INCH mode, charging & pushing operations shall also be carried out in ONCE mode and Auto mode. Accordingly site systems namely Automated Direct Fuel Transfer System (ADFTS), Automated Charging Facility (ACF) & Indexing Cask shall be interlocked in the cycle.

2.3.15 The design shall include provision to view the fuel movement, fuel transfer, cutting & distribution actions through CCTV systems and these systems shall be remotely replaceable without breaking the seal tightness of in-cell components. The design shall also include provision to view the junction of the cask liner & step in the fuel feed liner of SFC. The CCTV (6 Nos.) cameras need not be radiation resistant.

2.3.16 After cutting of each bundle in auto mode, one dummy cycle consisting of cylinder forward, cylinder return, CTA forward & CTA retract shall be included in PLC programming.

2.3.17 The control panel housing PLC, contactors, MCBs etc shall be of cubicle type, fully compartmental, free standing floor mounted, dust proof construction. It shall have all interconnection links, internal wiring etc suitable for 415V, 3 Phase, 4 wire, 50 Hz system. All the components shall be of Siemens/L&T make.

2.3.18 An emergency stop facility shall be provided on the control console for suspending any abnormal/unintended operation with relevant messages displayed for trouble shooting.

2.3.19 All the power cables shall be 1.1 KV XLPE insulated round wire armored FRLS PVC sheathed type and all the control cables shall be 1.1 KV PVC insulated round wire armored FRLS PVC sheathed type.
2.4 Hydraulic System:
2.4.1 Hydraulic system for pushing, bundle transfer & shearing shall have sufficient design margin to take care of any unforeseen eventuality taking place during operation.
2.4.2 Hydraulic system shall be provided with pressure limits while pushing & chopping.
2.4.3 In addition to limit switches, mechanical stoppers shall be provided to restrict the movement of hydraulic cylinder.
2.4.4 Hydraulic motor with extended Non Drive End (NDE) shaft shall be employed to mount absolute encoder.
2.4.5 Hydraulic control system shall have Proportional Flow cum Directional Control Valve (PCV) in place of simple directional control valve for better control over the flow rate & direction of the oil.
2.4.6 An Electrostatic Oil Cleaner (EOC) of suitable capacity shall be incorporated in the circuit used for cleaning the oil of hydraulic power pack. It shall remove particles of sub-micron (less than 1 micron) sizes only & shall not remove oil additives like antifoaming, anti-wear and antioxidants agents.
2.4.7 The Hoses required at various locations in hydraulic circuit shall confirm to SAE100R13 or equivalent depending on the pressure requirement of the hydraulic circuit. The length of hoses for main cylinder & hydraulic motor shall be approximately 15 m & 25 m respectively.
2.4.8 The fittings (made of SS304/316) employed in the power pack shall be either high pressure double ferrule Parker A- LOK fitting or threaded fitting with nominal pipe threads on both ends & shall be suitable for use at maximum working pressure of the power pack selected for the new machine.
2.4.9 The hydraulic power pack shall be checked for any leakage or design intents by conducting hydro test (at 1.5 times the maximum operating pressure for 10 min) & functional test (at maximum operating pressure).
2.4.10 Provision to set, indicate & record the fuel pushing force, drive torque and cutting forces shall be available. On-line monitoring/ recording of cutting pressure shall be provided with respect to main cylinder movement.
2.4.11 The hydraulic power pack shall have a decompression system to avoid shocks/fatigues.
2.4.12 All hydraulic conduits inside hot cell shall be made of SS304L.
2.4.13 ‘On line diagnostic system’ of reputed make shall be employed to check health of the hydraulic system

2.5 Remote Maintainability:
2.5.1 The machine shall be designed for remote maintenance. Maintenance of all components pertaining to shearing machine inside dissolver cell shall be feasible with the help of 2 Te capacity in-cell crane, Master Save Manipulators (MSMs) with 15 kg payload & bridge mounted Power Manipulator (PM) having 100 kg payload capacity. Special tools to be handled with the crane and manipulators shall be designed & developed to carry out maintenance of the machine. The technical details of existing
tools shall be provided as guidelines for developing these tools required for maintenance.

2.5.2 Sub-systems shall be designed for easy dismantling such that radiation exposure during contact maintenance is kept to a minimum.

2.5.3 The aim of the new machines should be to increase the throughput by reducing the downtime. Modular concept in design should be adopted. Each component of the shear assembly should be available in spare so that if any of the working components goes into breakdown, it should be replaced immediately with the spare one. The components design shall be such that it is easy & quick to replace.

2.5.4 All remote lifting tools & tackles required for assembly / disassembly of Shearing Machine components shall be made separately for each machine & tried out. The technical details of existing tools shall be provided as a guideline for developing these tools.

2.5.5 The components, which will see powder after spent fuel cutting, should have geometrical features to avoid powder accumulation and ease in decontamination.

3.0 LAYOUT

3.1 Civil Layout: The following layout drawings can be referred to in

1. Drg. No.: IP1/102A/08002225/DWG/001/R-0, (Sheet 1 of 2 & 2 of 2)
2. Drg. No.: IP1/102B/08002225/DWG/001/R-0, (Sheet 1 of 2 & 2 of 2)

The above layout drawings will be given to supplier at the time of execution of the job. The main features are given as below.

3.1.1 The inside dimensions of dissolver cell is 19 m long x 19 m wide with 1.5 m thick concrete wall from all four sides. The dissolver cell is designed to house two nos. of Shearing Machines & two nos. of dissolver for each machine. Both machines are isolated from each other by a 1.0 m thick partitioning wall in dissolver cell for independent operation and maintenance.

3.1.2 The charging centerline of the fuel is at an elevation of 6250 mm from the floor of dissolver cell & 1000 mm from the operating sides. Therefore EP for Transfer Port Assembly (TPA) is provided at these locations.

3.1.3 The EP for the shear housing is provided at an elevation of 5600 mm from the floor of dissolver cell. The hydraulic cylinder connection to the shear modules will be through a cut out provided in the dissolver cell wall (operating sides).

3.1.4 EPs for Radiation Shielding Windows (RSWs) & Master Slave Manipulators (MSMs) are provided on the dissolver cell wall (operating sides) at appropriate locations for viewing and carrying out any remote maintenance at the shearing area.

3.1.5 An EP is provided on the cell wall (operating sides) at appropriate locations for pusher hydraulic drive and chain magazine housing locking system.

3.1.6 EPs for an RSW & corresponding MSMs are provided on the dissolver cell wall (operating sides) at appropriate locations for viewing and carrying out any remote assembly/ disassembly of chain magazine housing.

3.1.7 A 2 Te in cell crane & bridge mounted Power Manipulator is provided at elevations 11900 mm & 10200 mm respectively from the floor of the cell.
3.1.8 The roof of the dissolver cell is provided with cell top plugs for installation & maintenance of in-cell equipments.

3.1.9 EP’s are provided in the dissolver cell wall (operating sides) for entry of cables, hydraulic lines, compressed air line etc inside the cell.

3.2 Machine Layout:

The General Arrangement (GA) layout of new machines meant for chopping 37/19 pins spent fuel bundles is attached (Refer Drg. No. IP1/102A/08060000/DWG/002/R0) and shall be considered only as guidelines. The supplier shall prepare exact layout for new machines in line with that of existing 19 pins Shearing Machines and modifications carried out later on to meet our functional & design safety requirements. The basic features of the machine layout which needs to be taken care by the supplier during design of new SFCs are as follows:

3.2.1 The fuel feed channel of the Shearing Machines shall hold 5 nos. of either 37 or 19 pins spent fuel bundles in one batch. The fuel bundles shall be pushed into the shearing unit in a horizontal fashion employing hydraulic motor.

3.2.2 The fuel feed magazine shall be connected to Automated Direct Fuel Transfer System (ADFTS) or Transfer Port Assembly (TPA) at one end from where the fuel is charged into the fuel feed magazine from Fuel Handling Area (FHA).

3.2.3 The other end of fuel feed magazine shall be connected to shearing unit. At the junction of fuel feed unit & shearing unit, there is a bundle stopper assembly which is required to stop the bundle at a fixed position. Movement of bundle stopper pin is in vertical plane & perpendicular to fuel feed direction.

3.2.4 The pusher drive mechanism is in the operating gallery of the dissolver cell & a cut out is provided in the cell wall for shaft to transfer the rotary motion from the hydraulic motor to chain sprocket which results in linear motion of the pusher. The chain magazine above the fuel feed channel houses the push-pull chain.

3.2.5 There is Component Transfer Assembly (CTA) attached to shearing unit & opposite to fuel feed magazine, which receives fuel pushed by bundle pusher & leaves it between the cutting blades of the shearing unit during its return motion.

3.2.6 In the shearing unit, the moving blade motion of shear module is in horizontal fashion & perpendicular to the fuel feed direction inside a shear housing.

3.2.7 The cut pieces of the fuel bundle fall by gravity into a chute, which directs the same into either of the two dissolvers.

3.2.8 The shear module shall be connected to hydraulic cylinder through pusher rod assembly & operated by hydraulic power pack. The pusher rod assembly shall be long enough so that one end of the same is connected to shear module inside the hot cell while other end is connected to hydraulic cylinder in the operating gallery. Hydraulic connections to the cylinder are provided in the operating gallery.

3.2.9 The fuel feed unit and the shearing unit are supported on the sub cell top and the distributor is supported from the floor of the sub cell, which is at an elevation of 5600mm from floor.

3.2.10 The electrical panel, control console/operator’s work station, power pack, pendant etc shall be located in the operating gallery of dissolver cell.
4.0 TECHNICAL SPECIFICATIONS FOR SHEARING MACHINES:

4.1 Introduction:

The Shearing Machine meant for cutting 37/19 pins spent fuel bundles into 11 pieces employing multi blade assembly shall be designed & manufactured in line with that of existing 19 pins Shearing Machines, improvements made on the existing 19 pins machines and other details such as design basis, layout (civil & machine) etc provided in this document. Details of simulated 37 & 19 pins simulated dummy bundles are provided under Para-4.4.

4.2 Design Basis: Refer Para – 2 of this document for design basis for designing the new machines.

4.3 Layout: Refer Para – 3 of this document for civil & machine layout, while designing the new machines.

4.4 Fuel Description:

Description | 19 pins fuel bundle | 37 pins fuel bundle |
---|---|---|
No of pins per bundle | 19 | 37 |
Over all dia | 82.0 ± 0.5 mm | 102.36 ± 0.13 mm |
Over all length | 495.3mm | 495.3mm |
Pin OD | 15-15.2 mm | 13.08 mm |
Pin thickness | 0.38-0.42 mm | 0.38-0.42 mm |
End cap OD | 15-15.2 mm | 13.08 mm |
End cap thickness | 5.33±0.1mm | 5.33±0.1mm |
End Plate OD | 68.2±0.2mm | 90.98±0.2mm |
End Plate thickness | 1.57±0.05 mm | 1.63±0.05 mm |
Bearing pad | 1.3 x 2.5 x 33mm | 1.3 x 2.5 x 33mm |
Spacer pad | 0.9±0.05x 2.5x 8.6 mm | 0.9±0.05x2.5x8.6 mm |

4.5 Machine Description:

The machine mainly comprises of Mechanical System, Hydraulic System and Electrical & Control System. The mechanical system performs the operations of fuel pushing, placing the fuel bundle between shear blades, chopping & diverting the cut pieces to either dissolver limb-1 or 2 with one of the side distributor door in open condition. The hydraulic system facilitates pushing & chopping of fuel bundles employing a common power pack whereas electrical & control system provides electrical power to various actuators and controls the operation of SFC through PLC which receives the signal from field sensors.

