



**INTERNATIONAL ADVANCED RESEARCH CENTRE FOR
POWDER METALLURGY AND NEW MATERIALS (ARCI),
BALAPUR P.O-500005**

EoI Reference No. SC20250158/PO

Date: 16.07.2026

**EXPRESSION OF INTEREST (EoI) FOR THE "PROCUREMENT OF
EQUIPMENT FOR SETTING UP A 2MWh CELL FABRICATION LINE FOR
CYLINDRICAL AND PRISMATIC CELLS: SUPPLY, INSTALLATION,
COMMISSIONING, DEMONSTRATION, TESTING, TRAINING OF 2MWh
CELL FABRICATION LINE AT ARCI, HYDERABAD"**

EoI Documents	:	Documents can be downloaded from www.arci.res.in and www.eprocure.gov.in
Submission of the EoI	:	As per Notice Inviting Tender
Date of Publication of EoI Notice	:	16.07.2026
Last date for clarifications, if any	:	21.07.2026 1700 hrs
Bidders meeting (Technical presentation and demonstration of system capabilities)	:	Will be intimated after evaluation
EoI submission start date and time	:	22.07.2026 at 09.00 Hrs
EoI submission end date and time	:	06.08.2026 15:30 Hrs
Opening of EoI	:	08.08.2026 at 10:00 Hrs



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Table of Contents

Sl. No.	Description	Page No.
1.	Introduction	3
2.	Notice for EOI	4-7
3.	Special Instructions for Online Bid submission	8-10
4.	Technical bid- Terms & Conditions (Part I)	11-13
5.	Process & evaluation of EOI (Part II)	14
6.	Scope of scope (Annexure-I)	17-91
7.	Technical compliance statement (Annexure-II)	92
8.	Declaration of Local Content (Annexure III)	93
9.	Tender Acceptance Letter (Annexure-III)	94-95
10.	Certificate by bidder (Annexure-IV)	96
11.	Certificate of declaration (Annexure-V)	97
12.	Checklist	98-99

Expression of Interest

Introduction:

International Advanced Research Centre for Powder Metallurgy and New Materials (ARCI) is an Autonomous Research and Development Centre of Department of Science and Technology (DST), Government of India with its main campus at Balapur, Hyderabad and with operations in Chennai and Gurugram.

This current document published by ARCI invites Expressions of Interest (EOI) from reputed and eligible vendors for **"PROCUREMENT OF EQUIPMENT FOR SETTING UP A 2MWh CELL FABRICATION LINE FOR CYLINDRICAL AND PRISMATIC CELLS: SUPPLY, INSTALLATION, COMMISSIONING, DEMONSTRATION, TESTING, TRAINING OF 2MWh CELL FABRICATION LINE AT ARCI, HYDERABAD"**.

The main objective of this EOI is to assess and arrive at prospective vendors technical and commercial capabilities in delivering the system before proceeding to the formal Request for Proposal (RFP)/tendering.

This document is to provide information that is required by the potential bidders to understand the scope of supply, evaluation criteria, commercial terms, bid process details, etc thereby participate in the bid process for **"PROCUREMENT OF EQUIPMENT FOR SETTING UP A 2MWh CELL FABRICATION LINE FOR CYLINDRICAL AND PRISMATIC CELLS: SUPPLY, INSTALLATION, COMMISSIONING, DEMONSTRATION, TESTING, TRAINING OF 2MWh CELL FABRICATION LINE AT ARCI, HYDERABAD"**.

Final specifications, Terms and Conditions of the contract shall be made available after going through the responses of the respondents. However, it may please be noted that the decision of Director, ARCI shall be final while addressing the issues raised by respondents, in response to this document.

Invitation for Bids shall be called for after the specifications are finalized by ARCI.

ARCI reserves the right to summarily reject any or all of the offers received in response to this Expression of Interest without assigning any reason thereof.



INTERNATIONAL ADVANCED RESEARCH CENTRE FOR POWDER METALLURGY AND NEW MATERIALS (ARCI), BALAPUR P.O-500005

NOTICE FOR EOI

International Advanced Research Centre for Powder Metallurgy and New Materials (henceforth referred to as ARCI) is an Autonomous Research and Development Centre of Department of Science and Technology (DST), Government of India with main campus at Hyderabad and with operations in Chennai and Gurugram.

Tender Enquiry No: (Case No.) SC20250158/PO Dt: 16.07.2026

Scope of supply: Expression of Interest (EoI) for the procurement of equipment for setting up a 2MWh cell fabrication line for cylindrical and prismatic cells.

You are invited to submit your most competitive online quotation through CPP Portal (Central Public Procurement Portal) website <https://eprocure.gov.in> on or before the prescribed due date. Manual bids shall not be accepted except for the original documents, if any mentioned in this tender.

As per Ministry of Finance, Department of Expenditure Order No. F.No:6/18/2019 PPD Dated 23.07.2020, any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Department of Promotion of Industry and Internal Trade (DPIIT). Format of certificate for the same as given in Annexure VI of the tender document. " Bidder "for the purpose of this order Including the term Tenderer, consultant, vendor or service provider in certain context(s) means any person or firm or company including any member of consortium or joint venture (that is an association of several persons or firms or companies), every artificial juridical person not falling in any of the description of bidders stated here in before, including any agency, branch or office controlled by such person participating in procurement process. Bidder from a country which share a land bordered with India, "For the purpose this order means:

1. An entity incorporated, established or registered in such a country; or
2. A subsidiary of an entity incorporated, established or registered in such a country; or
3. An entity substantially controlled through entities entity incorporated, established or registered in such a country; or
4. An entity whose beneficial owner is situated in such a country; or
5. An Indian (or other) agent of such of an entity; or

6. A natural person who is a citizen of such a country; or
7. A consortium or joint venture where any member of consortium of Joint Venture falls under any the above.

As per Ministry of Finance, Department of Expenditure Order No. F. No:6/18/2019 PPD Dated 23.07.2020, Restrictions under Rule 144(xi) of the General Financial Rules (GFRs) 2017, are applicable in the present case.

(i) Requirement of registration: Any bidder from a country which shares a land border with India will be eligible to bid in any procurement whether of Goods, Services, (including consultancy Services/ Non Consultancy Services) or works (including turnkey projects) only if the bidder is registered with the Competent Authority, specified in Annexure I of the above O.M.

(ii) Validity of registration: In respect of tenders, registration should be valid at the time of submission of bids and at the time of acceptance of bids.

(iii) Revised application format for registration of bidders from countries sharing land border with India from the following link.

<https://dpiit.gov.in/related-links/revised-application-format-registration-bidders-under-rule-144-xi-gfr>

Bidder“ for the purpose of this order Including the term Tenderer, consultant, vendor or service provider in certain context(s) means any person or firm or company including any member of consortium or joint venture (that is an association of several persons or firms or companies), every artificial juridical person not falling in any of the description of bidders stated here in before, including any agency, branch or office controlled by such person participating in procurement process. Bidder from a country which share a land bordered with India, “For the purpose this order means:

1. An entity incorporated, established or registered in such a country; or
2. A subsidiary of an entity incorporated, established or registered in such a country; or
3. An entity substantially controlled through entities entity incorporated, established or registered in such a country; or
4. An entity whose beneficial owner is situated in such a country; or
5. An Indian (or other) agent of such of an entity; or
6. A natural person who is a citizen of such a country; or
7. A consortium or joint venture where any member of consortium of Joint Venture falls under any the above.

- **Item/ Services to be provided to:**

International Advanced Research Centre for Powder Metallurgy and New Materials, Balapur Post, Hyderabad – 500 005, Telangana, India.

Validity of Bid

Quotation should have minimum validity of **120 days** from the date of opening.

Last date for submission: 06.08.2026 before 15:30 Hrs.

The bidders are required to submit soft copies of their bids electronically on the CPP Portal before the last date stated above using valid Digital Signature Certificates.

All the tenders, in which any of the prescribed conditions are not fulfilled or incomplete in any respect are liable to be rejected.

Clarification on bid

Bidders can seek clarification as per the schedule start and end date through email IDs given below:

For Technical clarifications: [**anandan@arci.res.in**](mailto:anandan@arci.res.in)

- "NO REQUEST FOR CLARIFICATION OR QUERY SHALL BE NORMALLY ENTERTAINED AFTER THE CLARIFICATIONS END DATE" Should ARCI deem it necessary to amend the bidding documents as a result of a clarification, it shall do so by hosting the clarifications and amendments on the website of ARCI/CPP Portal only for the benefit of other prospective bidders. Hence, prospective bidders are requested to follow the websites regularly.

Opening of the tender

Only the EoI Technical bid shall be opened online on the date of the tender opening.

Patent Rights:

The Supplier shall indemnify ARCI against all third-party claims of infringement of patent, trademark or industrial design rights, copy rights arising from use of the Goods or any part thereof in India.

Disqualification of tenders:

The tenders are liable for rejection in the following circumstances:

- If they are not in line with the terms and conditions of this tender notice.
- Conditional quotations
- Incomplete/Unsigned tenders.
- Tenders submitted through Fax or e-mail.

Director, ARCI reserves the right to accept or reject any or all tenders either in part or in full or to split the order without assigning any reasons there for.

IMPORTANT NOTE: Amendment, Corrigendum if any to this tender document, WILL BE HOSTED ONLY IN ARCI WEBSITE and CPP Portal and no separate Press Notification will be issued. Bidders are advised to visit our website and CPP Portal regularly to know such details.

Director, ARCI, Hyderabad

SPECIAL INSTRUCTIONS FOR ONLINE BID SUBMISSION:

Instructions to the Bidders to submit the bids online through the Central Public Procurement Portal for e-Procurement are at <https://eprocure.gov.in/eprocure/app>. The bidders must carefully follow the instructions.

- Possession of valid Digital Signature Certificate (DSC) and enrolment/registration of the contractors/bidders on the e-procurement/e-tender portal is a prerequisite for e-tendering.
- Bidder should do the enrolment in the e-Procurement site using the "Click here to Enroll" option available on the home page. Portal enrolment is generally free of charge. During enrolment/registration, the bidders should provide the correct/true information including valid e-mail-id. All the correspondence shall be made directly with the contractors/bidders through e-mail-id provided.
- Bidder need to login to the site through their user ID/ password chosen during enrolment/registration.
- Then the Digital Signature Certificate (Class III Certificates with signing key usage) issued by NIC/SIFY/TCS/nCode/eMudra or any Certifying Authority recognized by CCA India on e-Token / Smart Card, should be registered.
- The DSC that is registered only should be used by the bidder and should ensure safety of the same.
- Contractor / Bidder may go through the tenders published on the site and download the required tender documents/ Annexures for the tenders he/she is interested.
- After downloading / getting the tender document/ Annexures/ Appendices, the Bidder should go through them carefully and then submit the documents as asked, otherwise bid will be rejected.
- If there are any clarifications, this may be obtained online through the tender site, or through the contact details. Bidder should take into account the corrigendum / addendum published before submitting the bids online.
- Bidder then logs in to the site through the secured log in by giving the user id/ password chosen during enrolment/registration and then by giving the password of the e-Token/ Smart Card to access DSC.
- Bidder selects the tender which he/she is interested in by using the search option & then moves it to the 'my tenders' folder.
- From my tender folder, he selects the tender to view all the details indicated.
- It is construed that the bidder has read all the terms and conditions before submitting their offer. Bidder should go through the tender Annexures and appendices carefully and upload the documents as called for; otherwise, the bid will be rejected.
- Bidder, in advance, should get ready the bid documents to be submitted as indicated in the tender document/ Annexure and generally, they can be in

PDF/xls/rar/zip/dwf formats. If there is more than one document, they can be clubbed together and can be provided in the requested format. Each document to be uploaded through online for the tenders should be less than 2 MB. If any document is more than 2MB, it can be reduced through zip/rar and the same can be uploaded, if permitted. Bidders Bid documents may be scanned with 100 dpi with black and white option. However if the file size is less than 1 MB the transaction uploading time will be very fast.

- Bidder should take into account the corrigendum / addendum published from time to time before submitting the online bids.
- The Bidders can update well in advance, the documents such as certificates, annual report details etc., under My Space option and these can be selected as per tender requirements and then send along with bid documents during bid submission. This will facilitate the bid submission process faster by reducing upload time of bids.
- While submitting the bids online, the bidder reads the terms & conditions and accepts the same to proceed further to submit the bid packets.
- The bidder has to digitally sign and upload the required bid documents one by one as indicated. Bidders to note that the very act of using DSC for downloading the bids and uploading their offers shall be deemed to be a confirmation that they have read all sections and pages of the bid document including General conditions of contract without any exception and have understood the entire document and are clear about the requirements of the tender requirements.
- The bidder has to upload the relevant files required as indicated in the covered content. In case of any irrelevant files, the bid will be rejected.
- The bidders are requested to submit the bids through online e-tendering system to the Tender Inviting Authority (TIA) well before the bid submission end date & time (as per Server System Clock). The TIA will not be held responsible for any sort of delay or the difficulties faced during the submission of bids online by the bidders at the eleventh hour.
- After the bid submission (i.e after Clicking "Freeze Bid Submission" in the portal), the acknowledgement number, given by the system should be printed by the bidder and kept as a record of evidence for online submission of bid for the particular tender and will also act as an entry pass to participate in the bid opening date.
- The time settings fixed in the server side & displayed at the top of the tender site, will be valid for all actions of requesting, bid submission, bid opening etc., in the e-tender system. The bidders should follow this time during bid submission.

- All the data being entered by the bidders would be encrypted using PKI encryption techniques to ensure the secrecy of the data. The data entered will not be viewable by unauthorized persons during bid submission & not be viewable by any one until the time of bid opening.
- Any bid document that is uploaded to the server is subjected to symmetric encryption using a system generated symmetric key. Further this key is subjected to asymmetric encryption using buyers/bid openers public keys. Overall, the uploaded tender documents become readable only after the tender opening by the authorized bid openers. The confidentiality of the bids is maintained since the secured Socket Layer 128 bit encryption technology is used. Data storage encryption of sensitive fields is done.
- The bidder should logout of the tendering system using the normal logout option available at the top right hand corner and not by selecting the (X) exit option in the browser.
- For any queries regarding e-tendering process, the bidders are requested to contact as provided in the tender document. For any further queries, the bidders are asked to contact over phone as mentioned in the CPP website or send an email to - [**cphp-nic@nic.in**](mailto:cphp-nic@nic.in).

PART-1
TECHNICAL BID - TERMS AND CONDITIONS

1. Vendor qualification criteria:

- a) Latest release of the model should be quoted.
- b) All items should be with part number and full description.
- c) All the relevant documents should be uploaded at the time of tender.
- d) Requirements: Registered /incorporated companies with valid statutory and regulatory compliances.
- e) Financial Capability.
- f) Average annual turnover during last three financial years.
- g) The firms should have prior experience in the supply, installation, commissioning, and successful operation of a complete cell manufacturing line, covering all essential equipment from slurry mixing through to finished cell assembly similar to that is required for ARCI. They should have supplied and commissioned at least two pilot line with similar features earlier and the supplied machines should be working satisfactorily. The proof of supply and commissioning along with performance certificate of at least two pilot line anywhere in the globe should be provided (The contact details of the machine users should be furnished).
- h) Original Equipment Manufacturer (OEM) or authorized representatives of OEM only can quote for this tender. The vendor should provide an authorization letter valid on the tender date from the OEM along with the quotation.
- i) The vendor should have an adequate qualified man power for designing the system and financial capability.
- j) Should have local service center to respond service calls at short time.
- k) OEM/vendor is required to submit a letter of commitment at the time of quote for supply of spares and also for efficient and prompt after sales service of the equipment for a minimum period of 10 years after the guarantee/warranty period under mutually agreed terms and conditions.
- l) The bidder or bidder's principal shall have experience of having executed at least one purchase order / contract of value 2 million us \$ (or in equivalent other currencies) or above (or) two purchase orders / contracts of value 1 million us \$ (or in equivalent other currencies) or above each of the po consisting lithium ion battery plant within the last 5 financial years (2023-24, 2022-23, 2021-22, 2020-21 & 2019-20) or latest to research institutes like any of the CSIR LABS OR IITS OR NITS OR IISER OR DRDO OR DAE OR IISC OR ISRO OR REPUTED CENTRAL GOVERNMENT OWNED / CENTRAL AUTONOMOUS RESEARCH INSTITUTE, CENTRAL PSUs AND OTHER RESEARCH INSTITUTIONS OF REPUTE IN INDIA OR REPUTED BATTERY MANUFACTURERS IN INDIA OR REPUTED UNIVERSITIES / RESEARCH LABORATORIES / REPUTED BATTERY MANUFACTURERS ABROAD. To

substantiate the above, documentary evidence shall be submitted along with the offer such as necessary technical details, purchase orders, specification and scope of work, INSTALLATION CERTIFICATE and PERFORMANCE CERTIFICATE etc. Offers without the above are liable for rejection.

- m) Bidder should have service centre or authorized service centre with trained service engineers in India. Service centre address, contact person details, phone/fax numbers, email should be provided along with the offer. Proof of service centre is to be attached. Service centre in India is Mandatory for all prospective vendors. Buyers is at liberty to visit, and verify the site to check the infrastructure, the availability of engineers, service set up etc., Any false claim or not being in line with the tender, bid is likely to be rejected.
- n) If requires, ARCIs Techno-Commercial team will visit prospective vendors facility to satisfy themselves about the techno-commercial capability of the vendors.
- o) Bidder must comply with Make in India Order No. No. P-45021/2/2017-PP (BE-II) dated 16th September 2020 of Ministry of Commerce and Industry, Government of India and any amendments thereon. (DOES NOT APPLY TO NON LOCAL SUPPLIER). PRICE PREFERENCE WILL BE GIVEN AS PER THE POICY OF MII TO CLASS I ONLY.
- p) Bidder must be comply with order no.P-45021/112/2020-PP(BE-II)(E-43780) dated 24.08.2020 of Ministry of Commerce and Industry, Department for Promotion of Industry and Internal Trade and any amendments thereon
- q) The offer of the firms not fulfilling the any of the above aspects of vendor qualification criteria will not be considered for further evaluation.

2. Documents to be submitted:

- a) Company profile, incorporation documents, statutory registrations.
- b) Audited financial statements of last three years.
- c) List of major and similar nature of supplies executed.
- d) Technical plus Commercial capability details.

3. Technical compliance statement:

The vendor should provide item wise details against each and every specification. Deviations if any are to be highlighted. Suppliers are required to provide the Technical Compliance Statement as per Annexure while submitting the Technical Bid.

4. General instructions:

- a) The bidder should submit the scanned copy of the Technical Bid for online submission. No brochures/leaflets etc. should be submitted in loose form. Please indicate page nos. on your quotation. The price should not be mentioned anywhere in this document.
- b) Each page of the bid and strikeout/corrections shall be duly signed and stamped by the bidder. Unsigned Tenders are liable to be rejected. Failure to comply with this requirement may result in the bid being rejected.
- c) The purpose of certain specific conditions is to get or procure best product/service etc. for ARCI. The opinion of Technical Committee shall be the guiding factor for technical short listing.

PART - II

PROCESS AND EVALUATION OF EOI TWO STAGE BIDDING PROCEDURE

Stage 1:-

Invitation for Expression of Interest (EoI): This document details the terms and conditions for inviting EoI from eligible bidders. The interested bidders are requested to submit their Expression of Interest as a turnkey solution.

Basic Qualification Criteria: The bidder has to submit their Expression of Interest along with qualification documents as per the basic qualification criteria defined in this document. Qualification criteria submitted by the bidder will be evaluated by the concerned authorities.

Technical Presentation and Demonstration of System Capabilities: The bidders, who are qualified in the basic qualification process, will be invited to deliver a presentation about their experience and proposed solution towards the EoI. During their presentation, bidder should provide enough evidence of their claims and explain the proposed solution in detail. The Concerned Authority will evaluate the bidders' experience, technical presentation of the proposed solution and qualify/disqualify bidders accordingly.

Request for Proposal: The Final RFP with desired solution will be prepared based on the evaluated proposals received from the technically qualified bidders during the stage-1.

Stage 2:-

The **technically qualified bidders** based on stage-1 will be invited for submission of their techno commercial bids for the decided solution (RFP) in 2 bid method.

