

## **DEVELOPMENT AND SUPPLY OF DUAL VOLTAGE AUXILIARY POWER UNIT**

**Bid / RFP Reference No: CVRDE/MMG/OT/22DCT002/2021-22**

### **Part I – General Information and Instructions**

#### **1. Pre- bid Conference:**

A pre-bid meeting will be held at 10:30 hrs on 12.10.2021 at CVRDE, AVADI, CHENNAI – 600 054 to answer any queries or to clarify doubts on technical points and commercial points if any. Bidders or their authorized representatives (duly authorized in writing) are invited to attend. Attending Pre-bid meeting is mandatory for the bidder to participate in the tender. This event will not be postponed due to non-presence of the firm's representative. **(Please refer NIT for Date and Time)**

**[Note- Design inputs, Technical data, if any and other details will be shared to the vendors during pre-bid conference on written request]**

#### **2. Place of Opening of the Bids: CVRDE, Avadi, Chennai – 600 054.**

The Bidders may depute their representatives, duly authorized in writing, to attend the Technical bid opening on the due date and time. Such authorized representatives should also carry their acknowledgement (generated through e-procurement module) as a proof for their online bid submission. Technical bid opening date will not be postponed due to non-presence of your representative.

**3. Technical Bid:** Along with the Technical bid, the following **applicable** documents are to be furnished by the bidder:-

- i. Scanned Copy of documents like EMD / Proof of registration with DRDO/ MOD/ DGS &D / NSIC etc., and ECS details
- ii. Signed and scanned copy of Tender Acceptance Letter, Price bid undertaking.
- iii. Scanned Copy of Proforma for End User Certificate for Export License.
- iv. Scanned copy of Technical Literature / Catalogue & Brochures
- v. Scanned copy of PAN details / GST registration certificate.
- vi. Any other scanned copy or hard copy of documents as mentioned in the RFP / Appendix-A.

**4. Clarification Regarding Contents of the RFP:** A prospective bidder who requires clarification regarding the contents of the bidding documents shall notify to the Buyer in writing about the clarifications sought not later than 14 (fourteen) days prior to the date of opening of the Bids. Copies of the query and clarifications by the purchaser will be sent to all prospective bidders who have received the bidding documents from the lab and would be posted on the website in case of advertised tender enquiry.

~~5. Indian firms need to quote only in Indian Rupees. An Indian firm can quote in FE on behalf of their OEM only if they are either a 100% subsidiary of the OEM or an Indian Agent of the foreign OEM in accordance with their agency agreement. The firms claiming to be:~~

~~a) A 100% subsidiary would be required to produce documentary evidence in support of their claim along with their Techno-Commercial bid failing which their bid would be disqualified.~~

~~b) An agent of foreign OEM, for submitting the offer on behalf of OEM, would be required to produce a copy of their agency agreement with their principals and a copy of registration/enlistment with DRDO/Ministry of Defence/ DGS&D as an Indian agent, if registered/enlisted, along with their Techno-Commercial bid, failing which their bid would be disqualified. It would be mandatory for an Indian agent to get registered/ enlisted with DRDO/ Ministry of Defence/ DGS&D as an Indian agent of OEM prior to evaluation of their Price bid, failing which their bid also would be disqualified.~~

**6. Validity of Bids:** The Bids should remain valid for 180 days from the last date of submission of the Bids.

**7. Modification and Withdrawal of Bids:** A bidder may modify or withdraw his Bid after submission provided that the written notice of modification or withdrawal is received by the Buyer prior to deadline prescribed for submission of bids. A withdrawal notice may be sent by fax, however, it should be followed by a signed confirmation copy to be sent by post and such signed confirmation should reach the purchaser not later than the deadline for submission of bids. No bid shall be modified after the deadline for submission of bids. No bid may be withdrawn in the interval between the deadline for submission of bids and expiration of the specified period of bid validity. **As per the provisions given in the e-procurement module, the modifications and withdrawal of bids may be followed.**

**8. Earnest Money Deposit:** Bidders are required to submit a Bid Security Declaration in the enclosed format. The Bid will be considered invalid if Bid Security Declaration is not submitted.

**9 Clarification Regarding Contents of the Bids:** During evaluation of bids, the Buyer may, at his discretion, ask the bidder for clarification on his Bid. The request for clarification will be given in writing. No clarification on the initiative of the bidder will be entertained after opening of bid.

**10. Rejection of Bids:** Canvassing by the Bidder in any form, unsolicited letter and post-tender correction may invoke summary rejection with forfeiture of EMD. Conditional tenders will be rejected. Non-compliance of applicable General Information will disqualify your Bid.

**11. Unwillingness to Quote:** Bidders unwilling to quote should ensure that intimation to this effect reaches before the due date and time of opening of the bid, failing which the defaulting bidder may be de-registered for the range of items in this RFP, as per the policy in vogue.

**12.** Bidders must submit Quotation pertaining to themselves only except in cases covered under Para 11 above.

**13.** Bids of debarred / blacklisted firms will not be considered for evaluation.

## **Part II – Standard Terms and Conditions**

The Bidder is required to give confirmation of their acceptance of the Standard Terms and Conditions of the RFP mentioned below which will automatically be considered as part of the Contract concluded with the successful Bidder as selected by the Buyer. Failure to do so may result in rejection of the Bid submitted by the Bidder.

1. **Effective Date of the Contract** : : In case of placement of a supply order, one month from the date of supply order would be deemed as effective date (or) as agreed by both the parties. This one month includes intimation about the readiness of the order along with a copy of the order to the successful bidder, submission of Performance cum Warranty Bond and order acceptance letter by the successful bidder. In case a contract is to be signed by both the parties, the Contract shall come into effect on the date of signatures of both the parties on the Contract (Effective Date) or as agreed by both the parties. The deliveries and supplies and performance of the services shall commence from the effective date of the Contract
2. **Law**: The Contract shall be considered and made in accordance with the laws of the Republic of India and shall be governed by and interpreted in accordance with the laws of the Republic of India.
3. **Arbitration**: All disputes or differences arising out of or in connection with the Contract shall be settled by bilateral discussions. Any dispute, disagreement or question arising out of or relating to the Contract or relating to product or performance, which cannot be settled amicably, shall be resolved by arbitration in accordance with the following applicable provision:
  - a) For Central and State PSEs: The case of arbitration shall be referred to the Department of Public Enterprises for the appointment of sole arbitrator by the Secretary to the Government of India in-charge of the Department of Public Enterprises. The Arbitration and Conciliation Act, 1996 shall not be applicable to arbitration under this clause.
  - b) For Defence PSUs: The case of arbitration shall be referred to the Secretary Defence (R&D) for the appointment of arbitrator(s) and proceedings.
  - c) For other Firms: Any dispute, disagreement or question arising out of or relating to the Contract or relating to product or performance, which cannot be settled amicably, shall be resolved by arbitration in accordance with either of the following provisions:

“The case of arbitration may be referred to respective CFA or a person appointed by him who will be sole arbitrator and the proceedings shall be conducted in accordance with procedure of Indian Arbitration and Conciliation Act, 1996.”

Or

“The case of arbitration may be referred to International Centre for Alternative Dispute Resolution (ICADR) for the appointment of arbitrator and proceedings shall be conducted in accordance with procedure of Indian Arbitration and Conciliation Act, 1996.”

Or

“The case of arbitration may be conducted in accordance with the rules of Arbitration of the International Chamber of Commerce by one or more arbitrators appointed in accordance with the said rules in India. However, the arbitration proceedings shall be conducted in India under Indian Arbitration and Conciliation Act, 1996.”

4. **Penalty for Use of Undue influence:** The Seller undertakes that he has not given, offered or promised to give, directly or indirectly, any gift, consideration, reward, commission, fees, brokerage or inducement to any person in service of the Buyer or otherwise in procuring the Contract or forbearing to do or for having done or forborne to do any act in relation to the obtaining or execution of the Contract or any other contract with the Government of India for showing or forbearing to show favour or disfavour to any

person in relation to the Contract or any other contract with the Government of India. Any breach of the aforesaid undertaking by the Seller or anyone employed by him or acting on his behalf (whether with or without the knowledge of the Seller) or the commission of any offers by the Seller or anyone employed by him or acting on his behalf, as defined in Chapter IX of the Indian Penal Code, 1860 or the Prevention of Corruption Act, 1986 or any other Act enacted for the prevention of corruption shall entitle the Buyer to cancel the contract and all or any other contracts with the Seller and recover from the Seller the amount of any loss arising from such cancellation. A decision of the Buyer or his nominee to the effect that a breach of the undertaking had been committed shall be final and binding on the Seller. Giving or offering of any gift, bribe or inducement or any attempt at any such act on behalf of the Seller towards any officer/ employee of the Buyer or to any other person in a position to influence any officer/ employee of the Buyer for showing any favour in relation to this or any other contract, shall render the Seller to such liability/ penalty as the Buyer may deem proper, including but not limited to termination of the contract, imposition of penal damages, forfeiture of the Bank Guarantee and refund of the amounts paid by the Buyer.

5. **Agents / Agency Commission:**

The Seller confirms and declares to the Buyer that the Seller has not engaged any individual or firm, whether Indian or foreign whatsoever, to intercede, facilitate or in any way to recommend to the Government of India or any of its functionaries, whether officially or unofficially, to the award of the contract to the Seller; nor has any amount been paid, promised or intended to be paid to any such individual or firm in respect of any such intercession, facilitation or recommendation. The Seller agrees that if it is established at any time to the satisfaction of the Buyer that the present declaration is in any way incorrect or if at a later stage it is discovered by the Buyer that the Seller has engaged any such individual/firm, and paid or intended to pay any amount, gift, reward, fees, commission or consideration to such person, party, firm or institution, whether before or after the signing of this contract, the Seller will be liable to refund that amount to the Buyer. The Seller will also be debarred from entering into any contract with the Government of India for a minimum period of five years. The Buyer will also have a right to consider cancellation of the Contract either wholly or in part, without any entitlement or compensation to the Seller who shall in such an event be liable to refund all payments made by the Buyer in terms of the Contract along with interest at the rate of 2% per annum above (i) Prime Lending Rate of State Bank of India for Indian bidders, and (ii) London Inter Bank Offered Rate (LIBOR) for the foreign bidders. The applicable rates on the date of opening of bid shall be considered for this. The Buyer will also have the right to recover any such amount from any contracts in vogue with the Government of India.