4.5.1 Mechanical System: The mechanical system comprises of Fuel Feed System, Fuel Shearing System, Component Transfer Assembly (CTA) & Fuel Distribution System. Details are as follows:
(a) Fuel Feed System:

This system feeds the fuel to the shearing unit. It has following sub assemblies with their design features & functions as mentioned.

- **Fuel Feed Channel** provides an enclosed passage for smooth flow of spent fuel bundles on 125 NB SCH40 semicircular pipe right from Transfer Port Assembly (TPA) to shearing zone inside shear housing. A flange seating is provided for resting the chain magazine housing assembly. A frame with wedges is provided on this to lock the chain magazine inside the cell. Dowel pins are provided on the flange for easy mounting and dismounting of chain magazine housing assembly on this. The fuel feed magazine is mounted on supports/brackets provided on the concrete platform inside cell.

- **Pusher Drive Assembly** consists of hydraulic motor along with its mounting bracket, reduction gearbox with output shaft, set of idle gears & pinions, encoder along with its mounting bracket and wall mounted bracket (to place & fix the hydraulic pusher drive unit). The entire drive assembly remains outside the cell.

  The hydraulic motor is mounted on a bracket and provides the necessary torque required to move the pusher link against the fuel bundles during its forward stroke & brings the pusher back to its home/original position during return stroke. The motor also provides enough torque to overcome the frictional force to move the entire chain length, which is rolling on chain guides on both sides & a pulley at the centre. For this a hydraulic line is tapped from a dedicated power pack to supply requisite hydraulic oil with pressure & connected to two ports of hydraulic motor for its rotation in both directions. Hydraulic motor with gear box mounting bracket & encoder assembly bracket along with their respective spacers are located by dowel pins to ensure their alignment and are mounted on a right angle wall mounted bracket. The motor & gear box are connected to the chain magazine assembly through a wall penetration assembly employing universal joint. RPM from output shaft of gearbox is transferred to a parallel shaft on which an encoder is mounted through a set of idle gears & pinions to measure the linear movement of pusher in terms of number of pulses by an encoder.

- **Chain Magazine Assembly**: The chain magazine assembly comprises of outer casing, bundle pusher, guide rollers, push-pull chain, sprockets, pusher drive shaft and special end link. It is mounted on fuel feed magazine & locked by wedges remotely. Locking is achieved by operating a hand wheel from outside the cell employing wall penetration assembly, universal joint, bevel gear unit, screw drive etc. Presently, the chain magazine assembly houses a complete length of open ended chain (approx 6000 mm long) for controlled movement of the pusher. The chain is connected to the pusher & properly guided by guide rails at Fuel Feed Magazine and Chain Magazine. The design of the chain is such that during backward motion it coils in the chain magazine where as during forward motion it acts like a rod and pushes the pusher. The bundle pusher is driven by hydraulic motor & pushing force is limited by a pressure switch. The charged bundles are pushed against a bundle stopper which becomes the reference position. The...
bundles are then pushed by specific distance such that the first bundle reaches the end of fuel feed channel. Thereafter the pusher pushes the complete bundle into component transfer tube & the cycle follows.

- **Wall Penetration Assembly**: It comprises of two units – one unit is to lock the chain magazine housing assembly against the feed channel body & unlock the same whenever these assemblies are to be dismantled from feed channel body while other unit is to impart motion to pusher link through chain and sprockets from its home position up to completion of stroke towards the shear housing. Both the units consist of outer casing, inner casing & drive arrangement towards cold side. The outer casing is fixed in the cell wall EP by complementary shielding plugs covering the thickness of the cell wall and EP area. The inner casing passes through the outer casing & mainly consists of a shaft mounted on bearings & sealed against any leakage employing O-rings. On cold side, the shaft is connected to hand wheel (in case of chain magazine locking frame) or output shaft of hydraulic motor (in case of pusher drive assembly) while on hot side (cell side), the shaft of each unit is separately extended by addition of universal joint with a bellow for support. The shaft of each unit is pinned to drive shaft of chain magazine assembly & pusher drive shaft.

- **Bundle Stopper**: It provides a stopper in the passage of smooth flow of bundles in the fuel feed channel during forward stroke of pusher & records the position of bundles with respect to home position of pusher through encoder in order to carry out other operations in the given cycle. It consists of a double acting pneumatic cylinder mounted on a mounting block & a bundle stopper rod. The piston rod end is connected to bundle stopper rod. When the cylinder is actuated during forward stroke i.e. stroke down, the stopper rod moves downward & obstructs the fuel movement in the channel. When the required pushing force exceeds the set value, hydraulic motor gets stalled & the bundle stopper is withdrawn to its original place by actuating the cylinder upward.

**(b) Fuel Positioning System i.e. Component Transfer Assembly (CTA):**

Pneumatically actuated cradle moves & places the fuel bundle between shear blades in shear zone for cutting. It comprises of the following:

- **Component Transfer Tube**: Cylindrical tube receives the fuel pushed by the bundle pusher & leaves it between the cutting blades during its return motion.
- **Component Transfer Body**: This houses the component transfer tube & is locked to shear housing by spring loaded pin assembly and locking plate.
- **Support structure**: It supports the complete CTA through a ball transfer unit and facilitates its remote removal & assembly.
- **Pneumatic Cylinder**: It is fitted to the outer tube and provides necessary stroke required for component transfer tube for its forward & return motion.
(c) Fuel Shearing System:

- **Shear housing**: is rigidly mounted on its supporting structure. It houses a shear blade assembly, wedges etc.

- **Shear housing cover**: The shear cover is provided with wing nut assemblies for locking the same with shear housing. It is fitted with pneumatically operated isolating gate to isolate fuel feed magazine from shear zone. The cover is locked remotely prior to chopping using master slave manipulator & in-cell crane.

- **Shear Blade Assembly**: This system accommodates modified C shaped blades (one set fixed & one set moving) to cut one fuel bundle in one stroke and provides around 50 mm long cut pieces. The moving blade assembly is attached to hydraulic cylinder. The unit comprises of the following:

  - **Cutting Tool Holder Plate (stationary)**: This plate is fixed to shear housing cavity by wedges. Five Nos. of cutting blades is held together by two nos. of stripper bolts & is fixed to this plate using specially designed clamps & constitutes the fixed blade assembly.

  - **Cutting Tool Holder Plate (moving)**: Six Nos. of cutting blades is held together by two nos. of stripper bolts & is attached to a plate using specially designed clamps. This tool holder plate is fixed to blade holder plate, which is connected to hydraulic cylinder employing a pusher rod & pusher rod end clamp. The cutting tool holder plate (moving) along with blade holder is guided on three posts with self lubricated bushes.

  - **Tool Supports**: Two nos. of tool supports made out of brass are fitted to end moving blades (i.e. towards fuel feed side & component transfer side) to protect cutting tool from wear & tear.

  - **Post Holder**: This plate is also fixed to shear housing cavity by wedges. The three posts are held together by this plate along with the cutting tool holder (stationary).

  - **Post Retainer**: Six nos. of post retainers are attached to top & bottom posts to prevent them from rotation.

  - **Clamps & Spacers**: Set of fixed & moving blades are clamped to their respective tool holder plates using specially designed clamps while spacers are provided in the slot between two blades on either side i.e. fixed & moving for smooth movement of blades.

(d) Fuel Distributor System:

It directs the flow of cut pieces to any one dissolver. There are two drop doors for closing each dissolver and one isolating door for isolating dissolver from shear. Each door is pneumatically operated. The leak tightness of all three doors shall be ensured up to $10^{-3}$ cc/sec. The distributor unit consists of the following:

- **Distributor Housing**: This houses main isolating door, two side distributor doors & their actuating pneumatic cylinders. The pneumatic cylinders are mounted on to the distributor lid. The distributor housing is mounted rigidly on its supporting structure.

- **Main isolating Door**: It isolates the shear internals from the dissolver while dissolution is in progress thus avoiding ingress of nitric acid fumes. It is operated by pneumatic cylinder, which actuates at about 2.5 - 3 kg/cm². Presently the isolating door open or closed positions are indicated by reed switches only.
- **Side Distributor Doors:** It distributes the chopped fuel pieces either to dissolver-1 or to dissolver-2 by means of doors connected to pneumatic cylinders which opens/closes the chute connected to the dissolvers. The pneumatic cylinder actuates at about 2.5 - 3 kg/cm². Presently the distributor doors open or closed positions are indicated by reed switches only.

- **Distributor Lid/ Cover:** It covers the distributor housing on which, the pneumatic cylinders for both the side distributor doors and the isolating door are mounted along with the limit switch housings. The cover and the distributor body flange are provided with the center pin (dowel pin) for guiding and easy remote mounting and dismounting of the cover on the flange.

### 4.5.2 Hydraulic System:

The system is meant for pushing & chopping spent fuel bundles using High Torque Low Speed (HTLS) hydraulic motor & main hydraulic cylinder respectively. The system consists of power pack capable of providing oil supply for each of the hydraulic loop & hydraulic cylinder for actuating shear blade assembly:

- **Main Cylinder and Piston Arrangement:** This provides the actuation for cutting the fuel bundles. The cylinder piston arrangement is held between the moving blade holder inside the shear cavity and the fixed resistance head outside the shear cavity (which is connected to shear housing body by four columns. The piston connected to the resistance head is the stationary part and cylinder connected to the blade holder through a pusher rod is the moving member. The cylinder is guided by means of linear motion guides during its forward/reverse stroke.

- **Bundle Pusher Hydraulic Motor:** This actuates the bundle pusher for pushing the fuel into shear area. The pushing force is limited by PLC which gets continuous feed from the pressure transducer fitted on to the hydraulic line. The pushing length is sensed by rotary encoder which feeds to PLC.

- **Power Pack:** The unit mainly consists of two hydraulic pumps (variable displacement axial piston pump and gear pump operated by a single motor), oil reservoir assembled/fitted with suction strainer, breather, baffle plates, drain connection, float switch, temperature switch, filters (pressure line/return line/cooling line), valves, gauges, transducers/transmitters, Electrostatic Oil Cleaner (EOC), heat exchanger etc.

### 4.5.3 Electrical & Control System:

The controls of this Shearing Machine shall be based on PLC, which receives the inputs from field sensors (i.e. reed switches, limit switches, pressure transducer, pressure switches etc). The machine shall be operated either in Inching (manual) mode or Once (semi-auto) mode or Continuous (auto) mode. The sequence of operations & safety interlocks shall be provided by the ladder program. Following are the interlocks/conditions required to start the shearing cycle in Once or Continuous mode:

- TPA door is closed.
- There is no high oil temp indication.
- Pusher link assembly at home position.
- Locking frame in locked condition.
- Bundle stopper cylinder stroke down.
• Isolating gate open i.e. cylinder stroke up
• Hydraulic cylinder stroke retracted.
• Full load nut is fixed at a distance slightly more than the required stroke for complete cutting of bundles.
• Component transfer cylinder stroke retracted.
• The shear cover is properly closed and is indicated on the control panel.
• Distributor main door (isolating door) is open i.e. cylinder stroke up.
• Distributor side door (the chosen one out of two doors) is open to a particular dissolver i.e. cylinder stroke up & the other side door cylinder stroke down.