1. CONTENTS OF THE EOI:

The bidder should submit their expression of interest with following details:

The bidder shall provide the details asked in the Basic Qualification Criteria with supporting documents without which their offers will not be considered for further evaluation. Against each point, the bidder shall mention the compliance statement and relevant page numbers of the documents.

- 1.2 All documents submitted shall be duly signed by the authorized official of the bidder.
- 1.3 List of deliverables shall be submitted along with detailed specifications and time lines for delivery & execution of the contract.

2. GENERAL INSTRUCTIONS

- 2.1 Director, International Advanced Research Centre for Powder Metallurgy and New Materials (Herein after referred to as the Director) will receive bids in respect of the work mentioned in this document. Bids received after the closing date, as indicated in this document are liable to be rejected.
- 2.2 The bid shall be submitted in English language only.

3. CAPACITY OF THE BIDDER

- 3.1 Any person signing the bid shall submit documentary evidence that his/her signature on the bid, submitted by him/her is legally binding upon him/herself, and his/her firm or company, as the case may be.
- 3.2 The bidder shall produce satisfactory proof that they are financially in a position to fulfill the contractual obligations offered to be undertaken by them. The bidder shall indicate the details of their banker.

4 BIDDER TO INFORM HIMSELF/HERSELF FULLY

- 4.1 The bidder is required to carefully examine the documents enclosed and get fully aware himself/herself as to all conditions and matters which may in any way affect the works or the cost thereof, before submitting his offer.
- 4.2 If the bidder finds any discrepancies, omissions, or contradictions in the documents or is in doubt as to the true meaning of any part, he/she shall at once contact in writing for an interpretation/clarification to the Director, ARCI (eMail at: **director@arci.res.in**).
- 4.3 The bidder shall however not be entitled to any extension of time for submission of his/her bid on such account, unless the Director extends the due date.

SCOPE OF SUPPLY

EXPRESSION OF INTEREST (EoI) FOR THE PROCUREMENT OF EQUIPMENT FOR SETTING UP A 2MWh CELL FABRICATION LINE FOR CYLINDRICAL AND PRISMATIC CELLS: SUPPLY, INSTALLATION, COMMISSIONING, DEMONSTRATION, TESTING, TRAINING OF 2MWH CELL FABRICATION LINE AT ARCI, HYDERABAD”

Technical Specifications:

Introduction:

This document outlines the detailed technical specifications and equipment requirements for establishing a 2 MWh-scale rapid prototyping line dedicated to the fabrication of cylindrical, and prismatic Li/Na/Li-S cells. The facility is intended to support R&D, pilot-scale validation, and low-volume production, enabling process optimization, material evaluation, and design iteration.

List of Equipment for 2MWh:

1. Slurry mixer 40 L capacity
2. Electrode coating machine
3. Electrode calendaring machine
4. Electrode slitting machine
5. Roll to roll ultrasonic tab pre-welding machine
6. Electrode winding machine (18650, 21700, 32700) for cylindrical cells
7. flattening machine (for tab-less cylindrical welding)
8. Jelly roll insertion machine and cap welding
9. All-in-one equipment (bottom welding, insulating sheet insertion, short circuit test, grooving, and laser welding (Top cap) for 18650, 21700, 32700 format cylindrical cells.
10. Electrolyte filling machine
11. Roll to sheet electrode cutting
12. Electrode stacking machine
13. Tap to lead Ultrasonic welding machine
14. Laser welding machine for can to lid and filling port closing
15. Normal Vacuum Flat Oven (3-Layer Chamber Type)
16. Normal Vacuum Flat Oven (Single Chamber Type)
17. Accuracy weighing balance
18. Negative Pressure Formation Machine (5 V, 30 A, 64 Channels) for Prismatic Cells
19. Cylindrical Battery Formation Tester (5 V, 15 A, 128 Channels) for Cylindrical Cells
20. Pouch Cell Formation / Aging System (5 V, 15–20A, 64-Channels)
21. DCIR measurement at multiple time during formation
22. Trimming of gas pocket and gas removal.
23. 3-in-1 semiautomatic Pouch Cell Trimming, Folding, and Ironing Semiautomatic Machine

24. Racks for room temperature aging and K Value (self-discharge)

25. Insulation tester for cylindrical and prismatic cell

Technical Specifications of each equipment are given below:

1. Slurry Mixer (40 L Capacity):

1. Application

The slurry mixer shall be used for homogeneous mixing of active material, conductive carbon, and binder to prepare electrode slurries with the required rheological properties for battery electrode fabrication.

2. Type of Operation

Batch-type slurry mixer suitable for Li-ion/Na-ion battery electrode slurry preparation.

3. Capacity

Total vessel volume: 40 L

Effective working volume: Approximately 30 L

4. Mixing Vessel Construction

The mixing vessel assembly shall comprise the following:

Upper and lower vessels made of SS 304

Double-walled vessel with provision for water circulation

Provision for vacuum operation generated in

Number of mixing vessels/Jars: 2 (for cathode and anode)

Design operating temperature: 10°C to +60 °C

5. Mixing Method

Dual-shaft mixing system with planetary mixing and high-shear dispersion with PTFE scrapper

Suitable for preparing slurry with viscosity in the range of 2,000-100,000 cP

6. Mobility and Surface Finish

Equipment shall be mounted on caster alloy wheels for ease of movement

Tungsten carbide coating to be applied to all permissible external surfaces, except the mixing vessel/jar

7. Mixing and Dispersion System – Technical Parameters

Mixing System:

Mixing power: 6-12 kW

Mixing propeller speed: 0–200 rpm or higher

Mixing propeller diameter: 290 ± 5 mm or better

Mixing propeller design: Non-prismatic twist type, 90° spiral

Number of mixing propellers: 2 Nos.

Dispersion System:

Dispersion speed: 0–6000 rpm or higher

Dispersion power: power to be designed as per the dispersion speed

Dispersion disc pattern: Saw-tooth type

Number of dispersion discs: 4 Nos. or more
Dispersion disc material: SS 304
Distance between propellers: 4 ± 1 mm or better
Vacuum Capability
Maximum vacuum level: -0.098 MPa or better

8. Base Frame and Lifting Mechanism

Base material: Carbon steel with high structural rigidity
Lifting mechanism: Electric lifting
Lifting stroke: ≤ 600 mm

9. Wiped-Wall Assembly

Wiped-wall bracket material: SS 304
Wiped-wall blade/plate material: PTFE

10. Feeding and Viewing Ports

Powder feeding port: DN100 quick-open interface with 90° sight glass
Liquid feeding port: ISO standard 1" quick-open connection
Inspection/spot lighting port: DN75 tempered glass sight window
Additional view port and charge port for material/solvent feeding shall be provided

11. Vacuum Integrity

The container shall withstand vacuum of -0.098 MPa continuously for a minimum of one week without leakage or deformation

12. Additional Requirements

- 1) Keep one 5 Litre mixer for CNT and CMC on anode side for binder preparation. Sometime binder need to be prepared in advance before main mixing
- 2) Transfer tank for each main mixer with magnetic and coarse particle filter. Dynamic filtration is necessary to prevent clogging of coarse particle 150 mesh filter.
- 3) Storage tank of 40 L should have only slow rotation by blade up to 25 RPM to prevent sedimentation. It should also have vacuum for degassing and de-bubbling.

13. Safety and Protection

Frequency converter shall have built-in protection against overload, overcurrent, overvoltage, electrical leakage, Phase loss/short phase
Emergency stop button shall be provided
All alarms shall be displayed on the HMI screen

14. Vacuum System

Suitable vacuum pump (preferably Edward, Pfeiffer or Bosch) shall be provided

15. Temperature Control System

Chiller unit capable of maintaining vessel temperature in the range of 5–30 °C with a variation of ± 2 °C

Chiller shall be equipped with a temperature controller for precise regulation

All required interconnections between chiller and mixer shall be provided

Temperature measurement system for monitoring slurry temperature shall be provided

Water circulation system with thermostat to ensure slurry temperature does not exceed 25 °C

16. Material Compatibility

All seals, gaskets, and wetted parts shall be chemically compatible with NMP
Fluorinated O ring (Teflon encapsulated silicon) shall be NMP-resistant and suitable for long-term operation

17. Control System and Automation

PLC-based control system with touch-screen HMI (the programming and software must be in English)

Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley / / Schneider/Panasonic)

System shall support:

Manual and automatic operation modes

User-defined step sequences for material feeding, mixing, sampling, re-mixing, and dwell times

User-friendly interface for operation and monitoring

18. Cleaning and Maintenance

Mixing container and vacuum hood shall be easily removable for cleaning

Required spares and O-rings shall be supplied along with the equipment

19. Acceptance criteria:

Working condition of equipment as per the specifications to be demonstrated using commercial electrode materials.

Should maintain vacuum (10^{-3} MPa) at least for ~10 hours

Should work in both manual and auto mode as well as user defined sequence of operation

Should maintain temperature of the slurry as well as vessel, safety protections, automation etc as per the specs. Should demonstrate these parameters during FAT.

2. Electrode Coating (Slot Die) Machine:

The slot die coating machine shall be used for cathode and anode electrode fabrication with variable thicknesses, suitable for cylindrical and prismatic lithium-ion/Na-ion battery cells.

Applications:

Suitable Battery Materials for Coating

Positive electrode (Cathode):

Lithium iron phosphate (LFP), lithium cobalt oxide (LCO), lithium manganese oxide (LMO), NMC, LMFP, NVP, and other cathode materials suitable for non-aqueous electrode fabrication.

Negative electrode (Anode):

Graphite, Lithium Titanate (LTO), Hard carbon, Silicon and other anode materials suitable for non-aqueous or aqueous-based electrode fabrication.

Slurry Viscosity:

- a) Cathode slurries: 3000 to 20000 cPs
- b) Anode slurries: 3000 to 10000 cPs
- c) Viscosity variation tolerance: ± 500 cPs

Solid Content:

- a) Cathode: 30 to 70% or better
- b) Anode: 30 to 60% or better
- c) Operating Substrate Thickness
- d) Aluminium foil: 16 to 25 μm
- e) Copper foil: 6 to 10 μm

Dimensional Parameters:

- a) Roller width: 350 mm
- b) Operating substrate width: 50–300 mm
- c) Wet coating thickness: 30 - 500 μm with $\pm 0.01\%$ deviation or better

Mechanical

- a) Mechanical speed: 10 m/min or better
- b) Coating speed: 0.1 to 5 m/min or better (dependent on coating thickness, width, and slurry properties)
- c) Oven length: 6 m (three zones, each 2 m long)
- d) Coating modes: Continuous, zebra, and intermittent coating

Coating Accuracy

Area density accuracy:

- a) Single side: $\pm 1\%$
- b) Double side: $\pm 1\%$
- c) Thickness variation across width: less than 2 μm

- d) Coating length accuracy: ± 1 mm or lower
- e) Coating width accuracy: ± 1 mm or lower
- f) Two-side alignment error (offset): ± 0.5 mm or lower
- g) Minimum break length: < 10 mm
- h) Minimum coating length for multiple sections: 30–35 mm
- i) Single-side dry coating thickness range: 30 to 250 μm

Alarms and Safety Functions

- a) Alarm system: Audible and visual alarms for all functional failures
- b) Meter counting: Continuous and intermittent coating length measurement
- c) Over-temperature protection:
- d) Outside oven temperature not more than 50 degrees. Sandwich insulators necessary in oven window.
- e) Audible and visual alarm
- f) Main heating power supply cut-off
- g) Exhaust system remains operational
- h) Control management: Password-protected access and process parameter locking

Safety protection:

- a) Full interlock system
- b) Warning signage
- c) Emergency stop switches
- d) Protective covers for the entire system

Tension and Alignment Control

- a) Rewinding and unwinding correction accuracy: EPC (edge precision control) should have 0.1 mm accuracy
- b) Guide rollers (outside drying oven): Aluminium with hard anodized surface (smoothness ≤ 0.6)
- c) Equipment tension range: 40 to 120 N or better
- d) Tension system:
- e) Passive unwinding
- f) Adjustable tension Using Dancing roller to regulate tension during high-speed winding and unwinding process
- g) Tension fluctuation ≤ 5 N (less than 5 %)

Winding and Unwinding Device

- a) Unwind/Rewind diameter: $\Phi 500$ mm
- b) Unwind/Rewind load capacity: Maximum 100 kg or better
- c) Unwind/Rewind reel:
- d) 3-inch air shaft
- e) Maximum roller length: 350 mm or better
- f) Cantilever structure
- g) Winding and unwinding zone should not be below dryer but should be outside drying zone.
- h) Splicing unit on winding and unwinding side.
- i) Sensor to detect wounded coil diameter

Correction system:

- a) Edge Position Control (EPC) with automatic correction
- b) Correction accuracy: $\pm 100 \mu\text{m}$
- c) Coating length alarm: Real-time measurement of substrate/coated length
- d) Winding alignment: $\pm 100 \mu\text{m}$
- e) Circular runout: $\leq 40 \mu\text{m}$
- f) Cylindricity: $\leq 40 \mu\text{m}$
- g) Straightness: $< 30 \mu\text{m/m}$
- h) Installation Accuracy
- i) Horizontality: $\leq 0.05 \text{ mm/m}$
- j) Parallelism: $\leq 0.05 \text{ mm/m}$
- k) Winding drive: Asynchronous motor drive
- l) Emergency stop: Mandatory emergency stop button

Coating Unit

- a) The coating unit shall consist of a slot-die, drive motor, reducer, optical fiber sensor, precision bearings, pneumatic components, PLC, and human-machine interface (HMI).
- b) PLC-based control system with touch-screen HMI (the programming and software must be in English)
- c) Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley / / Schneider/Panasonic).
- d) The system shall include interval coating control.
- e) The coating mechanism shall be partially enclosed with a protective cover.
- f) Ultrasonic sensor for A and B side coating match should be compulsory.

Slot-Die

- a) Slot-die width: $300 \pm 10 \text{ mm}$
- b) The slot-die head (standard makes such as Mitsubishi, Hitachi), steel roller, and precision ball screw shall be servo-motor driven using an inclined block mechanism for fine gap adjustment.
- c) Left and right precision displacement sensors shall monitor the die-to-roller gap and provide feedback to the PLC.
- d) Closed-loop control shall be implemented via PLC and servo driver for automatic gap correction.
- e) Steel shims of varying sizes suitable for minimum and maximum (50–300 mm) shall be provided for thickness (200,300,400 μm) and coating width adjustment.
- f) Wet thickness input must be exclusively entered via PLC/HMI (manual adjustment not permitted).
- g) Coating and return valves shall be SS304 to ensure smooth slurry flow.
- h) Provision for comma-bar coating along with slot-die coating.
- i) Provision for ceramic edge coating (electrode and ceramic coating thickness must be same) on foil edges using the slot-die process.
- a) Buffer tank or transfer tank for ceramic coating to be provided

Feeding System

- a) Closed semi-circulation feeding system suitable for easy cleaning and maintenance, comprising slot-die, mixing barrel, filters, feeding pump, and servo drive.
- b) Two-stage filtration (mesh and magnetic) to prevent particle ingress into the die head.
- c) Flexible PTFE pipes or better with long service life.
- d) Pipes must be compatible with NMP-based slurries.
- e) Slurry feeding rate adjustable via HMI.
- f) Slurry tanks of 5 L, 10 L, and 40 L capacities with integrated stirrers.
- g) Ultrasonic level sensors for slurry level monitoring.
- h) Entire feeding system constructed from SS304.
- i) Slurry transfer mechanism: Screw Pump
- j) Pump Speed: 0-100rpm

Coating Roller

- a) Material: Carbon steel with chrome plating
- b) Mechanical accuracy:
- c) Coaxiality: $\leq 2.5 \mu\text{m}$
- d) Circular runout/straightness: $\leq 2 \mu\text{m}$
- e) Roller diameter: $\geq \Phi 200 \text{ mm}$ or better
- f) Chrome plating coating thickness: $\geq 100 \mu\text{m}$
- g) hardness HRC 65-67
- h) Drive system: Servo motor with precision reducer

Drying System

- a) Drying system includes fan, heater, insulated chamber, and air ducts.
- b) The assembly and functioning of exhaust air ducts to the coating unit should be demonstrated by the supplier.
- c) Multi-zone temperature-controlled insulation chamber with adjustable inlet and outlet dampers.
- d) Air inlet and outlet volumes regulated via PLC.
- e) Hot air circulation oven with observation window and access door.
- f) See-through oven window with internal LED lighting.
- g) Oven configuration: Three zones, total length 6 m, SS316L liner, double-sided heating.
- h) Heating method: Electric heating
- i) Temperature control: PID control with $\pm 1^\circ\text{C}$ tolerance per zone.
- j) Air volume control via frequency converter with PLC interface.
- k) Exhaust control via frequency converter with PLC interface.
- l) External surface temperature: $\leq 50^\circ\text{C}$.
- m) Adequate thermal insulation for main body.
- n) Integrated NMP solvent recovery system. along with NMP sensor in each drying zone
- o) The efficiency of the NMP recovery system shall be capable of recovering more than 98% of NMP solvent
- p) NMP solvent concentration alarm: $< 10 \text{ ppm}$.

- q) Integrated UPS to drive exhaust motor for at least 5 min in case of power drop.

Control System

- a) The system shall include PLC, motors, HMI, fiber optic sensors, and pneumatic solenoid valves.
- b) HMI to support graphical display, parameter setting, and system monitoring.
- c) PLC-based control system with touch-screen HMI (the programming and software must be in English)
- d) Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley / Schneider/Panasonic)
- e) Main controls installed on one side of the machine head.
- f) Emergency controls located near the winding section.
- g) Software-based upper and lower parameter limits with locking facility.
- h) Comprehensive troubleshooting and diagnostics for all fault conditions.
- i) Quality control: Online thickness measurement across the electrode width or gravimetric (weight-based) monitoring.
- j) Pressure sensor in each drying chamber to show required negative pressure inside drying chamber

Equipment operating conditions:

- a) Machine head temperature: 20–30°C; other areas: 10-40°C
- b) Relative humidity:
Positive electrode: 10% RH
Negative electrode: 10-65% RH

Environmental conditions

- a) Ambient temperature: 0–45°C
- b) Relative humidity: 30–75% RH
- c) Clean, dry, and non-corrosive air environment
- d) Protective grounding mandatory
- e) Spacers and shims 50–300 mm to be supplied
- f) Tool kit including spanners, bobbins, adjustable spanners, Allen keys, screwdrivers, and ratchets
- g) Necessary jigs and fixtures to be provided
- a) Electrical spares (fusers, relay) to be provided
- h) Pneumatic valves, solenoid valves and other mechanical spares to be provided
- i) Soft and hard copies of manuals and drawings to be provided
- j) Data logging and batch traceability with export capability (CSV/Excel)
- k) Recipe-based coating programs for rapid changeover
- l) Cleanroom-compatible design (ISO Class 10000)

Additional Advanced Specifications (Optional)

In-line laser-based thickness measurement

Vision-based defect detection system for streaks, pinholes, and edge defects (optional)

Acceptance Criteria:

- a) Uniform coating of LFP or NMC or Graphite or LTO electrodes across full length (Approx. 300m) and width.
- b) Wet coating thickness: 30–500 μm with $\pm 0.01\%$ deviation
- c) Coating speed: 0.1–5 m/min, both lower and higher should be demonstrated with the thickness accuracy of 0.01 % and should maintain precision across length, width, and thickness.
- d) Coating uniformity deviation: <2% of the loading weight over the entire coated area.
Side A and Side B edges in machine and transverse direction should match with 0.5 mm tolerance.
- e) Thickness variation across width <2 μm ,
- f) Coating length deviation ± 1 mm,
- g) Side A & Side B error ≤ 0.5 mm.
- h) Winding alignment ± 100 μm .
- i) Dry coating thickness variation (Single/double side): $\pm 1\%$

3. Electrode Calendaring Machine

Scope of Supply:

Design, supply, installation, testing, and commissioning of an electrode calendaring machine suitable for lithium-ion battery electrode processing.