Or

The Seller confirms and declares in the Techno-Commercial bid that they have engaged an agent, individual or firm, for performing certain services on their behalf. The Seller is required to disclose full details of any such person, party, firm or institution engaged by them for marketing of their equipment in India, either on a country specific basis or as a part of a global or regional arrangement. These details should include the scope of work and responsibilities that have been entrusted with the said party in India. If there is non-involvement of any such party then the same also be communicated in the offers specifically. The information is to be submitted as per the format at DRDO.SA.01. Without prejudice to the obligations of the vendor as contained in various parts of this document, appointment of an Agent by vendors will be subjected to the following conditions:

- a) Details of all Agents will be disclosed at the time of submission of offers and within two weeks of engagement of an Agent at any subsequent stage of procurement.
- b) The Seller is required to disclose termination of the agreement with the Agent, within two weeks of the agreement having been terminated.
- c) Buyer /MoD reserves the right to inform the Seller at any stage that the Agent so engaged is not acceptable whereupon it would be incumbent on the Seller either to interact with Buyer / MoD directly or engage another Agent. The decision of Buyer / MoD on rejection of the Agent shall be final and be effective immediately.
- d) All payments made to the Agent 12 months prior to tender submission would be disclosed at the time of tender submission and thereafter an annual report of payments would be submitted during the procurement process or upon demand of the Buyer / MoD.
- e) The Agent will not be engaged to manipulate or in any way to recommend to any functionaries of the Govt of India, whether officially or unofficially, the award of the contract to the Seller or to indulge in corrupt and unethical practices.
- f) The contract with the Agent will not be a conditional contract wherein payment made or penalty levied is based, directly or indirectly, on success or failure of the award of the contract.
- g) On demand, the Seller shall provide necessary information/inspection of the relevant financial documents/ information, including a copy of the contract(s) and details of payment terms between the Seller and the Agent engaged by him.
- h) If the equipment being offered by the Seller has been supplied /contracted with any organization, public/ private in India, the details of the same may be furnished in the technical as well as commercial offers. The Sellers are required to give a written undertaking that they have not supplied/is not supplying the similar systems or subsystems at a price lower than that offered in the present bid to any other Ministry/ Department of the Government of India and if the similar system has been supplied at a lower price, then the details regarding the cost, time of supply and quantities be included as part of the commercial offer. In case of non disclosure, if it is found at any stage that the similar system or subsystem was supplied by the Seller to any other Ministry/Department of the Government of India at a lower price, then that very price, will be applicable to the present case and with due allowance for elapsed time, the difference in the cost would be refunded to the Buyer, if the contract has already been concluded.

Following details are also to be submitted in the Techno-Commercial bid:

- i) Name of the Agent
  - ii) Agency Agreement between the Seller and the agent giving details of their contractual obligation
  - iii) PAN Number, name and address of bankers in India and abroad in respect of Indian agent
  - iv) The nature and scope of services to be rendered by the agent and
  - v) Percentage of agency commission payable to the agent
6. **Access to Books of Accounts:** In case it is found to the satisfaction of the Buyer that the Bidder/Seller has violated the provisions of use of undue influence and / or employment of agent to obtain the Contract, the Bidder/Seller, on a specific request of the Buyer, shall provide necessary information/ inspection of the relevant financial documents/information/Books of Accounts.

7. **Non-disclosure of Contract Documents:** Except with the written consent of the Buyer/ Seller, other party shall not disclose the Contract or any provision, specification, plan, design, pattern, sample or information thereof to any third party.
8. **Handling of Classified Information by Indian Licensed Defence Industry:** Any classified document/ information/ equipment being shared with Indian Licensed Defence Industries will be protected/ handled to prevent unauthorized access as per provisions of Chapter 5 of Security Manual for Indian Licensed Defence Industries issued by MoD (Department of Defence Production).
9. **Withholding of Payment:** In the event of the Seller's failure to submit the Bonds, Guarantees and Documents, supply the stores/goods and conduct trials, installation of equipment, training, etc. as specified in the Contract, the Buyer may, at his discretion, withhold any payment until the completion of the Contract.
10. **Liquidated Damages:**

“The Buyer may deduct from the Seller, liquidated damages / penalty at the rate of 0.25% per week or part thereof, of the basic cost of the delayed stores, which the Seller has failed to deliver/ carry out within the period, as agreed, in the contract. LD can also be levied on the Seller on the basic cost of the stores supplied done partially within the scope of the order/ contract that could not be put to use due to late delivery / execution of the remaining stores. The maximum quantum of LD would be 10% of the total cost of contract value (excluding taxes & duties).”
11. **Termination of Contract:** The Buyer shall have the right to terminate the Contract in part or in full in any of the following cases :-
  - i) The store/service is not received/rendered as per the contracted schedule(s) and the same has not been extended by the Buyer.
  - ii) The delivery of store/service is delayed due to causes of Force Majeure by more than 6 months provided Force Majeure clause is included in the contract and the delivery period has not been extended by the Buyer.
  - iii) The Seller is declared bankrupt or becomes insolvent.
  - iv) The Buyer has noticed that the Seller has violated the provisions of Para 4 and/or Para 5 above to obtain the Contract.
  - v) As per decision of the Arbitration Tribunal.
12. **Notices:** Any notice required or permitted by the Contract shall be written in English language and may be delivered personally or may be sent by FAX or registered pre-paid mail/ airmail, addressed to the last known address of the party to whom it is sent.
13. **Transfer and Sub-letting:** The Seller has no right to give, bargain, sell, assign or sublet or otherwise dispose of the Contract or any part thereof, as well as to give or to let a third party take benefit or advantage of the Contract or any part thereof without written consent of the Buyer.
14. **Use of Patents and other Industrial Property Rights:** The prices stated in the Contract shall be deemed to include all amounts payable for the use of patents, copyrights, registered charges, trademarks and payments for any other Industrial Property Rights. The Seller shall indemnify the Buyer against all claims from a third party at any time on account of the infringement of any or all the rights mentioned in the previous paragraphs, whether such claims arise in respect of manufacture or use. The Seller shall be responsible for the completion of the supplies including spares, tools, technical literature and training aggregates irrespective of the fact of infringement of the supplies or any or all the rights mentioned above.
15. **Amendments:** No provision of the Contract shall be changed or modified in any way (including this provision) either in whole or in part except when both the parties are in written agreement for amending the Contract.

## 16. Taxes and Duties

i) **In respect of Foreign Bidders: Not Applicable.**

ii) **In respect of Indigenous Bidders**

a) **General**

- Bidders must indicate separately the relevant GST likely to be paid in connection with delivery of completed goods specified in RFP. In absence of this, the total cost quoted by them in their bids will be taken into account in the ranking of bids.
- If a Bidder is exempted from payment of any GST up to any value of supplies from them, he should clearly state that no such duty/ tax will be charged by them up to the limit of exemption which they may have. If any concession is available in regard to rate/ quantum of any duty / tax, it should be brought out clearly. In such cases, relevant certificate will be issued by the buyer later to enable the seller to obtain exemptions from taxation authorities.
- Any changes in levies, GST levied by Central/ State/ Local governments ~~such as excise duty, VAT, Service tax, Octroi/entry tax, etc~~ on final product upward as a result of any statutory variation taking place within contract period shall be allowed reimbursement by the Buyer, to the extent of actual quantum of such duty/ tax paid by the Seller. Similarly, in case of downward revision in any such duty/tax, the actual quantum of reduction of such duty/tax shall be reimbursed to the Buyer by the Seller. All such adjustments shall include all reliefs, exemptions, rebates, concession etc., if any, obtained by the Seller. Section 64-A of Sales of Goods Act will be relevant in this situation.
- Levies, GST levied by Central/ State/ Local governments ~~such as excise duty, VAT, Service tax, Octroi/ entry tax, etc~~ on final product will be paid by the Buyer on actuals, based on relevant documentary evidence, wherever applicable. Taxes and duties on input items will not be paid by Buyer and they may not be indicated separately in the bids. Bidders are required to include the same in the pricing of their product.
- TDS as per Income Tax Rules will be deducted and a certificate to that effect will be issued by the Buyer.

b) **Customs Duty**

- Custom Duty Exemption Certificate (CDEC) will not be provided for imported items.

**Note :** As per Government of India procedure in vogue, the following concessional rate of taxes are permissible towards supply of equipments/goods for Research and Development activities of DRDO, Ministry of Defence.

- (i) Notification No. 45/2017 Central Tax (Rate) Dt. 14<sup>th</sup> Nov 2017
- (ii) Notification No. 47/2017 Integrated Tax (Rate) Dt. 14<sup>th</sup> Nov 2017
- (iii) Notification No. G.O.No. 161, Commercial Taxes and Registration (B1) Dt. 14<sup>th</sup> Nov 2017 vide No.II(2)/CTR/917 (e-5)/2017.

a) **Concessional GST** certificate will not be extended for **jobs and services**.

17. **Denial Clause** -“Variations in the rates of statutory levies within the original delivery schedule will be allowed if taxes are explicitly mentioned in the contract/ supply order and delivery has not been made till the revision of the statutory levies. Buyer reserves the right not to reimburse the enhancement of cost due to increase in statutory levies beyond the original delivery period of the supply order/ contract even if such extension is granted without imposition of LD.”
18. **Pre-Integrity Pact Clause: Not Applicable.**
19. **Undertaking from the Bidders:** An undertaking will be obtained from the Bidder/firm/company/vendor that in the past they have never been banned/debarred for doing business dealings with Ministry of Defence/Govt. of India/ any other Govt. organization and that there is no enquiry going on by CBI/ED/ any other Govt. agency against them.

### **Part III – Special Terms and Conditions**

The Bidder is required to give confirmation of their acceptance of Special Terms and Conditions of the RFP mentioned below which will automatically be considered as part of the Contract concluded with the successful Bidder as selected by the Buyer. Failure to do so may result in rejection of Bid submitted by the Bidder.

1. **Apportionment of Quantity: Not Applicable**

2. **Performance Security Bond:**

ii) Indigenous Bidder:

The Seller may be required to furnish a Performance Security Bond by way of Fixed Deposit Receipt / Bank Guarantee (BG, in favour of **“The Director, CVRDE, Avadi, Chennai – 54”** for a sum equal to **3% (As per office memorandum bearing no. F.9/4/2020 – PPD dated 12.11.2020 a Bank Guarantee / Fixed deposit)** of the Contract value (including taxes). The Bond submitted by way of Fixed Deposit Receipt/ Bank Guarantee (BG) should be valid up to 60 days beyond the date of completion of all contractual obligations. The specimen of bond can be provided on request.

“The Performance Security Bond will be forfeited by the Buyer, in case the conditions regarding adherence to delivery schedule and/or other provisions of the Contract/ SO are not fulfilled by the Seller.”

iii) Foreign Bidder: **Not Applicable**

3. **Option Clause: Not Applicable**

4. **Repeat Order Clause:**

The Contract will have a Repeat Order Clause, wherein the Buyer can order up to 50% quantity of the original contracted quantity under the Contract within twelve months from the date of supply/successful completion of this contract. The Repeat Order will have rates on not exceeding basis while the terms and conditions will remain unchanged. It will be entirely the discretion of the Buyer to exercise the Repeat order or not.

5. **Tolerance Clause: Not Applicable**

6. **Purchase Preference Clause:**

Purchase preference will be granted to the nominated agencies for the specified quantity as per the policy of Govt. of India in vogue

7. **Transfer of Technology (ToT): Not Applicable**

8. **Permissible Time Frame for Submission of Bills:** To claim payment (part or full), the Seller shall submit the bill(s) along with the relevant documents within **30 / 45** days from the completion of the activity/supply.