In addition, the following interlocks shall be monitored while the chopping cycle in auto mode or once mode is being executed:

• CTA forward: time-out
• Pusher forward: time-out
• CTA retraction: time-out
• Isolating gate closed: time-out
• Hydraulic cylinder forward: time-out
• Hydraulic cylinder retraction: time-out
• Dummy cycle operations
  - Hydraulic cylinder forward: time-out
  - Hydraulic cylinder retraction: time-out
  - CTA forward: time-out
  - CTA retraction: time-out
• Isolating gate opened: time-out
• Side door-1 preset count reached
• Side door-2 preset count reached
• Reset count

4.5.3.1 Control Panel: The panel is fabricated out of 14 SWG CRCA M.S. sheets. Gland plate is 3 mm thick. It is dust and vermin proof with IP-54 protection class of enclosure. Doors have concealed hinges and interlocks with the incoming switches. Provisions for bottom/ top cable entry are provided. Neoprene rubber gaskets are provided on doors. Adequate provisions are made for mounting of main 3 phase & neutral bus bars and ground bus bars in the electrical panel. Cut outs for exact mounting of push button, selectors switches, meters etc and for cable are provided. Two earth studs with suitable nuts, washers etc. are provided for earth wire termination.

All fabrication work shall undergo seven tank hot process of pretreatment, which are as follows:
1. DEGREASING in alkaline solution to remove oil, deposited dirt and grease.
2. PICKLING in dilute acid at 40° to 50°c for rust and scale removal.
3. PHOSPHTISING in dichromate solution at 70° to 80°c for scale prevention coating.

Intermittent water swiveling & passivation are done in between above processes. Two coats of red oxide/zinc chromate primer with stoving are given. Minimum 2 coats of epoxy powder coating of Siemens grey (RAL 7032) shade is applied by spraying & baking in oven afterwards. Paint thickness is maintained between 70 to 100 microns.
4.5.3.2 Operators Panel: The operator’s panel or work station comprises of display unit & control console kept outside the cell. The following settings are carried out by the operator on the display unit before starting the auto cycles in continuous or once mode:

- Decompression time
- Cycle delay time
- Pusher pressure - upper limit
- Hydraulic cylinder pressure - upper limit
- Bundle length
- Number of bundles
- Pusher retraction pressure
- Bundle charging pressure
- Fixed distance between bundle stopper to end of feed channel i.e. the distance, the bundles to be pushed before start of auto cycle
- Door-1 preset count
- Door-2 preset count

The following information are displayed on the display unit

- Pusher pressure
- Hydraulic cylinder pressure
- Pusher position
- Cycle sequence steps such as
  - Isolating gate up (open)
  - CTA to forward position
  - Pusher movement forward by one bundle length
  - CTA to retracted position
  - Isolating gate down (closed)
  - Hydraulic cylinder forward to shear the bundle
  - Hydraulic cylinder to retracted position.
  - Dummy cycle
- Number of bundles cut from a charge
- Cumulative count through side door-1
- Cumulative count through side door-2

In addition to above, push buttons & indicating lamps along with machine stop button & selector switch are provided on the control console. These push buttons are required to compliance with the interlocks as well as to operate the machine in INCH/ONCE/Auto modes. The following hydraulic/ pneumatic faults are indicated by indicating lamps on the control panel. Alarm text messages are displayed on the display unit.

- Suction valve of main pump closed
- Oil temperature high
- Oil level low
- Oil filter clogged
- Air pressure low.
4.5.3.3 **Electrical Circuit:** Control cable is designated as 1x1Cx1.5 sq mm for internal wiring of panel & console as well as from panel to console. Power cable designated as 1x3Cx35 sq mm is used for wiring from panel to respective loads i.e. motors etc.

4.6 **Drawings:** The machine shall be manufactured in line with the following assembly & part drawings.

4.6.1 **Assembly Drawings:** The supplier shall prepare assembly drawings for various systems/ sub-systems of the new machines in consultation with the purchaser & **got approved by BARC prior to start of manufacturing.** The following assembly drawings of the existing 19 pins Shearing Machines shall be provided to the supplier after placing the order & shall be considered **only as guidelines/reference.**

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4.6.2 Part Drawings: The supplier shall prepare following part drawings for the new machines in consultation with the purchaser & got approved by BARC prior to start of manufacturing:

(a) Fuel Feed System:
- Wall Penetration Assembly (Locking Frame)
- Wall Penetration Assembly (Pusher Drive)
- Hydraulic Pusher Drive & Encoder Assembly
- Locking Frame Assembly
- Chain Magazine Assembly
- Chain Magazine Housing Assembly
- Feed Channel Assembly
- Pusher Link Assembly
- Pusher Stopper Assembly (Forward & Rear)
- Bundle Stopper Assembly

(b) Component Transfer Assembly (CTA)

(c) Fuel Shearing System:
- Shear Housing & Wedge Assembly
- Blade Holder & Stop Assembly
- Pusher Rod & Sleeve Assembly
- Main Cylinder & Support Assembly
- Main Cylinder Limit Switch Assembly
- Piston Extension & Clamp Assembly
- Resistance Head Assembly
- Resistance Head Support Assembly
- Column Tie Rod & Nut Assembly
- Column Supports Assembly
- Bottom Plate & Distributor Chute Assembly
- Leveling Jack Screw
- Shear Blade Assembly
- Shear Cover along with Isolating Gate

(d) Fuel Distributor System:
- Distributor Body Assembly
- Distributor Main Door Assembly
- Distributor Side Door Assembly

(e) Pneumatic Piping Layout

(f) Machine Support & Anchoring

(g) Remote Handling
4.7 **Technical Details:** The technical details of existing 19 pins Shearing Machines shall be provided to the successful bidder for reference & detailing.

4.8 **Remote Operation & Maintenance:**

4.8.1 **Operation:** The Shearing Machine is operated remotely so as to have a minimum radiation exposure to operating personnel. The operation sequence is indicated on the control panel which, help in proper & safe functioning of the machine. The machine can be operated either in Inching (manual) mode or Once (semi-auto) mode or Continuous (auto) mode. In auto or once mode, the machine starts to shear the bundles provided machine ready conditions are fulfilled & ‘Machine Ready’ lamp is glowing. The shearing (chopping) cycle is started either in once or continuous mode after fulfilling the interlocks/conditions as laid out under Para 4.5.3.

Following are the operation sequence to complete a cycle:

- Switch on the control panel – Lamp glows on the panel
- Switch on the operating panel – Lamp glows on the panel
- Unlock the selector switch with appropriate key – selector switch becomes free
- Open the valve for pneumatic line
- Press the push button to start auxiliary motor – corresponding lamp on operating panel glows & motor starts.
- Press the push button to start main motor - corresponding lamp on operating panel glows & motor starts.
- Run the machine & its components in ‘INCH’ mode and ascertain total system response to controls.
- Ensure compliance of control panel lamps with respect to interlocks/conditions and in particular bundle stopper cylinder at stroke down.
- Open Transfer Port Assembly (TPA) door & load 5 bundles into fuel feed magazine through Automated Charging Facility (ACF) till the first bundle presses bundle stopper & stops.
- Close the TPA & confirm that the TPA open alarm is not displayed on operating panel.
- Feed the data in the display panel (kept outside the cell) i.e. number of bundles to be charged, pusher stroke during auto cycle, the distance the bundles to be pushed before start of auto cycle, number of cycles the side distributor door to be changed etc.
- Press the ‘pusher forward’ push button. The pusher starts moving from its home position, slides down the ramp & moves forward horizontally, presses the last bundle, develops the set pressure (sensed through pressure transducer) & stops. Corresponding lamp on operating panel ‘bundles charged’ glows.
- Press the push button of ‘bundle stopper up’ – corresponding lamp glows. This will allow the bundles to travel further towards the shear housing.
- Press the ‘pusher forward’ push button – confirm the lamp ‘bundles at feed channel’ glows & the pusher will be actually pushing the bundles in the feed channel. This will ensure that all the bundles shall complete to a value of constant distance, which is already fed in the PLC controls.
- Take selector switch to either ‘once mode’ or ‘auto mode’ depending on the requirement. If m/c is to be operated on auto mode, then position the selector
switch to auto mode - ‘Machine Ready’ lamp glows. This ensures that the first bundle is ready to enter into the shearing zone.

- Press cycle start button – cycle start lamp glows. Observe / confirm the sequence of operation & interlocks.
- The CTA cylinder makes forward stroke – ‘CTA forward’ lamp glows at the completion of the operation.
- Pusher advances to a distance of approximately one bundle length (already fed into the PLC) – Lamp blinks during operation & becomes steady at the completion of the operation. This will ensure that one bundle is pushed into the component transfer pick up tube.
- CTA cylinder makes return stroke. During this movement, the bundle which is inside the component transfer tube is stopped by a bundle stopper plate within the cutting zone while tube continues to travel back – ‘CTA retracted’ lamp glows at the completion of the operation, which ensures that the full bundle is settled in the well of cutting zone & judiciously centered by bundle stopper plate. Now the bundle is ready for cutting action to take place.
- Isolating gate cylinder at stroke down - corresponding lamp glows.
- Hydraulic cylinder starts moving from its home/initial position towards shear housing to make cutting stroke. During the forward stroke of the cylinder, the bundle gets squeezed & compressed between cutting tools & offers maximum resistance when cutting takes place & gradually reduces by the end of the cutting stroke. During this operation ‘cylinder forward’ lamp glows. The cut pieces fall into the distributor body through bottom chute & get diverted into one of the dissolver by closed side door.
- Hydraulic cylinder starts moving backward from extreme forward position to home position. Stationary & moving cutting blades get away from each other and all trapped pieces fall into respective dissolver. ‘cylinder retracted’ lamp glows at the completion of the operation.
- A dummy cycle comprises of main ‘cylinder forward’, ‘cylinder retract’, ‘CTA forward’ & ‘CTA retract’ is repeated once. Corresponding dummy cycle lamp glows.
- Isolating gate cylinder at stroke up i.e. making the passage clear for pushing next bundle into CTA - corresponding lamp glows.
- Operations ‘CTA forward to isolating gate up’ are repeated for next bundle. After completion of cutting of all 5 bundles, the pusher starts moving backward & reaches its home position where it waits for another set of 5 bundles to be charged into fuel feed magazine.

4.8.2 Maintenance: The Shearing Machine components are categorized into two parts with regard to maintenance i.e. in-cell components & out-cell components.

4.8.2.1 In-Cell Components: Remote handling & contact maintenance are considered for the following in-cell components. The components shall be disassembled remotely from the machine with the help of 2 Te in-cell crane, wall mounted MSM, bridge mounted PM and 10 Te double girder EOT crane. CCTV camera mounted on PM bridge shall assist the viewing of handling operation in addition to Radiation Shielding Window (RSW) mounted on cell wall. The components shall be thoroughly decontaminated by washing/putting in Ultrasonic Cleaning System. Contact maintenance shall be carried out after bringing the activity level down to allowable working level.
• **Chain Magazine Assembly**: The wedges, which are used to lock chain magazine with fuel feed magazine are unlocked by operating the hand wheel from outside the cell. After this, the splined drive shaft of chain sprocket within the chain magazine housing is disengaged from outside the cell using a special tool. The chain magazine assembly becomes free & is removed from the fuel feed magazine employing in-cell crane & specially designed yoke. Reverse operations are carried out for locking the chain magazine with fuel magazine.

• **Component Transfer Assembly (CTA)**: Before venturing into remote handling of CTA, pneumatic cylinder shall be brought to fully retracted condition & all pneumatic and electrical connections are disconnected. After this, the CTA shall be disengaged from the shear housing body & pulled out on its semicircular loading frame. CTA becomes free & is removed from its position with the help of in-cell crane & specially designed tool. Reverse operations are carried out for placing & fixing the CTA with shear housing.

• **Bundle Stopper Assembly**: Pneumatic cylinder shall be brought to fully retracted condition & all pneumatic and electrical connections are disconnected. After this bundle stopper assembly is disengaged from fuel feed magazine with the help of MSM & in-cell crane. Reverse operations are carried out for placing & fixing the bundle stopper assembly with the fuel feed magazine.