1. Electrode Material Compatibility:

The calendaring machine shall be suitable for processing electrodes based on the following active materials:

- a) Lithium Iron Phosphate (LFP)
- b) Lithium Cobalt Oxide (LCO)
- c) Lithium Manganese Oxide (LMO)
- d) Nickel Manganese Cobalt Oxide (NMC)
- e) LMFP
- f) Lithium Titanate Oxide (LTO)
- g) Graphite
- h) Sodium Vanadium Phosphate (NVP)
- i) Hard Carbon
- j) Graphite
- k) Si/Graphite

Electrode and Foil Specifications:

- a) Cathode electrode thickness: 50–400 μm
- b) Anode electrode thickness: 50–300 μm
- c) Aluminium current collector thickness: 10–25 μm
- d) Copper current collector thickness: 8–10 μm
- e) electrode coated width: 50–300 mm

2. Unwinding Unit Specifications

- a) Maximum electrode web width: 300 mm
- b) Unwinding shaft type: 3-inch air shaft
- c) Unwinding shaft length: 350 mm
- d) Maximum unwinding diameter: 500 mm or better
- e) Maximum unwinding load capacity: 100 kg or better
- f) Edge guiding accuracy: ≤ 0.1 mm, with edge position sensors
- g) Equipped with closed-loop tension control
- h) Tension control range: 5–200 N
- i) Provided with corrective deviation control using edge sensors
- J) Splicing on winding and unwinding side

3. Calendaring Unit Specifications

- a) Roller diameter: 500 mm
- b) Roller length: 350-400 mm
- c) Roller material: SS 316L
- d) Chrome plating thickness of 100-300 μm , HRC 65-67
- e) Roller surface roughness: $< 0.02\text{Ra}$
- f) Roller press speed range: 0.1–10 m/min
- g) Maximum roller operating temperature: 120 °C
- h) Heating mechanism of rollers must be oil based
- i) Temperature controllers for each roller

Roller Gap Adjustment System:

- a) Digital gap setting with unloading; servo motor-driven middle wedge iron through a reducer
- b) Roller gap adjustment range: 0–2 mm, displayed on touch screen
- c) Roller gap adjustment accuracy: 1 μm
- d) Calendaring thickness tolerance 2 micron or better

4. Work Pressure and Hydraulic System

- a) Hydraulic system with constant pressure control and integrated hydraulic station
- b) Pressure monitoring through pressure sensors and set via touch screen
- c) Maximum hydraulic system pressure: 30 MPa (300 ton)
- d) Pressure control precision: ± 0.05 MPa
- e) Oil level detection with alarm system
- f) Oil leakage collection tray provided at hydraulic station

5. Rewinding Unit Specifications

- a) Maximum electrode web width: 300 mm
- b) Rewinding shaft type: 3-inch air shaft
- c) Rewinding shaft length: 350 mm
- d) Maximum rewinding diameter: 500 mm or better
- e) Maximum rewinding load capacity: 100 kg or better
- f) Edge guiding accuracy-EPC: ≤ 0.1 mm, with edge position sensors
- g) Equipped with closed-loop tension control
- h) Tension control range: 5–200 N

- i) Provided with corrective deviation control using edge sensors
- j) Sensor to detect rewinding coil diameter

6. Additional Provisions

- a) Integrated vacuum-based dust removal system
- b) Provision for pre-heating of electrodes prior to feeding into the calendaring rollers
- c) Edge trimming should be provided on both left and right side of foil. This should be before wrinkle removing device
- d) Heating on the edge before calendaring process
- e) Laser thickness measurement machine required. It should have 0.5 micron measurement accuracy.
- f) Automatic roll cleaning during calendaring process by paper wetted with alcohol. (both wet and dry cleaning).
- g) Magnetic rod to pick up magnetic particles before and after calendaring
- h) Easy removal of calendaring roller for redressing
- i) Calendaring of single side coating should be possible (optional)

7. Safety, Control, and Quality Systems

- a) Fully servo-controlled operation
- b) Adjustable line speed and web tension
- c) EPC (Edge Position Correction) sensor/system
- d) PLC-based control system with touch-screen HMI (the programming and software must be in English)
- e) Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley / / Schneider/Panasonic)
- f) Real-time display of process parameters including:
Line speed
Web tension
Calendaring pressure

8. Safety & Protection System

- a) The machine shall be provided with comprehensive safety and protection systems to ensure safe operation and maintenance.
- b) Emergency stop push buttons shall be provided at accessible locations on the machine.
- c) Safety interlocking doors and guards shall be provided for all moving, rotating, and heated parts.
- d) Electrical safety protections including overload protection, short-circuit protection, and proper earthing shall be incorporated.
- e) Hydraulic system safety features including pressure relief valves, oil level monitoring, and leakage protection shall be provided.
- f) Over-temperature protection for heated rollers with alarms and automatic cut-off shall be provided.
- g) PLC-based safety logic shall monitor critical faults and trigger alarms and safe shutdown.
- h) All safety indications and alarms shall be displayed on the HMI.

9. Acceptance Criteria

- a) The electrode calendaring machine shall meet the following performance requirements:
- b) Stable and repeatable calendaring performance across the specified speed, pressure, and temperature ranges
- c) The thickness variation in the calendared electrode and surface finish across the specified coated width must be less than 2 micron.
- d) No cracking, delamination, peeling, or damage to the electrode coating or current collector during calendaring
- e) Accurate and repeatable roller gap control through the HMI (Roller gap adjustment accuracy should be $< 1 \mu\text{m}$)
- f) Stable hydraulic pressure application without pressure fluctuation during operation (Should be able to exert a Max pressure 30 MPa with a precision control of $\pm 0.05 \text{ MPa}$ for the whole range)
- g) Effective web tension control with no wrinkling, slippage, or edge damage
- h) Accurate edge guiding and corrective deviation control throughout continuous operation
- i) Consistent calendaring quality during continuous and repeated production runs
- j) Reliable operation of roller heating, pre-heating, and dust removal systems
- k) Smooth unwinding and rewinding without telescoping or misalignment
- l) Safe operation with functional emergency stops, interlocks, and alarm systems
- m) All process parameters including speed, tension, pressure, and temperature shall be adjustable and displayed in real time through the HMI

4. Roll-to-Roll Electrode Slitting Machine

The supplier shall provide a fully automatic roll-to-roll electrode slitting machine suitable for precision slitting of positive and negative electrodes. The system shall be designed for high accuracy, burr-free cutting, stable tension control, and safe operation, suitable for electrode manufacturing.

Scope of Supply:

The complete system shall include, but not be limited to, the following integrated modules:

- a) Unwinding mechanism
- b) Precision slitting/cutting module
- c) Dual rewinding modules (upper & lower rolls)
- d) Edge waste rewinding mechanism
- e) Closed-loop tension control system
- f) Edge Position Control (EPC) system
- g) Vacuum cleaning and dust evacuation system
- h) Fully enclosed safety housing
- i) Electrical control system with PLC & HMI

PLC-based control system with touch-screen HMI (the programming and software must be in English) Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley/ Schneider/Panasonic)

- j) All required accessories, tools, and consumables
- k) Complete technical documentation

Electrode Material Compatibility:

The machine shall be suitable for slitting electrodes coated with the following active materials:

Cathode Materials:

- a) Lithium Iron Phosphate (LFP)
- b) Lithium Cobalt Oxide (LCO)
- c) Lithium Manganese Oxide (LMO)
- d) Nickel Manganese Cobalt (NMC)
- e) LMFP
- f) Sodium Vanadium Phosphate (NVP)
- g) C-S composite
- h) Anode Materials:
- i) Graphite
- j) Lithium Titanate (LTO)
- k) Hard Carbon
- l) Si/C

Current Collectors:

- a) Aluminium foil thickness: 10–25 μm
- b) Copper foil thickness: 6–12 μm

Electrode Thickness Range

- a) Cathode electrode thickness: 50–300 μm
- b) Anode electrode thickness: 50–200 μm
- c) PE/PP Separator of thickness 15-25 μm

General Technical Specifications:

- a) Maximum web width: 350 mm
- b) Adjustable cutting width (slit width): 40–150 mm suitable for making 18650, 21700, 32700, 32140, 4680, 4695, 6080,
- c) Gap adjustment accuracy: $\pm 1 \mu\text{m}$
- d) Tool positioning accuracy: $< \pm 0.02 \text{ mm}$
- e) Cutting width consistency: $\pm 0.1 \text{ mm}$
- f) Speed range: 0.1 to 10 m/min or better (main operation is 2m/min)
- g) Cutting method: Slicing-type roll slitting
- h) Servo-controlled feeding and cutting
- i) Continuous and stable operation without burrs, wrinkles or telescoping
- j) Burr detection system

Unwinding Unit:

- a) Unwinding shaft: 3-inch pneumatic air shaft
- b) Shaft length: 350mm or better
- c) Maximum unwinding roll diameter: 500 mm or better
- d) Maximum unwinding roll weight: 100 kg or better
- e) Edge guiding system with sensors
- f) Edge guiding accuracy: ≤ 0.1 mm
- g) Independent tension control with closed-loop feedback
- h) Smooth acceleration and deceleration to prevent coating damage
- i) Splicing in unwinding area

Slitting Unit:

- a) Drive system: Servo motor-based precision drive
- b) Number of slitting blades: Maximum 5 nos.
- c) Blade material: Tungsten Carbide
- d) Detachable slitting head assemblies for cathode and anode electrodes
- e) Height-adjustable trolley for slitting head mounting and replacement
- f) Two (2) trolleys for easy detachment and attachment
- g) Burr and dust evacuation attachment near cutting zone
- h) Burr-free cutting on electrode edges
- i) Cutting distance (slit width) fully adjustable
- j) User-friendly blade replacement and alignment mechanism
- k) Both upper and lower slitting cutters to be rotated by separate motor
- l) Easy to adjust overlap distance between upper and lower cutter
- m) Easy to get constant force between upper and lower cutter

Safety Features (Slitting Section):

- a) Full safety cover
- b) Emergency stop buttons
- c) Emergency pressure release system
- d) Blade covers for operator protection
- e) Compliance with industrial electrical and mechanical safety standards

Rewinding Unit:

- a) Rewinding shafts: 3-inch pneumatic air shafts
- b) Number of rewinding shafts: 2 (upper and lower)
- c) Maximum rewinding roll diameter: 500 mm or better
- d) Maximum rewinding roll weight: 100 kg or better
- e) Tension control via power brake or clutch brake
- f) Edge guiding system with sensors
- g) Edge guiding accuracy: ≤ 0.1 mm or better
- h) Uniform roll build-up without wrinkles or telescoping
- i) Sensor to detect winding coil diameter

Edge Waste Rewinding System:

- a) Independent edge trim collection mechanism

- b) Continuous waste rewinding during slitting
- c) Proper containment of edge waste to prevent contamination

Cleaning and Dust Control System:

- a) Integrated vacuum cleaning system
- b) Brush-assisted particle removal at slitting zone
- c) Efficient evacuation of coating particles during operation
- d) Sealed dust extraction paths to avoid cross-contamination

Control, Automation & HMI:

- a) PLC-based control system
- b) Touchscreen HMI interface
- c) Real-time display of:
Line speed, Web tension, EPC alignment status
- d) Adjustable speed and tension settings
- e) Error detection and alarm system
- f) Data logging and batch record storage
- g) Recipe storage for repeatable operations

Edge Position Control (EPC) System:

- a) Automatic EPC sensor/system
- b) Continuous edge tracking during unwinding and rewinding
- c) Deviation correction accuracy: $\leq \pm 0.2$ mm

Safety & Enclosure:

- a) Fully enclosed machine with transparent safety panels
- b) Interlocked access doors
- c) Emergency stop buttons at accessible locations
- d) Emergency shutdown with door interlocks
- e) Compliance with industrial electrical and mechanical safety standards

Accessories & Spares

- a) Spare slitting blades: 10 Nos.
- b) Standard tool kit for operation and maintenance
- c) Essential, general and critical spares to be quoted for each equipment
- d) Small motors, encoders
- e) All sensors, PLC/HMI should be from same manufacturers

Acceptance criteria

- a) The slitting machine should meet all the specifications, safety features and meet few important performance parameters such as
- b) Adjustable slit width: 40–150 mm for all specified cell formats (18650, 21700, 32700, 4680.), verifiable, Positioning accuracy $\leq \pm 0.02$ mm., Cutting width accuracy of ± 0.1 mm across full length, Gap adjustment of ± 1 μ m.
- c) Burr-free, wrinkle-free cutting and smooth acceleration/deceleration without coating damage Operation.

5. Roll-to-Roll Automatic Ultrasonic Tab Welding, Tape Sticking & Rewinding Machine:

The equipment shall be designed for fully automatic tab welding, protective tape application, quality inspection, and rewinding of electrodes. The system shall enable continuous processing of slitted electrode rolls, including precise ultrasonic tab welding, accurate insulation tape sticking, real-time quality detection, and stable rewinding of finished electrode rolls.

The machine shall be suitable for production environments, ensuring high precision, repeatability, and operator safety.

Working Process Flow:

1. Electrode Unwinding
 - a) Slitted electrode roll mounted on the unwinding air shaft
 - b) Closed-loop tension control system for stable feeding
 - c) High-accuracy deviation correction system to ensure wrinkle-free operation
2. Electrode Feeding to Ultrasonic Tab Welding
 - a) Electrode guided through precision rollers to the welding station
 - b) Coating start position used as the reference for tab welding alignment
 - c) Servo-controlled feeding to ensure accurate welding position
3. Ultrasonic Tab Welding
 - a) Automatic ultrasonic welding of tabs at pre-set positions
 - b) Welding head with high mechanical stability
 - c) No over-welding, no virtual welding, and high tensile strength
 - d) Welding parameters precisely controlled through PLC
 - e) Automatic tab feeding from tab roll
4. Tape Sticking (Protective Tape Application)
 - a) Two independent tape-sticking mechanisms
 - b) Protective adhesive tape applied on tab and electrode after welding
 - c) Tape position and length controlled within ± 0.5 mm accuracy
 - d) Taping both side above and lower side of tab
5. Quality Inspection
 - a) The system shall automatically inspect:
 - b) Completion of tab welding
 - c) Correct application of protective tape
 - d) If abnormality is detected:
 - e) Operator can activate manual return function
 - f) Re-welding or repair tape application can be performed
 - g) Process can resume without discarding the roll
6. Rewinding – Finished Electrode Roll
 - a) Finished electrodes rewound into clean, aligned rolls

- b) Anti-explosion edge design
- c) Integrated dust brushing and suction device during rewinding

Electrode & Tab Specifications:

- a) Electrode Specifications:
- b) Electrode thickness: 60–300 μm
- c) Electrode width: 40–150 mm
- d) Carbon coated (1 μm) Aluminium foil thickness: 10–25 μm
- e) Copper foil thickness: 8–10 μm

Tab Specifications:

- a) Tab width: 3 / 4 / 5 / 6 mm
- b) Tab length: 30–80 mm
- c) Tab thickness: 30–200 μm
- d) Tab exposed length: 10–25 mm
- e) Tab materials:
 - Aluminium
 - Nickel
 - Nickel-coated copper
 - Copper

Protective Tape Specifications:

- a) Tape width: 5–8 mm
- b) Tape length: 40–80 mm

Winding / Rewinding Specifications:

- a) Winding/Rewinding shaft: 3-inch pneumatic air shaft
- b) Air shaft length: 150 mm or better
- c) Maximum winding/rewinding diameter: 500 mm
- d) Shaft holding capacity: 20 kg or better
- e) Edge sensors for alignment during winding and unwinding
- f) Line sensor for measuring electrode length / welding distance
- g) Welding anvil: Customized as per electrode and tab design
- h) Diameter sensor on rewinding and unwinding
- i) Number of layers: Single
- j) Smooth roll build-up without wrinkles or telescoping

Ultrasonic Welding Specifications:

- a) Welding type: Energy mode
- b) Operating frequency: 20 kHz $\pm 10\%$ or better
- c) Welding parameters controlled via PLC
- d) Welding time range: 0–10 sec or better
- e) Welding surface life: $\sim 100,000$ operations
- f) Welding strength: > 2000 N or better
- g) Welding distance adjustable through PLC control
- h) Ultrasonic welding head should have four welding head, which can be used when other welding head gets worn out. Welding head just need to be rotated 90 degrees

- i) The welding horn and anvil dimensions and design patterns need to be provided

Additional Functional Features:

- a) Automatic tension control for electrode feeding
- b) High-accuracy deviation correction system
- c) Integrated dust brushing and dust-collection device during rewinding
- d) Automatic detection and correction support for welding and taping defects
- e) Continuous operation with minimal electrode damage
- f) Modular design for easy maintenance and future upgrades
- g) Suction near ultrasonic welding head by negative suction

Control System & Automation:

- a) PLC-based automation control system
- b) Touchscreen HMI for:
 - Parameter setting
 - Recipe storage
 - Calibration
 - Real-time process monitoring
 - Diagnostics and troubleshooting
- c) Servo motor control for:
 - Feeding
 - Welding
 - Tape application

Alarm & Fault Display:

The system shall provide alarms for:

- a) Welding failure
- b) Tape missing or misplacement
- c) Electrode misalignment
- d) Tension abnormality
- e) Air pressure drop

Safety & Enclosure

- a) Fully enclosed machine structure with transparent safety panels
- b) Emergency stop buttons at accessible locations
- c) Safety interlocks on access doors
- d) Automatic shutdown during unsafe conditions
- e) Compliance with standard industrial electrical and mechanical safety norms

Required Quality Standards

The machine shall ensure:

- a) No wrinkles, scratches, or dents on electrodes
- b) Strong and consistent tab welding
- c) Protective tape firmly attached without bubbles or offset
- d) Smooth rewound rolls with neat, deflection-free alignment

Acceptance Criteria:

- a) Tab welding quality test: Tensile force ≥ 15 N
- b) Tape sticking alignment and length accuracy verification
- c) Rewinding alignment tolerance check
- d) Stable continuous operation without defects
- e) Minimum 12 PPM

6. Electrode Winding (Cylindrical) Machine

Scope of Supply:

Design, supply, installation, testing, and commissioning of an automatic cylindrical electrode winding machine suitable for making 18650, 21700, 26700 and 32700 format cylindrical cells.

1. Electrode Material Compatibility

The winding machine shall be suitable for processing electrodes based on the following active materials:

- a) Lithium Iron Phosphate (LFP)
- b) Lithium Cobalt Oxide (LCO)
- c) Lithium Manganese Oxide (LMO)
- d) Nickel Manganese Cobalt Oxide (NMC)
- e) LMFP
- f) Lithium Titanate Oxide (LTO)
- g) Graphite
- h) Si/C
- i) Hard Carbon
- j) Sodium Vanadium Phosphate (NVP)

Electrode, Separator, and Tape Specifications

- a) Cathode electrode thickness: 50–300 μm
- b) Anode electrode thickness: 50–200 μm
- c) Protective tape thickness: 10–50 μm
- d) Electrode width: 40–80 mm
- e) Separator width: 40–80 mm
- f) Protective tape width: 8–35 mm

2. Unwinding Unit Specifications

- a) Dedicated unwinding units shall be provided for electrodes, separator, and protective tape.
- b) Unwinding shaft type: 3-inch air shaft
- c) Maximum unwinding diameter: 500 mm or better
- d) Maximum unwinding load capacity: 100 kg or better
- e) Edge guiding system with edge position sensors
- f) Edge guiding accuracy: ≤ 0.3 mm
- g) Proper tension control to avoid wrinkles, tearing, or misalignment
- h) Splicing unit on unwinding side for separator and electrode

3. Feeding and Alignment System

- a) Automatic feeding facility shall be provided for:
- b) Cathode electrode
- c) Anode electrode
- d) Separator
- e) Protective tape
- f) Feeding system shall ensure synchronized and continuous material supply during winding
- g) Electrostatic charge removal on separator by blowing ionised air. It should be for both separators before they enter winding process

4. Winding Unit Specifications

- a) Cell formats supported: 18650, 21700, 32700 Equipment capacity: 6-12 ppm
- b) Needle diameter range: 3-6 mm
- c) Fully automatic winding operation including:
- d) Automatic needle change
- e) Winding accuracy should be ≤ 0.1 mm
- f) Automatic separator cut-off
- g) Automatic tape sticking and termination
- h) Automatic trimming of electrode, separator and tapes
- i) Protective tape application shall be adjustable to accommodate changes in cell type and diameter
- j) Hot ironing process to expand centre hole before short circuit test. Here mandrel enters at temperature range of 100 -150 degrees and expands hole. This is necessary for future resistance welding.
- k) Separator trimming hot punch or hot wire as most separator are ceramic coated with PVDF coating
- l) Height sensor to be integrated in hot ironing process

5. Detection, Process Control, and Monitoring

In-built detection system for:

- a) Loose core
- b) Short circuit
- c) Electrode dislocation

Continuous monitoring of:

- a) Winding tension
- b) Electrode and separator alignment
- c) Number of winding turns
- d) Any abnormal condition shall trigger:
- e) Automatic alarm
- f) Machine shutdown
- g) Short circuit monitor to display voltage current and resistance

6. Tape Sticking (Protective Tape Application)

- a) Protective tape application shall be integrated within the winding process
- b) The winding operation shall be considered complete only after proper protective tape application
- c) Tape position, length, and termination shall be adjustable for 18650, 21700, and 32700 cell formats
- d) Conveyor system to be provided for the collection of jelly rolls after winding
- e) Cathode start and end edges will be covered by insulation tapes from both the sides.