9. **Payment Terms :**

a) **For Indigenous Seller :**

The payment will be made as per the following terms:-

(i) 10 % of the total basic value of the purchase order exclusive of taxes will be paid as advance against submission of Bank guarantee for 110% value of the advance payment

(ii) Stage –wise / Pro-rata payments as per the Milestones / time described in the Scope of supply will be paid as per the following terms:-

Payment terms	Activities to be completed	% of Payment
Advance payment	-	10 % of the Total basic value of the purchase order will be paid as advance.
Mile stone - I (*T0 + 6 months)	PDR of DVAPU, successful completion of manufacturing, functional testing and validation of alternator prototype and DDR	10 % of the total basic value of supply order with relevant taxes will be paid.
Mile stone - II (T0 + 09 months)	CDR, successful completion of prototype testing and delivery of prototype APU	20 % of the total basic value of supply order with relevant taxes will be paid
Mile stone - III (T0 + 15 months)	Development of QT units, Completion of Qualification testing and delivery of QT units (2 nos.)	30% of the total basic value of supply order with relevant taxes will be paid.
Final Payment (T0 + 20 months)	Realization of AT units (3 nos.), successful completion of Acceptance testing (3 nos.) and delivery of AT units (3 nos.) including all reports and documents	30% of the total basic value of supply order with relevant taxes + the balance taxes payable against advance payment made.

**\*T0 = Effective date of contract (i.e, date of release of contract)**

b) **For Foreign Seller : Not Applicable**

10. **Advance Payments:**

Interest free mobilization advance payment of 10% of the Contract value may be made, against submission of Bank Guarantee, in favour of The Director (CVRDE), (CHENNAI), of 110% of advance payment (from first class bank of international repute in case of foreign seller) by the private firm or against submission of Indemnity Bond by the Govt. organizations/ PSUs. In case of termination of the Contract due to default of the Seller, interest free mobilization advance would be deemed as interest bearing advance, compounded quarterly, at the rate of 2% above (i) Prime Lending Rate of State Bank of India for Indian seller, and (ii) LIBOR rate for the foreign seller. The rates as applicable on the date of receipt of advance will be considered for this.

11. **Part Supply and pro rata payment: Applicable (refer Part III S.No. 9(a))**

12. **Mode of Payment**

a) **For Indigenous Sellers:** It will be mandatory for the Bidders to indicate their bank account numbers and other relevant e-payment details to facilitate payments through ECS/EFT mechanism instead of payment through cheque, wherever feasible.

b) **For Foreign Seller: Not Applicable**

13. **Documents to be Furnished for Claiming Payment**

i) **Indigenous Sellers:**

The payment of bills will be made on submission of the following documents by the Seller to the Buyer:

- a) Ink-signed copy of Contingent Bill.
- b) Ink-signed copy of Commercial Invoice / Seller's Bill.
- c) Bank Guarantee for Advance, if applicable.
- d) Guarantee/ Warranty Certificate.

- e) Details for electronic payment viz. Bank name, Branch name and address, Account Number, IFS Code, MICR Number (if these details are not already incorporated in the Contract).
- f) Original copy of the Contract and amendments thereon, if any.
- g) Income Tax PAN No along with the Xerox copy of the PAN card
- h) Copy of GST registration certificate
- i) Self certification from the Seller that the GST received under the contract would be deposited to the concerned taxation authority. In this regard, extant Government orders will be applicable as communicated by DRDO HQ.
- j) Material Test Certificate/Certificate of Conformance from OEM if applicable.
- k) Any other document/ certificate that may be provided for in the Contract.

ii) **Foreign Sellers: Not Applicable**

**14. Exchange Rate Variation (ERV) Clause: Not Applicable**

**15. Force Majeure Clause:**

- i) Neither party shall bear responsibility for the complete or partial non-performance of any of its obligations, if the non-performance results from such Force Majeure circumstances as Flood, Fire, Earth Quake and other acts of God as well as War, Military operations, blockade, Acts or Actions of State Authorities or any other circumstances beyond the parties control that have arisen after the conclusion of the present contract.
- ii) In such circumstances the time stipulated for the performance of an obligation under the Contract is extended correspondingly for the period of time commensurate with actions or circumstances and their consequences.
- iii) The party for which it becomes impossible to meet obligations under the Contract due to Force Majeure conditions, is to notify in written form to the other party of the beginning and cessation of the above circumstances immediately, but in any case not later than 10 (Ten) days from their commencement.
- iv) Certificate of a Chamber of Commerce (Commerce and Industry) or other competent authority or organization of the respective country shall be considered as sufficient proof of commencement and cessation of the above circumstances.
- v) If the impossibility of complete or partial performance of an obligation lasts for more than 6 (six) months, either party hereto reserves the right to terminate the Contract totally or partially upon giving prior written notice of 30 (thirty) days to the other party of the intention to terminate without any liability other than reimbursement on the terms provided in the agreement for the goods received.

**16. Buy-Back: Not Applicable**

**17. Export License:** The Bidder is required to furnish full details and formats of End Use Certificate required for obtaining export clearance from the country of origin. This information will be submitted along with Techno-Commercial bid. In the absence of such information, it would be deemed that no document is required from the Buyer for export clearance from the country of origin.

**18. Free Issue of Material (FIM): Not Applicable**

**19. Terms of Delivery**

- **For Foreign Bidder: Not Applicable**
- **For Indigenous Bidder:** The delivery of goods shall be on F.O.R (**CVRDE, Avadi, Chennai-54**) basis.

## 20. Packing and Marking Instructions:

- a) The Seller shall provide packing and preservation of the equipment and spares/goods contracted so as to ensure their safety against damage in the conditions of land, sea and air transportation, transshipment, storage and weather hazards during transportation, subject to proper cargo handling. The Seller shall ensure that the stores are packed in containers, which are made sufficiently strong. The packing cases should have provisions for lifting by crane/fork lift truck. Tags with proper marking shall be fastened to the special equipment, which cannot be packed.
- b) The packing of the equipment and spares/goods shall conform to the requirements of specifications and standards in force in the territory of the Seller's country.
- c) A label in English shall be pasted on the carton indicating the under mentioned details of the item contained in the carton. The cartons shall then be packed in packing cases as required.
  - i) Part Number :
  - ii) Nomenclature :
  - iii) Contract annex number :
  - iv) Annex serial number :
  - v) Quantity contracted :
- d) One copy of the packing list in English shall be inserted in each cargo package, and the full set of the packing lists shall be placed in Case No.1 painted in a yellow colour.
- e) The Seller shall mark each package with indelible paint in English language as follows:-
  - i) Contract No. \_\_\_\_\_
  - ii) Consignee \_\_\_\_\_
  - iii) Port / airport of destination \_\_\_\_\_
  - iv) Ultimate consignee \_\_\_\_\_
  - v) Package No. \_\_\_\_\_
  - vi) Gross/net weight \_\_\_\_\_
  - vii) Overall dimensions/volume \_\_\_\_\_
  - viii) The Seller's marking \_\_\_\_\_
- f) If necessary, each package shall be marked with warning inscriptions: <Top>, <Do not turn over>, category of cargo etc.
- g) Should any special equipment be returned to the Seller by the Buyer, the latter shall provide normal packing, which protects the equipment and spares/goods from damage or deterioration during transportation by land, air or sea. In such case the Buyer shall finalize the marking with the Seller.

## 21. Inspection Instructions:

- i) Raw material inspection
  - ii) Part inspection
  - iii) Stage/Subsystem inspection
  - iv) Pre Delivery Inspection-
  - v) Factory Acceptance Test
  - vi) Post Delivery inspection on receipt of store
  - vii) **Inspection Authority:** The Inspection will be carried out by a representative of the Lab/Estt duly nominated by the Director, CVRDE.
- } **Refer QT/AT Document**

## 22. Franking Clause:

- i) **In Case of Acceptance of Store(s):** "The fact that the goods have been inspected after the delivery period and passed by the Inspecting Officer will not have the effect of keeping the contract alive. The goods are being passed without prejudice to the rights of the Buyer under the terms and conditions of the Contract".
- ii) **In Case of Rejection of Store(s):** "The fact that the goods have been inspected after the delivery period and rejected by the Inspecting Officer will not bind the Buyer in any manner. The goods are being rejected without prejudice to the rights of the Buyer under the terms and conditions of the contract."

## 23. Claims:

- i) The quantity claims for deficiency of quantity and/ or the quality claims for defects or deficiencies in quality noticed during the inspection shall be presented within 45 days

of completion of inspection.

- ii) The Seller shall collect the defective or rejected goods from the location nominated by the Buyer and deliver the repaired or replaced goods at the same location, within mutually agreed period, under Seller's arrangement without any financial implication on the Buyer.

## 24. Warranty:

The Seller will declare that the goods, stores articles sold/supplied shall be of the best quality and workmanship and new in all respects and shall be strictly in accordance with the specifications and particulars contained/mentioned in the contract. The Seller will guarantee that the said goods/stores/articles would continue to conform to the description and quality for a period of, **01 year** from the date of acceptance / installation of the said goods stores/articles. If during the aforesaid period of **01 year**, the said goods / stores are discovered not to conform to the description and quality aforesaid, not giving satisfactory performance or have deteriorated, the Buyer shall be entitled to call upon the Seller to rectify the goods/stores/articles or such portion thereof as is found to be defective by the Buyer within a reasonable period without any financial implication on the Buyer.

**24.1** Warranty of the Equipment would be extended by such duration of downtime. Record of the down time would be maintained by user in logbook

**24.2** If the defective Part/Subsystem/System needs to be taken by the SELLER to their premises to rectify defective Goods, SELLER shall provide a Bank Guarantee of the equipment amount to the BUYER to cover for the time taken to rectify the defective Goods. If the defective Part/Subsystem/System needs to be replaced. The time taken to process and submit the Bank Guarantee shall not be added to the downtime provided such time does not exceed seven 7 days.

**24.3** The SELLER also undertakes to diagnose, test, adjust, calibrate and repair/replace the goods/equipment arising due to accidents by neglect or misuse by the operator or damage due to transportation of the goods or any other reason attributable to the BUYER, during the Warranty period, at the cost mutually agreed to between the BUYER and the SELLER. The SELLER shall intimate the assignable cause of the failures.

**24.4** SELLER hereby warrants that necessary service and repair back up during the warranty period of the equipment shall be provided by the SELLER and he will ensure that the downtime is within 30% of the Warranty period.

**24.5** SELLER shall associate Technical Personnel of Maintenance Agency and QA Of BUYER during warranty repair and shall also provide the details of complete defects, reasons and remedial actions for defects.

**24.6** If a particular equipment/goods fails frequently and/or, the cumulative Down time exceeds 30% of the warranty period, the complete equipment shall be replaced free of cost by the SELLER within a stipulated period of 45 days of receipt of the notification from the BUYER duly modified/upgraded through design improvement in all equipment supplied/yet to be supplied and Engineering Support Package (ESP) supplied and yet to be supplied. Warranty of the Replaced Equipment would start from the date of acceptance after JRI by the BUYER/date of installation and commissioning.

**24.7** In case the complete delivery of ESP is delayed beyond the period stipulated in this Contract, then SELLER undertakes that the warranty period for the Goods/stores shall be extended to that extent.

**24.8 Warranty Bond** for an amount of 3 percent of the contract value should be submitted from the seller prior to return of performance security bond by the buyer (submitted earlier by the seller as per Part III Sl.No 2 (i)). In case of Indian bidder, Warranty Bonds may be accepted in the form of Fixed Deposit Receipt or a Bank Guarantee. For foreign bidders, It may be accepted in the form of Bank Guarantee or Stand-by Letter of Credit. It should remain valid for a period of sixty days beyond the date of completion of all warranty obligations. Warranty Bond would be returned to the Seller on successful completion of warranty obligations, under the contract.