• **Shear Module**: Hydraulic cylinder is brought to its fully retracted condition. The shear cover along with pneumatically operated isolating gate is made free after opening all four wing nuts using in-cell crane/MSM. All pneumatic and electrical connections for pneumatic cylinder are disconnected. The shear cover is removed from the shear housing using yoke, in-cell crane & MSM. The wedges, which are used to lock shear module with the shear housing is unlocked by rotating the handle using MSM. The shear module is hooked by a specially designed tool & support plate assembly employing in-cell crane. The shear module is taken out for thorough decontamination & replacement of blades, support tool etc. Reverse operations are carried out for placing & fixing the shear module inside shear housing.

• **Distributor Main & Side Doors**: For their maintenance, the pneumatic cylinders shall be brought to fully extended condition & all pneumatic and electrical connections are disconnected. After this cylinders are decoupled from the lid using MSMs & in-cell crane. The distributor lid is removed & the door is hooked using its respective actuator and slowly taken out with the help of in-cell crane. Reverse these operations for assembling the distributor main door, side door, distributor lid and fitting the pneumatic cylinders along with air connections.

### 4.8.2.2 Out-Cell Components
Normal preventive maintenance is proposed for mechanical, electrical and hydraulic components/equipment outside the cell. Following are major out-cell components, which require preventive maintenance:

- Hydraulic Power Pack (motor, pump, valves, filters etc)
- Main Cylinder & Piston (seals, gaskets, lubrication of LM guide)
- Hydraulic Motor of Pusher Drive System
- Pneumatics & Solenoid Valves
- Electrical Panel, PLC etc.
4.9 **Deficiencies/ Problems Observed with the Existing Shearing Machines:**

Following deficiencies /problems are encountered during regular operation of the existing Shearing Machines:

- Pusher home position shows erratic reading in some cases.
- High & erratic pressure noticed on some occasions during forward & return stroke of pusher.
- Accumulation of cut pieces between cutting tools leading to breakage of the tools.
- Suitable sealing over cylinder connecting rod & pusher rod of shear module to prevent air borne activity in operating gallery.
- Distributor main & side doors get stuck up in few occasions.
5.0 DESIGN and SHOP DRAWINGS:

5.1 The supplier shall study the requirements & prepare all drawings necessary for the manufacture of the machines in line with guidelines provided under Para-2, 3 & 4 of this document.

5.2 All design & shop drawing shall be submitted to BARC for approval and on approval only the manufacturing activities shall start.

5.3 Manufacturing process, material selection, design, tolerances etc required in critical application shall be incorporated in the shop drawings & got approved by BARC.

5.4 BARC shall have access to all shop drawings prepared by the supplier.

5.5 Four sets of finally approved as built drawings (hard & soft copies) for each machine shall be submitted to BARC for their retention & future use. As-built drawings shall accommodate all major & minor changes taking place during fabrication.

5.6 Codes for reference:
   - ASTM C1217 - Standard Guide for design of the equipment for processing nuclear and radioactive material.
   - IS 813/ ASME Sec-IX – Symbols for Welding.
   - IS 919 – Recommendations for limits & fits for engineering
   - IS 2709 - Guide for Selection of fits.

   In case, the supplier is employing any unique code the same shall be indicated along with the corresponding Indian /International code.

6.0 QUALITY ASSURANCE PROGRAM (QAP):

6.1 Component wise detailed QAP indicating activities for each component/sub-assembly/ assembly of each machine shall be submitted to BARC for approval before commencement of procurement of raw material, bought out items etc & manufacturing of the machines. The supplier shall submit FOUR sets of approved copy of QAP to BARC for their retention & future use.

6.2 QA/ inspection shall be carried out by BARC or agencies authorized by BARC as per approved QAP, technical specifications & drawings indicating the scope & extent of QA/inspection.

6.3 Stages of QA shall be decided as per mutually agreed between BARC & the supplier.

6.4 The supplier shall maintain their own QA records for each machine separately & QA agency authorized by BARC shall have access to these documents. Spot checks would be carried out to ascertain the veracity of the internal records and if the deviations are found from the specifications, the component as a whole is liable to rejection. The supplier shall replace the complete lot.
7.0 MATERIALS:

7.1 The material shall be selected depending upon its purpose (for strength), the environment (for corrosion / radiation resistant), fabrication, machining, availability & cost.

7.2 The components to be used inside cell shall have high radiation resistance. Special care shall be taken in case of organic materials (plastomers & elastomers) being used for gaskets, o-rings, flexible tubes etc for pneumatic applications.

7.3 The materials employed within the hot cell may come in contact with the process solution i.e. nitric acid fumes & therefore the material used for components of Shearing Machines shall be of corrosion resistant alloys.

7.4 The material selection shall take care of type of load it experiences for example the cutting blade may experience repeated impact load etc.

7.5 Graphite impregnated phosphor bronze bushes (Oiless bushes) shall be employed for rubbing surfaces wherever applicable.

7.6 Selection of material for the Shearing Machines shall also take care of the decontamination aspect. Water washing / mild acid & alkali washing etc are routine procedure and components exposed to contamination shall be made of Stainless Steel only.

7.7 Suitable filler wires or covered electrodes shall be used for welding of similar/dissimilar materials & shall be indicated in the shop drawings. The welding electrodes are subjected to purchaser’s approval.

7.8 The material codes followed shall be AISI or ASTM. If the supplier uses their own codes in the drawings, the equivalent AISI /ASTM/ IS codes shall also be specified.

7.9 All raw materials employed for the work shall be of prime quality & as per specified codes and standards. Selection of materials for each component shall be based on the stipulations of this document.

7.10 All materials (plates, pipes, tubes, flats etc), which undergo welding shall be of SS304L as per relevant ASTM/ASME standards.

7.11 Codes

- ASTM A 240 : Specification for heat resistant chromium, chromium nickel Stainless Steel Plates, Sheets or Strips
- ASTM A 473 : Specification for Stainless Steel forgings
- ASTM A 962 : Common Requirement of Steel Fasteners
- IS 7291 : High Speed Steel (AISI T1/M2 Grade)/HCHC Die Steel (AISI-D2Grade)
- IS 2062 : Specification for Structural Steel,
7.12 Material Testing:

7.12.1 304L plates shall confirm to acceptance standard as per ASTM A262, Practice-C for Inter Granular Corrosion (IGC) test.

7.12.2 100% ultrasonic examination shall be carried out as per relevant codes for plates, forged steel blocks, rounds & flats in presence of purchaser’s representative & the reports shall be made available.

7.12.3 100% dye penetrant test for defects open to surface shall be carried out in presence of purchaser’s representative & the reports shall be made available.

7.12.4 Finish & surface quality: The plates shall have No.1 finish and shall be hot rolled, solution annealed, de-scaled, pickled and passivated. Plates shall be completely free from defects like roll mark, anneal pits, over pickling etc.

7.12.5 Codes:

- ASTM A 370- Standard test method & definition for mechanical testing of steel products.
- ASTM A262, Practice-C – Inter Granular Corrosion testing.
- NDE as per ASME SEC V
  - ART 1 - General requirement of NDE
  - ART 2 - Radiography Examination (ASTM E 94, IS 2595, IS 1182, IS 3697)
  - ART 5 - Ultrasonic Examination for material.(ASTM A 577, A435, A388)
  - ART 6 - Liquid Penetrant Test (ASTM E 165)

8.0 BOUGHT OUT ITEMS:

The supplier shall prepare comprehensive list of all bought out items required for each machine. The supplier shall also identify the firms & get approval from BARC before going ahead with their procurement. Components shall be of best quality or imported to have long mean time between failures. The details of major bought out components, their tentative quantity & probable supplier are indicated in the attached Annexure-2.

9.0 MANUFACTURING:

9.1 Fabrication:

9.1.1 General:

- Identification & Control of Materials: The fabricator shall maintain a detailed record that lists the description & marking of each piece of material used in fabrication and shall co-relate this information with material test reports. The record shall be incorporated in the fabrication/inspection reports. Material identification chart shall be prepared in detail for ease in tracing the same.
• **Cutting & Forming**: Materials can be cut and formed to the required shape by any process that will not unduly impair the physical properties of the materials. The details of cutting processes shall be approved by the purchaser. Edges which will be exposed in the finished form shall be rounded off to a radius of at least 3 mm or chamfered at 45° to at least 4 mm flat. All the materials shall be grounded smooth. The fabrication tolerances shall be as per latest relevant IS standards.

• **SS Fabrication**: The supplier shall set up an exclusive shop/area for fabrication of stainless steel components within its premises. Care shall be taken to avoid mixing of components or accessories like wire brushes, sand grinders etc for SS and CS.

• **Sub-Contracting**: Sub-contracting the work partly or fully, if any, shall be approved by BARC prior to awarding the contract.

9.1.2 **Welding:**

• The welding methods and welding electrodes used for welding of Carbon Steel (CS) to Carbon Steel (CS), Stainless Steel (SS) to Stainless Steel (SS) and Carbon Steel (CS) to Stainless Steel (SS) as per ASME Boiler & Pressure Vessel Code shall be as detailed below:

<table>
<thead>
<tr>
<th>Materials</th>
<th>Welding Process</th>
<th>Welding Electrodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS to CS</td>
<td>Shielded Metal Arc Welding (SMAW)</td>
<td>AWS - E6013</td>
</tr>
<tr>
<td>SS 304L to SS 304L</td>
<td>Gas Tungsten Arc Welding (GTAW)</td>
<td>AWS - E308L/ER308L</td>
</tr>
<tr>
<td>CS to SS 304L</td>
<td>Gas Tungsten Arc Welding (GTAW)</td>
<td>AWS - ER309L</td>
</tr>
</tbody>
</table>

• **Qualification of Welding Procedures**: Each welding procedure to be used in fabrication shall be qualified by the fabricator in accordance with Section-IX of ASME Boiler and Pressure Vessel Code. A copy of the procedure qualification test report and the welding procedure shall be incorporated in the fabrication report after approval by the purchaser/inspector.

• **Qualification of Welders and Welding Operators**: Performance qualification of welders and welding operators shall confirm to Section-IX of ASME Boiler & Pressure Vessel Code. A copy of performance qualification report for welders and welding operators shall be incorporated into the fabrication record after approval by the purchaser/inspector.

• **Fitting and Alignment**: Edges to be welded shall be uniform and free of all foreign materials. Parts to be welded shall be fitted, aligned and retained in position during the welding operation. Jigs & fixtures, bars, jacks, clamps, tack welds or other appropriate means may be used to hold the edges to be welded in line and to avoid or minimize warping due to welding. Tack welds may be incorporated in the final welding, provided they are free of visible defects.

• **Cleaning of Surfaces to be Welded**: Surfaces to be welded shall be clean and free from foreign materials such as grease, oil, lubricants and marking points, for a distance of at least 25 mm from the welding edge. Detrimental oxides shall be removed from the weld portion area. When the weld material is to be deposited over a previously welded surface, any slag shall be removed.
• **Joints-Alignment Tolerances:** The edges of butt joints, after being welded, shall not have an offset from each other at any point in excess of one-eighth of nominal thickness of the part or 1.5 mm whichever is less.