7. Safety, Control, and Quality Systems

- a) Servo-controlled feeding and winding accuracy
- b) Adjustable winding speed and web tension
- c) EPC (Edge Position Correction) sensor/system
- d) Deviation control accuracy: $\leq \pm 0.2$ mm
- e) Emergency stop push buttons and safety interlocking doors
- f) PLC-based control system with HMI touchscreen (English language is must)
- g) Real-time display of process parameters including:
- h) Winding speed
- i) Web tension
- j) Number of winding turns
- k) Integrated error detection and alarm system
- l) Minimum 12 ppm of 32700 format with rejection rate of less than 5%

8. Safety & Protection System

- a) Comprehensive safety and protection systems for safe operation and maintenance
- b) Emergency stop push buttons at easily accessible locations
- c) Safety guards and interlocking doors for all moving parts
- d) Electrical safety protections including overload protection, short-circuit protection, and proper earthing
- e) PLC-based safety logic for fault monitoring and safe shutdown
- f) All safety alarms and indications displayed on the HMI

9. Acceptance Criteria:

Equipment to be demonstrated as per the technical specifications mentioned for all formats of 18650, 21700, 26700 and 32700 cylindrical cells.

- a) The electrode winding machine shall meet the following performance requirements:
- b) Stable and repeatable winding performance for all specified cell formats
- c) Uniform and consistent jelly-roll formation without telescoping, looseness, or misalignment
- d) No damage, tearing, or deformation of electrodes, separator, or protective tape during winding

- e) Accurate control of winding tension, speed, and number of turns
- f) Proper functioning of automatic needle change, separator cut-off, and tape sticking operations
- g) Effective detection and rejection of loose core, short circuit, and electrode dislocation conditions
- h) Smooth and continuous operation during repeated production runs
- i) Safe operation with functional emergency stops, interlocks, and alarm systems
- j) All process parameters shall be adjustable and displayed in real time through the HMI
- h) Short-circuit test on jelly roll with digital megger at ~500 V to show the resistance in $G\Omega$

7. Automatic Tab-less Cylindrical Battery Cell Flattening Machine:

The equipment shall be designed for automatic end-face flattening and shaping of tab-less cylindrical cells, including 32140, 4680, and 6080 formats, to ensure uniform, flat, and mechanically stable end surfaces prior to downstream welding and assembly processes.

The system shall provide high repeatability, controlled compression, and balanced shaping, suitable for production-scale battery manufacturing environments.

Machine Function & Working Principle:

The Tabless Cylindrical Battery Cell Flattening Machine performs dual-side end-face compression and shaping of cylindrical lithium-ion cells using servo-driven flattening heads and pneumatic clamping.

Operating Sequence:

1. Manual Loading

Operator manually places the cylindrical cell onto a dedicated precision cell jig Jig designed to support tabless cell architecture without deformation

2. Automatic Clamping

Upon pressing the start button, the jig automatically clamps the cell

Pneumatically controlled clamping ensures uniform holding force

Interlock prevents operation without proper clamping

3. Dual-Side Shaping Operation

Two flattening heads (left and right) operate simultaneously

Each head driven by an independent servo motor through synchronous belts

One flattening head rotates clockwise and the other counter-clockwise

Balanced compression prevents torsion or twisting of the cell body

4. Slow-Feed Compression

Flattening heads advance inward with controlled slow-feed motion

Inner rollers rotate due to friction with the cell end surface

Even distribution of compressive force ensures uniform flattening

5. End-Face Shaping Completion

Compression continues until the programmed shaping depth/length is achieved

Shaping depth and force monitored by sensors

System automatically retracts flattening heads and releases the clamp

Height sensor to be provided

6. Finished Output

Cell with uniform, flat, and stable end surface

Ready for subsequent welding, sealing, or assembly operations

Technical Details:

Cell / Jelly Roll Compatibility:

- a) Jelly roll formats:
 - 32140
 - 4680
 - 6080
- b) Compatible with tabless cylindrical cells

Mechanical & Pneumatic System:

- a) Pneumatically controlled clamping and actuation system
- b) Stable machine frame with vibration-resistant structure
- c) Precision-machined jigs for accurate cell positioning
- d) Smooth and repeatable motion for long-term operation

Positioning & Sensing System:

- a) Laser / optical positioning sensor
- b) Ensures accurate cell placement before clamping
- c) Prevents misalignment during shaping operation
- d) Sensors for:
 - Cell position
 - Cell height
 - Flattening head position
 - Shaping depth
 - Pneumatic pressure

Electrical Control System:

- a) PLC-based sequence and motion control
- b) Touchscreen HMI for:
 - Operation control
 - Parameter setting
 - Recipe storage for different cell formats
 - Real-time status monitoring
 - Fault diagnosis
- c) Integrated sensors for:
 - Position
 - Pressure

- Shaping depth
- d) Emergency stop circuit
- e) Relay modules
- f) Power supply protection and isolation

Safety & Protection Features:

- a) Emergency stop buttons at accessible locations
- b) Safety door with interlocking mechanism
- c) Over-travel protection for flattening heads
- d) Overload protection for servo drives
- e) Electrical grounding and insulation protection
- f) Air pressure drop alarm
- g) Automatic fault detection and error display on HMI
- h) Machine operation inhibited during unsafe conditions

Performance & Quality Requirements

- a) Uniform flattening on both ends of the cell
- b) No cell body distortion, cracks, or surface damage
- c) Stable and repeatable shaping depth
- d) Suitable for downstream welding and assembly processes
- e) Consistent performance across different cell formats
- f) Output should be greater than or equal to 10 PPM

Additional Requirements (Scope of Supply)

- a) 3 × flattening head assemblies
For 32140, 4680, and 6080 format cylindrical cells
- b) 3 × servo transmission modules
- c) Basic spare parts kit
- d) Standard tools required for operation and maintenance
- e) User manuals and technical documentation
- f) Dust collection system during flattening
- g) Dedicated dust collector
- h) Hipot test (short circuit test) after flattening should be needed (Manual loading)
- i) Clean flattened area with brush and negative suction in process before Hipot test
- j) Flattening cone should have tungsten carbide coating

Acceptance criteria:

- a) The machine should be compatible and easy to handle all the cell formats (32140, 4680, and 6080) as per specs with minimal fixture changes and alignments
- b) Finished cells should edge must be flat, stable, and free of cracks, with no distortion or damage of cell body and should be OK for the next operation.
- c) Output should be greater than or equal to 10 PPM

- d) **Flattening Width & Depth:** The remaining exposed foil length (uncoated zones) on positive and negative sides must meet process specifications with high repeatability.
- e) **Jelly Roll Geometry:** The flattening must achieve a symmetrical end-face forming, ensuring an even, flush surface to facilitate subsequent disc-to-roll laser welding.
- f) **Thickness & Profile:** Total cell diameter or specific flattening height must stay strictly within the prescribed tolerance (± 0.05 mm) to ensure smooth insertion into the battery casing.
- g) **Foil Protection:** The machine must not cause visible cracking, tearing, or deformation of the current collectors (aluminum/copper).
- h) **No Delamination:** The flattening process should not cause telescoping of the jelly roll layers.
- i) **Foil & Separator Condition:** The separator must remain intact with zero punctures or short-circuit indications caused by the flattening mechanism.
- j) No loose foil burrs, copper/aluminum spatter, or machine oil residue should be left on the flattened end-faces.
- k) The flattening blade sharpness should have long endurance.
- l) The output noise from the machine must be minimum during process.
- m) The counting after completion of each piece must be in ascending order.

8. Automatic Jelly Roll Insertion Machine

The Jelly Roll Insertion Machine shall be designed for automatic insertion of jelly rolls (electrode cores) into steel shells for cylindrical lithium-ion battery cells. The system shall support both tabbed and tabless cylindrical cell formats, ensuring accurate positioning, tab correction, insulation placement, defect rejection, and smooth core insertion with high reliability and operator safety.

The machine shall require manual loading and unloading by the operator, while all intermediate processes shall be fully automated.

Applicable Cell Formats:

The machine shall be suitable for the following cylindrical cell formats:

- a) Tabbed Cylindrical Cells (Steel Shell)
 - 18650
 - 21700
 - 32700
- b) Tabless Cylindrical Cells (Steel Shell with Bottom Gasket)
 - 32140
 - 4680
 - 6080

Machine Function & Working Principle:

The machine shall automatically perform the following sequence of operations:

Steel Shell Loading

- a) Automatic feeding and positioning of empty steel shells
- b) Shell presence detection before processing

Jelly Roll Transfer

- a) Automatic transfer of the jelly rolls from loading position to insertion station
- b) Controlled handling to avoid deformation

Tab Correction & Alignment (for tabbed cells)

- a) Automatic correction of tab orientation
- b) Ensures proper alignment for downstream processes

Tab Flattening (for tabbed cells)

- a) Controlled flattening of tabs to ensure smooth shell insertion
- b) Prevents tab damage or misplacement

Defect Detection & Removal

- a) Detection of misaligned or defective jelly rolls
- b) Automatic rejection to a designated reject bin

Insulation Sheet Formation

- a) Automatic preparation of insulation sheet
- b) Ensures electrical isolation inside the shell

Steel Shell Sheathing

- a) Controlled shell positioning for smooth insertion

Insulation Sheet Placement

- a) Accurate placement of insulation sheet inside the steel shell

Core Insertion

- a) Jelly roll inserted into the shell with controlled speed and force
- b) Prevents damage to electrodes, tabs, or shell

Unloading

- a) Finished cell unloaded for subsequent processes

Technical Specifications

- a) Stackable Electrode / Cell Specifications

Supported cell sizes:

- a) 18650
- b) 21700
- c) 32700
- d) 32140
- e) 4680
- f) 6080

Compatible with:

- a) Multi-tab cylindrical cells
- b) Tab-less cylindrical cells

Mechanical & Process Parameters:

- a) O-ring depth with top cap: Adjustable
- b) Steel shell entry speed: Adjustable
- c) Top and bottom cylinder speeds: Adjustable and synchronized
- d) Tooling mould service life: Minimum 5,00,000 cycles
- e) Production capacity: $\leq$ Twelve cell per minute

Pneumatic System:

- a) Integrated pressure regulator
- b) Air supply pressure control range: 0.5 to 0.8 MPa
- c) Pneumatic components designed for stable and repeatable operation
- d) Air pressure monitoring with alarm

Electrical System:

- a) Power supply (380 V) compatible with Indian electrical standards
- b) PLC-based automation control
- c) Servo and pneumatic motion coordination
- d) Industrial-grade electrical components

Control System & Automation:

- a) PLC-controlled sequence logic
- b) Touchscreen HMI for:
 - Operation control
 - Parameter setting
 - Recipe selection for different cell formats
 - Real-time process monitoring
 - Alarm and fault display
- c) Sensors for:
 - Shell presence
 - Jelly roll position
 - Tab alignment
 - Insertion depth
 - Pneumatic pressure

Other Requirements

1. Tapping after insulation disk is placed so that it properly aligns with jellyroll. May be not necessary if done in all in one machine.
2. Bending of anode tab in tab based jelly roll should be such that it covers the centre hole. As it will be resistant welded with bottom in next machine.
3. In tables version, bottom aluminium disk needs to be inserted first followed by jelly roll and then do laser welding of aluminium bottom housing,

aluminium disk and cathode flattened surface of jellyroll in one time laser weld.

Safety & Protection System

The machine shall be equipped with a comprehensive protection and safety system to ensure hassle-free and safe operation, including:

- a) Fully enclosed safety guarding with transparent panels
- b) Emergency stop buttons at accessible locations
- c) Safety interlocks on access doors
- d) Over-travel and overload protection
- e) Electrical grounding and insulation protection
- f) Air pressure drop alarm
- g) Automatic fault detection and error display on HMI
- h) Operation inhibited under unsafe conditions

Quality & Performance Requirements

- a) Smooth and damage-free jelly roll insertion
- b) No deformation of jelly roll, tabs, insulation, or steel shell
- c) Accurate and repeatable insulation placement
- d) Stable operation with minimal downtime
- e) Consistent performance across all supported cell formats

Acceptance criteria:

- 1) The insertion mandrel, nest, and grippers are made of corrosion-resistant, battery-grade materials such as SUS304 and SUS316 to avoid metallic contamination.
- 2) The automated feeding hopper, centring mechanisms, and vision systems consistently align and transfer the jelly roll appropriately.
- 3) The optical sensors, pressure transducers, and rejection mechanisms should be enable properly for empty or misaligned rolls.
- 4) The separator must remain entirely intact without tearing or stretching during the high-speed insertion process.
- 5) Electrode layers and the jelly roll must able to maintain precise alignment (± 0.05 mm tolerance) during the push into the can, preventing internal short circuits.

9. All-in-one equipment (bottom welding, insulating sheet insertion, short circuit test, grooving, and laser welding (Top cap) for 18650, 21700, 32700 format cylindrical cells.

Scope of Supply:

The equipment shall be designed for fully automatic line suitable for the cylindrical 18650, 21700 and 32700 format cells to

- 1. bottom welding (Resistance spot welding)
- 2. Swaging
- 3. Add the insulation sheet,

4. Short-circuit test,
5. Grooving and
6. Laser welding cap, and gather.

This machine should be fully automated: the operator only needs to load and receive the battery, and the machine automatically completes a series of actions.

Working Process Flow:

- The inserted jelly roll from the insertion machine will be loaded into resistance spot welding manually, which will be fed to the bottom welding process automatically
- The extended tab from the jelly roll will be welded to the bottom of the can using resistance spot welding
- The weld joint will be tested by the pull strength testing process, and qualified cells will be moved to the insulation insertion process
- Short circuit test should be carried out before it moves to the grooving operation, and qualified cells will be moved to the grooving operation
- After the grooving operation, the cells will be moved for the cap welding operation using laser welding
- Laser welding should have nitrogen gas passage around laser. Air cooled fiber laser source

Main Functions

- a) Spot welding machine: discharge through the spot welding needle to complete the welding
- b) Short circuit tester: discharge to test short circuit
- c) Grooving machine: Set the speed through the motor to achieve the purpose of grooving
- a) Performance parameters such as grooving accuracy $\leq \pm 0.1$ mm.
- d) Laser welding: Tab to cap welding

Applicable Cell Formats:

The machine shall be suitable for the following cylindrical cell formats:

Tabbed Cylindrical Cells (Steel Shell)

18650

21700

32700

Tab Material Specifications

- a) Positive Terminal Tab
Material: Aluminium/Nickel
Thickness: 50µm – 300µm
- b) Negative Terminal Tab
Material: Copper/ Nickel-coated copper
Thickness: 50µm – 300µm

Terminal Tab Width:4-10 mm

Can Specifications

- c) Material: Nickel coated mild steel/Aluminium 3003
- d) Thickness: 0.3mm – 1mm

Mechanical & Process Parameters:

- a) Machine should also run by manual mode for optimization and setting
- b) Tooling mould service life: Minimum 500,000 cycles
- c) Production capacity: One cell per minute

Control System & Automation:

- a) PLC-controlled sequence logic
- b) Touchscreen HMI for:
- c) Operation control
- d) Parameter setting
- e) Recipe selection for different cell formats
- f) Real-time process monitoring
- g) Alarm and fault display

Other features

- 1) Tapping after insulation is inserted to align it properly
- 2) Hot ironing process before bottom resistance welding
- 3) Flattening of top cathode tabs so they are not interfering with copper electrode movement of resistance welding.
- 4) Proper alignment of tabs by optical sensor or by moving can with jelly roll in correct position by rotating it. So that cathode tabs exactly passes inside the hole of insulation sheet.
- 5) Swaging process after bottom resistance welding

Safety & Protection System

The machine shall be equipped with a comprehensive protection and safety system to ensure hassle-free and safe operation, including:

- i) Enclosed safety guarding with transparent panels
- j) Emergency stop buttons at accessible locations
- k) Safety interlocks on access doors
- l) Over-travel and overload protection
- m) Electrical grounding and insulation protection
- n) Air pressure drop alarm
- o) Automatic fault detection and error display on HMI
- p) Operation inhibited under unsafe conditions

Quality & Performance Requirements

- f) Smooth and damage-free operation
- g) No deformation of jelly roll, tabs, insulation, or steel shell
- h) Accurate and repeatable insulation placement
- i) Consistent performance across all supported cell format

Acceptance criteria:

Bottom welding:

- 1) The welding current must not penetrate the outer steel shell of the cell can.
- 2) The nickel plating on the outer surface must remain intact during process and excessive heat that leads to change in colour is a rejectable defect.
- 3) The tab pull strength must exceed >12 N per each weld point of tabs.

Insulating sheet insertion, short circuit test:

- 1) The insulation paper must be perfectly concentric with the cell's outer can.
The maximum allowable concentricity deviation can be ≤ 0.15 mm
- 2) The sheet must be heat resistant, free of residues.

Grooving:

- 1) The grooving operation must not compress or pierce the spiral-wound core.
- 2) The width of the groove determines the mechanical stability of the bead and the tolerance can be 1.0 to 1.2 (Max.)

Laser welding:

- 1) The weld seam must be continuous and welded portion should not have any cracks observed with microscope.
- 2) Weld depth must be controlled.
- 3) Zero tolerance for spattering during welding process.

**10. Semi-Automatic Electrolyte Filling Machine:
For Cylindrical and Prismatic Cells**

The Semi-Automatic Electrolyte Filling Machine shall be designed for accurate electrolyte dosing, vacuum standing, gas purging, in-situ weighing, and sealing preparation during lithium-ion cell assembly.

Cell feeding: Manual

All subsequent operations: Automatic

System Overview & Functions

- a) Quantitative electrolyte filling with high accuracy
- b) Single-stage vacuum standing and optional gas purging
- c) In-process weighing and verification
- d) CNC-controlled needle positioning (XYZ)
- e) Fully enclosed glove box with safety interlocks
- f) Recipe-based operation for multiple cell formats
- g) Data logging and alarm management

Detailed Technical Specifications – **Cylindrical Cells**

Cell Details

- a) Cell type: Cylindrical (with tab and tab-less type)
- b) Cell model: Crimping / welding
- c) Cell sizes: 18650, 21700, 32700, 32140, 4680, 6080
- d) Cell diameter: 18–60 mm
- e) Cell height: 60–160 mm
- f) Core diameter: 4–10 mm

Cell Holders

- a) Individual cell holder trays for each cell size (6 sizes)
- b) Number of cells per holder: 10–30 nos, depending on cell size

Detailed Technical Specifications – **Prismatic Cells**

- a) Proposed dimension for 100 Ah Prismatic cell size:
 - 1. 205 × 175 × 35 mm (H*W*T)
 - 2. Supplier must provide cell dimension as well as container suitable for the fabrication of 50Ah prismatic cells.
- b) Cell height: 100–250 mm
- c) Cell width: 10–35 mm or better

Electrolyte Specifications

- a) Electrolyte density: 1–1.5 g/cm³ or better
- b) Electrolyte type: Liquid electrolytes

Electrolyte Filling System

- a) Filling volume range: 0.5–500 g or better
- b) Filling accuracy: 1% or better
- c) Filling mode: Quantitative filling
- d) Needle material: SS316 (anti-corrosion)
- e) Flow control: PLC controlled
- f) Filling pump precision: 0.5% or better
- g) Number of filling pumps:
 - 2 pumps (1 for cylindrical, 1 for prismatic cells)
 - Electrolyte tank volume vary from 0. 200L to 2L & 5L
- h) Prismatic cell need two electrolyte injection process. One before formation and one after formation. Both electrolytes are having different chemistry. Hence we need two electrolyte tanks for two different electrolytes. One tank for 1st electrolyte injection and second tank for 2nd electrolyte injection
- i) One need additional tank for DEC (Diethylene carbonate to clean the piping before second electrolyte injection.
- j) In cylindrical cell (crimping type like 21700, 1865 and 32700) we have to put lid on the can and do pre-bending of can (not crimping) so that lid is positioned inside the can and prevents electrolyte spilling during transportation to crimping process.
- k) Electrolyte must be supplied in 5-120 L tank It has 3P connection. Nitrogen is pumped inside this main tank and then electrolyte flows outside from this

main tank to 5L electrolyte tank. It is also desirable to have vacuum pump connected with 5L tank so that electrolyte can be sucked from small bottle (coming from supplier like 5-20 L) to 5L tank

- l) Electrolyte tank need stirrer to prevent sedimentation.
- m) Directional control valve will be necessary to shift electrolyte coming from 1st tank or 2nd tank into the prismatic cell.