## **25. Product Support:**

The Seller agrees to provide Product Support for the stores, assemblies/sub-assemblies, fitment items, Spares and consumables, Special Maintenance Tools (SMT)/Special Test Equipments (STE) / Softwares for a minimum period of **5** years excluding **12** Months of warranty period after the delivery / end date of contract period.

## **26. Annual Maintenance Contract (AMC) Clause: Not Applicable**

AMC is not part of this tender; However the L1 vendor has to submit the willingness to undertake AMC subsequent to warranty.

## **27. Price Variation (PV) Clause: Not Applicable**

## **28. Intellectual Property Rights (IPR):**

The rights of Intellectual Property, developed under the Contract, will be the property of Govt. of India. The holding of rights of intellectual property will be decided by the Buyer based on the merits of the case. The Development Partner will, however, be entitled to license fee / royalty from designated agency as per agreed terms and conditions. The Development Partner will also be entitled to use these intellectual properties for their own purposes, which specifically excludes sale or licensing to any third party.

## **PART IV- Vendor Qualification Criteria Refer Appendix 'Z'**

**Part V – Essential Details of Items Required**

1. **Schedule of Requirements:** List of items required are as follows :-

SI. No.	Description of article(s) / Service(s)	Qty Reqd	A/U
1.	Development of Dual Voltage Auxiliary Power Unit – Details as per Appendix – A of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1	Job
2.	Supply of Dual Voltage Auxiliary Power Unit – Details as per Appendix - B of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	6	Set
3.	Qualification Testing of Dual Voltage Auxiliary Power Unit – Details as per Appendix - C of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1	Job
4.	Acceptance Testing of Dual Voltage Auxiliary Power Unit – Details as per Appendix - D of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1	Job

2. **Technical Details:**

- a) **Specifications/Drawings:** Refer Appendix 'A' of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU
- b) Technical details with technical parameters : Refer Appendix 'A', 'C' & 'D' of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU
- c) Requirement of training/on-the-job training : **Applicable**
- d) Requirement of installation/commissioning : **Applicable**
- e) Full Inspection details as per provisions made in Para 21 of Part III of the RFP
- f) Requirement of Technical Documentation : Refer Appendix 'A' & 'B' of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU
- g) Nature of assistance required after completion of warranty as per provisions made in Para 24 of Part III of the RFP : **Applicable**
- h) Requirement of pre-site inspection : **Applicable**
- i) Any other details, as considered necessary : **D CPP as per Appendix 'A' of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU**

3. Bidders are required to furnish clause by clause compliance of specifications bringing out clearly the deviations from specification, if any. Bidders are advised to submit compliance statement for the technical parameters separately in the following format along with the Techno-Commercial Bid.

Para of RFP specifications (item-wise)	Specifications of item offered	Compliance to RFP specifications – whether Yes / No	Remarks (In case of non-compliance, deviation from RFP to be specified in unambiguous terms. In case of compliance, catalogue/brochure reference, if available, to be indicated)

4. **Delivery Period:** Expected Delivery period for supply of items/rendering of services would be **20 months** from the Effective Date of the Contract. Please note that the Contract can be cancelled unilaterally by the Buyer in case items are not received within the contracted delivery period. Extension of contracted delivery period with/ without LD clause will be at the sole discretion of the Buyer.

5. **INCOTERMS for Delivery and Transportation (for Foreign Bidders only): Not Applicable**

6. **Consignee details:**

- Name: The Director
- Address: CVRDE, Avadi, Chennai-600 054, Tamil Nadu
- Contact details:

(i) For Technical Queries :- Contact Person

**Smt PRABHAVATHY R, SCIENTIST 'G', Phone No. 044 – 26364181,**

**E-mail : [prabhavathy.r@cvrde.drdo.in](mailto:prabhavathy.r@cvrde.drdo.in)**

(ii) For Commercial Queries :- Contact Person

**Shri. K .SIVAKUMAR, SCT'F', Phone No. 044 – 26364010, E-mail : [sivakumar.k@cvrde.drdo.in](mailto:sivakumar.k@cvrde.drdo.in)**

## **Part VI – Evaluation Criteria of Bids**

1. **Evaluation and Acceptance Process:** The bid will be considered and selected based on instructions contained in Part I of the RFP for further evaluation of bids as per sequence given below:
  - i) **Techno-Commercial Bid Evaluation:** Bids will be evaluated based on vendor qualification requirement as per Part IV of RFP, if applicable, and bids of the qualified bidders will be considered for further evaluation as mentioned in Part V of the RFP.
  - ii) **Price Bid Evaluation:** The Price bid of those bidders whose Techno-Commercial bid (if applicable) has been accepted will be opened and comparative statement will be prepared. The best acceptable bid will be decided upon the lowest price quoted by the particular Bidder as per the Price Format given at Part VII of the RFP **(Lot wise)**. The comparison of the bids would be done on the principle of the total cash outgo from procuring entity's pocket. The financial bids of the qualified bidders would be compared on the basis of the total cost (FOR destination basis – consignment to buyers premises) of the deliverables and services including statutory levies, taxes and duties on final product/service which are to be paid extra as per actual.
2. **Procedure for Cost Comparison:** The basis for comparison of cost in different situations would be as follows:
  - a) If competition is only among Indian bidders, the financial implication should be considered on the basis of FOR prices at destination, **including** the GST levied by Central / State / Local government ~~such as excise duty, VAT, service Tax, octroi / entry tax etc.~~, on final product payable by the DRDO Lab/Estt after availing various benefits of exemptions from taxes/duties as applicable to DRDO.
  - b) ~~In import cases, all the foreign quotes will be brought to a common denomination in Indian Rupees by adopting the exchange rate as BC selling rate of the State Bank of India on the date of the opening of Price Bids.~~
  - c) ~~If competition is among foreign bidders, the basis for comparison should be the landed price at the destination (designated port) in accordance with Para 19 of Part III of the RFP.~~
  - d) ~~If competition is amongst Indian and foreign bidders, the CIP/CIF cost quoted by the foreign bidders would be the basis for comparison with the basic cost (FOR) offered by Indian bidders, after off loading the applicable taxes and levies. The term Indian bidders would also include DPSUs and Indian Ordnance Factories.~~
  - e) ~~The Buyer reserves the right to evaluate the offers received by adopting Discounted Cash Flow (DCF) method with a discounting rate in consonance with the existing Government borrowing rate. DCF method would be used for evaluation of bids in the following cases:~~
    - i) ~~To compare different payment terms, including advance payments and progressive stage payments so as to bring them to a common denomination for determining lowest bidder.~~
    - ii) ~~To deal with cases where entering into AMC for period in excess of one year is a part of the contract for evaluation of the bid.~~

f) ~~**Net Present Value (NPV):** NPV method is a variant of DCF method which may be used for evaluation of tenders. The NPV of a contract is equal to the sum of the present values of all the cash flows associated with it. When choosing among the various bids, the bid with the lowest NPV will be selected. The following formula may be used for calculating NPV of a bid:~~

$$NPV = \sum_{t=0}^N \frac{A_t}{(1+i)^t}$$

Where

$A_t$  : Expected cash flow at time t

t : Time of expected cash flow

N : Total period

i : Discount rate

- g) ~~Discount rate to be used under the method is to be the Prime Lending Rate of State Bank of India on the Date of Opening of Price Bids.~~
- h) If there is a discrepancy between the unit price and the total price that is obtained by multiplying the unit price and quantity, the unit price will prevail and the total price will be corrected accordingly.
- i) If there is a discrepancy between words and figures, the amount in words will prevail for calculation of price.
3. The best acceptable bid will be considered further for placement of the Contract after price negotiation as decided by the Buyer.

### **Part VII – Price Bid Format**

Price bid to be uploaded as per the prescribed format (i.e BoQ\_XXXX.xls) provided in the E-Procurement Module

**Note: All fields of BOQ should be entered. Taxes are to be indicated as per Govt order in force.**

**CGST will be extended for equipments and goods.**

**CGST is not applicable for jobs and services.**

**If GST is not applicable, necessary exemption certificate is to be uploaded by the firm alongwith the techno commercial bid.**

**COMPLIANCE SHEET**  
**Part I : Technical Specification**

<b>Sl. No.</b>	<b>Item description</b>	<b>Quantity</b>	<b>Complied / Not Complied</b>
1	Development of Dual Voltage Auxiliary Power Unit – Details as per Appendix – A of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1 Job	
2	Supply of Dual Voltage Auxiliary Power Unit – Details as per Appendix - B of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	6 Set	
3	Qualification Testing of Dual Voltage Auxiliary Power Unit – Details as per Appendix - C of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1 Job	
4	Acceptance Testing of Dual Voltage Auxiliary Power Unit – Details as per Appendix - D of Doc No. CV/ELE/CVR-272/DOC/RFP-DV APU	1 Job	

**Part II: Techno-Commercial Terms**

<b>S No</b>	<b>Description of the item</b>	<b>Complied / Not Complied</b>
1	Validity of bid - 180 days from the last date of submission of bids.	
2	Performance Security Bond : 3% of the contract value as per SI.No. 2 (i) of Part III of the RFP. (For PSUs : Indemnity Bond is acceptable in lieu of FDR/BG)	
3	Payment terms: as per SI.No. 9 (a) of Part III of the RFP.	
4	Warranty period : 01 year	
5	LD Clause as per SI.No. 10 of Part II of the RFP.	
6	Registration status <ul style="list-style-type: none"> <li>• If you are registered firm, Please mention the registration details, also attach a copy of the registration certificate</li> </ul>	
7	Delivery period –Within 20 months from the effective date.	
8	Acceptance of General Terms and conditions as per Part II of RFP	
9	Acceptance of Special Terms and Conditions as per Part III of RFP	
10	Training	

(Authorized Signatory)

Seal

Please note that duly filled in **Appendix ‘Z’<sup>1</sup>** signed by Authorized signatory with seal to be enclosed along with technical bid.

## QT/AT Document

### 1. Introduction:

CVRDE is one of the premier DRDO establishments responsible for design, development and test evaluation of Armoured Fighting Vehicles (AFVs). CVRDE's flagship product, Arjun Main Battle Tank, was successfully completed and accepted by army, meeting stringent specifications with superior fire power, mobility and survivability. Electrical system forms the backbone of any automotive vehicle and major role is starting, power generation & distribution. CVRDE has gained expertise in the development and testing of 28 V DC electrical power generating systems for Armoured Fighting Vehicles (AFV).

The NGMBT gun control system is configured with electrically operated turret system. Electrical drive utilises electric motor which operates at 270 V DC. This demands the generation and distribution of 270 V DC system in addition to 28 V DC system. During silent watch mode, 270 V DC is also required apart from 28 V DC. This necessitates the development of Dual Voltage Auxiliary Power Unit. Each set of Dual Voltage Auxiliary Power Unit comprises the following:

- Engine
- Alternator
- Automatic Power converter
- Control Panel
- Interconnecting harnesses
- Sound-proof enclosure unit

### Overall QT/AT plan

Design Reviews viz. PDR, DDR and CDR will be conducted. One prototype shall be manufactured after Detailed Design Review. Subsequently, the prototype will be tested. CDR will be conducted to finalise the design and configuration based on the outcome of prototype testing. The outcome of the prototype-I testing will be discussed in CDR and necessary modifications/ improvements will be incorporated in prototype-I to meet the specifications as per CDR. If required, the vendor shall develop additional prototype(s) to meet the specifications and the same will be tested.