• **Finished Joints:** Joints shall have complete penetration and shall be free from cracks, undercuts, overlaps, abrupt ridges or valleys. Fillet weld shall have complete fusion at the root of the fillet. To ensure that the weld grooves are completely filled so that the surface of the weld metal at any point does not fall below the surface to the adjoining part, weld metal may be built up as reinforcement on each side of the joint without affecting the integrity of the job. The thickness of this reinforcement shall not exceed the following dimensions:

<table>
<thead>
<tr>
<th>Thickness of the part (mm)</th>
<th>Max. thickness of the reinforcement (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 12 (inclusive)</td>
<td>2.5</td>
</tr>
<tr>
<td>over 12 and up to 25 (inclusive)</td>
<td>3.0</td>
</tr>
<tr>
<td>over 25</td>
<td>5.0</td>
</tr>
</tbody>
</table>

• **Miscellaneous welding requirements:**

(a) The reverse side of double-welded butt joints shall be prepared by chipping or grinding, so as to secure sound metal at the root of the weld before applying filler metal from the reverse side. This requirement is not intended to apply to any process of welding by which proper fusion and penetration are otherwise obtained and by which the base of the weld remains free from impurity.

(b) If the welding is stopped for any reason, extra care should be taken in restarting the process to achieve the required penetration and fusion. For submerged arc welding, chipping out a groove in the crater is recommended.

(c) Where single welded joints are used, particular care should be taken in alignment to ensure complete penetration and fusion at the roof of the weld over its full length.

(d) In case of plug welds, a fillet around the bottom of the hole should be deposited first.

• **Repair of weld Defects:** Visible defects such as cracks, pinholes and incomplete fusion, as well as defects that can only be detected by prescribed examination or tests, shall be removed and the joints re-welded.

• **Post weld Heat Treatment:** Post weld heat treatment is neither required nor prohibited if it does not affect the integrity of the materials used or the job itself. Any post weld heat treatment shall be documented & made a part of the fabrication record.

• **Codes:** ASME SEC II - PART - B

SFA 5.1 - Carbon Steel electrode for shielded arc welding.
SFA 5.9 - Stainless Steel filler wire/rod for GTAW/SAW
SFA 5.22- SS electrode for flux cored arc welding and SS flux cored for GTAW.
Applicable parts of AWS code.
9.2 Machining:

9.2.1 The machining of the components shall be carried out to meet the dimensional tolerances, surface finish or other features required by the shop drawings duly approved by BARC. The machining tolerances shall be as per latest relevant IS standards.

9.2.2 Smooth surface finishes are required. Irregularities that hide & retain radioactive particulates or other adherent contamination must be eliminated.

9.2.3 The supplier shall inform BARC about the kind of machines that are available with them & specify the machines that are going to be used for different machining process such as turning, planning, boring, milling etc.

9.2.4 The supplier shall make use of high precision machines like CNC to achieve close tolerances (0.02 µ) & other geometric features where it is not achievable by conventional machines.

9.2.5 All welds shall be ground finish from inside & ground smooth from outside.

9.2.6 Codes for Reference

- IS 919 – Recommendation for limits and fits for engineering
- IS 2709 – Guide for Selection of fits

9.3 Heat Treatment:

9.3.1 The supplier shall have proper heat treatment facility or hire a quality heat-treating agency approved by BARC. The procedure for heat treatment shall be approved by BARC.

9.3.2 All the forgings procured by the supplier for machining of components shall be heat-treated for removing the residual stresses (i.e. to make uneven stress distribution uniform), improve the strength, grain structure etc.

9.3.3 Components like blades should undergo proper heat treatment to achieve the appropriate hardness.

9.3.4 Heat treatment of shear body after final welding shall be carried out as per procedure approved/mutually agreed by BARC. The shear housing shall be machined from all sides.

9.3.5 Detailed records shall be maintained for each heat treatment carried out.

9.3.6 Codes for Reference:

- ASTM A 240 - Specification for heat resistant chromium , chromium nickel stainless steel Plates, Sheets or Strips
- ASTM A 480 - Specification for general requirement for flat rolled stainless steel Plates, Sheets and strips.
- ASTM A 473 - Specification for Stainless Steel forgings

9.4 Surface Treatment:

9.4.1 Surface treatment procedures such as hard chrome plating, nitriding, anodizing, galvanizing etc. shall be carried out as per procedure approved by BARC.

9.4.2 The supplier shall have proper surface treatment facility or hire a quality surface-treating agency authorized by BARC.
9.4.3 Surface treatment shall be carried out for components wherever good surface hardness is required.

9.4.4 Two components of same base material in contact with relative motion between them calls for surface treatment in one of the components to have difference in hardness to avoid galling.

9.4.5 All SS assembly shall be pickled & passivated after fabrication/ welding as per procedure approved by BARC.

9.4.6 Code for reference:
- ASTM B 177 - Hard Chrome Plating
- ASTM A 380- Pickling and Passivation

9.5 Assembly:
9.5.1 The machined components shall be assembled as per approved assembly drawings. The functionality of the components shall be ensured in assembled condition. Each system in assembled condition shall be checked for their intended purpose at the supplier’s end.

9.5.2 After system check, each system of the machine shall be first assembled at the test set up facility at the supplier’s works, tested fully as per acceptance criteria laid out in this document & then disassembled in major sub-assemblies, which shall be assembled later on at actual site.

9.5.3 The supplier shall develop tools if required for easy and precise assembly of the systems/ sub-systems/ components. The assembly & disassembly of the components at actual site shall be done remotely.

9.6 Painting:
All C.S. materials and structures shall be painted with two coats of epoxy primer & two coats of epoxy gray. Procedure for painting shall be approved by BARC. After installation at site and commissioning, the Shearing Machines shall be finish painted before handing over to BARC.

10.0 INSPECTION:
10.1 Stage wise & final inspection shall be carried out by BARC or QA agencies approved by BARC. The supplier shall have adequate inspection instruments such as surface plate, surface roughness meter, height gauge, inside/outside calipers, digital vernier etc.

10.2 Internal QA of the supplier shall carry out the works as per agreed procedure & keep the records of all internal/external inspection connected with each machine separately and this shall be accessible to BARC QA at any point of time. QA agency of BARC shall carry out spot checks to verify records & if found unacceptable the complete lot is liable for rejection.

10.3 Access for Inspection: The inspector shall be permitted free access, at all times while work on the fabrication is being performed at all parts of the fabricator’s shop. The fabricator shall keep the inspector informed regarding progress of the work & shall notify him reasonably in advance for any required tests or inspections.
10.4 **Inspection of Material:** The inspector shall assure himself that all materials used for the manufacturing of Shearing Machines comply with the specifications as per relevant codes & is properly marked and correlated with the test reports. The fabricator shall make available all test certificates/ reports of the material to the inspector for verification prior to use. A copy of all material test certificates / reports shall be incorporated into the fabrication record. If there is a question regarding the identity or genuineness of the material, the fabricator shall perform chemical analysis and mechanical tests to verify that the material complies with the applicable specifications. Reports of such tests shall be reviewed by the inspector and if approved, such reports shall be placed in the fabrication record. All materials to be used in fabrication shall be inspected for the purpose of detecting, as far as possible, defects that would affect the adequacy of the fabrication. Particular attention should be given to cut edges and other parts of rolled plate that would disclose the existence of serious laminations, shearing cracks & other objectionable defects. The inspector shall assure himself that the thickness and other dimensions of the materials comply with those specified on the design drawings.

10.5 **Inspection of Materials during Fabrication:** As fabrication progresses, the edges of plates, openings & fittings shall be examined to detect defects as well as to determine that the work has been properly done.

10.6 **Dimensional Inspection:** The inspector shall satisfy himself that the components conform to the prescribed shape & meet thickness requirements after forming. The inspector shall assure himself regarding proper fit, curvature of the surfaces, appurtenances to be attached to curved surfaces. During & after fabrication, such dimensional inspection shall be performed to ensure that the completed fabrication conforms to the design drawings and that mechanical parts can be physically assembled. Any critical feature requiring special inspection, such as the flatness of the surface finish of gasket seats, shall be specifically indicated on the shop drawings. Dimensional inspection reports of all such features shall be incorporated into the record.

10.7 **Weld Inspection:** The inspector shall assure himself that the welding procedures employed in the fabrication have been qualified under the provisions of these criteria. The inspector shall assure himself that only welders & welding procedures that are qualified under the provisions of these criteria are being used to fabricate the weldment. The inspector shall have the right, at any time, to call for & to witness tests of the welding procedure or tests to determine the ability of any welder or welding operator. All welds, including the heat affected zone, shall be inspected at least twice with liquid penetrant, using procedure A-2 or B-3 of ASTM E 165, first on completion of the root pass, after preparing the second side of the weld made from two sides (if appropriate) and second, after completing the weld. Finished welds shall be inspected on both the surfaces after heat treatment and/or any machining. Cracks, in line porosity or other linear defects should be removed down to sound metal & then repaired. Adequate penetrant inspection will, in most cases, require some grinding of the welds.

10.8 All butt welds shall be radiographed as per relevant ASME codes & procedure approved by BARC.
10.9 **Inspection during Fabrication:** The inspector shall inspect each component, at various stages of fabrication as he deems necessary, to assure himself that the fabrication is in accordance with the design drawings. Interior surfaces of enclosed chambers shall be examined as completely as possible before final closure is made.

10.10 **Inspection of Machined Components:** The inspector shall inspect the machined components for the designed dimensions, tolerance & various geometrical features indicated in the shop drawings.

### 11.0 TEST SETUP & PRE DISPATCH DEMONSTRATION:

#### 11.1 Test Set Up:

11.1.1 A test setup should be established at the supplier’s works to carry out the assembly and testing of each Shearing Machine. A separate area shall be exclusively earmarked for assembly and testing of all components.

11.1.2 The floor shall be cemented to prevent any contact with muddy surface. The area shall be enclosed to prevent dust collection & shall be accessible by crane for material handling.

11.1.3 The minimum area for Test Setup should be 10 m x 7 m, which would accommodate full machine (comprises of fuel feed unit, component transfer assembly, shearing unit, distribution unit & hydraulic cylinder), pusher drive mechanism, power pack for hydraulic cylinder, electrical panel & work station. The proper structural support shall be made to carry out testing of the machine.

11.1.4 Provision should be made for personnel accessibility at the earmarked area of machine.

11.1.5 The area should have pneumatic supply for operation & testing of pneumatic cylinders.

11.1.6 Electrical supply of 440V, 3 phases & 220V single phase should be made available for testing of the machine.

11.1.7 The area shall have suitable material handling facility.

#### 11.2 Pre Dispatch Demonstration & Acceptance Criteria:

The supplier shall satisfy BARC regarding all functional & operational / maintenance requirements of each Shearing Machine at the Test Set Up. The machines shall be dispatched to site only on obtaining the written approval from BARC after Pre Dispatch Inspection is carried out. Following operations shall be carried out at the supplier’s works as well as at actual site. Various parameters to be recorded during testing of each machine shall be decided as per mutually agreed between BARC & the supplier.

**11.2.1 Testing Before Despatch:**

- Component level testing of each machine.
- Sub-system level testing of each machine.
- System Acceptance Test (SAT) for each machine
- Factory Acceptance Test (FAT) for control & instrumentation system shall be carried out for each machine.
• All interlocks & components functioning shall be ascertained in both auto and manual mode of operation of each machine for repeatability of 50 times to check the reliability of mechanical and electrical components with CCTV in circuit.

• Functional trials of each machine.

• Idle run: Each Machine shall be operated in dummy cycle (without any fuel) in auto mode for at least 16 hours a day for 15 days to ascertain the reliability of all components for prolonged operations.

• Cutting trials: Each machine shall be rigorously subjected to cutting trials with about 500 simulated dummy bundles (made of SS tubes filled with white cement, whytheat i.e. alumina & steatite pellets). The simulated dummy bundles required for testing will be provided by BARC as Free Issue Material (FIM). The cut pieces shall be returned back to BARC.

• Remote replacement verification: Modules/components to be employed inside cell shall be checked for their remote assembly/disassembly with each machine.

• The machines shall be accepted provided it performs to the satisfaction of BARC during the above mentioned tests & also meets all QA requirements mentioned in this document elsewhere.