Vacuum, Purging & Weighing System

- a) Vacuum range: -0.09 MPa or better.
- b) Pressure range: 0 to 0.8 MPa or better
- c) Vacuum standing time: 1-99 seconds (adjustable)
- d) Vacuum mode: Single-stage vacuum standing
- e) Gas purging line: Provided
- f) Weighing module accuracy: 0.05 g or better
- g) Weighing module capacity: 6 kg or better

Needle Motion & Positioning System

- a) Filling needle movement: CNC-controlled XYZ drives
- b) Travel range:
 - X = 350 mm
 - Y = 250 mm
 - Z = 150 mm or better
- c) Movement accuracy: 0.05 mm or better
- d) Smooth motion control to prevent splashing or air entrainment

Control System & Automation

- a) PLC-based control architecture
- b) Touchscreen HMI for:
 - Operation and parameter setting
 - Recipe management for different cell formats
 - Real-time display of vacuum, filling quantity, and cycle status
- c) Data logging for:
 - Vacuum level
 - Filling quantity
 - Cycle count

Alarm & Fault Monitoring

- a) Low electrolyte level
- b) Vacuum leakage
- c) Overfilling
- d) System malfunction
- e) Door open status

Safety Features

- a) Emergency stop switch
- b) Door and glove-box interlock protection
- c) Electrolyte leakage detection and alarm

- d) Overpressure protection
- e) Anti-static grounding
- f) Chemical-resistant internal surfaces
- g) Automatic system shutdown under unsafe conditions

Quality & Performance Requirements:

- a) Accurate and repeatable electrolyte dosing
- b) No electrolyte leakage or contamination
- c) Stable vacuum standing performance
- d) Uniform filling across all supported cell formats
- e) Safe and reliable operation under cleanroom conditions
- f) FAT with Alcohol and SAT with water or alcohol. Density should be closer to actual electrolyte.

Acceptance criteria:

- 1) For a targeted fill volume of 1g - 500g, the filling volume accuracy must remain within $\pm 0.1\%$ per dose.
- 2) The vacuum system must create a vacuum of $\geq -98\text{kPa}$ to ensure effective outgassing and uniform electrolyte penetration into the cell windings or layers.
- 3) The machine must be equipped with ceramic or highly corrosion-resistant dosing pumps to prevent degradation when handling lithium-ion or other electrolyte formulations.
- 4) All components in direct contact with the electrolyte (tubing, nozzles, and pump seals) must be fabricated with inert materials like PTFE (Teflon), 316L SS to prevent corrosion and metallic contamination.
- 5) The machine should integrate with localized exhaust or have an enclosed housing to vent toxic corrosive vapours.
- 6) All cells must pass the strict weight tolerance checks after filling process.

11. Automatic Electrode Roll-to-Sheet Die Cutting Machine:

The Automatic Electrode Roll-to-Sheet Die Cutting Machine shall be designed for high-precision roll-to-sheet die cutting of battery cathode and anode electrodes. The system shall ensure accurate alignment, stable tension control, burr-free cutting, efficient waste removal, and precise stacking, suitable for laboratory, pilot, and small-scale production lines.

Scope of Supply:

The complete system shall include the following integrated modules:

- a) Automatic unwinding unit
- b) Auto correction / Edge Position Control (EPC) unit
- c) Electrode alignment and positioning unit
- d) High-precision die punching / cutting module
- e) Vacuum pick-and-place receiving and stacking unit
- f) Waste collection and extraction system
- g) Electrical control system with PLC & HMI
- h) Safety enclosure and interlock system

- i) All required accessories, tools, and documentation

Unwinding Unit

- a) Unwinding shaft: 3-inch pneumatic air shaft
- b) Shaft length: 350mm or better
- c) Maximum unwinding diameter: 500 mm
- d) Maximum unwinding weight: 100 kg
- e) Edge guiding accuracy: ≤ 0.1 mm (edge position sensors)
- f) Automatic tension stabilization with closed-loop control
- g) Smooth acceleration and deceleration to prevent electrode damage

Electrode Compatibility

The machine shall be suitable for die cutting electrodes made from the following materials:

- a) Cathode Materials
 - Lithium Iron Phosphate (LFP)
 - Lithium Cobalt Oxide (LCO)
 - Lithium Manganese Oxide (LMO)
 - Nickel Manganese Cobalt (NMC)
 - Sodium Vanadium Phosphate (NVP)
 - LMFP
- b) Anode Materials
 - Graphite
 - Hard Carbon
 - Lithium Titanate (LTO)
 - Si/C
- c) Electrode Thickness Range
 - Cathode electrode thickness: 50–300 μm
 - Anode electrode thickness: 50–300 μm
- d) Current Collector / Tab Foils
 - Aluminium foil thickness: 10–25 μm
 - Copper foil thickness: 4.5–12 μm

Feeding & Traction System

- a) Stepper / servo motor-controlled automatic traction
- b) Programmable electrode feeding length
- c) Feeding step accuracy: ± 0.1 mm
- d) Guide-plate and guide-wheel assembly
- e) Active anti-deviation mechanism to prevent electrode shift
- f) Stable feeding without wrinkles or slippage

Punching / Die Cutting Unit

- a) Upper and lower die punching structure
- b) Rigid, vibration-resistant die mounting frame
- c) Modular die pallet for fast die changeover
- d) Punching size capability: Max. 280 mm (incl. tab) $\times$ 240 mm (L $\times$ W)

- e) Die thickness: > 8 mm or better
- f) Two customized die tool sets (drawings to be provided at time of PO)
- g) Cutting accuracy: 0.05 mm or better
- h) Clean and burr-free cutting performance
- i) Two separate cutting moulds necessary. One for notching and then trimming.

Receiving & Stacking Unit

- b) Vacuum suction cup pick-up arrangement
- c) Precise X–Y placement using linear guide rods
- d) Left–right sequential stacking on receiving platform
- e) Stack misalignment: $\leq \pm 0.3$ mm
- f) Gentle handling to avoid deformation or surface damage

Waste Collection System

- a) Automatic scrap / waste removal from die-cut area
- b) Sealed waste collection bin
- c) Extraction blower for dust and scrap evacuation
- d) Prevents contamination of electrodes and work area
- e) Web cleaning and edge cleaning necessary after and before cutting process.
- f) Embossing on current collector area to make it stiffer. Separate station after notching. All electrodes now a days have texture creation on current collector to prevent bending and increase its stiffness. Especially necessary for aluminium.
- g) Dust collection system integrated in cutting process, web cleaning and edge cleaning area
- h) Dedicated dust collector system with fire extinguisher powder dispenser.

Safety & Protection Features

- a) Fully enclosed machine structure with aluminium profile or SS304 frame
- b) Transparent glass safety enclosure
- c) Safety grating at die cutting zone
- d) Door interlock system
- e) Emergency stop switches at accessible locations
- f) Overload protection for motors and pneumatic systems
- g) Electrical grounding and insulation protection

Other Technical Specifications

- a) Cutting lifetime: $\geq 300,000$ strokes per die
- b) Maximum feeding width: 300 mm
- c) Single-sheet cutting and stacking per cycle
- d) Stable long-term operation with minimal maintenance

Control System Requirements

- a) PLC-based automation control
- b) Touchscreen HMI user interface
- c) Real-time monitoring of:
 - Web tension
 - Feeding speed

- EPC alignment status
- d) Recipe management for different electrode sizes and formats
- e) Error and alarm notification via HMI
- f) Cycle counter and production statistics display

Quality & Performance Requirements:

- a) No burrs, cracks, or edge damage on electrodes
- b) Burr $\leq 7\mu$ in vertical
- c) Accurate and repeatable sheet dimensions
- d) Stable alignment and stacking consistency
- e) No wrinkles, scratches, or contamination
- f) Suitable for downstream stacking or cell assembly processes
- g) FAT with paper and SAT with anode and cathode electrode

Acceptance criteria:

- a) The equipment should meet all the mentioned specifications
- b) Operations should be burr-free, edge damage and tear-free
- c) Accurate and repeatable electrode sheet dimensions after blanking
- d) The electrode stacking alignment should be $\leq \pm 0.3$ mm
- e) SAT with anode and cathode electrodes as per the specifications
- f) Feeding step accuracy: ± 0.1 mm
- g) Cutting accuracy: 0.05 mm or better

12. Automatic Electrode Stacking Machine:

For Large-Format Prismatic Cells:

The Automatic Stacking Machine shall be designed for fully automatic, high-precision stacking of cathode, anode, and separator sheets to form electrode stacks for large-format prismatic and pouch cells.

The system shall ensure accurate alignment, repeatable layer positioning, gentle handling of coated electrodes, and stable stack formation, suitable for production environments.

Stackable Electrode Specifications

- a) Minimum electrode size: 120 × 80 mm or better
- b) Maximum electrode size: 250 × 200 mm or better
- c) Cathode electrode thickness: 50–300 μ m
- d) Anode electrode thickness: 50–300 μ m
- e) Maximum stacked thickness: 35 mm or better
- f) Maximum stacking layers: 200 or more layers
- g) Stacking speed: ~ 2 seconds per layer
- g) Cathode -Anode alignment tolerance should be $\leq \pm 0.2$ mm

Separator Feeding Unit

- a) Unreeling rotor for separator film feeding
- b) Automatic closed-loop tension control
- c) Precise separator cutting and positioning mechanism
- d) Separator feeding shaft: 3-inch pneumatic air shaft
- e) Air shaft length: 250 mm

- f) Smooth separator transport without wrinkles or misalignment

Electrode Pick-Up & Stacking Mechanism

- a) Vacuum suction manipulator for electrode sheet pick-up
- b) High-response servo motors for positioning and motion control
- c) Precision mechanical fixtures for consistent electrode alignment
- d) Non-contact handling to prevent damage to coated electrode surfaces
- e) Accurate layer-to-layer alignment to ensure stack integrity

Additional:

Dust removal and electrostatic removal should be included.

Vacuum System

- a) Built-in oil-less/dry vacuum pump
- b) Stable and uniform suction for high-speed pick-and-place operation
- c) Vacuum pressure monitoring with alarm indication

Required Operation Sequence:

- a) Manual Loading
Operator manually loads cathode and anode sheets onto the sample tray
- b) Parameter Setting
Stacking layer number and process parameters set through PLC/HMI
- c) Automatic Stacking
Machine automatically picks electrodes and separator sheets
Alternating stacking of cathode, separator, and anode layers
- d) Post-Stacking Operations
Automatic separator cut-off
Automatic taping on both sides of the electrode stack
- e) Automatic pick-and-place of the finished (stacked) jelly stack onto the output tray
- f) Vibration to be given to electrode before picking to remove double electrode pickup.
- g) After stacking there will be minimum seven tapes. Two on each sides and one between tabs.
- h) Hot/normal pressing and hipot test should be included after taping
- i) Separator trimming by hot wire method

Control System & Automation:

- a) PLC-based automation control system
- b) Touchscreen HMI for:
Operation control
Parameter and recipe setting
Layer count monitoring
Real-time process status display
- c) Servo motor synchronization for stacking accuracy
- d) Alarm and fault display on HMI

- e) One CCD camera on cathode alignment table and one more on anode alignment table is mandate to control stacking accuracy.

Protection & Safety System

- a) Emergency stop switches at accessible locations
- b) Over-travel protection for all moving axes
- c) Overload protection for motors and vacuum system
- d) Safety door with interlocking mechanism
- e) Alarm system for abnormal conditions, including:
 - Vacuum failure
 - Positioning error
 - Separator feed error
 - Servo or system fault

Quality & Performance Requirements:

- a) Accurate electrode and separator alignment throughout the stack
- b) No wrinkles, scratches, or coating damage
- c) Uniform stack thickness and stable structure
- d) Repeatable stacking accuracy across multiple batches
- e) Suitable stack quality for downstream pouch or prismatic cell assembly

Machine Construction

- a) Rigid, vibration-resistant machine frame
- b) Precision linear guides and bearings
- c) Cleanroom-compatible design and materials
- d) Low particle generation during operation

High potential test to be carried out after stacking (to be added along with the system)

Acceptance Criteria:

Equipment to be demonstrated as per the technical specifications mentioned

The electrode stacking machine shall meet the following performance requirements:

- a) Stable and repeatable stacking performance for the specified cell formats
- b) Uniform and consistent stacking without looseness or misalignment
- c) No damage, tearing, or deformation of electrodes, separator, or protective tape during stacking
- d) Accurate control of stacking tension, alignment
- e) Effective detection and rejection of short circuit, and electrode dislocation conditions
- f) All process parameters shall be adjustable and displayed in real time through the HMI
- g) Short-circuit test on stacking with digital megger at ~500 V to show the resistance in $G\Omega$
- h) Output should be greater than or equal to 10 PPM with rejection rate of 5%
- i) Cathode -Anode alignment tolerance should be $\leq \pm 0.2$ mm

13. Tab-to-Lead Ultrasonic Welding Machine:

(For Prismatic Cells)

1. General Description

- a) The equipment shall be a high-precision ultrasonic welding machine designed for reliable welding between:
Positive aluminium terminal tabs and aluminium current collector foils, and
Negative terminal tabs (nickel / nickel-coated copper / copper) and copper current collector foils
- b) The machine shall be suitable for prismatic lithium-ion battery jelly roll assemblies, ensuring low electrical resistance, high mechanical strength, and consistent weld quality without foil damage.

2. Tab Material Specifications

- a) Positive Terminal Tab
 - a. Material: Aluminium
 - b. Thickness: 0.1–0.5 mm
- b) Negative Terminal Tab
 - a. Material: Nickel / Nickel-coated copper / Copper
 - b. Thickness: 0.1–0.5 mm
- c) Terminal Tab Width: 15–40 mm

3. Current Collector Foil Specifications

- a) Aluminium foil thickness: 10–25 μm
- b) Copper foil thickness: 4.5–20 μm
- c) Maximum number of foils per weld: 60 layers

4. Stacked Jelly Roll Specifications

- a) Jelly roll length: 100–250 mm
- b) Jelly roll width: 150–300 mm
- c) Jelly roll thickness: 10–30 mm

5. Ultrasonic Welding Unit Specifications

- a) Welding mode: Energy / Frequency mode
- b) Welding frequency: 40 kHz $\pm 10\%$
- c) Welding time range: 0–60 s
- d) Welding tension (clamping force): $\geq 300\text{ N}$
- e) Welding Area (Anvil & Horn)
 - Welding area: Customized
 - Welding area length: 15–40 mm
 - Welding area width: 3–4 mm
- f) Welding Tool Life
 - Welding surface usage: $\sim 100,000$ cycles
 - Welding head material: Wear-resistant, high-strength alloy suitable for ultrasonic applications

6. Welding Platform

- a) Customized welding platform compatible with two jelly roll sizes
- b) Platform sizes shall fall within the specified jelly roll dimensional range

For Prismatic Cell with top terminal:

- c) Pre ultrasonic welding of current collector foil needs to be done first followed by final trimming of current collector foil.
- d) Final Ultrasonic welding of current collector with tab, whether it is one jelly roll or two jelly roll, as in the form of butterfly welding

7. Control System & Process Capabilities

- a) Digital ultrasonic generator with real-time control
- b) Automatic frequency tracking
- c) Constant voltage control ensuring stable output power and working frequency
- d) Up to 20 welding parameters programmable and stored for different welding recipes
- e) Adjustable welding time, energy, welding tension ($\sim >70$ N) between tab and foil, and pressure parameters

8. Additional features:

- 1. Dedicated dust collector with fire extinguisher powder sprinkler is needed. Powder will be sprinkles in dust collector, once temperature increases
- 2. Collection of dust both in ultrasonic welding and trimming process by negative suction
- 3. Start of ultrasonic weld will be done by pressing two buttons apart. That means both hands will be used. This is important for safety.
- 4. Weld head should be designed such that it can be rotated and used multiple times. That means weld profile is available on welding head at opposite surface or at four adjacent surfaces. Welding head can be rotated 90 degrees or 180 degrees to bring new weld profile.
- 5. Separate trimming station for anode and cathode to avoid particle contamination. This trimming cutter also should operate with two buttons so both hands to be used to press start button.
- 6. Fixture should cover all the areas other than weld areas.

9. Electrical & Power Protection Features

- a) Voltage protection system
- b) Overload protection system
- c) Overcurrent protection
- d) Automatic compensation for unstable power supply frequency
- e) Welding overload protection signal feedback with alarm indication

10. Safety & Interlock Features

- a) Emergency stop switch
- b) Electrical isolation and grounding protection
- c) Welding head overload protection

- d) Audible and visual alarm for abnormal operating conditions
- e) Operator-safe enclosure with appropriate insulation
- 11. Acceptance Criteria
 - a) The machine shall meet the following performance requirements:
 - b) Stable and repeatable welding performance
 - c) No foil tearing or deformation during welding
 - d) Automatic frequency tracking during welding process
 - e) High electrical conductivity after welding
 - f) Weld joint resistance close to zero
 - g) Adjustable welding time and energy
 - h) Strong metallurgical bonding between tab and foils

14. Laser Welding Machine for Prismatic Cells (Top Lid Sealing & Filling Port Welding)

- 1. General Description
 - a) The equipment shall be a high-precision laser welding system designed for hermetic sealing of prismatic and cylindrical lithium-ion battery cells. The system shall ensure gas-tight sealing, structural integrity, and long-term safety of the final assembled cell.
 - b) The machine shall perform the following operations:
 - Top Lid Pre-Welding (Tack Welding)
 - Top Lid Full Welding (Final Seam Welding)
 - Filling Port (Electrolyte Hole) Welding
- 2. Application Scope
 - a) Cell Formats Supported
 - b) Prismatic Cells
 - Size range:
 - Height: 100–250 mm
 - Width: 60–200 mm
 - Thickness: 10–35 mm
 - c) Cell Can & Port Materials
 - Aluminium alloy
 - Nickel-coated mild steel
- 3. Process Description
 - 3.1 Top Lid Welding Process
 - d) Manual loading of the cell into the welding fixture
 - e) Automatic fixture clamping
 - f) CCD vision system locates the welding contour
 - g) Laser pre-welding (tack weld) around the lid
 - h) Laser full seam welding (final weld)
 - i) Welding parameters automatically recorded
 - j) Manual unloading after cycle completion

3.2 Filling Port Welding Process

- a) Manual loading of the cell with filling port exposed
- b) Automatic fixture clamping
- c) Operator places the filling nail / plug
- d) Laser performs circumferential welding
- e) CCD vision system verifies weld position
- f) Manual unloading after completion

4. Laser & Welding System Specifications

- a) Laser source: 450 / 4500 W QCW Fiber Laser or better
- b) Welding head: Wobbler laser welding head
- c) Welding mechanism: 6-axis custom welding system
- d) Vision system: CCD-based positioning and inspection
- e) Welding depth capability: 3 mm or better

5. Motion & Mechanical Specifications

- a) 6 axis travel
- b) Travel size (X × Y): 300 × 300 mm
- c) Travel size (Z axis): 350 mm
- d) Rotary chuck holding size: 10–80 mm diameter (for cylindrical cells), For rectangular cells (user customization and dimensions will provide after P.O.)
- e) Position accuracy: ±0.2 mm
- f) XY axis speed: 0–35 mm/sec or better
- g) Rotary axis speed: 0–180°/sec

6. Welding Environment & Auxiliary Systems

- a) Welding gas flow direction: Automatic
- b) Shielding gas compatibility: Argon / Nitrogen
- c) Integrated fume extraction system
- d) Closed laser-safe enclosure with viewing window

7. Fixtures & Tooling

- a) Upper cap welding fixture for customized cell formats:
 - 1 prismatic cell size
- b) Dedicated filling port welding fixture

8. Welding Accuracy & Quality Requirements

- a) Positioning accuracy: ±0.1 mm
- b) Repeatability: ±0.1 mm
- c) Weld Quality Criteria
 - No porosity
 - No undercut
 - No spatter
 - No micro-cracks
 - Seam must be continuous, smooth, and uniform
 - Filler nail welded without distortion

- d) Hermetic Sealing Performance
 - Leakage rate: $\leq 1 \times 10^{-7} \text{ Pa}\cdot\text{m}^3/\text{s}$
 - Waterproof and gas-tight sealing required
 - Helium detector to test the leakage to be included
- 9. Control System
 - a) PLC-based automatic control system (branded PLC)
 - b) Industrial HMI with recipe-based operation
 - c) Real-Time Monitoring Parameters
 - Laser power
 - Welding speed
 - Cooling system temperature
 - Vision system alignment status
- 10. Alarm & Interlock Functions
 - a) Laser interlock alarm
 - b) Cooling system alarm
 - c) Door open / safety interlock alarm
 - d) Axis travel limit alarm
 - e) Fume extraction system fault alarm
- 11. Data Logging & Recipe Management
 - a) Data logging of:
 - Laser power
 - Welding speed
 - Seam patterns
 - Weld history and timestamps
 - b) Exportable weld data for quality traceability
- 12. Safety Features
 - a) Class-1 laser safety enclosure
 - b) Emergency stop switches
 - c) Door safety interlocks
 - d) Laser radiation shielding
 - e) Electrical grounding and isolation protection
- 13. Perform the following process

Following laser welding are necessary for tabless cylindrical welding of 32140, 4680 and 6080

 - a) Laser welding of cathode flat tabs with aluminium plate
 - b) Bottom laser welding of flat aluminium current collector or aluminium plate to can bottom housing
 - c) Top copper plate to anode current collector
 - d) Top lid to can.