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Then, two QT units shall be realised and tested. One QT unit (QT1) will undergo EMI/EMC and Endurance tests and another QT unit (QT2) will undergo all environmental tests. After successful testing of two QT units, three AT units shall be realised and tested. The vendor shall supply one prototype unit, 2 QT unit & 3 AT units, related documents and reports viz. design documents, test reports and technical documents etc. as per the timeline mentioned in Appendix A.

The total duration of the contract is 20 months from the placement of Supply Order.

**2. Part No. / Specification:** Refer Appendix-A

**3. Applicable documents if any:** Enabling Electrical Technologies for NGMBT - RFP for Development and Supply of Dual Voltage Auxiliary Power Unit.

**Doc No:** CV/ELE/CVR-272/DOC/RFP-DVAPU

**4. Item Description:**

S.No	Description of article(s)/ Services	Qty Reqd.	A/U
1	Development of Dual Voltage Auxiliary Power Unit - Details as per Appendix-A	1.00	Job
2	Supply of Dual Voltage Auxiliary Power Unit as per Appendix-B	6.00	Set
3	Qualification Testing of Dual Voltage Auxiliary Power Unit -Details as per Appendix-C	1.00	Job
4	Acceptance Testing of Dual Voltage Auxiliary Power Unit- Details as per Appendix-D	1.00	Job

**5. List of Deliverables:**

- i. Six sets of Dual Voltage Auxiliary Power Unit along with necessary reports as per Appendix-B.
- ii. Three sets of Technical manual and other documents (in hard copy and soft copy) as per Appendix-B

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- iii. Three sets of Design documents and reports as per Appendix-A.
- iv. Two Sets Qualification test reports and one set of test rigs if any as per Appendix-C.
- v. Three sets of Acceptance test reports and one set of test jigs if any as per Appendix-D.
- vi. One set of Test Rig and jigs required for the manufacturing and testing of Dual Voltage Auxiliary Power Unit.

**6. Receiving and Inspection :**

- 6.1 Tests / Checks and Acceptance criteria for raw material: CoC for raw material/components shall be obtained from manufactures
- 6.2 Final Inspection
  - 6.2.1. Features for Visual Inspection and Acceptance Criteria: Refer Appendix-D
  - 6.2.2. Dimensional Inspection: As per Appendix-D
  - 6.2.3. Details of tests / checks on finished items and Acceptance Criteria:
    - a. Test on prototype - Refer Appendix A
    - b. Tests on QT units– Refer Appendix C
    - c. For Acceptance testing on final deliverables – Refer Appendix D

**7. Performance Acceptance Test:**

- a. For the development of Dual Voltage Generating System (prototype acceptance)
  - Refer Appendix A
- b. For Qualification testing (QT units) – Refer Appendix C
- c. For Acceptance testing on final deliverables – Refer Appendix D

**8. Suppliers Certification : Warranty Certificate**

**9. QT/AT conformance report : Refer Appendix-A, Appendix-C and Appendix-D**

*C. Ishley:*

Doc. No: CV/ELE/CVR-272/DOC/RFP-DVAPU

**Enabling Electrical Technologies for Next Generation  
MBT (NGMBT)**

**RFP for Development and Supply of Dual Voltage  
Auxiliary Power Unit**



AUGUST 2021

**COMBAT VEHICLES RESEARCH AND DEVELOPMENT  
ESTABLISHMENT**

**Defence Research and Development Organisation (DRDO)  
Government of India, Ministry of Defence  
Avadi, CHENNAI - 600 054**

*P. J. Jeyaraj*

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## Glossary

<b>ADC</b>	Analog to Digital Converter
<b>AFV</b>	Armoured Fighting Vehicle
<b>ATP</b>	Acceptance Test Procedure
<b>APC</b>	Automatic Power Controller
<b>BH</b>	Bulk Head
<b>CAN</b>	Controller Area Network
<b>CBIT</b>	Continuous Built-in Test
<b>CDR</b>	Critical Design Review
<b>CFD</b>	Computational Fluid Dynamics
<b>COC</b>	Certificate of Conformance
<b>DGQA</b>	Directorate General of Quality Assurance
<b>DVAPU</b>	Dual Voltage Auxiliary Power Unit
<b>EMC</b>	Electromagnetic Compatibility
<b>EMI</b>	Electromagnetic Interference
<b>ESS</b>	Environmental Stress Screening
<b>FMECA</b>	Failure Mode Effects and Criticality Analysis
<b>IBIT</b>	Initiated Built-in Test
<b>IPMS</b>	Intelligent Power Management System
<b>MSL</b>	Mean Sea Level
<b>MTBF</b>	Mean Time Between Failures
<b>NGMBT</b>	New Generation Main Battle Tank
<b>PBIT</b>	Power on Built-in Test
<b>PCB</b>	Printed Circuit Board
<b>QT</b>	Qualification Testing
<b>SMT</b>	Special Maintenance Tools
<b>STE</b>	Special Test Equipment
<b>TVR</b>	Transient Voltage Rise
<b>TVD</b>	Transient Voltage Drop

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## Development of Dual Voltage Auxiliary Power Unit

### A.1 Introduction

CVRDE is one of the premier DRDO establishments responsible for design, development and test evaluation of Armoured Fighting Vehicles (AFVs). CVRDE's flagship product, Arjun Main Battle Tank, was successfully completed and accepted by army, meeting stringent specifications with superior fire power, mobility and survivability. Electrical system forms the backbone of any automotive vehicle and major role is starting, power generation & distribution. CVRDE has gained expertise in the development and testing of 28 V DC electrical power generating systems for Armoured Fighting Vehicles (AFV).

Auxiliary Power Unit (APU) is an additional power source provided in the MBT for addressing the load requirements during silent watch mode i.e when the main engine is OFF. APU is also used to charge the batteries and supply power to all essential loads during firing.

The NGMBT gun control system is configured with electrically operated turret system. Electrical drive utilises electric motor which operates at 270 V DC. This demands the generation and distribution of 270 V DC in addition to 28 V DC system. During silent watch mode, 270 V DC is also required apart from 28 V DC. This necessitates the development of Dual Voltage Auxiliary Power Unit.

The Dual Voltage Auxiliary Power Unit shall develop 11 kW power (4.5 kW at 28 V DC and 6.5 kW at 270 V DC). It comprises the following major components:

- Engine
- Alternator
- Automatic Power converter
- Control Panel
- Interconnecting harnesses
- Sound-proof enclosure unit

Development of Dual Voltage Auxiliary Power Unit is first time in the country and similar configuration is not available. Hence detailed design analysis has to be carried out by the way of modelling and simulation. Extensive testing is required to qualify the DVAPU for AFV applications.

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### Overall Contract summary

The Dual Voltage Auxiliary Power Unit mainly consists of Engine, Alternator, Automatic Power Converter, Control Panel, and associated sub-assemblies. The vendor shall carryout design, development, testing and supply of Dual Voltage Auxiliary Power Unit (along with subassemblies) as per the specifications. The configuration of the alternator will be provided by CVRDE. The firm shall carry out detailed design, analysis and manufacture the alternator as per CVRDE configuration. Other subassemblies of DVAPU shall be designed and manufactured or procured by the firm so as to comply CVRDE specifications. Design Reviews viz. PDR, DDR and CDR will be conducted. One prototype shall be manufactured after Detailed Design Review. Subsequently, the prototype will be tested. CDR will be conducted to finalise the design and configuration based on the outcome of prototype testing. The outcome of prototype-I testing will be discussed in CDR and necessary modifications/ improvements will be incorporated in prototype-I to meet the specifications as per CDR. If required, the vendor shall develop additional prototype(s) (by incorporating design modifications) to meet the specifications and the same will be tested.

After completion of prototype DVAPU unit, two QT units shall be realised and tested. After successful testing of two QT units, three AT units shall be realised and tested. The vendor shall supply one prototype unit, 2 QT units & 3 AT units, related documents and reports viz. design documents, test reports and technical documents, etc.

The total duration of the contract is 20 months from the placement of Supply Order. List of major activities along with timeline are as given in Table A.1.

Activity		PDC
Placement of S.O	-	T0
PDR	-	T0 +02 months
Manufacturing of prototype alternator	-	T0 +04 months
Functional testing and validation of alternator prototype using test rig.	-	T0 +05 months
DDR	-	T0 +06 months
Development testing on DVAPU (includes alternator, engine, APC and Control panel etc) and delivery of prototype	-	T0 +08 months
CDR	-	T0+09 months
Qualification Testing on QT units and delivery	-	T0+15 months
Design modifications if any	-	T0+16 months

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Manufacturing of AT units	-	T0+17 months
Acceptance Testing on AT units and delivery of AT units with all test jigs, test reports & documents	-	T0 +20 months

Table A.1 List of major activities

Payment terms are as given in Table A.2.

Payment terms	Activities to be completed	% of Payment	Time
<b>Advance payment</b>		10 % will be paid as advance	-
<b>Mile stone - I</b>	PDR of DVAPU, successful completion of manufacturing, functional testing and validation of alternator prototype and DDR	10 % payment	T0+06 months
<b>Mile stone - II</b>	CDR, successful completion of prototype testing and delivery of prototype	20% payment	T0+09 months
<b>Mile stone - III</b>	Development of QT units, Completion of Qualification testing and delivery of QT units (2 no.s)	30% payment	T0+15 months
<b>Final payment</b>	Realisation of AT units (3 no.s) , successful completion of Acceptance testing(3 no.s) and delivery of AT units (3 no.s) including all reports and documents	30% payment	T0+20 months

Table A.2 Payment terms

Note:

- LD as applicable will be imposed for any delay in completion of mile stone activities.
- Additional review meetings will be conducted whenever deemed necessary to monitor the progress of the work.

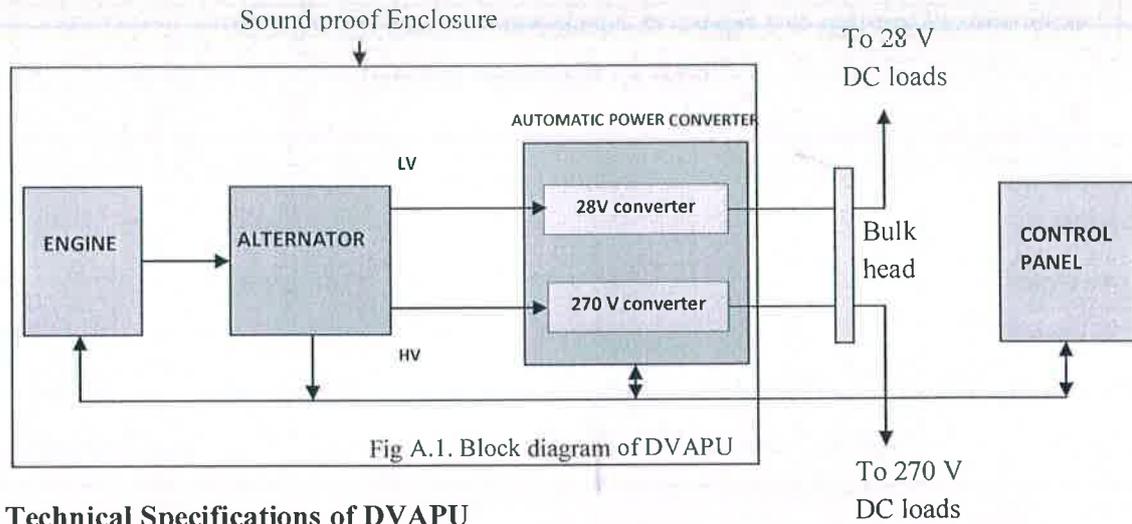
## A.II Description of Dual Voltage Auxiliary Power Unit

### 1. General

Auxiliary Power Unit (APU) is an additional power source provided in the MBT for addressing the load requirements during the silent watch mode (i.e.) when the main engine is not running. Dual Voltage Auxiliary Power Unit shall deliver a total power of

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11 kW (4.5 kW at 28 V DC and 6.5 kW at 270 V DC). The APU should be self started with the help of 24V batteries. The block diagram of DVAPU is shown in Fig A.1.