11.2.2 Testing at Site After Despatch:

• Testing Facility: First Shearing Machine shall be installed at Component Testing Facility (CTF) at Tarapur site & tested for 6 months continuously with/without simulated dummy bundles. Cutting trials on 2000 simulated dummy bundles shall be carried out during this period. If at any time during trials & testing at CTF, problem arises in the machine performance, the same shall be rectified or replaced by the supplier without any extra cost. These rectifications/modifications/improvements shall be incorporated in the remaining two machines.

• Actual Site: Installation of balance 2 machines at actual site and functional trials of the same.

• All interlocks & components functioning shall be ascertained in both auto and manual mode of operation of each machine for repeatability of 50 times to check the reliability of mechanical and electrical components with CCTV in circuit.

• Idle run: Each Machine shall be operated in dummy cycle (without any fuel) in auto mode for at least 16 hours a day for 15 days to ascertain the reliability of all components for prolonged operations.

• Cutting trials: Each machine shall be subjected to cutting trials with about 500 simulated dummy bundles (made of SS tubes filled with white cement, whytheat i.e. alumina & steatite pellets). The simulated dummy bundles required for testing will be supplied by BARC.

• Remote replacement verification: Modules/components of each machine to be employed inside cell shall be checked for their remote assembly/disassembly.

11.2.3 If at any time during testing at actual site & within one year of its regular operation in the plant, problem arises in the machine performance, the same shall be rectified or replaced by the supplier without any extra cost.
12.0 DOCUMENTATION:

12.1 Design Report & Drawing:

12.1.1 One set of approved design report giving the design criteria, features, design calculations considering load & sizing of the components & all relevant design data concerning each component of the machine shall be furnished. The design shall be reviewed by BARC & if required changes shall be incorporated.

12.1.2 FOUR sets of finally approved as built drawings (assembly & part drawings) in blue print as well as in electronic form (soft copy) shall be submitted to BARC along with each machine.

12.2 Quality Assurance (QA) Document:

The QA document for each machine shall be generated, maintained & submitted separately. FOUR sets of finally approved QA document for each machine shall be submitted to BARC for their retention & future use. The final QA document shall have the minimum details as per attached sample sheet (Annexure-1) & shall contain necessarily all the QA reports approved by BARC QA agency during course of execution of the work. All internal inspection reports including material test certificates & dimensional reports for each item as indicated below shall be attached in the final QA document. Relevant internal QA document of the supplier in special cases shall be included, if found necessary. The following shall be made a part of the QA document.

12.2.1 Material Test Report:

- Material test certificates for mechanical properties & chemical composition including hardness of the raw material of the original manufacturer /tests carried out at approved lab shall be furnished by the supplier and approved by BARC.
- Material identification chart showing Item No./Part No., Description of Material, Heat No., T.C. No.1/T.C. No.2, remark etc shall be maintained, certified & included in the final QA document.
- Heat treatment chart shall also be provided, if product is subjected to heat treatment at any stage of manufacturing.
- Test certificates & design data including catalogues shall be submitted for all bought out components.

12.2.2 Fabrication Record:

- A material record shall be kept & shall specify the following:
  
  (a) Product form & heat number, if any.
  (b) Correlation of part & test report.
  (c) Component name & its parts number as per the relevant design drawings.

Marked drawings or unnoted bills of materials may be necessary to satisfy this requirement.
- Material test report for each of the material or other evidence of acceptability, shall be incorporated into the fabrication record after the material has been accepted.
• Welding procedure, procedure qualification, welder performance records and jigs & fixtures.
• Reports of all inspections and tests, including penetrant examinations, dimensional inspections and pressure & leak tests shall be prepared in detail that compliance with these criteria is clearly demonstrated. The radiographic inspection reports shall be made a part of the fabrication record.
• Reports of any required check analysis shall be clearly identified with the material they represent.
• Any other relevant fabrication reports. Any deviations from the Tender Specification shall be reported in detail in the fabrication record.
• If for any reason, the fabrication process deviates significantly from the design drawings which either do not present a clear and correct description of the machine/equipment or do not show proper sizes of the materials and location & geometric of welds, the fabricator shall prepare as-built drawings to accomplish this purpose. As-built drawings shall be verified & certified by the inspector. The fabrication record shall be complied by the fabricator and shall be kept ready at all times. The inspector shall have access to the fabricator record and at regular intervals, shall assure himself that it is complete and correct. The fabricator shall promptly rectify any deficiencies found. On completion of the fabrication, the fabrication record shall be reviewed by the manufacturer and by the inspector, each of whom shall certify in writing, that the record is correct & complete and that the fabrication is (with noted exceptions) in complete conformity with the contract. The fabrication record shall then be submitted to the purchaser.

12.2.3 Dimensional Inspection Record:
• The supplier shall furnish as built dimension of the critical components such as shear housing, shear module etc, which needs frequent replacement for future use.
• The supplier shall submit the dimensional inspection records showing finally achieved dimensions of components & assemblies against the designed dimensions. The record shall also mention all geometrical features & tolerances of the components what was finally achieved.

12.2.4 Heat / Surface Treatment Record:
• The supplier shall submit the heat treatment /surface treatment records mentioning the procedure adopted & codes followed along with test reports to ascertain the property changes achieved during the treatment.

12.2.5 Machine Functional Test Report:
• The supplier shall submit a report showing all necessary parameters recorded during functioning of the machine at its designed capacity. The report shall have all the relevant data from the pre dispatch test, which shall be compared with the testing carried out during commissioning at site.

12.3 Operation & Maintenance (O&M) Manual:
The supplier shall submit FOUR bound copies of following O&M manual for each machine:
12.3.1 **O&M Manual for Mechanical System:** The manual shall include the following.

- Description along with drawings/sketches of parts/components & the type of periodic maintenance these components should undergo for their long life.
- Sequence & method for remote assembly and disassembly of components/sub-assemblies.
- Probable/foreseeable type of failures & their remedies.
- Catalogues of bought out components, if any.

12.3.2 **O&M Manual for Hydraulic System:** The manual shall include the following.

- Description along with drawings/sketches of parts/components employed in the hydraulic power pack & the type of periodic maintenance these components should undergo for their long life.
- Probable/foreseeable type of failures & their remedies.
- Catalogues of bought out components, if any.

12.3.3 **O&M Manual for Electrical & Control System:** The manual shall include the following.

- Description of parts/components employed in the control panel & operator’s work station & the type of periodic maintenance these components should undergo for their long life.
- Block diagram & ladder diagram mentioning the sequence of operation in auto as well as manual mode employing PLC.
- Preset values of the Programme.
- List of interlocks
- Probable/foreseeable type of failures & their remedies.
- Catalogues of bought out components, if any.

13.0 **SPARES:** The following shall be supplied as a spare **common for all three machines** to meet contingency requirements:

- **Push-Pull Chain** : One complete pushing length
- **Sprockets** : 01 set compatible with above chain
- **Pusher Link Assembly (assembly of pusher link & pad only)** : 01 Set
- **Main Hydraulic Cylinder along with Limit Switch Assembly** : 01 Set
- **Shear Housing** : 01 No.
- **Shear Module along with Wedges** : 01 Set
- **Component Transfer Assembly (CTA)** : 01 No.
- **Hydraulic Motor (with extended non-drive end shaft)** : 01 No.
- **Hoses for Main Cylinder & Hyd. Motor** : 01 Set
- **Strainers, Pressure-Line Filters, Cooling Line Filters & Return-Line Filters** : 02 Nos. for each item
- **Pressure Gauge for Main Hydraulic Cylinder & Hydraulic Motor** : 02 Nos. for each item
- **Pressure Transmitter (PT)** : 01 No.
- **Differential Pressure Transmitter (DPT)** : 01 No.
14.0 PACKING & TRANSPORTATION:

After carrying out the tests at the supplier’s works as specified in this specification & match markings, the equipment covered in the contract shall be carefully disassembled into major subassemblies, properly packed, suitably crated and protected from damage during transport, transit & storage at site. The packing shall include adequate cushioning, blocking, bracing, anti skidding, hoisting and tie down provisions with the approval of the Purchaser. All machined parts shall be protected with anti rust grease.

The supplier shall be responsible for any damage to the equipments during transport, transit & storage at the site. Any short supply inside the intact package cases shall be supplied by the supplier without any extra cost. All three machines shall be transported to following destination.

Stores Officer,
INRP Stores,
NRB site, Tarapur

Safety of the items being transported shall be the responsibility of the supplier & shall make necessary arrangement to deliver the goods safely to the INRP Stores, Tarapur.

The supplier shall notify the dispatch of the goods well in advance to the above NRB, BARC stores giving all pertinent details of the packing. This is necessary to avoid delays / damages during unloading of the packages and storages at site.

15.0 INSTALLATION AND COMMISSIONING:

15.1 The supplier shall install two Shearing Machines at designated locations in the dissolver cell. For this, 20/5 Te Cell Top crane, compressed air line & electrical power supply will be made available by BARC. All other requirements such as tools & tackles including set of consumables shall be arranged by the supplier.
15.2 Installation and commissioning of the complete equipment at site shall be done as per agreed time schedule between BARC & the supplier and the availability of site for installation. The complete responsibility for installation & commissioning shall rest with the supplier. The supplier shall demonstrate the functioning of the assembly after installation at site to meet the machine acceptance criteria.

16.0 SITE CONSTRAINTS:
16.1 Project Site:
Lots of formalities to be fulfilled before taking up the installation and commissioning work at project site, Tarapur. A separate list of Do’s & Don’ts will be issued by Project Director before commencement of installation and commissioning of the machines.

16.2 Security:
The project is constructed inside fully guarded security system. Any person entering the premises of the project or plant shall adhere to formalities of the security requirements. The project office can be contacted in advance for any clarification before taking up any activity for compliance of the security to avoid any inconvenience & for easy coordination so as to complete the installation and commissioning activities in desired time schedule.

17.0 TRAINING:
The supplier shall provide adequate training to engineers & operators appointed by BARC. The training shall be given at the supplier’s works as well as at site for the following:
- Details of Shearing Machine components.
- Familiarization about various features of the machine.
- Operational sequence & parameter settings.
- Maintenance aspect & trouble shouting.

18.0 DELIVERY SCHEDULE, GUARANTEE & GENERAL INSTRUCTIONS:
18.1 Delivery Period & Delivery Schedule:
All three machines shall be delivered to NRB site, Tarapur within 4 years from the date of placement of purchase order. The supplier shall submit to the purchaser the detailed time schedule covering various aspects involved in the manufacturing & supply of ordered items such as preparation of shop drawings, procurement of raw materials & bought out components, fabrication/machining, parts inspection, assembly, testing and safe delivery in the form of Bar chart or PERT chart. Delivery Period along with delivery schedule for each machine shall be clearly mentioned in the offer.

18.2 Guarantee/Warranty:
18.2.1 The supplier shall guarantee that the goods furnished by him shall be in full accordance with the requirements of the tender technical specifications.
18.2.2 The supplier shall provide the warranty that the goods are new & of high quality and that the goods are free from defects in design, materials or workmanship as applicable. The warranty shall cover for a period of eighteen (18) months from the date of satisfactory handing over the equipments to the purchaser at the site.
18.2.3 If within the expiry of the above stipulated warranty / guarantee period, the subject goods or an part thereof are found defective because of workmanship or materials, the supplier shall at his own expense repair or furnish a new part of proper workmanship & material duly approved by the purchaser. The same shall be installed & tested to the satisfaction of the purchaser. The guarantee period for replaced parts or repair works shall be the same as above.