Following laser welding are necessary for prismatic welding with top terminal

 - a) Copper current collector will be laser welded by laser spot welding after ultrasonic welding to give higher welding strength (preferably Green laser)
 - b) Tab welded to current collector. Copper tab to (already ultrasonic and may be also laser welded) current collector (preferably green laser)

- c) Tab welded to current collector. Aluminium tab to cathode (already ultrasonic welded) current collector.
- d) Butterfly welding where tab is welded with terminal in bracket
- e) Lid to case tack laser welding
- f) Lid to case final laser welding (preferably pulse type)

Acceptance Criteria:

- a) Equipment to be demonstrated as per the technical specifications mentioned
- b) The equipment should support all format cells
- c) Welding should be without porosity, undercut, spatter and micro-cracks
- d) Leakage rate should be $\leq 1 \times 10^{-7} \text{ Pa}\cdot\text{m}^3/\text{s}$
- e) CNC position accuracy should be: $\pm 0.2 \text{ mm}$

15. Vacuum Flat Oven (3-Layer Chamber Type) (For Electrode / Cell Drying Applications)

1. Scope of Supply

Supply, installation, testing, and commissioning of a high-vacuum flat oven designed for battery electrode and cell drying under controlled temperature, vacuum, and inert atmosphere conditions.

The system shall be equipped with:

- a) Stainless steel inner chambers
- b) Independent multi-layer chamber operation**
- c) Automatic heating, vacuuming, and nitrogen filling cycles
- d) PLC + touchscreen control system
- e) High-efficiency hot-air circulation
- f) High pressure-holding performance
- g) Comprehensive safety protection system

2. Inner Chamber Design

- a) Number of chambers: 3-layer flat chamber configuration
- b) Inner chamber material: Stainless steel
- c) Inner chamber thickness: 3 mm or better
- d) High durability and corrosion resistance suitable for electrolyte exposure
- e) Inner chamber dimensions (each layer):
 $\geq W600 \times D900 \times H300 \text{ mm}$ or better
- f) Each chamber shall be fully independent, allowing:
Separate temperature control
Separate vacuum control
Separate nitrogen purging

3. Heating & Hot-Air Circulation System

- a) Heating element material: 304 stainless steel heating tubes
- b) Heating tube arrangement: Surrounding the inner chamber for uniform heating
- c) Hot-air circulation type: High-efficiency flow-blast circulation
- d) Performance Objectives

Faster heating rate
Faster heat dissipation
Improved temperature uniformity across the chamber
Uniform temperature rise ensured by controlled hot-air flow

4. Door & Sealing Structure

- a) Sealing material: Silicone rubber sealing strip suitable for high-vacuum operation
- b) Door type:
15 mm thick tempered glass door
Each chamber equipped with an observation window
- c) Door structure:
Elastic double-glass door design
Over-pressure protection mechanism for safety
- d) Universal fixture to hold coil up to 500 mm diameter should be supplied along with this equipment

5. Mobility

- a) Equipped with heavy-duty universal castor wheels
- b) Designed for easy movement and positioning within the laboratory or pilot line

6. Functional Features

6.1 Automatic Vacuum & Nitrogen Cycle

- a) Text-controlled (PLC-controlled) valves for vacuum and nitrogen filling
- b) Fully automatic programmable cycle for:
Heating
Vacuuming
Nitrogen filling
- c) High operational efficiency with reduced manpower requirement

6.2 Temperature Control

- a) Temperature range: RT to 150 °C (adjustable)
- b) Temperature control accuracy: ± 3 °C
- c) Control algorithm: PID-based temperature control for precise regulation

6.3 Vacuum Performance

- a) Ultimate vacuum level: -0.98 kPa
- b) Vacuum holding capability:
- c) $\geq 98\%$ retention after 48 hours
- d) Vacuum pump with suitable capacity should be delivered together with equipment.
- e) Ducting should be connected to outside to remove water vapour for anode and NMP vapour for cathode

7. Control System

- a) Centralized control: PLC + HMI touchscreen interface
- b) Real-time monitoring and display of:
Chamber temperature

- Vacuum level
- Nitrogen filling cycles
- c) Independent parameter setting for each chamber
- d) Automated alarm handling and safety interlocks

8. Safety & Protection System

- a) Over-temperature protection
- b) Over-pressure protection
- c) Vacuum abnormality alarm
- d) Door safety interlock
- e) Emergency stop function
- f) Electrical grounding and insulation protection

Acceptance criteria:

- Temperature range: Ambient to 150 °C.
- Temperature control accuracy: ± 3 °C.
- Temperature uniformity: ± 5 °C at 120 °C.
- Ultimate vacuum level: ≤ -0.98 bar (gauge) or equivalent.
- Vacuum retention: $\geq 98\%$ after 48 hours.
- Successful demonstration of fully automatic PLC-controlled heating, vacuuming, and nitrogen filling cycle.
- Functional demonstration of (i) Over-temperature protection, (ii) Vacuum abnormality alarm, (iii) Over-pressure protection, (iv) Door interlock, and (v) Emergency stop.

16. Vacuum Flat Oven (Single Chamber)

(For Lithium-Ion Electrode Powder Conditioning)

1. Scope of Supply

Supply, installation, testing, and commissioning of a single-chamber high-vacuum flat oven suitable for conditioning and drying of lithium-ion electrode powders under controlled temperature, vacuum, and inert atmosphere conditions.

The system shall include:

- a) Stainless steel inner chamber
- b) Automatic heating, vacuuming, and nitrogen filling
- c) PLC + touchscreen control system
- d) High-efficiency hot-air circulation
- e) High pressure-holding performance
- f) Integrated safety protection system

2. Inner Chamber Design

- a) Chamber configuration: Single stainless steel inner chamber
- b) Chamber wall thickness: 3 mm or better
- c) Material characteristics: High durability and corrosion resistance
- d) Inner chamber dimensions: $\geq W600 \times D900 \times H600$ mm or better
- e) Internal fixtures:

- f) Removable stainless-steel trays – 2 Nos
- g) Trays suitable for uniform powder spreading and easy cleaning

3. Heating & Hot-Air Circulation System

- a) Heating element material: 304 stainless steel heating tubes
- b) Heating tube arrangement: Surrounding the inner chamber to ensure uniform heating
- c) Air circulation type: High-efficiency flow-blast hot-air circulation

Performance Objectives

- a) Faster heating rate
- b) Faster heat dissipation
- c) Improved temperature uniformity throughout the chamber
- d) Uniform temperature rise ensured by controlled hot-air flow

4. Door & Sealing Structure

- a) Sealing method: Silicone rubber sealing strip suitable for high-vacuum operation
- b) Door construction:
 - 15 mm thick tempered glass door
 - Integrated observation window for process monitoring
- c) Door structure:
 - Elastic double-glass design
 - Over-pressure protection for safe operation

5. Mobility

- a) Equipped with heavy-duty universal castor wheels
- b) Designed for easy movement and positioning within laboratory or pilot-scale facilities

6. Functional Features

6.1 Automatic Vacuum & Nitrogen Cycle

- a) PLC-controlled (text-controlled) valves for vacuum and nitrogen filling
- b) Fully automatic programmable cycle for:
 - Heating
 - Vacuuming
 - Nitrogen gas filling

6.2 Temperature Control

- a) Operating temperature range: RT to 150 °C (adjustable)
- b) Temperature control accuracy: ± 3 °C
- c) Control method: PID-based temperature regulation for precise and stable control

6.3 Vacuum Performance

- a) Ultimate vacuum level: -0.98 kPa
- b) Vacuum holding capability:

≥98% retention after 48 hours at

7. Control System

- a) Control architecture: PLC + HMI touchscreen centralized control
- b) Real-time monitoring and display of:

Chamber temperature

Vacuum level, Nitrogen filling cycles

- c) Recipe-based operation for different powder conditioning processes
- d) Automated alarm handling and safety logic

8. Safety & Protection System

- a) Over-temperature protection
- b) Over-pressure protection
- c) Vacuum abnormality alarm
- d) Door safety interlock
- e) Emergency stop switch
- f) Electrical grounding and insulation protection
- g) Power-failure recovery protection
- h) Ducting should be provided
- i) Filtration should be provided so spill powder can be collected

Acceptance criteria:

- Temperature range: Ambient to 150 °C.
- Temperature control accuracy: ± 3 °C.
- Temperature uniformity: ± 5 °C at 120 °C.
- Ultimate vacuum level: ≤ -0.98 bar (gauge) or equivalent.
- Vacuum retention: $\geq 98\%$ after 48 hours.
- Successful demonstration of fully automatic PLC-controlled heating, vacuuming, and nitrogen filling cycle.
- Functional demonstration of (i) Over-temperature protection, (ii) Vacuum abnormality alarm, (iii) Over-pressure protection, (iv) Door interlock, and (v) Emergency stop.
- Functional demonstration of ducting and filtration system
- Powder collection filter shall effectively prevent powder carry-over during vacuum operation.

17. Precision Weighing Machine

(For Lithium-Ion Battery Powder Materials)

1. Scope of Supply

Supply, installation, testing, and commissioning of a precision weighing machine suitable for accurate measurement of lithium-ion battery powder materials in laboratory and pilot-scale battery manufacturing environments.

The system shall be designed to provide high accuracy, repeatability, and digital connectivity for data recording and process traceability.

2. Technical Specifications

a) Weighing Performance

Balance type: Precision balance

Maximum capacity: 15 kg

Minimum weight: 10 g or better

Readability (resolution): 10 mg (0.01 g) or better

Repeatability: As per manufacturer standard for given readability

Stabilization (settling) time: 2 seconds or better

Adjustment: Automatic internal calibration

Linearity: As per manufacturer specification

b) Mechanical & Display

Display type: Touchscreen display

User interface: Intuitive menu-driven operation

Weighing pan material: Corrosion-resistant stainless steel

Weighing pan size: 175 × 200 mm (W × D) or better

Overload protection: Mechanical and electronic overload protection

3. Interface & Communication

The balance shall be equipped with the following interfaces for data transfer and integration:

Ethernet

USB

Bluetooth

Accessories:

All required interface cables and connectors shall be supplied along with the equipment

4. Functional Features

a) Multiple weighing units (g, kg, etc.)

b) Tare and zero functions

c) Stability indication

d) Data output for external systems (PC/LIMS/PLC)

e) Suitable for fine and bulk powder weighing

5. Environmental & Installation Conditions (Standard)

a) Operating environment: Laboratory / clean dry room

b) Ambient temperature: Stable room temperature conditions

c) Relative humidity: Non-condensing

d) Provide an anti-vibration sheet to be placed below weighing machine or legs should be anti vibration

6. Safety & Protection

a) Electrical grounding protection

b) Overload and shock protection

c) Password-protected settings (if supported by manufacturer)

7. Calibration & Compliance

a) Automatic internal calibration system

b) External calibration support (optional)

- c) Calibration certificate traceable to national/international standards
- d) Compliance with applicable electrical and metrology standards

18. Negative Pressure Formation Machine (5 V, 50 A, 64 Channels) for Prismatic Cells

Scope of Supply:

Design, supply, installation, testing, and commissioning of a 5 V, 50 A, 64-channel negative-pressure formation machine suitable for prismatic Lithium-ion and Sodium-ion battery cells, including formation under controlled high-temperature and negative-pressure conditions.

1. Application and Equipment Function

The negative-pressure formation machine shall be used for electrochemical formation of prismatic battery cells under:

High temperature: 30–50 °C

Negative pressure: 10–95 kPa

The system shall:

Accelerate battery activation during formation

Enable vacuum extraction of internal gases during formation

Reduce formation time

Shorten the overall battery production cycle

2. Battery Compatibility

The equipment shall be suitable for formation of prismatic cells for:

Lithium-ion batteries

Sodium-ion batteries

Li-S Batteries

3. Electrical Channel Specifications

Number of channels: 64 channels

Rated channel capacity: 5 V / 50 A per channel

Voltage Parameters:

Charging voltage setting range: DC 0–5 V

Discharge voltage setting range: DC 5–0.7 V

Voltage accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$

Voltage resolution: 1 mV

Voltage stability: $\leq 0.1\%$

Current Parameters:

Charging and discharging current range: DC 0.05–50 A

Current accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$

Current resolution: 1 mA

Current stability: $\leq 0.1\%$

Power and Energy Performance

Power accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$

Charging energy-saving efficiency: 80% or better

Discharge energy feedback efficiency: up to 78%

4. Time and Recording Specifications

Time setting range: 0–9999 minutes

Time units: h / min / s

Time resolution: 0.1 s

Time accuracy: $\leq \pm 0.1\%$

Data Recording

Recording modes:

Charging

Discharging

Static

Global recording time

Recording frequency: 100 ms to 2 hours or better

5. Charging and Discharging Functions

Charging Modes:

Constant current with voltage limit

Constant current and constant voltage

Constant power charging

Charging Cut-off Conditions

Voltage

Current

Time

Capacity

Temperature

Discharge Modes:

Constant current discharge

Constant power discharge

Discharge Cut-off Conditions

Voltage

Current

Time

Capacity

Temperature

6. Process Programming Capability

Maximum steps per single cycle: ≤ 100 steps

Nested cycle programming capability

Flexible multi-step formation profiles supported

7. Continuous Operation Capability

Equipment shall support full-load operation across all channels

Designed for 365 days $\times$ 24 hours uninterrupted continuous operation

8. Software and Control System Requirements

The system shall be supplied with dedicated formation control software with the following capabilities:

Support for:

- ✓ Manual pause connection
- ✓ Software shutdown connection
- ✓ Power interruption recovery
- ✓ Equipment communication interruption recovery
- ✓ Abnormal stop handling

Local storage of detailed test data for:

- ✓ Real-time channel monitoring
- ✓ Historical data review per channel

Battery capacity sorting and grade classification

Comprehensive protection features:

- ✓ Work-step protection
- ✓ Global abnormal voltage protection
- ✓ Global abnormal current protection
- ✓ Global abnormal temperature protection

Abnormal condition alarm and notification

Support for channel parallel connection (optional, depending on configuration)

Software offline protection

Free software upgrades

Automatic process recovery:

- a) In case of communication interruption or PC failure, the equipment shall enter a safe waiting state
- b) Upon restoration of communication, the system shall continue the current process automatically

9. Vacuum System Specifications and other requirements:

- a) Achievable vacuum range: -1 kPa to -95 kPa
- b) Vacuum setting resolution: ± 0.01 Pa
- c) Vacuum system shall support stable and uniform negative pressure during formation
- d) Keep vacuum cups (Trap) just above electrolyte injection port. Vacuum is applied locally on injection hole so gas will be sucked by negative pressure. Vacuum cups would be holding electrolyte in case of electrolyte would also come out of the cell due to negative suction.
- e) Uniform compression upto 3 bar is applied on sides
- f) Temperature in chamber should be kept constant during formation at set temperature
- g) Fixture is needed to hold prismatic cell. This fixture will give compressive force, negative suction through vacuum pumps and also constant temperature to the cell. In addition, it will have temperature sensor near anode electrode to monitor the rise in temperature

- h) Provide options for electricity energy during discharge can be collected and can be transported to grid or can be saved in storage battery. Keep it as optional.
- i) A tray should be provided in the chamber to load and unload the fixture.

10. Structural and Material Requirements

Overall machine structure shall be manufactured from specially treated materials

Materials shall be:

- a) Corrosion resistant
- b) High-temperature resistant

Suitable for long-term operation under vacuum and elevated temperature conditions

11. Safety & Protection System

Electrical protection against:

- a) Overload
- b) Short circuit
- c) Over-voltage and over-current

Emergency stop system for immediate shutdown

- a) Software-based safety interlocks and fault protection
- b) Automatic alarm generation for abnormal voltage, current, temperature, and vacuum conditions
- c) Safe shutdown and recovery logic integrated within the control system

12. Acceptance Criteria

- a) The negative-pressure formation machine shall meet the following performance requirements:
- b) Stable and repeatable formation performance across all 64 channels
- c) Accurate control of voltage, current, power, temperature, and vacuum parameters
- d) Reliable operation under specified high-temperature and negative-pressure conditions
- e) No abnormal interruption during continuous long-term operation
- f) Correct execution of programmed charging and discharging profiles
- g) Effective vacuum extraction throughout the formation process
- h) Accurate data recording, storage, and retrieval for each channel
- i) Functional safety systems, alarms, and protection mechanisms
- j) Successful completion of formation cycles as per programmed parameters without data loss

19. Formation Tester (5 V, 20 A, 128 Channels) for Cylindrical Cells

Scope of Supply:

Design, supply, installation, testing, and commissioning of a 5 V, 20 A, 128-channel battery formation tester suitable for cylindrical Lithium-ion and Sodium-ion battery cells of formats 18650, 21700, 32700, 32140, 4680, and 6080.

1. Application and Equipment Function

The formation tester shall be used for electrochemical formation and initial charge–discharge cycling of cylindrical battery cells.