## 2. Technical Specifications of DVAPU

The technical requirement of the Dual Voltage Auxiliary Power Unit is given in Table A.3.

Overall Specifications	
Nominal output voltage of DVAPU	28V DC $\pm 0.3$ V DC and 270V DC $\pm 3$ VDC (Refer MIL-STD-1275E for 28 VDC and MIL-STD-704 F for 270 VDC for compliance)
Nominal output current of DVAPU	$\geq 161$ A @ 28 $\pm 0.3$ V DC and $\geq 24.07$ A @ 270 $\pm 3$ VDC
Nominal output Power of DVAPU (Total)	$\geq 11$ kW (4.5 kW at 28 $\pm 0.3$ V DC and 6.5 kW at 270 $\pm 3$ V DC)
Overload current capacity (%)	110% for 60 mins
Grounding	28 V DC - Negative grounded 270 V DC - Two wire system
Operating environmental temperature	-20°C to +65 °C
Endurance life	2000 Engine hours
Overall Dimensions of DVAPU(mm)	Refer Fig.A.2 for details
Mass of DVAPU	300 $\pm$ 10 kg (with enclosure)
Operational Hours	Min 8 hrs (continuous)
Altitude	Upto 16000 ft above MSL
Communication	MIL CAN and Ethernet
Warranty	1 Year from date of delivery and acceptance
Specifications	MIL-STD-461G , MIL-STD- 1275E, Refer MIL-STD-704F & JSS 55555: L2J

Table A.3 Specification of Dual Voltage Auxiliary Power Unit

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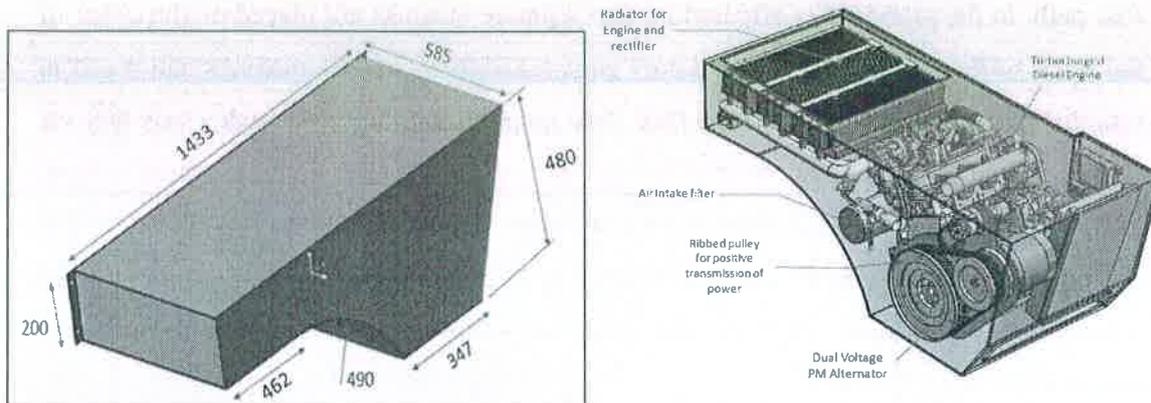


Fig.A.2 Overall dimensions of DVAPU

### 3. Description of major subsystems

Dual Voltage Auxiliary Power Unit comprises the following major components:

- Alternator
- Automatic Power converter
- Engine
- Sound-proof enclosure unit
- Control Panel
- Interconnecting harnesses

#### 3.1 Alternator

The alternator shall develop 3-phase AC power of 13.75 KVA (5.625 KVA for 28V DC output and 8.125 KVA for 270V DC output, the assumed pf is 0.8) which is fed to Automatic Power Converter. The output of Automatic Power Converter shall be 11 kW (4.5 kW at 28 V DC and 6.5 kW at 270 V DC). Alternator shall be driven by a standalone diesel engine. The variation in the engine speed is in a very narrow range and selection of permanent magnet alternator will be a better choice in terms of efficiency, weight and volume.

The proposed dual stator alternator architecture is shown in Fig.A.3. Alternator will have two independent stators and the rotor is common to both the stators. There will be two radial air gaps. One stator will be similar to the conventional AC machine with inner rotor configuration. Stator housing is used for holding the stator and removal of heat generated is very easy here. On the other hand, the inner stator will be similar to the hub wheel motor. This configuration effectively utilises the unused inner space of the machine by constructing a hollow shaped rotor and thus improves the overall efficiency of the

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generator. A part of the rotor is used for mounting magnets and some part is used for the flux path. In the proposed configuration, two separate magnets are placed on the either of the rotor surface. Hence, both the stators get excitation by nearby magnets and result in establishing good amount of air gap flux. Two magnets are placed in such a way that the flux produced by one magnet is added to another and thus form a series magnetic circuit. The AC voltages generated from outer and inner stators are fed to separate rectifiers present in the Automatic Power Converter. The voltages are regulated via phase angle control. The APC outputs 28 V DC and 270 V DC voltages to the loads through Bulk head connectors.

**Salient Features of alternator**

- Single-frame Dual output voltages
- High power-to-weight ratio
- Compact
- Full output power available over the complete speed range

The firm has to carry out detailed design analysis and develop the alternator for the DVAPU.

The specifications of the alternator are given in Table A.4.

1	Alternator Type type	Single frame Dual Output PM Alternator
2	Output	≥ 13.75 KVA (assumed pf is 0.8)
3	Rated speed	3600 rpm
4	Insulation Classification	Class H or Higher
5	Efficiency	Not less than 80% (with Cooling)
6	Cooling	Liquid cooling
7	Electromagnetic compatibility	As per MIL-STD-461 G for Ground Army
8	Compliance of standards	<ul style="list-style-type: none"> <li>• MIL-STD-1275E (28 VDC voltage characteristics for military vehicles)</li> <li>• MIL-STD-704 F (270 VDC voltage characteristics)</li> <li>• MIL-STD-461 G (EMI/EMC compatibility)</li> <li>• JSS 55555: L2J ( Environmental tests)</li> </ul>

**Table A.4.** Specifications of the Alternator

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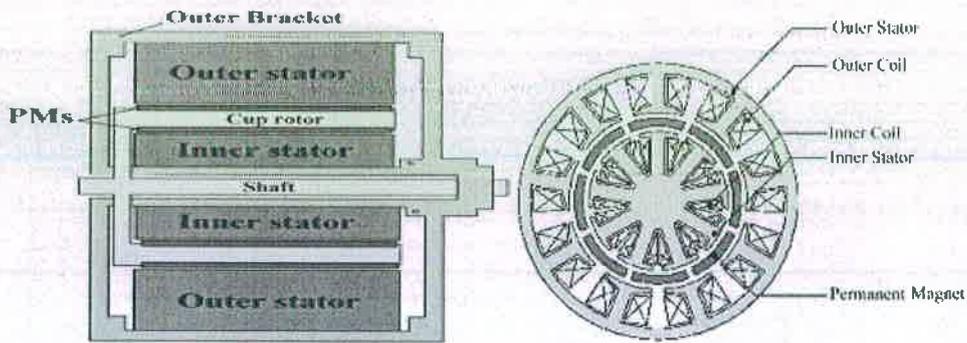


Fig.A.3 Architecture of dual stator alternator (Dual Stator Single Rotor configuration)

### 3.2 Automatic Power Converter

The main role of automatic power converter is to convert and regulate the output voltages of the alternator. In addition to this, the role is extended to monitor the operation of the alternator. Automatic Power Converter (APC) receives dual input (A.C) from the alternator and outputs 11 kW (4.5 kW at 28 V DC and 6.5 kW at 270 V DC) to the loads. It consists of independent full bridge controlled rectifiers for HV and LV with firing angle control circuits, etc. Controlled rectifiers are selected so as to regulate the output voltage. Alternatively, IGBT AC-DC converters may be used for voltage regulation. Functional block diagram of APC is given in Fig.A.4. The overall block diagram of APC with interconnected assemblies is given in Fig.A.5.

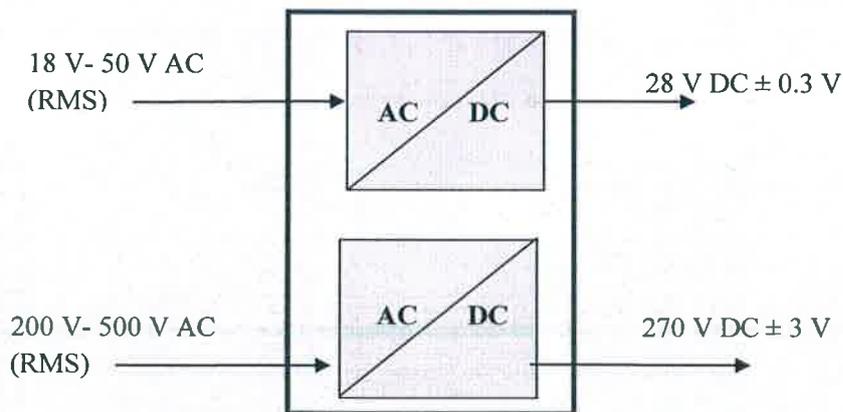


Fig.A.4 Function of APC

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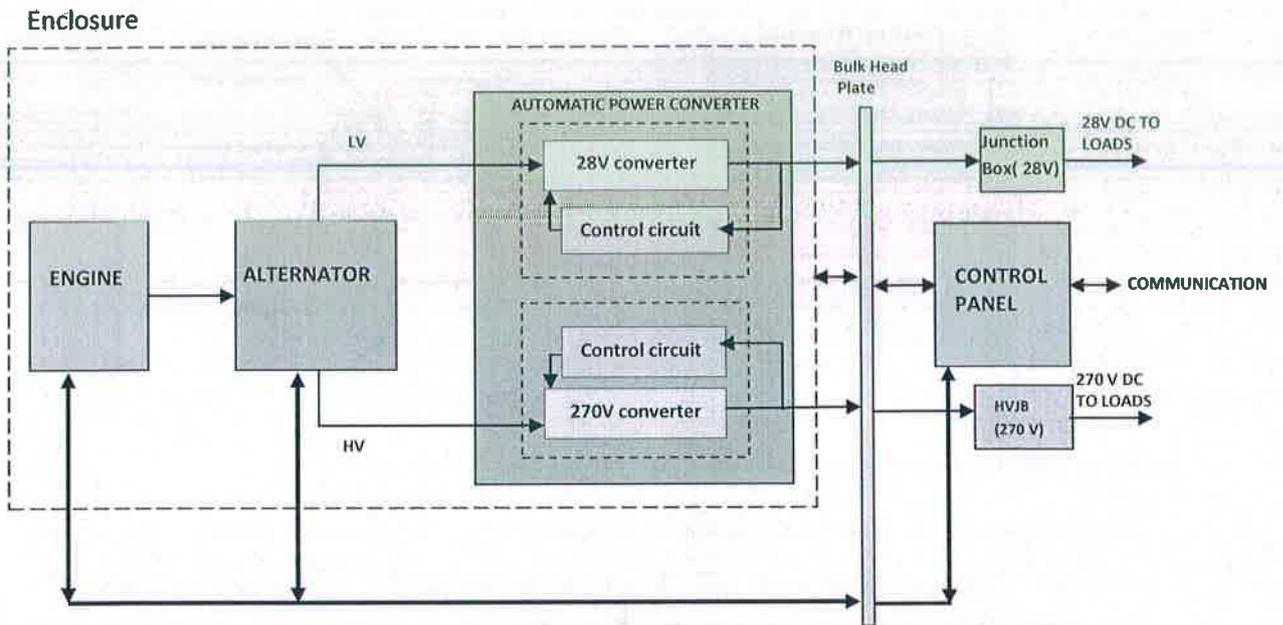