18.2.4 After the guarantee period, the supplier shall offer a contract covering after sales service & maintenance.

18.3 General Instructions:

18.3.1 The supplier shall submit the detailed techno-commercial offer as per Annexure-3. The commercial offer i.e. cost structure shall be provided in Part-II envelope only. If supplier wants to add any additional information (commercial or technical), the same can be indicated in the appropriate annexure for which additional sheet can be attached. The supplier shall note that the cost figures shall not be revealed anywhere in the tender document.

18.3.2 The supplier shall confirm regarding compliance of the technical specification. Any deviation from tender specification shall be clearly indicated in the offer.

18.3.3 The validity of the offer shall hold good for a period of 120 days.

18.3.4 The purchaser reserves the rights to place the purchase order for full or part quantity of Shearing Machines on any party based on the technical evaluation, vendor evaluation & cost comparison.

18.3.5 Payment terms & conditions: Advance & other payment may be considered as per following terms & conditions:
- 10% of the basic cost of one unit as advance on unconditional acceptance of the purchase order/contract.
- 10% of the basic cost against approval of design, drawings & quality assurance plan (on pro-rata basis).
- 70% of the basic cost with total statutory levies after issue of shipping release.
- Balance 10% of the basic cost along with installation charges after complete installation, testing & commissioning of each machine at site.
- Any delay in agreed milestones will attract penal interest on advance payment as per prevailing rates.

19.0 VENDORS:

The firm shall ensure that they will be able to carry out the assignment either of their own or through their Affiliated Company/Joint Venture/Consortia (all of them shall be registered in India). Participation of the main firm (lead partner) in more than one joint venture/consortium is not permitted. Organizational set up shall be provided (limitations on joint venture/consortia may be stated). However the responsibility of executing the contract lies with the main firm.

Sub-contracting part of the assignment to only those firms who are registered in India is acceptable.

19.1 Vendor Qualification Criteria:

Since this is a multi-disciplinary work, the supplier shall be evaluated for the award of the contract for manufacturing of the Shearing Machines on the following basis:
19.1.1 The firm should have expertise in design, manufacturing & testing of Special Purpose Machines (SPMs) involving 650Te capacity hydraulic press with high precision requirements. The firm should have in-house facilities for precision machining, fabrication work & tool room facilities. The firm should have an experience in fabrication & machining of Stainless Steel (SS) material. Feedback report from users shall be enclosed along with offer for reference.

19.1.2 The firm should have experience /tie-ups with reputed manufacturers for the design & manufacturing of hydraulic power pack to generate a minimum force of 630 Te with test set up.

19.1.3 The firm should have in-house facility for testing of entire machine including power pack.

19.1.4 The firm should have expertise in design, manufacturing, assembly & testing of PLC based control & instrumentation system and their integration with mechanical system.

19.1.5 The firm should have adequate, qualified & experienced staff along with required design codes, software codes & work stations for carrying out design & analysis, 3D modeling and generation of 3D/2D auto-cad drawings/ animation. The firm should have adequate qualified welders, fabricators & machinist.

19.1.6 The firm should have completed at least two similar assignments in critical high technology area i.e. DAE, Defense, Aerospace.

19.1.7 The firm should have Quality Management System confirming to National/ International standards.

19.1.8 The firm should have satisfactorily completed (based on certification of performance by client) similar assignments consisting of the nature of activities as mentioned during last 5 years as follows:
   - Three assignments, each costing not less than ₹18.0 Crore or
   - Two assignments, each costing not less than ₹27.0 Crore or
   - One assignment of value not less than ₹36.0 Crore

19.1.9 The firm should have average annual financial turnover of at least ₹13.5 Crore for similar job contracts during the last three years ending March 31, 2014. The firm should have bank solvency of ₹18.0 Crore.

19.1.10 The firm should not have incurred loss in more than two years during the last five years & financial net worth of the firm should not be negative.

19.1.11 The firm should not be under liquidation, court receivership or similar proceedings. A self certified statement by the firm should be furnished.

19.1.12 The vendors will be evaluated based on points rating criteria as per following table. The decision of BARC will be final.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Criteria</th>
<th>Maximum Marks</th>
<th>Marks Obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Financial Criteria:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a)</td>
<td>Average Annual Turnover (16 Marks)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>Solvency (04 Marks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Experience in Similar Jobs Executed</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Performance of Works (Time Overrun)</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Performance of Works (Quality)</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Personnel &amp; Establishment</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Plant &amp; Equipment</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>
Note: The minimum qualifying points shall be 70% marks (in total) & 60% marks against individual criteria.

19.2 Pre-Bid Meeting:
A pre-bid meeting shall be arranged to explain the entire system in detail & to address the queries of the qualified bidders. Bidders should nominate technical representative for the meeting.

19.3. Documents Required from the Bidders: The firm should submit the following documents as documentary proof for meeting the above requirements:

19.3.1 List of similar jobs/orders i.e. design, manufacturing & testing of Special Purpose Machines (SPMs) involving 650Te capacity hydraulic press with high precision requirements executed for government & private organizations as per Annexure-4.

19.3.2 Financial turnover statement for the last three years ending March 31, 2014 (refer Annexure-5).

19.3.3 List of qualified & experienced key personnel as per Annexure-6.

19.3.4 The profile of the organization with the organization chart & the total technical/non-technical staff as per Annexure-7.

19.3.5 List of machining/fabrication facilities, installation/erection capabilities, quality control/testing facilities as per Annexure-8.

19.3.6 List of qualified welders, fabricators, machinist as per Annexure-9.

19.3.7 List of engineer/staff proposed for this work as per Annexure-10.

19.3.8 List of jobs to be outsourced as per Annexure-11.

19.3.9 National / International standard for Quality Management System.

19.3.10 Audited balance sheet and profit & loss a/c for the last five years.

19.3.11 Statement showing the net worth of the firm.

19.3.12 Declaration or self certified statement that the firm is not under liquidation, court receivership or similar proceedings.

19.3.13 Two performance certificates from the users/clients for similar jobs executed.

19.3.14 Agreements/MoU for similar jobs (if any).

19.3.15 The Time Over-Run (TOR) for similar works will be calculated as per following table:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Parameters</th>
<th>Score, if TOR = Max Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Without levy of compensation</td>
<td>20.00 13.34 6.67 0.00</td>
</tr>
<tr>
<td>2.</td>
<td>With levy of compensation</td>
<td>13.34 6.67 0.00 -6.67</td>
</tr>
<tr>
<td>3.</td>
<td>Levy of compensation not decided</td>
<td>13.34 6.67 0.00 0.00</td>
</tr>
</tbody>
</table>

TOR = AT/ST, where AT: Actual Time; ST: Stipulated Time
Marks for value in between the stage indicated above are to be determined by straight line variation basis.

Notes: 1. The bidders/suppliers shall indicate the above information (agreements with other firms) clearly in their quotation.
2. No part bid for part supply will be accepted.
3. BARC reserves the right to split the requirements into two purchase orders to different vendors.
ANNEXURE-1
(Sample Sheet)

Final QA document shall have the following minimum details.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CERTIFICATE OF WARRANTY</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>PURCHASE ORDER COPY</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>MATERIAL IDENTIFICATION CHART</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RAW MATERIAL TEST CERTIFICATES</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>ULTRASONIC REPORTS FOR RAW MATERIAL</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>HEAT TREATMENT CHART</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>LIQUID PENETRANT EXAMINATION (LPE) REPORTS</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>RADIOGRAPHIC TEST REPORTS</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>PNEUMATIC TEST REPORTS</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>DIMENSION INSPECTION REPORTS</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>FINAL INSPECTION REPORTS</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>TRIAL TEST REPORTS</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>AS BUILT DRAWINGS</td>
<td></td>
</tr>
</tbody>
</table>
### ANNEXURE-2

**Major Bought Out Components per Shearing Machine**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty per Shearing Machine</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>A. Mechanical System:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Push-Pull Chain along with set of Sprockets</td>
<td>Push-Pull Chain: 3.5 m</td>
<td>M/s Serapid, France/Equivalent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sprocket: 4 Nos.</td>
<td></td>
</tr>
<tr>
<td>2.0</td>
<td>Coupling</td>
<td>As per approved drgs.</td>
<td>M/s Lovejoy/ Equivalent</td>
</tr>
<tr>
<td>3.0</td>
<td>Bushes (Self Lubricating)</td>
<td>As per approved drgs.</td>
<td>M/s Oiless, Japan/Eqvt.</td>
</tr>
<tr>
<td>4.0</td>
<td>Seals &amp; Gaskets</td>
<td>As per approved drgs.</td>
<td>M/s Busak Shamban Parker/Hallite/Economos</td>
</tr>
<tr>
<td>5.0</td>
<td>Fasteners, E-bolts etc</td>
<td>As per approved drgs.</td>
<td>M/s Unbrako/ Equivalent</td>
</tr>
<tr>
<td>6.0</td>
<td>LM Guide for Hydraulic Cylinder</td>
<td>As per approved drgs.</td>
<td>M/s THK/ Equivalent</td>
</tr>
<tr>
<td>7.0</td>
<td>20 mm thick Poly-Carbonate sheet</td>
<td>As per shear cover design</td>
<td>M/s DOW Chemicals / Equivalent</td>
</tr>
<tr>
<td></td>
<td><strong>B. Electrical &amp; Control System:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>Electric Motors for Hydraulic Power Pack (HPP)</td>
<td>02 Nos.</td>
<td>M/s ABB/ Siemens/GEC</td>
</tr>
<tr>
<td>2.0</td>
<td>PLC – Hot Redundant</td>
<td>01 No.</td>
<td>M/s Siemens/Schneider/ABB</td>
</tr>
<tr>
<td>3.0</td>
<td>PLC Programming – Licensed version of PLC</td>
<td>01 No.</td>
<td>M/s Siemens/Schneider/ABB</td>
</tr>
<tr>
<td></td>
<td>programming software with simulator features</td>
<td><em>(for all machines)</em></td>
<td></td>
</tr>
<tr>
<td>4.0</td>
<td>SCADA – Licensed version with unlimited tags &amp;</td>
<td>01 No.</td>
<td>M/s Wonderware/ Citect Wincc</td>
</tr>
<tr>
<td></td>
<td>reporting features</td>
<td><em>(for all machines)</em></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>PC with latest configuration and 19” LCD Monitor</td>
<td>01 No.</td>
<td>M/s HP/ IBM/ Zenith</td>
</tr>
<tr>
<td></td>
<td>and 19” LCD Monitor loaded with Licensed Windows</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.0</td>
<td>Laptop with latest configuration and 15” LCD</td>
<td>01 No.</td>
<td>M/s HP/Dell</td>
</tr>
<tr>
<td></td>
<td>Monitor loaded with Licensed Windows Professional</td>
<td><em>(for all machines)</em></td>
<td></td>
</tr>
<tr>
<td>7.0</td>
<td>PLC Panel &amp; Electrical Panel</td>
<td>01 No. each</td>
<td>M/s Rittal/ Equivalent</td>
</tr>
<tr>
<td>8.0</td>
<td>10” HMI Panel</td>
<td>01 No.</td>
<td>M/s Siemens/ Equivalent</td>
</tr>
<tr>
<td>9.0</td>
<td>12” Video Graphic Recorder</td>
<td>01 No.</td>
<td>M/s Yokogawa/Eurotherm</td>
</tr>
<tr>
<td>10.0</td>
<td>4-20 mA Signal Distributor</td>
<td>07 Nos.</td>
<td>M/s P&amp;F/Telemecanique</td>
</tr>
<tr>
<td>11.0</td>
<td>Absolute Encoder for Hydraulic Motor</td>
<td>01 No.</td>
<td>M/s P &amp; F / Hangstler / Jayshree</td>
</tr>
<tr>
<td>12.0</td>
<td>Optical Sensors (Optional)</td>
<td>03 Nos.</td>
<td>M/s P&amp;F/Telemecanique/Teknik</td>
</tr>
<tr>
<td>13.0</td>
<td>Electrical Quick Connectors</td>
<td>01 Set</td>
<td>M/s Lemo/ Equivalent</td>
</tr>
<tr>
<td>14.0</td>
<td>Limit Switches</td>
<td>06 Nos.</td>
<td>M/s Telemechanique/P&amp;F/Teknik</td>
</tr>
<tr>
<td>15.0</td>
<td>Reed Switches for Pneumatic Cylinders</td>
<td>24 Nos.</td>
<td>M/s Telemechanique/ P&amp;F/ Teknik / KITA</td>
</tr>
<tr>
<td>16.0</td>
<td>CCTV Cameras</td>
<td>06 Nos.</td>
<td>M/s Bosch/ Honeywell</td>
</tr>
<tr>
<td>17.0</td>
<td>Video Switcher</td>
<td>02 Nos.</td>
<td>M/s ATEN / KVM</td>
</tr>
<tr>
<td>18.0</td>
<td>Display Unit for Cameras (15” LCD Monitor)</td>
<td>02 Nos.</td>
<td>M/s Philips / LG / Sony</td>
</tr>
</tbody>
</table>
## Technical Specification - Shearing Machine