The system shall:

- Perform precise formation charging and discharging
- Support programmable multi-step formation profiles
- Enable long-term, continuous formation operation
- Support capacity evaluation, grading, and data recording for each channel

2. Battery Compatibility

The equipment shall be suitable for cylindrical cells of the following formats:

- 18650
- 21700
- 32700
- 32140
- 4680
- 6080

Applicable battery chemistries:

- a) Lithium-ion batteries
- b) Sodium-ion batteries
- c) Li-S Batteries

3. Electrical Channel Specifications

- a) Number of channels: 128 channels
- b) Rated channel capacity: 5 V / 20 A per channel

Voltage Parameters:

- a) Charging voltage setting range: DC 0–5 V
- b) Discharge voltage setting range: DC 5–0.7 V
- c) Voltage accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
- d) Voltage resolution: 1 mV
- e) Voltage stability: $\leq 0.1\%$

Current Parameters:

- a) Charging and discharging current range: DC 0.05–20 A
- b) Current accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
- c) Current resolution: 1 mA
- d) Current stability: $\leq 0.1\%$

- e) Power and Energy Performance
- f) Power accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
- g) Charging energy-saving efficiency: 80% or better
- h) Discharge energy feedback efficiency: up to 78%

4. Time and Recording Specifications

- a) Time Control:
- b) Time setting range: 0–9999 minutes
- c) Time units: h / min / s
- d) Time resolution: 0.1 s
- e) Time accuracy: $\leq \pm 0.1\%$

Data Recording:

- a) Recording modes:
- b) Charging
- c) Discharging
- d) Static
- e) Global recording time
- f) Recording frequency: 100 ms to 2 hours or better

5. Charging and Discharging Functions

- a) Charging Modes
- b) Constant current with voltage limit
- c) Constant current and constant voltage
- d) Constant power charging

Charging cut-off conditions:

- a) Voltage
- b) Current
- c) Time
- d) Capacity
- e) Temperature

Discharge Modes

- a) Constant current discharge
- b) Constant power discharge

Discharge cut-off conditions:

- a) Voltage
- b) Current
- c) Time
- d) Capacity
- e) Temperature

6. Process Programming Capability

- a) Maximum steps per single cycle: ≤ 100 steps

- b) Nested cycle programming supported
- c) Flexible multi-step formation and cycling profiles

7. Continuous Operation Capability

- a) Equipment shall support full-load operation across all 128 channels
- b) Designed for 365 days × 24 hours uninterrupted continuous operation

8. Other Requirements:

- a) Adjustable trays for different kind of cylindrical cells.
- b) Current Probes should be adjustable in X, Y and Z direction
- c) Beryllium Gold probe should break oxide film and hence spring should have enough force to break the oxide film.
- d) Temperature sensor connected with nitrogen gas spray.
- e) Electricity energy during discharge can be collected and can be transported to grid or can be saved in storage battery. Keep it as optional cost

8. Software and Control System Requirements

The system shall be supplied with dedicated formation control software with the following features:

Connectivity and Recovery Functions

- a) Manual pause connection
- b) Software shutdown connection
- c) Power interruption recovery
- d) Equipment communication interruption recovery
- e) Abnormal stop handling

Data Management

- a) Local storage of detailed test data
- b) Real-time monitoring of each channel
- c) Historical data review for each channel

Quality and Protection Functions

- a) Battery capacity sorting and grade classification
- b) Work-step protection
- c) Global abnormal voltage protection
- d) Global abnormal current protection
- e) Global abnormal temperature protection
- f) Automatic abnormal alarm indication

Additional Software Features:

- a) Support for channel parallel connection (optional, depending on configuration)
- b) Software offline protection
- c) Free software upgrades

Automatic Process Recovery:

- a) In case of communication interruption or PC failure, the equipment shall automatically enter a safe waiting state
- b) Upon restoration of communication, the system shall automatically continue the ongoing process

9. Structural and Material Requirements

- a) Overall machine structure shall be manufactured from specially treated materials
- b) Materials shall be:
- c) Corrosion resistant
- d) High-temperature resistant
- e) Suitable for long-term continuous operation

10. Safety & Protection System

- a) Electrical protection against:
- b) Overload
- c) Short circuit
- d) Over-voltage and over-current
- e) Emergency stop system for immediate shutdown
- f) Software-based safety interlocks and fault protection
- g) Automatic alarm generation for abnormal voltage, current, and temperature conditions
- h) Safe shutdown and recovery logic integrated within the control system

11. Acceptance Criteria

- a) The formation tester shall meet the following performance requirements:
- b) Stable and repeatable formation performance across all 128 channels
- c) Accurate control of voltage, current, power, and time parameters
- d) Correct execution of programmed charging and discharging profiles
- e) Reliable operation during long-term continuous use
- f) Accurate data recording, storage, and retrieval for each channel
- g) Effective capacity measurement and grading functionality
- h) Functional safety systems, alarms, and protection mechanisms
- i) No abnormal interruption during continuous operation
- j) Successful completion of formation cycles as per programmed parameters without data loss

20. Hot Press Formation Machine Pouch Cell Formation / Aging System (5 V, 15–30A, 64-Channels)

Scope of Supply:

Design, supply, installation, testing, and commissioning of a multi-channel pouch cell formation and aging system suitable for Lithium-ion and Sodium-ion battery pouch cells, supporting controlled charging, discharging, formation, and aging processes with high accuracy and long-term stability.

1. Application and Equipment Function

The pouch cell formation/aging system shall be used for:

- a) Initial electrochemical formation of pouch cells
- b) Controlled aging and stabilization cycles
- c) Capacity grading and performance evaluation

The system shall support:

- a) Continuous long-duration operation
- b) Accurate control of electrical and thermal parameters
- c) Reliable data acquisition and traceability for R&D and pilot-line applications

2. Battery Compatibility

- a) The equipment shall be suitable for pouch cells based on:
 - b) Lithium-ion battery chemistry
 - c) Sodium-ion battery chemistry
 - d) Li-S battery chemistry

The system shall accommodate pouch cells of varying thickness and footprint using adjustable fixtures.

3. Electrical Channel Specifications

- a) Number of channels: 64 channels
- b) Rated channel capacity: 5 V / 15–30 A per channel
- c) Voltage Parameters
 - d) Charging voltage setting range: DC 0–5 V
 - e) Discharge voltage setting range: DC 5–0.7 V
- f) Voltage accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
- g) Voltage resolution: 1 mV
- h) Voltage stability: $\leq 0.1\%$

Current Parameters

- a) Charging and discharging current range: DC 0.05–/30 A
- b) Current accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
- c) Current resolution: 1 mA
- d) Current stability: $\leq 0.1\%$
- e) Power and Energy Performance
 - f) Power accuracy: $\pm (0.05\% \text{ RD} + 0.05\% \text{ FS})$
 - g) Charging energy-saving efficiency: 80% or better
 - h) Discharge energy feedback efficiency: up to 78%

4. Time and Data Recording Specifications

- a) Time setting range: 0–9999 minutes
- b) Time units: h / min / s
- c) Time resolution: 0.1 s
- d) Time accuracy: $\leq \pm 0.1\%$

Data Recording

Recording modes:

- a) Charging
- b) Discharging
- c) Static
- d) Global recording time
- e) Recording frequency: 100 ms to 2 hours or better
- f) Channel-wise data logging with time stamps

5. Charging and Discharging Functions

Charging Modes

- a) Constant current with voltage limit
- b) Constant current and constant voltage
- c) Constant power charging
- d) Charging Cut-off Conditions
 - Voltage
 - Current
 - Time
 - Capacity
 - Temperature

Discharge Modes

- a) Constant current discharge
- b) Constant power discharge
- c) Discharge Cut-off Conditions
 - Voltage
 - Current
 - Time
 - Capacity
 - Temperature

6. Process Programming Capability

Maximum steps per single cycle: ≤ 100 steps

Nested cycle programming supported

Flexible multi-step formation and aging profiles

7. Continuous Operation Capability

Full-load operation across all channels

Designed for 365 days $\times$ 24 hours uninterrupted operation

8. Cell Fixture, Clamping, and Contact System

Dedicated pouch cell holders with:

Uniform clamping pressure

Low contact resistance

Adjustable fixtures to accommodate varying pouch thicknesses

Tray should be provided in chamber to load and unload the fixture

Contact design shall prevent:

Tab overheating

Contact loosening during long aging cycles

Uniform compression up to 3 bar is applied on sides

Fixture is needed to hold pouch cell. This fixture will give compressive force and also constant temperature to the cell. In addition, it will have temperature sensor near anode electrode to monitor the rise in temperature. Chamber should have common negative suction. It is not necessary to have negative suction at each cell

9. Temperature Monitoring and Control

Provision for cell surface temperature monitoring using thermocouples or equivalent sensors

Temperature data shall be:

Displayed in real time

Logged for each channel

Used for protection and cut-off logic

Temperature in chamber should be kept constant during formation at 45 degrees

10. Channel Isolation and Protection

Electrical isolation between channels

Fault in one channel shall not affect other channels

Independent channel-level protection for:

Over-voltage

Under-voltage

Over-current

Reverse polarity

Over-temperature

Electricity energy during discharge can be collected and can be transported to grid or can be saved in storage battery. (Optional)

11. Software and Control System Requirements

The system shall be supplied with dedicated formation/aging control software with the following capabilities:

System Recovery and Connectivity

Manual pause and resume

Software shutdown recovery

Power interruption recovery

Communication interruption recovery

Abnormal stop handling

Data Management

Local storage of real-time and historical data for each channel

Data export in CSV / Excel formats

Channel-wise traceability with cycle number and timestamps

Advanced Features

Battery capacity sorting and grade classification

Support for channel parallel connection (optional)

Software offline protection

Free software upgrades

Automatic Recovery

In case of PC or communication failure, system shall enter safe waiting state

Upon restoration, system shall continue the current process automatically without data loss

12. HMI and User Interface

Centralized PC/HMI interface

Real-time display of:

Voltage

Current

Capacity

Temperature

Channel status

Multi-level user access:

Operator

Engineer

Administrator

13. Alarm and Fault Management

Visual and audible alarms for:

Electrical faults

Temperature faults

Communication failures

Alarm history logging with timestamps

Safe shutdown logic for critical faults

14. Structural and Material Requirements

Machine structure made of specially treated materials

Materials shall be:

Corrosion resistant

High-temperature resistant

Suitable for long-term aging operation

Chamber should be anti-burst

15. Safety & Protection System

Electrical protection against:

a) Overload

b) Short circuit

c) Over-voltage and over-current

d) Emergency stop system

e) Software-based safety interlocks

f) Automatic alarms for abnormal voltage, current, and temperature

g) Controlled safe shutdown and restart logic

16. Acceptance Criteria

a) Stable and repeatable formation and aging performance across all channels

b) Accurate control of voltage, current, power, and temperature

c) Reliable long-duration operation without abnormal interruption

d) Correct execution of programmed formation and aging profiles

- e) Accurate and complete data recording for each channel
- f) Effective operation of all protection and alarm systems
- g) Successful completion of cycles without data loss

17. Heating and pressure Specifications:

- a) Temperature range: 30-60°C or better
- b) Independent temperature control per cell
- c) Temperature rise: Should be settable (Should reach the set temperature within the range of 10-20 min.
- d) Pressure plate structure: Aluminium grid plate, both sides with SS, covered with name card
- e) Heating accuracy: $\pm 2^{\circ}\text{C}$
- f) Pressure Range: 100-2500 Kg or better
- g) Pressing method: Vertical press
- h) Pressure accuracy: $\leq 50\text{Kg}$ or better

21. Semiautomatic DCIR Testing Machine for cylindrical, pouch and prismatic cells

1. It should automatically calibrate the power supply and upload calibration data, and the production management control system can automatically store and generate calibration reports.
2. Set up a secondary positioning mechanism for the tray, with a secondary positioning accuracy of $\pm 0.5\text{mm}$;
3. Loading method: Manual loading and unloading.
4. Data processing: The software is independently developed and interacts with MES, WMS, and WCS system data, with strong plasticity.
5. Vendor should provide trays with manual adjustment of compression force. Three different trays are necessary. One for cylindrical, one for pouch and one for prismatic.
6. Pulse current and duration can be variable and adjustable in HMI
7. DCIR should be able to calculate both during charge and discharge phase by undergoing charge – discharge cycle

II. Technical parameters

- a) Capacity: $\geq 5\text{ PPM}$
- b) Negative pressure control method: PLC + computer
- c) Charging voltage setting range DC: 0~5000mV
- d) Discharge voltage setting range DC: 1800mV~5000mV
- e) Voltage setting resolution: 1mV
- f) Voltage display resolution: 0.1mV
- g) Charging and discharging current setting range: 5A-300A
- h) Control accuracy: $\pm 0.05\%$ F.S
- i) Charge discharge current response time: $\leq 10\text{ms}$
- j) Probe service life: ≥ 30000 times

Acceptance criteria:

- Current range: 5–300 A.
- Voltage range: 1800–5000 mV.
- Control accuracy: $\pm 0.05\%$ at full scale
- Voltage display resolution: 0.1 mV.
- DCIR measurement shall be demonstrated during both charge and discharge pulse tests.
- Pulse current and duration shall be programmable through HMI.
- DCIR values shall be automatically calculated and recorded.
- Current response time: ≤ 10 ms.
- Tray positioning accuracy: ± 0.5 mm or better.
- Testing capacity: ≥ 5 cells per minute (PPM).

22. Pouch Cell Semiautomatic Degassing and Sealing Machine

The equipment should be designed for the gas extraction, sealing, airbags pre-cut, trimming, flanging, hot forming.

Process:

- a) Manually load material to seal the body, after completion of loading automatically close cavity, pierce gas pocket, gas suction and final sealing.
- b) Avoid electrolyte loss during gas suction.
- c) Machine should be compatible for pouch having terminal on same side or terminal on opposite sides. Pouch cell with opposite sides terminal will have gas pocket on one side. Pouch cell with same side terminal can have gas pocket on both sides or one side. Gas suction outlet piping should be connected to outside ducting.
- d) During degassing process, compression force will be given, to remove all entrapped gases. Compression force can be given upto 45 degrees and upto 3 bar pressure.
- e) Cell has an independent servo mechanism, pressure monitoring through the pressure sensor control and output display on HMI
- f) Use knife to Pierce gas pocket to remove gas, then trim the gas pocket and then seal the trimmed area. It is also possible that one can first seal the area between pouch and gas pocket and then do piercing and trimming. Weighing of pouch before and after is necessary, hence provide weighing machine with 0.1 gm accuracy.

Technical Parameter:

The cell size:

- a) Width: 50-250 mm
- b) Height: 50-150mm
- c) Thickness: 5-15mm

Other parameters/specification.

- a) Cell Fixture, Clamping, and Contact System
- b) Dedicated pouch cell holders with:
- c) Uniform clamping pressure

- d) Low contact resistance
- e) Adjustable fixtures to accommodate varying pouch thicknesses

Acceptance Criteria:

- Successful demonstration of automatic cavity closing, gas pocket piercing, degassing, trimming, and final sealing.
- Demonstration with pouch cells having (i) Terminals on the same side and (ii) Terminals on opposite sides.
- Cell size compatibility with (i) Width: 50-250 mm, (ii) Height: 50-150 mm, and (iii) Thickness: 5-15 mm
- Compression pressure adjustable up to 3 bar.
- Compression angle adjustable up to 45°.
- Pressure value displayed and controlled through HMI.
- Final seal shall be uniform and leak-free after degassing and trimming.
- Weighing balance with accuracy of ± 0.1 g.
- Demonstration of pouch weight measurement before and after degassing.
- Adjustable fixtures suitable for specified pouch cell dimensions.
- Uniform clamping pressure during operation.

23. 3-in-1 semiautomatic Pouch Cell Trimming, Folding, and Ironing Semiautomatic Machine

This equipment should be designed for a cutting, folding, and ironing all-in-one machine for pouch cells

Operating principle: This equipment should be designed for the following processes: the cell correction and positioning mechanism, corner trimming mechanism, 180 degrees edge-folding mechanism, edge-ironing mechanism,

After manual loading and cell correction/positioning, the operator presses the dual start buttons with both hands to activate the equipment.

The cell then undergoes corner trimming, edge 180 degrees folding, and edge ironing in sequence. Once the ironing process is finished, the ironing mechanism opens, and the cell fixture returns to its original position. The cell is then manually removed.

Extra workstation should be available to apply taping to the folded edge. Minimum of total of 4 tapes need to be applied on the edges.

Ironing process can be done at maximum temperature of 100 degrees. It should also be possible to apply glue manually between folded edges.

Cell sizes:

Cell length: 50~250 mm

Cell width: 50~~155 mm

Cell thickness: 5~15 mm

Other required Features

- a) Supports both single and double folding operations either by multiple bending sequence or by robot arm.
- b) Cutting knives rotate synchronously in opposite directions, ensuring high trimming accuracy; knife life exceeds 1.5 million cycles.
- c) All four main mechanisms can be adjusted simultaneously for in-and-out motion, providing flexible operation.
- d) Multiple products can be loaded at once to enhance production efficiency.
- e) Manual and automatic modes of operation.
- f) Position adjustments for each mechanism should be guided by linear slide rails.
- g) The cutting knife and fixture operating speeds, as well as the edge-heating temperature, are all adjustable.

Other technical details

- a) Equipment precision: 0.05 mm
- b) Trimming accuracy: 0.02 mm
- c) Double fold
- d) One set of cutting knives will be provided

Acceptance Criteria:

- Successful demonstration of corner trimming, 180° edge folding (single and double fold), and edge ironing in a single operating cycle.
- Demonstration with pouch cells having: (i) Length: 50–250 mm, (ii) Width: 50–155 mm, and (iii) Thickness: 5–15 mm
- Equipment positioning accuracy: ≤ 0.05 mm.
- Trimming accuracy: ≤ 0.02 mm.
- Successful demonstration of double-fold operation.
- Ironing temperature adjustable up to 100 °C.
- Folded edges shall be uniform without visible damage or delamination.
- Demonstration of additional workstation capable of applying four tapes on folded edges.
- Functional demonstration of both Manual and Automatic operation modes.

24. Specification for Room Temperature Aging Equipment for Lithium Battery Cells

Equipment Model: Customizable (According to customer channel quantity and test requirements)

Applicable cell formats: Cylindrical lithium battery cells, pouch lithium battery cells, prismatic lithium battery cells

Technical Parameters

Temperature Control System

- a) Working Temperature Range: Room temperature control ($25 \pm 2^\circ\text{C}$), adjustable within 20°C - 30°C

- b) Temperature Uniformity: $\leq \pm 1^{\circ}\text{C}$
- c) Temperature Fluctuation: $\leq \pm 0.5^{\circ}\text{C}$
- d) Temperature Control Accuracy: $\pm 0.1^{\circ}\text{C}$
- e) Temperature Sensor Type: PT100 platinum thermal resistance, high precision and stable performance

Test Channel Configuration

- a) Channel Quantity: Customizable (Standard configuration: 128/256/512 channels, independent control of single channel)
- b) No. of channel: 128
- c) Applicable Cell Voltage Range: 0-5V
- d) Channel Current Range: 0-10A
- e) Voltage Measurement Accuracy: $\pm 0.02\%$ F.S.
- f) Current Measurement Accuracy: $\pm 0.05\%$ F.S.
- g) Channel Isolation: Single channel independent control, no mutual interference, support simultaneous aging test of different specifications of cells

Equipment Structure & Material

- a) Cabinet Material: External high-quality cold-rolled steel plate with plastic spraying treatment, anti-corrosion and wear-resistant; Internal 304 stainless steel plate, clean and easy to clean, suitable for battery production environment
- b) Insulation Material: High-density polyurethane foam insulation layer, good thermal insulation effect, low energy consumption
- c) Air Circulation System: Forced air circulation design, uniform air distribution, ensure consistent temperature in the cabinet
- d) Sample Rack: Detachable 304 stainless steel sample rack, adjustable layer spacing, suitable for placing different sizes of lithium battery cells
- e) Cabinet Door: Single/double hinged door, equipped with transparent tempered glass observation window, built-in LED lighting, convenient for real-time observation of test status; Sealed with high-temperature and corrosion-resistant silicone rubber strip, good sealing performance
- f) Wiring System: Built-in special wiring terminal for lithium battery test, anti-loose design, safe and reliable connection

Core Functions

Aging Test Function

- a) Support constant temperature standing aging (default room temperature 25°C), timing range: 1min-9999h, arbitrary setting
- b) Support real-time monitoring of cell voltage, temperature and other parameters during aging
- c) Support automatic recording of test data, abnormal data automatic marking
- d) Control & Operation System
- e) Industrial touch screen, human-machine interface, simple and intuitive operation
- f) Support Chinese/English bilingual switching of operation interface

- g) Support parameter preset, one-key start test, automatic operation without manual duty
- h) Support program editing, store multiple sets of aging test processes, call at any time

Data Acquisition & Storage

- a) Real-time acquisition and storage of test data (temperature, voltage, time, etc.), data storage interval adjustable (1s-30min)
- b) Support U disk/USB port data export, data format: CSV/Excel, convenient for data analysis and archiving
- c) Equipped with power-off data protection function, test data will not be lost after power-off, and the test can be continued after power-on

Safety Protection System

- a) Over-temperature Protection: Cabinet built-in over-temperature alarm device, automatic power-off and alarm when temperature exceeds set limit
- b) Over-voltage & Over-current Protection: Single channel independent over-voltage, over-current, short-circuit protection, automatic cut-off of faulty channel, no impact on other channels
- c) Reverse Connection Protection: Prevent cell positive and negative reverse connection, avoid equipment damage and potential safety hazards
- d) Leakage Protection: Equipped with leakage circuit breaker, ensure the safety of operators and equipment
- e) Abnormal Alarm: Sound and light dual alarm, prompt abnormal information (over-temperature, over-voltage, short circuit, power failure, etc.) on the touch screen
- f) Emergency Stop Button: Equipped with emergency stop switch, one-key stop all operations in case of emergency
- g) Fire protection system in the form of sprinklers or Nitrogen blow should be available on the cell at regular intervals.