Fig. A.5 Block diagram of APC with interconnected subassemblies

The APC associated with Dual Voltage APU shall perform the following control functions:

Voltage regulation:

- i) Steady state voltage =  $28 \pm 0.3$  V &  $270 \pm 3$  V DC (for rated speed range and 0 to 100% load conditions)
- ii) Voltage transient: As per MIL-STD-704F for 270 V DC and as per MIL-STD-1275E for 28 V DC (Fig A.9-A.12).

The specifications of the APC is as follows:

Nominal Output	28V DC $\pm 0.3$ V DC and 270V DC $\pm 3$ VDC (Refer MIL-STD-1275E for 28 VDC and MIL-STD-704 F for 270 VDC for compliance)
Tolerance (static)	$\pm 0.3$ V DC for 28V DC and 3V for 270V DC
Efficiency	Not less than 90%
AC/DC conversion	Using controlled/ uncontrolled rectifiers separately for 28 V DC and 270 V DC outputs or using IGBT based AC-DC converters separately for 28 V DC and 270 V DC Output
Voltage regulation and drooping characteristics	<b>For 28 V DC output:</b> <ul style="list-style-type: none"> <li>• When load on 28 V DC bus is within 110% of rated capacity of 4.5 kW, output voltage shall be 28V DC <math>\pm 0.3</math> V DC.</li> <li>• When load on 28 V DC bus is beyond 110% of rated capacity, output voltage shall drop in proportion with load such that batteries and DVAPU share the load.</li> </ul>

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	<b>For 270 V DC output:</b> <ul style="list-style-type: none"> <li>Output voltage shall be maintained at 270V DC<math>\pm</math>3 VDC irrespective of load.</li> </ul>
Transient voltages limit	Refer Fig A.9, Fig A.10 for 28 V DC and Fig A.11, Fig A.12 for 270 VDC
Output ripples	Comply to MIL-STD-1275 E and MIL-STD-704 F
Compliance of standards	<ul style="list-style-type: none"> <li>MIL-STD-461 G (EMI/EMC compatibility)</li> <li>JSS 55555: 2012 Rev 3 ( Environmental tests)</li> </ul>

**Table A.5.** Specifications of the APC

**Note:**

- All critical components shall be MIL grade and selection of components shall be approved by CVRDE.
- The components used in the APC shall not become obsolete for 10 years.

**3.3 Engine**

A standalone diesel engine drives the alternator. The engine is required to be customized and dimensionally suitable for fixing in the specified envelope and size. The output power of engine shall be sufficient to drive the generator to provide rated power at all operating environments as per the specifications. The firm has to identify/select suitable engine to use in **AFV application** (Harsh environments) from reputed manufacturers. The selection of engine will be finalised/approved during PDR. Engine shall meet all the requirements/specifications as per CVRDE. The engine shall have an electrical starter (24 V DC), that can be controlled from the control panel.

**3.4 Sound Proof enclosure unit:**

The DVAPU enclosure shall be designed & manufactured considering the following aspects:

- Enclosure shall house the Engine, Alternator, Automatic Power Converter (other than Control Panel) fitted with requisite components like ventilation system, cooling arrangement, etc. within specified envelope dimensions. These assemblies should be accessible for carrying out maintenance.
- Air ventilation system designed for maintaining average temperature differential (inside DVAPU) of 5°C to 7°C (max) excess of the outside ambient temperature (maximum 55°C) while the DVAPU in operation.

Acoustic Noise level of DVAPU should not exceed 80 dBA (at full load condition) when measured at 6 meter distances in open space.

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- The structure of enclosure should be strong enough to withstand the shock & vibrations. The sealing provided shall meet the requirement of IP68 upon closing the openings of enclosure prior to fording operation.
- Necessary liquid cooling system shall be housed within the enclosure.
- Fuel input line and Exhaust outlet will be finalised during PDR.
- There should be a provision for Air ventilation with automatic doors operation in the enclosure. The doors shall be operated from the control panel.
- Contactors shall be used to connect the DVAPU output to the load through bulk head.
- Output connectors shall be mounted on the enclosure
- EMI gaskets should be used for compliance. Provision for achieving earthing/grounding should be included.
- The maximum permissible envelope of the enclosure is as follows (Fig A.6):

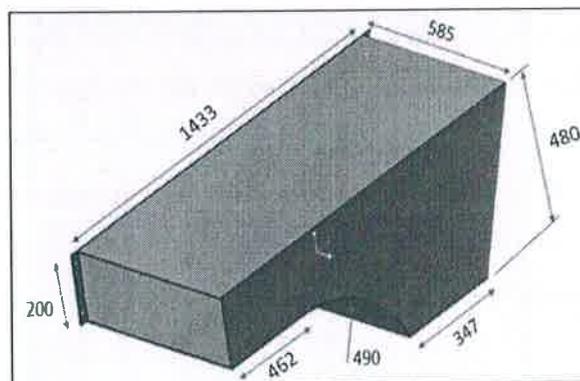


Fig.A.6 Envelope of DVAPU

### 3.5 Control Panel

The control panel comprises of logic control, protection features, etc. It shall perform functions such as monitoring, control and protection of the Auxiliary Power unit. The Control Panel shall be housed separately in the crew compartment. It provides interface for operation of DVAPU. The functional block diagram of Control Panel is shown in Fig. A.7. Control Panel shall be designed considering the following major requirements:

- Integrated control panel for controlling overall operation of DVAPU (Switch ON/OFF, etc.).
- Control Panel shall connect DVAPU to the load through contactors.
- Monitoring and protection of alternator, monitoring of diesel-engine parameters, data acquisition and storage, CAN and Ethernet communication.

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- Electrical interlocks shall be provided such that DVAPU is operational when the main engine is off & shall not switch ON when the main engine is running.
- Colour Display unit (4" TFT) for displaying electrical parameters such as alternator voltages, output DC voltages, currents, power, etc. (to monitor performance of alternator) and mechanical parameters such as engine output power, engine ON/OFF status, rpm, Lube oil pressure, coolant temperature, engine oil level, fuel flow, engine hour, etc.
- LED indications should be provided for ON/OFF, Overload, etc.
- Protection of DVAPU in case of low oil pressure, engine overheat, over load, short circuit, over temperature, etc.
- The Control Panel shall possess a device for storing critical parameters of DVAPU (output voltages, power, engine oil, etc.). The memory shall be sufficient to store data of 100 operational hours. Provision shall be made for displaying the data and transferring the data using Ethernet and CAN.
- Power required for control panel electronics shall be obtained from Junction Box through connectors.
- A GUI shall be developed to download the control panel data and for analysis.
- Interfacing the data with Vehicle common data bus.
- All critical components shall be MIL grade and selection of components shall be approved by CVRDE.

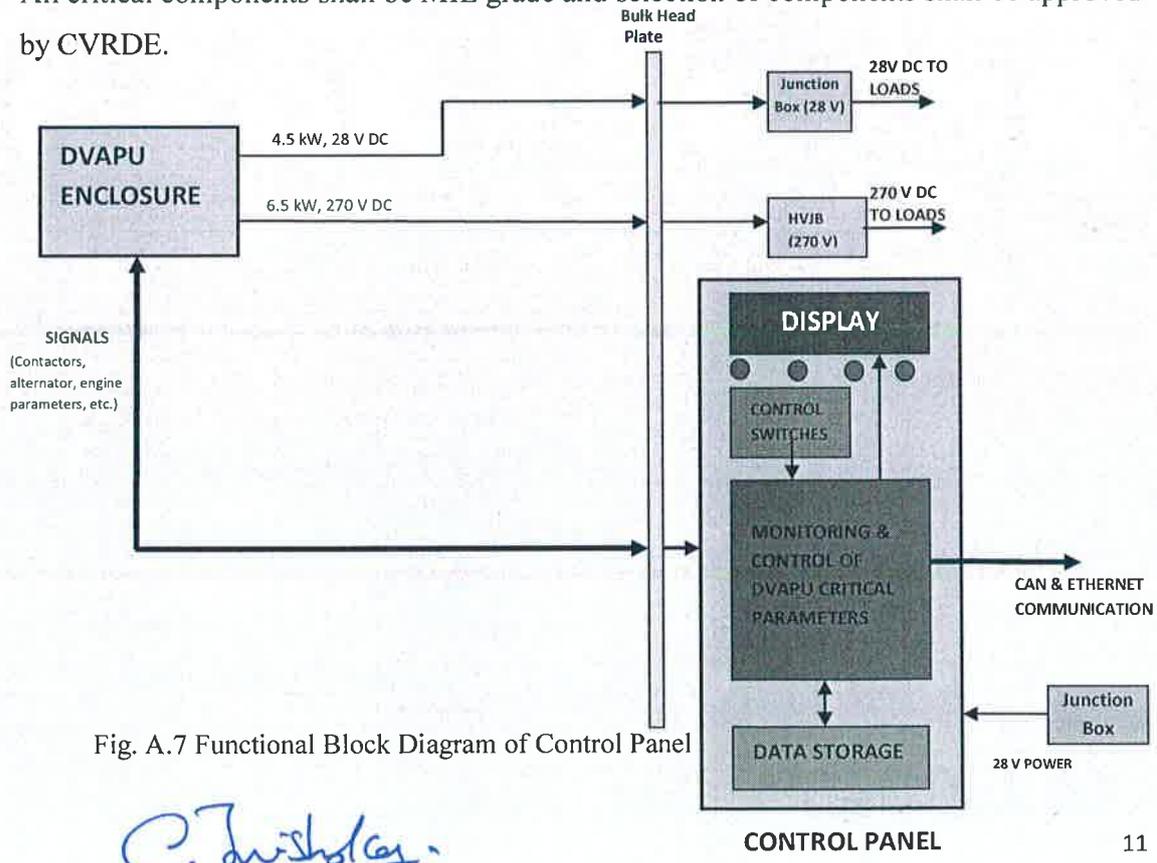


Fig. A.7 Functional Block Diagram of Control Panel

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Note:

- The necessary transient voltage protectors, filters and lightning protection devices shall be incorporated in Control panel power lines to comply with MIL-STD 704F, MIL-STD-1275E and MIL-STD-461G requirements.