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty per Shearing Machine</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.0</td>
<td>Managed Ethernet Switch - 24 Ports</td>
<td>01 No.</td>
<td>M/s D-Link/3-COM/NORTELL</td>
</tr>
<tr>
<td>20.0</td>
<td>Contactors</td>
<td>As per approved electrical circuit layout</td>
<td>M/s Siemens/Telemecanique</td>
</tr>
<tr>
<td>21.0</td>
<td>Radiation Resistant (RR) Cable</td>
<td>50 m</td>
<td>M/s Helu/ LAPP</td>
</tr>
</tbody>
</table>

### C. Hydraulic System:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty per Shearing Machine</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Hydraulic Power Pack (HPP) with following components:</td>
<td>01 No.</td>
<td>M/s Bosch-Rexroth/Equivalent</td>
</tr>
<tr>
<td>1.1</td>
<td>Electric Motors</td>
<td>As per details mentioned under Electrical &amp; Control System</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Variable Displacement Pump &amp; Gear Pump</td>
<td>01 No. each</td>
<td>M/s Bosch-Rexroth/Equivalent</td>
</tr>
<tr>
<td>1.3</td>
<td>Hydraulic Motor for Pusher Drive</td>
<td>01 No.</td>
<td>M/s Bosch-Rexroth/Equivalent</td>
</tr>
<tr>
<td>1.4</td>
<td>Proportional cum Directional Control Valve</td>
<td>01 No.</td>
<td>M/s Bosch-Rexroth/ Sauer Danfoss</td>
</tr>
<tr>
<td>1.5</td>
<td>Hoses for Hydraulic Cylinder &amp; Hydraulic Motor</td>
<td>Hydraulic Cyl: 15 m</td>
<td>M/s Markwel/ Gates</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hydraulic Motor: 25 m</td>
<td></td>
</tr>
<tr>
<td>1.6</td>
<td>Piping &amp; Fittings for HPP</td>
<td>As per approved hydraulic circuit layout</td>
<td>M/s Parker/ Equivalent</td>
</tr>
<tr>
<td>1.7</td>
<td>Pressure Gauge</td>
<td>04 Nos.</td>
<td>M/s Fiebig/Heise/ H-Guru</td>
</tr>
<tr>
<td>1.8</td>
<td>Solenoid (3/2 way, 5/2 way) &amp; other Valves</td>
<td>As per approved hydraulic circuit layout</td>
<td>M/s Bosch-Rexroth/ Equivalent</td>
</tr>
<tr>
<td>1.9</td>
<td>Filters, Strainers</td>
<td>As per approved hydraulic circuit layout</td>
<td>M/s Hydac/ Equivalent</td>
</tr>
<tr>
<td>2.0</td>
<td>Instrumentation for HPP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Pressure Transmitters (PT) &amp; Differential Pressure Transmitter (DPT) with accessories (i) 0 - 600 Bar (ii) 0 - 40 Bar</td>
<td>01 No. 01 No.</td>
<td>M/s Yokogawa/Rosemount M/s Yokogawa/Rosemount</td>
</tr>
<tr>
<td>2.2</td>
<td>Level Transmitter (0 – 1000 mm)</td>
<td>01 No.</td>
<td>M/s Yokogawa/ Rosemount</td>
</tr>
<tr>
<td>2.3</td>
<td>Thermocouple, T-Type (0 – 100°C) N-Type (0 – 350°C)</td>
<td>01 No. 03 Nos.</td>
<td>M/s Tempsans / Detrive</td>
</tr>
<tr>
<td>2.4</td>
<td>SS Head Mounted Temperature Transmitter with accessories</td>
<td>04 Nos.</td>
<td>M/s INOR / Yokogawa</td>
</tr>
<tr>
<td>3.0</td>
<td>Electrostatic Oil/Liquid Cleaner</td>
<td>01 No.</td>
<td>M/s Ferrocare/Equivalent</td>
</tr>
<tr>
<td>4.0</td>
<td>Quick Connectors, Fittings &amp; flexible SS Hoses for water application</td>
<td>03 sets</td>
<td>M/s Swagelock/Equivalent</td>
</tr>
</tbody>
</table>

### D. Pneumatic System:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty per Shearing Machine</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Pneumatic Cylinders</td>
<td>06 Nos.</td>
<td>M/s Festo/ Equivalent</td>
</tr>
<tr>
<td>2.0</td>
<td>Quick Connectors, Fittings, Valves &amp; flexible SS Hoses for Pneumatic Cylinders</td>
<td>06 Sets (1 set for each cylinder)</td>
<td>M/s Swagelock/Equivalent</td>
</tr>
<tr>
<td>3.0</td>
<td>Solenoid Valves -3/2way, 5/2 way</td>
<td>As per approved pneumatic circuit layout</td>
<td>M/s Rotex/ Ross Control</td>
</tr>
</tbody>
</table>
## ANNEXURE – 3

### Cost Structure

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty Required</th>
<th>Unit Cost (₹)</th>
<th>Total Cost (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ex-Works Cost of each Machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Shearing Machine in SS construction for cutting 37 &amp; 19 pins fuel bundles</td>
<td>3 Nos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Set of standby modules &amp; spares (as per Para-13 of this specification)</td>
<td>1 Set</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Set of tools &amp; tackles</td>
<td>3 Sets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Set of supports, spacers, weld pads &amp; fasteners</td>
<td>3 Sets</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5</td>
<td>Installation &amp; Commissioning of Shearing Machine at NRB site, Tarapur</td>
<td>3 Nos.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Packing &amp; forwarding charges for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Taxes, duties, octroi charges &amp; transit insurance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Specify the amount of applicable taxes for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Specify the amount of applicable excise duty for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Specify the applicable octroi charges for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Specify the transit insurance charges for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Transportation/freight charges for each machine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Validity period of the offer (Min. 120 days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Delivery period</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Payment terms (Refer Para 18.3.5): agree/disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Guarantee/Warrantee period</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE -4

Proforma for Past Experience of Similar Orders Executed

The following information should be provided in the format given below for each reference assignment for which your firm, either individually as a corporate entity or as one of the major companies within an association has been primarily responsible to render the services.

<table>
<thead>
<tr>
<th>Description of Job:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Schedule Time Period:</td>
<td></td>
</tr>
<tr>
<td>Contract Value (Rs):</td>
<td></td>
</tr>
</tbody>
</table>

| Name of the Client: |  |

| Address of the Client: (with name, telephone & fax no. of contact person) |  |

| Start Date (Month/Year) | Completion Date: (Month/Year) |

Narrative description of the Project with the name of activities carried out by your professional staff under mechanical (machining/fabrication), hydraulics, electrical & control (schematic drawings/diagrams can be attached)

List of design codes & standards used:

Any other relevant information:

**Important Notes:**

- Bidders may use separate sheet for more details.
- Two performance certificates from users/clients for already completed work shall be submitted along with the offer.
### ANNEXURE-5

**Assets & Liabilities of the Firm**

<table>
<thead>
<tr>
<th>Assets &amp; Liabilities (In Rs Crores)</th>
<th>2011-2012</th>
<th>2012-2013</th>
<th>2013-2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Assets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Liabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Liabilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profits Before Taxes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Annual Turnover</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total annual turnover from</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Design</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Manufacturing</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Welding (including material content)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Fabrication (Labour Content)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- In case of a consortium, annual of the LEAD PARTNER only will be considered. Hence bidders shall indicate details of the lead partner only. Bidders shall also indicate details of the consortium partner separately.

- Please enclose audited balance sheet and profit & loss a/c for last five years.
# ANNEXURE-6

## Qualification & Experience of Key Personnel

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Position &amp; total number on companies rolls</th>
<th>Experience</th>
<th>Qualification</th>
<th>Area of Expertise/Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Team Leaders - Nos.</td>
<td>&gt;20 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Project Coordinator (S)/Project Manager - Nos.</td>
<td>&gt;15 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>(a) Sr. Design Engineer (Mech/Hyd./Elec. &amp; Controls) or equivalent - Nos.</td>
<td>&gt;10 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) QA Managers or equivalent - Nos.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Production Engineer or equivalent - Nos.</td>
<td>&gt;5 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Planning Engineers/QA Engineers – Nos.</td>
<td>&gt;4 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Specialist in Assembly &amp; Testing - Nos.</td>
<td>&gt;5 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Support Staff – Nos. (Draftsman/Supervisors/Fabricators/Welders etc)</td>
<td>&gt;4 years</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Any other information</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE-7
Organization & Structure

Please indicate below or attach the organization chart showing the company structure including communication & responsibilities, structure of engineering group, production group, erection group (project group), finance group, QA group, the positions of Directors & relevant key personnel (by name, educational qualification & experience), specially bring out the line of reporting.
ANNEXURE-8

List of Typical Plant & Machinery

A. Machining / Fabrication

Bidder to indicate separate lists of equipment / machinery owned by him and available to him for this project

B. Erection/ installation

Bidder to indicate separate lists of equipment / machinery owned by him and available to him for installation of the machine.

C. Quality Control/ Testing

Bidder to indicate separate lists of equipment / machinery owned by him and available to him for testing of the machine.

Note: Bidder to indicate complete list of equipment for Machining/Fabrication / Erection & Testing required for completing the tendered works.
ANNEXURE-9

List of Machinists, Qualified Welders & Fabricators

(Employed in service since last three years)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name</th>
<th>Age</th>
<th>Qualification</th>
<th>Experience</th>
<th>Nature of Work Handled</th>
<th>Previous Employment</th>
<th>Project Handled</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
<td>(5a)</td>
<td>(5b)</td>
<td>(6)</td>
<td>(7)</td>
</tr>
<tr>
<td>(2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# ANNEXURE-10

List of Engineers/Staff Proposed for this Work

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Number</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Project Coordinator /Project Manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Sr. Design Engineer</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Mechanical</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Hydraulic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Electrical, Instrumentation and Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Planning Engineers or equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>QA Engineers or equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Production Engineer or equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Specialists in Assembly &amp; Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Support/Auxiliary Staff</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(a) Draftsman</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(b) Mechanical Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) E, I &amp; Control Supervisor</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Welder</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(e) Fitter</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(f) Mechanic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(g) Electrician</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(h) Helper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Any other information</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ANNEXURE-11

List of Jobs to be Outsourced

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description of the Job</th>
<th>Sub-Vendor Details</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>