Equipment Performance & Features

- a) Adopt high-precision temperature control system, stable temperature control, meet the requirements of lithium battery cell room temperature aging test
- b) Independent channel design, flexible configuration, suitable for mass production line aging test of lithium battery cells
- c) Complete safety protection functions, in line with lithium battery production safety standards, avoid potential safety hazards
- d) Humanized operation design, easy to operate and maintain, reduce labor cost
- e) Stable performance, low failure rate, suitable for long-term continuous operation in industrial production environment
- f) Modular design, convenient for later maintenance and function upgrade

Safety and Industrial standards:

- a) IEC 62619: Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications
- b) GB/T 2423.1-2008 Environmental testing – Part 2: Tests – Test A: Cold
- c) GB/T 2423.2-2008 Environmental testing – Part 2: Tests – Test B: Dry heat
- d) GB 3836.1-2010 Explosive atmospheres – Part 1: Equipment – General requirements
- e) Lithium battery production and testing industry safety specifications

Acceptance criteria:

- Operating temperature range: 20–30 °C.
- Temperature uniformity: $\leq \pm 1$ °C.
- Temperature fluctuation: $\leq \pm 0.5$ °C.
- Temperature control accuracy: ± 0.1 °C.
- Voltage range: 0–5 V.
- Current range: 0–10 A.
- Independent operation and monitoring of each channel.
- Voltage measurement accuracy: $\pm 0.02\%$ at full scale
- Current measurement accuracy: $\pm 0.05\%$ at full scale
- Real-time monitoring and recording of voltage, temperature, and time.
- Successful export of test data in CSV/Excel format.
- Power-failure data protection and test recovery function demonstrated.
- Functional demonstration of (i) Over-temperature protection, (ii) Over-voltage and over-current protection, (iii) Short-circuit protection, (iv) Reverse polarity protection, (v) Leakage protection, (vi) Emergency stop, and (vii) Audible and visual alarm system
- Demonstration of integrated fire protection system (Nitrogen suppression or sprinkler system) and associated alarm/interlock functionality.
- Submission of calibration certificates, FAT reports, and declaration of compliance with specified safety and industrial standards

25. Semi-automatic Insulation Testing Machine

Equipment Model: Customised (Based on customer test channels, cell type and production capacity)

Applicable Cell formats: Cylindrical lithium battery cells, pouch lithium battery cells, prismatic lithium battery cells of various conventional models

Technical Parameters

Insulation Resistance (IR) Test Parameters

- a) Test Voltage Range: DC 10V - 1000V (Stepless adjustable, accuracy $\pm 0.5\%$ F.S.)
- b) Insulation Resistance Measurement Range: $1\text{M}\Omega$ - $2000\text{G}\Omega$
- c) Resistance Measurement Accuracy: $\pm 3\%$ of reading value
- d) Test Time: 0.1s - 999s (Freely programmable)
- e) Test Mode: Single cell independent test, batch automatic continuous test

Withstand Voltage (Hi-Pot) Test Parameters

- a) AC Withstand Voltage Range: 0 - 5kV (Adjustable)
- b) DC Withstand Voltage Range: 0 - 6kV (Adjustable)
- c) Leakage Current Range: 0.01mA - 10mA
- d) Leakage Current Trip Threshold: Customizable according to test requirements
- e) Withstand Voltage Test Time: 1s - 999s (Programmable setting)

Equipment System & Configuration

- a) Test Channels: 8 channel for cylindrical cell (adjustable to different cylindrical dimensions). 1 channel for prismatic and pouch cell. Compatible for both side and top terminal pouch and prismatic cell
- b) Channel Mode: Single channel independent control, no mutual interference, support simultaneous test of different specification cells
- c) Operating System: Industrial-grade embedded control system, 10-inch HD industrial touch screen
- d) Suitable Communication Interface: Ethernet, RS485, USB 2.0/3.0, support data remote transmission
- e) Manual loading and unloading of cell in trays or in fixture. After that safety door should be closed and then insulation test should be done automatically.

Mechanical Parameters

- a) Fixture Type: Customized fixture for lithium battery cells, quick replacement, compatible with multiple cell sizes
- b) Material: Frame adopts high-strength aluminum profile, surface anti-static treatment; Contact probe uses gold-plated material, stable conductivity

Equipment Main Functions

- a) Support independent insulation resistance test and withstand voltage test, also support combined test of two items
- b) Automatic identification of test results, clear display of PASS/FAIL, automatic alarm for unqualified products
- c) Real-time display of test data: Test voltage, insulation resistance, leakage current, test time, etc.
- d) Program storage function: Store 100+ groups of test programs, call at any time without repeated setting
- e) Data acquisition and storage: Automatic record of all test data, storage interval adjustable, support historical data query
- f) Data export: Support U disk export of test data, format is CSV/Excel, convenient for data archiving and traceability
- g) Power-off protection: Test parameters and data will not be lost after power-off, restart to continue unfinished test
- h) Interface switching: Support Chinese/English bilingual operation interface, easy to operate

Equipment Structure & Features

- a) Compact integrated structure, small footprint, suitable for pilot line online test and laboratory offline test
- b) Humanized operation design, touch screen man-machine interface, simple parameter setting, easy to learn and operate
- c) Special anti-short circuit and anti-reverse connection fixture, avoid damage to cells and equipment
- d) Forced air cooling system, ensure long-term stable operation of equipment
- e) Detachable test fixture, convenient for later maintenance and size replacement
- f) High test accuracy, strong stability, reduce misjudgement and missed judgment rate

Safety Protection System

- a) Emergency Stop Protection: Equipped with high-sensitivity emergency stop button, one-key stop all test operations in case of emergency
- b) High Voltage Interlock Protection: Equipped with safety door/protective cover interlock device, high voltage output is cut off when the cover is opened
- c) Over-current & Over-voltage Protection: Independent over-current, over-voltage protection for each channel, automatic cut-off of faulty channel
- d) Leakage Protection: Equipped with independent leakage circuit breaker to ensure operator safety
- e) Abnormal Alarm: Sound and light dual alarm, synchronous display of fault code on the touch screen, convenient for troubleshooting
- f) High Voltage Warning: Equipped with obvious high voltage warning signs, to prevent electric shock hazards
- g) Short Circuit Protection: Instantaneous short circuit protection, avoid cell short circuit fire and equipment damage

Safety standards

- a) IEC 62619: Safety requirements for secondary lithium cells and batteries for industrial applications
- b) IEC 61010-1: Safety requirements for electrical equipment for measurement, control and laboratory use
- c) GB 3836.1: Explosive atmospheres - General requirements for equipment
- d) GB/T 17627: High-voltage test techniques for low-voltage equipment
- e) Lithium-ion battery manufacturing safety and electrical test industry standards

Packaging & Transportation

- a) Packaging: Standard wooden box packaging, built-in shockproof foam, suitable for long-distance transportation
- b) Transportation: Avoid violent collision, sun exposure and rain erosion during transportation
- c) Marking: The outer package is marked with equipment name, model, quantity, manufacturer and transportation precautions

Acceptance criteria:

- Test voltage range: 10–1000 V DC.
- Insulation resistance measurement range: 1 MΩ-2000 GΩ.
- Resistance measurement accuracy: $\pm 3\%$ of reading.
- AC withstand voltage: 0-5 kV.
- DC withstand voltage: 0-6 kV.
- Leakage current measurement range: 0.01-10 mA.
- Successful demonstration of PASS/FAIL judgment based on preset limits.
- 8-channel testing for cylindrical cells.
- 1-channel testing for pouch and prismatic cells.
- Demonstration with cylindrical, pouch, and prismatic cell fixtures.
- Real-time display and recording of test voltage, insulation resistance, leakage current, and test time.
- Successful export of test data in CSV/Excel format.
- Demonstration of power-failure data protection.
- Functional demonstration of: (i) High-voltage door interlock, (ii) Emergency stop, (iii) Over-current and over-voltage protection, (iv) Leakage protection, (v) Short-circuit protection, and (vi) Audible and visual alarm system
- Submission of calibration certificates, FAT reports, and declaration of compliance with specified safety standards.

General Conditions:

- a) Dry run option to be provided
- b) Provision of manual operation to be given
- c) 3-D drawing preview as per technical specifications for all machines to be provided
- d) All the passwords for PLC, HMI and programming to be given for all equipment
- e) Software and programming language must be in English for all equipment
- f) PLC (preferably Panasonic, Hitachi)
- g) Sensors (make preferably Keyence, Innovance)
- h) VFD (preferably Mitsubishi) and sensors must be from the same supplier
- i) Essential, general and critical spares (cutter, sensors, encoders, mandrel) to be quoted for each equipment
- j) PLC-based control system with touch-screen HMI (the programming and software must be in English)
- k) Make of PLC/controller: Siemens / Mitsubishi/ Omron/ Allen Bradley / / Schneider/Panasonic)
- l) The supplier should have prior experience in the supply, installation, commissioning, and successful operation of a complete cell manufacturing line, covering all essential equipment from slurry mixing through to finished cell assembly.

- a) **Past Experience and Client References:**
The bidder shall have successfully supplied, installed, and commissioned similar equipment to at least three (3) clients. Preference shall be given to supplies made to Government or Quasi-Government organizations.
The bidder shall submit a list of such installations, including the name of the organization, scope of supply, year of execution, and contact details of the responsible official for reference.
- b) **Design Documentation:**
The bidder shall submit complete technical documentation, including detailed system design, assembly drawings, electrical/electronic circuit diagrams, fabrication drawings, and operation and maintenance manuals.
- c) **Design Approval and Work Commencement:**
All design and fabrication drawings /3D model preview shall be submitted for review and approval by ARCI. The bidder shall commence fabrication and related activities only after receiving formal approval from ARCI.
- d) Essential, general, and critical spares shall be quoted separately for each equipment, including but not limited to: Cutters/Sensors/Encoders/Mandrels/Belts/Bearings.
- e) **Scope and Responsibility Definition:**
The bidder shall clearly define and acknowledge the scope of work and responsibility matrix prior to execution. All responsibilities shall be thoroughly understood and agreed upon before commencement of work.
- f) **Warranty and AMC:**
The system shall be covered under a comprehensive warranty for a minimum period of two (2) years, ensuring trouble-free operation. Upon completion of the warranty period, the bidder shall be willing to undertake an Annual Maintenance Contract (AMC) as per ARCI's standard AMC terms and procedures.
- g) **Design Flexibility and Minor Modifications:**
The bidder shall, at no additional cost, incorporate minor design or functional modifications, if required, during execution or commissioning to meet performance or operational requirements.
- h) **Pre-Delivery Inspection (PDI):**
Pre-delivery inspection of the complete system shall be mandatory at the bidder's premises. Dispatch of the equipment shall be permitted only after successful inspection and certification by ARCI's authorized representatives.
- i) **Installation, Commissioning, and Training:**
The bidder shall carry out installation and commissioning of the system at ARCI's site. Comprehensive hands-on training shall be provided to ARCI's operating and maintenance personnel after successful commissioning.
- j) **Control System Requirements**
The system shall be PLC-based with touch-screen HMI.
All PLC, HMI, and control software programming shall be in English.
All passwords for PLC, HMI, and associated programming shall be provided to ARCI at the time of commissioning. The preferred makes of PLC/controller,

HMI, VFD are: Siemens/Mitsubishi/Omron/Allen Bradley/Schneider/Panasonic
(Final selection shall be confirmed during technical evaluation.)

Sensors preference: Keyence / Innovance.

VFD and sensors shall preferably be sourced from the same supplier for compatibility and serviceability.

Provision for:

- a. Dry run mode
- b. Manual operation mode shall be mandatory.

k) **Maintenance Documentation:**

Detailed preventive maintenance schedules and breakdown maintenance procedures shall be provided as part of the documentation for effective long-term operation of the equipment.

l) **Calibration Procedures:**

Calibration procedures for all critical and essential equipment and sensors shall be clearly defined and included in the technical documentation, along with recommended calibration intervals.

m) **Performance Validation at Site:**

The bidder shall conduct trial runs and performance testing of the system at ARCI's site using commercial electrodes and/or ARCI-supplied electrodes. Final acceptance shall be subject to satisfactory performance demonstrated during these trials.

Documentation to be submitted during tender process:

- a) Complete operation and maintenance manuals, drawings, and related technical documents shall be supplied in both hard copy and soft copy formats
- b) Electrical schematics
- c) Pneumatic schematics
- d) Compliance with relevant industrial and electrical safety standards
- e) Vacuum and temperature calibration certificates
- f) Mechanical layout and GA drawings
- g) PLC & HMI program backup
- h) Spare parts list with part numbers
- i) Calibration certificates for critical sensors
- j) Calibration certificates for weighing and filling systems (For electrolyte)
- k) Necessary calibration certificates of the equipment
- l) Warranty certificate
- m) Recommended spare parts and accessories list to be provided

TECHNICAL COMPLIANCE STATEMENT

Technical bids will be evaluated based on following aspects:

- 1.1. **Compliance statement:** Technical should be provided as a table (representative format given below), containing the following columns: i) ARCI's specifications, ii) the corresponding number/ value for the specification in the instrument offered by the supplier, iii) a statement whether there is compliance or not, iv) explaining deviation(s) if any, and v) offered item no/ model no/ part no. Please provide related officially published brochures, data sheets and application sheets.

Specifica tion format number	ARCI's Specification	Correspo nding number/ value for the specificati on in the instrumen t offered by the supplier	Compli ance yes/no	Deviation, if any, to be explained here	Offered item/ model/part number, if any
1					
2					
3					

Suppliers are required to provide this Technical Compliance Statement while submitting the Technical Bid (Cover 2). Any deviations from the tender should be mentioned clearly.

NOTE: Please ensure all the relevant boxes are marked YES/NO against each column.

DECLARATION OF LOCAL CONTENT
(ON COMPANY LETTERHEAD)

(In case the procurement value is less than or equal to Rs.10 Crores declaration to be given in Bidder's/Company's letter head and if more than Rs. 10 Crores declaration to be issued from the statutory auditors or cost auditor of the company (in case of companies from a practicing cost accountant or practicing chartered accountant (in respect of suppliers other than companies).

To,
THE DIRECTOR,
INTERNATIONAL ADVANCED RESEARCH CENTRE FOR
POWDER METALLURGY AND NEW MATERIALS (ARCI),
Balapur P.O , Hyderabad-500 005.

Subject: Declaration of local content and compliance of Public Procurement (Preference to Make in India) Order 2017 and its amendments regarding.

Sl N O	Name of the Goods/Services/W orks	Category of the Supplier (I/II/III)	Currency (must be in INR)	Local Conten t (%)	Locatio n at which value Additio n is made	Country of Origin	Comply to the above referred rule (Yes/No)

- "Local Content "means the amount of value added in India which shall, be the total value of the item being offered excluding net domestic indirect taxes) minus the value of the imported content in the item (including all customs duties) as a proportion of the total value, in percent.
- False declaration will be in breach of Code of Integrity under Rule 175(I)(i)(h) of the General Financial Rules for which a bidder or its successors can be debarred for upto two years as per Rule 151 (iii) of the General Financial Rules along with such other actions permissible under Law.

Date:

Place:

Signature with Date and Stamp of the Bidder

TENDER ACCEPTANCE LETTER
(TO BE GIVEN ON COMPANY LETTER HEAD)

**To,
THE DIRECTOR,
INTERNATIONAL ADVANCED RESEARCH CENTRE FOR
POWDER METALLURGY AND NEW MATERIALS (ARCI),
Balapur P.O, Hyderabad-500 005.**

Sub: Acceptance of Terms & Conditions of Tender.

Tender Reference No: _____

Name of Tender/Work/Service: _____

Dear Sir,

1. I/We have download /obtained the tender document(s) for the above mentioned Tender/Work from the website(s) namely: _____ as per your advertisement, given in the above mentioned website(s).
2. I/We hereby certify that I/We have read the entire Terms & Conditions of the tender documents from Page No. ____ to ____ (including all documents like annexures, schedules, etc.,) which form part the contract agreement and I/We shall abide hereby the Terms & Conditions/ Clauses contained therein.
3. The Corrigendum(s) issued from time to time by your department/organization too have also been taken into consideration, while submitting this acceptance letter.
4. I/We hereby unconditionally accept the tender conditions of the above mentioned tender document(s)/corrigendum(s) in its totality/entirety.
5. I/We hereby declare that our firm has not been blacklisted/debarred by any Govt.department/Public Sector undertaking.
6. I/We Certify that all information furnished by our firm is true&correct and in the event that the information is found to be incorrect/untrue or found violated, then your department/organization shall without giving any notice or reason therefore or summarily reject the bid or terminate the contract, without giving any notice or reason therefore or summarily reject the bid or terminate the contract, without prejudice to any other rights or

remedy including the forfeiture of the full said earnest money deposit absolutely.

7. I/We declare the following information provided are correct to the best of my knowledge.

1	Name and Address of the Bidder	
2	Manufacturer/Dealer/Agent	
3	Contact Person	
4	Phone	
5	Email	
6	Mobile Number	
7	GST No	
8	PAN No	
9	UTR No/DD No(In case of online transfer of Tender Fee) if any	
10	UTR No/DD No(In case of online transfer of EMD) if any	
11	Warranty, if any	
12	Delivery period	
13	PO to be placed in favour of	
14.	Bank details copy	

Your faithfully,

Date:

Place:

Signature with Date and Stamp of the Bidder

CERTIFICATE BY THE BIDDER (FOR TENDERS)
(ON COMPANY LETTER HEAD)

I have read the clause regarding restrictions on procurement from a bidder of a Country which shares a land border with India. I certify that this bidder is not from such a company or, / if from such a country, has been registered with the competent Authority (copy of the registration Certificate enclosed). I hereby certify that this bidder fulfils all requirements in this regard and is eligible to be considered.

Date:

Place:

Signature with Date and Stamp of the Bidder

**CERTIFICATE OF DECLARATION
(ON COMPANY LETTER HEAD)**

I hereby certify that we M/s

_____(name and address of the firm) is neither blacklisted by any Central/State Government/Public Undertaking / Institute nor is any criminal case registered / pending against the firm or its owner / partners anywhere in India.

I also certify that the above information is true and correct in every aspect and in any case at a later date it is found that any details provided above are incorrect any contract given to the above firm may be summarily terminated and the firm blacklisted.

Date:
Place:

Signature with Date and Stamp of the Bidder

CHECK LIST

BIDDER HAS TO FILL IN THE CHECK LIST GIVEN BELOW
(Following documents are to be submitted online and manual as part of
Technical Bid. Bidders are requested to state Yes / No against each
column)

Sl. No.	Description	Online Submission
1.	If bidder is not an original equipment manufacturer, authorization letter attached.	
2.	Whether Tender Fee and EMD Submitted	
3.	Whether EoI proposal Technical Bid Submitted	
4.	Vendor BANK DETAILS, PAN / GSTIN Number from concerned authorities	
5.	Details of Products and Components	
6.	Whether declaration form signed and Submitted (Scanned Copy by online)	
7.	Whether warranty clause mentioned	
8.	Whether all pages of tender document signed on all pages along with bidders seal	
9.	Optional items, if any (Separate cover enclosed with Technical bid)	
10.	HSN/SAC CODES for the item mentioned in technical bid	
11.	Technical Compliance Statement (Annexure II)	
12.	Declaration of Local Content (Annexure III)	
13.	Tender Acceptance Letter (Annexure IV)	
14.	Certificate by the bidder (For Tenders) (Annexure V)	
15.	Certificate of Declaration (Annexure VI)	
16.	Brochure/Catalogue/Datasheet	

17.	Previous Purchase Orders (if any)	
18.	Statutory Registration Certificates	
19.	This Checklist	

NOTE:

1. Please ensure all the relevant boxes are marked YES/NO against each column.
2. Tenderers must ensure that all the required documents indicated in the Tender documents are submitted without fail. Tenders received without supporting documents for the various requirements mentioned in the tender document are liable to be rejected at the initial stage itself.