## Annexure I

**Instrumented universal electro-hydraulic sheet metal forming machine**

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<th>S. N.</th>
<th>Detailed Description</th>
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| 1.    | **Instrumented universal electro-hydraulic sheet metal forming machine** with 400 kN drawing force and blank clamping force up to 200 kN or higher as well as a maximum test stroke of 80 mm or higher is required for evaluation of properties of sheet/strip of different materials. The test system should posses the following features:  
  - The machine should have provision for  
    - Erichsen Cupping Test  
    - Deep Drawing Cup Test (first and a redrawing operation)  
    - Earing test  
    - Hole Expansion Tests according to ISO 16630,  
    - Test for determination of Forming Limit Curves (FLC)  
  - Basic features of the machine should have  
    - Electro-hydraulic drive  
    - PLC based control system  
    - Test load/drawing force up to 400 kN  
    - Clamping force up to 200 kN or higher  
    - Accuracy of drawing force as well as clamping force should be as follows  
      (i) At least ±2% from 15 kN to 100 kN  
      (ii) At least ±1% from 100 kN to 200 kN and above  
    - Test stroke in the range of 0 to 80 mm or higher  
    - Maximum drawing speed 1000 mm/min with ±1% accuracy  
    - Provision for sheet/strip dimension  
      - Width: up to 120 mm or more  
      - Thickness: up to 6 mm or more  
      - Diameter of circular sheet: up to 120 mm or more  
  - In order to conduct different tests, following features should be included:  
    - Test piece ejector and hydraulic test head for comfortable opening and closing  
    - All the necessary toolkits as applicable to the integrated system  
    - A suitable water chiller, if required, for the smooth operation of the system satisfying the required outlet temperature and flow rate for water inlet temperature range of 25-45°C. |
- All the measuring transducers and incremental position sensor
- Automatic test sequence and drawing punch stop at pre-defined punch stroke or after specimen failure
- Automatic crack detection and stroke limitation with automatic stop
- Digital display and data acquisition of drawing speed, drawing and sheet holder forces, punch stroke etc.

- Comfortable working height for the operator so that there is no need for any extra platforms
- The system should consist of sheet metal forming test programme user software for controlling, adjusting, documenting and filing of measured/recorded data. The measuring system should be integrated in the machine with analogue and digital inputs and outputs. User friendly data exchange between PC and machine and a software to create and evaluate test sequences for experiments. The scope of supply will include PC, Monitor, CD writer etc. including detailed instruction manual with examples.

- Proper safety provision is required for all the critical components of the system.

The provision should be in place for the operation of the machine independent of software interface.

**Requirements for conducting different tests on strip and sheet metal**

**A. Erichsen Cupping Test**  
(based on ISO 20482)  
- Sheet dimensions:  
  - Width: 55-90 mm; Thickness: 0.2-2 mm  
- It should consist of  
  - o ball punch diameter: 15-20 mm or more  
  - o die and sheet holder ring

**B. Hole/Bore expansion test**  
(based on ISO 16630)  
- It should consist of  
  - o conical drawing punch with cone angle 60°  
  - o drawing punch holder  
  - o sheet holder and  
  - o drawing die  
- Initial bore hole 10 mm  
- Minimum width of sheet metal 70 mm  
- Punching device for pre-punching of metal sheet in the thickness range from 1.5 to 4 mm
**C. Deep drawing Cup Test**
- Drawing quality and ear forming tendency on sheet metal
- Sheet thickness: 0.2 mm - 6 mm
- Blank will be 90 mm diameter consisting of drawing punch of 50 mm diameter with hydraulic ejector
- Drawing dies for sheet thickness of 0.6, 0.8, 1.0, 1.2 and 1.4 mm
- Blanking die rings for blank diameter of 90 mm
- Blanking punch for blank diameter of 90 mm

**D. Test for determination of Forming Limit Curve (FLC)**
(Nakajima Test based on ISO 12004)
- It should consist of a 100 mm diameter drawing punch to determine the local deformation on the surface of the test sample
- A drawing die with one bead
- A clamping die with one bead
- Die and sheet metal holding plate should be provided with a bead for safe clamping
- Sheet thickness range: 0.2-1.5 mm
- Width of the sheet: up to 175 mm or more
- An integrated 3D continuous strain measurement system along with required software for forming limit curve
- Sub size die of 50 or 60 mm diameter

**2. General requirements**

**A. Manuals, calibration certificates and tool kits**
- Manuals (including drawings) for regular operation, maintenance and troubleshooting of the system should be provided (two copies). All documents are to be supplied in English.
- All measuring instruments and sensors should be calibrated. Calibration certificates from authorized calibrating agencies should be included for all measuring instruments e.g. transducers, sensors etc.
A set of necessary toolkits as applicable for routine operations of the system should be provided.

### B. Installation, commissioning and training

- Detailed pre-installation requirements must be furnished along with the offer. The supplier should provide detailed infrastructure requirements including civil, electrical, plumbing, special foundation, environment (Temperature, Vibration, etc), required working space, etc.
- Equipment should be installed and commissioned at CSIR-NML premises.
- On-site training of machine operation, maintenance and software usage must be provided for a minimum 3 persons.
- Movement of consignment to the place of installation and erection of the equipment will be responsibility of the supplier and this should be included within the offer.

### C. Warranty

- 3 years comprehensive warranty to be included for price comparison.
- The warranty should be effective from the date of issue of satisfactory installation and commissioning certificate at the user laboratory/institute.

### D. Other requirements

- Demonstration for each test has to be carried out as per the standard with appropriate samples. Cost of the consumables (including samples) during the training would be the responsibility of the supplier.
- A complete list of essential spares and consumables (e.g. cooling oil, coolant and grease etc) should be provided separately for reference.
- Suppliers should provide necessary documents, e.g. order copies, customer satisfaction reports etc. to support their capability in supplying similar systems to reputed organizations, in the last five years.
- Supplier should provide details on their service and maintenance capabilities in India.