The specifications of the Control panel as follows (Table A.6):

Operating voltage	18 to 32 V DC
Control Panel Type	Digital (with colour display)
Keypad	Rugged type
Display	Built -in LED/LCD colour display (4")
Voltage set point adjusting range @ 28 V	18 V DC to 32V DC
Voltage set point adjusting range @ 270 V	250V DC to 280V DC
Communication	CAN and Ethernet
Storage	Non volatile memory sufficient to store data of 100 operational hours
Cooling	Via housing surface
Operating environmental temperature (ambient condition)	-30 °C to +65 °C
No. of Connectors	3
Installation	On rubber-bonded metal
Overall Dimensions of Control Panel Height x Width x Depth (in mm)	(270 x 270 x 120) ± 1%
Mass (weight)	Not more than 5 kg ± 2%
Type of protection	IP67 proof
GUI	For downloading the data, sharing the information with other units and analysis
Compliance of standards	<ul style="list-style-type: none"> <li>• MIL-STD-1275E (28 VDC voltage characteristics for military vehicles)</li> <li>• MIL-STD-704 F (270 VDC voltage characteristics)</li> <li>• MIL-STD-461 G (EMI/EMC compatibility)</li> <li>• JSS 55555: L2J ( Environmental tests)</li> <li>• SAE J1939 (CAN communication)</li> </ul>

Table A.6. Specifications of the Control panel

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### 3.5.1 Control Panel Functions

The control panel shall monitor critical parameters of DVAPU and provide protection against the following:

- i) Over voltage
- ii) Under voltage
- iii) Under Speed
- iv) Reverse Polarity
- v) Over load
- vi) Engine low lubricating oil pressure
- vii) Engine coolant temperature
- viii) No fuel

	Overload current	Time duration
28 V DC	(110% of rated)	60 min
270 V DC	(110% of rated)	60 min

Table A.7 Overload current

### 3.5.2 Protection BITs:

- **Power-On BIT (PBIT):** Power On BIT is carried out as soon as the battery power is made available.
- **Continuous BIT (CBIT):** The CBITs is diagnostic BIT performed when the DVAPU is under operation. CBIT does not interfere with normal control & protection functions. CBIT shall capture all the faults, power supply voltages, currents, etc.
- **Initiated BIT (IBIT):** This would be carried out when the DVAPU is running or not running. All the power supplies, functional and protection circuits are verified for their health.

Detection of fault during PBIT and IBIT displays a "DVAPU FAULT "on output lines to IPMS through CAN. Fault information should be stored in Non-volatile memory in Control Panel and warnings to be interfaced with IPMS. Control Panel shall also store the DVAPU operating hours.

### 3.5.3 Electrical connections

The electrical connections for signal sensing, interfacing with alternator, engine, Automatic Power Converter, communication and data logging functions, etc. shall consists of terminals and connectors complying to MIL standard.

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#### 4. Installation

The DVAPU shall be mounted on hull with necessary self contained liquid cooled system as shown in Figure A.8. Control Panel will be mounted in the crew compartment with its mounting surface in a vertical plane.

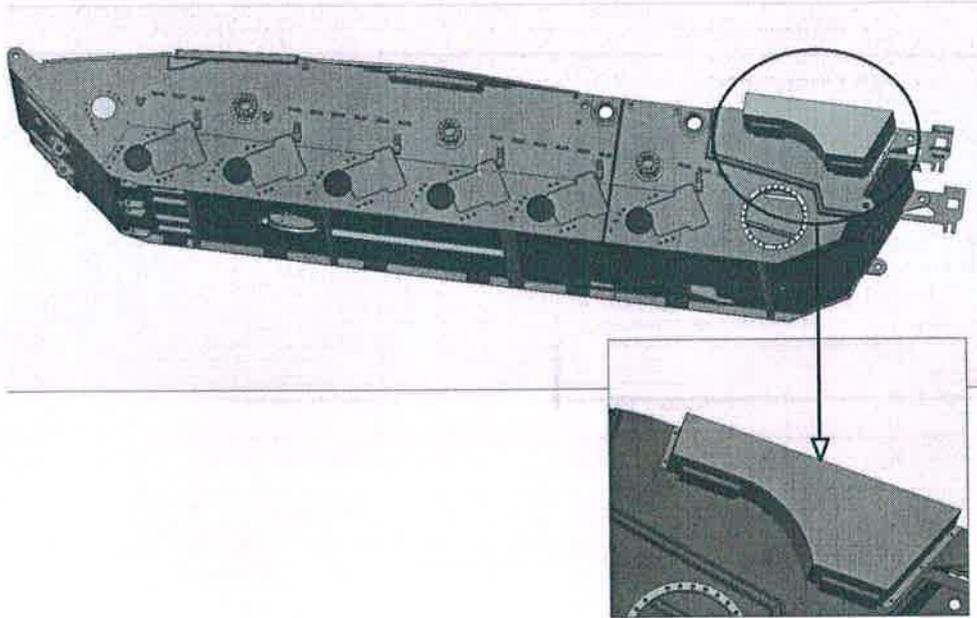


Fig. A.8 Mounting reference for DVAPU

#### 5. Electrical Interface

Load will be connected to the DVAPU through junction boxes and power connectors. For 28V DC, only positive terminal will be available (chassis return) and for 270 V DC, both positive and negative connectors will be available. There will be signal connectors from DVAPU enclosure to the Control Panel. Control Panel shall consist of additional signal connector for communication with IPMS, DIP and Vehicle common data bus system etc. Control Panel shall be powered externally.

Harnesses shall be covered with metallic braid and heat shrinkable Raychem tubing to protect from harsh environment. Only MIL approved Connectors and harness materials shall be used. Details will be finalised during PDR.

#### 6. Specification of Harnesses

The DVAPU and Control Panel are connected by set of harnesses. The harnesses are covered with metallic braid and heat shrinkable Raychem tubing to protect from harsh environment. Only MIL approved Connectors and harness materials shall be used. The details of harnesses are given in Table A.8.

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S. No	Nomenclature (Harness)	Type	Connector specification	Length* (metres)
1.	Dual Voltage APU LV (28V DC) output to Bulk Head Plate	Power (+ve)	MIL-DTL-38999	3
2.	Bulk Head Plate (LV) to Junction Box	Power	MIL-DTL-38999	3
3.	Dual Voltage APU HV (270V DC) output to Bulk Head Plate	Power (+ve & -ve)	MIL-DTL-38999	3
4.	Bulk Head Plate (HV) to HVJB	Power (+ve & -ve)	MIL-DTL-38999	3
5.	Control panel to Bulkhead	Signal	MIL-DTL-38999	3
6.	DVAPU to Bulkhead	Signal	MIL-DTL-38999	3
7.	Junction Box to Control Panel (28 V DC)	Power (+ve)	MIL-DTL-38999	3
8.	Communication (Ethernet/CAN) between Control Panel and IPMS	Signal	MIL-DTL-38999	3

Table A.8. Details of harnesses

\* Will be finalised during the PDR

**7. Cooling system**

Self contained Liquid cooling system may be used.

**8. Reliability and Maintainability**

The Dual Voltage APU Mean Time Between Failure (MTBF) should be more than 500 hours.

**9. Useful life**

The useful life of Dual Voltage Auxiliary Power Unit shall not be less than 2000 Engine hours.

**10. EMI/EMC for Dual Voltage APU**

The Dual Voltage APU system shall comply with MIL-STD-461G. EMI/EMC requirement shall be as per the clauses CE 102, RE 102, CS 101, CS 114, CS 115, CS 116, CS 118 and RS 103 (refer Appendix-C). Further the enclosure shall be the provided with EMI/EMC gaskets to avoid effects of interference due to conducted or radiated electric fields.

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## 11. Environmental Specification of Dual Voltage APU

The following tests need to be performed on the Dual Voltage APU:

(Refer Appendix -C)

- a. Vibration
- b. Shock
- c. High temperature- Operation, Storage
- d. Damp Heat
- e. Low temperature
- f. Rapid Temperature cycle
- g. Water Immersion test (For DVAPU only)
- h. Drip proof (For Control Panel only)
- i. Dust Test
- j. Tropical exposure
- k. Mould growth test
- l. Corrosion (salt)
- m. Contamination
- n. Drop
- o. Bump
- p. Bounce test (For harnesses only)

## 12. Environmental Stress Screening :

ESS will be carried out on QT and AT units as per Appendix-E

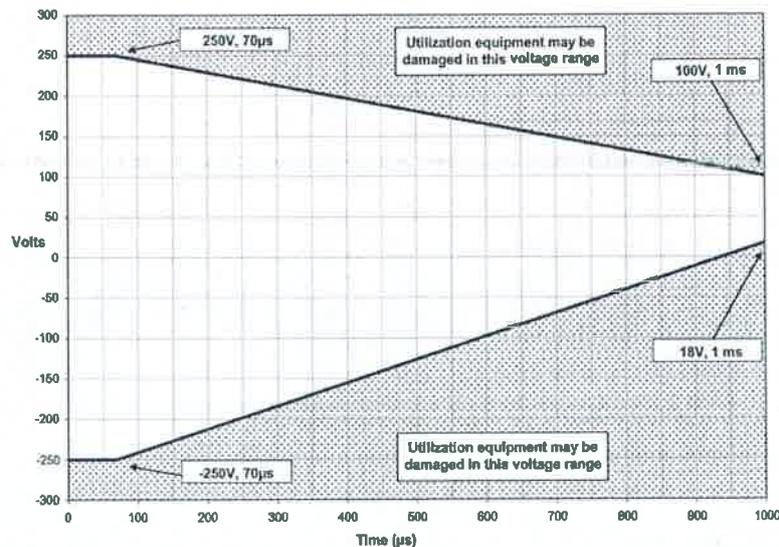


Fig A.9. Envelope of spikes in normal operating mode for 28VDC systems.

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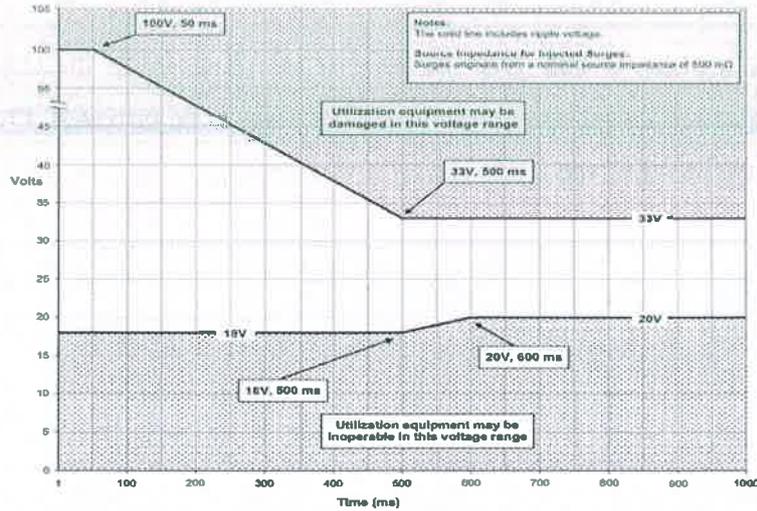


Fig A.10. Envelope of surges in normal operating mode for 28VDC systems.

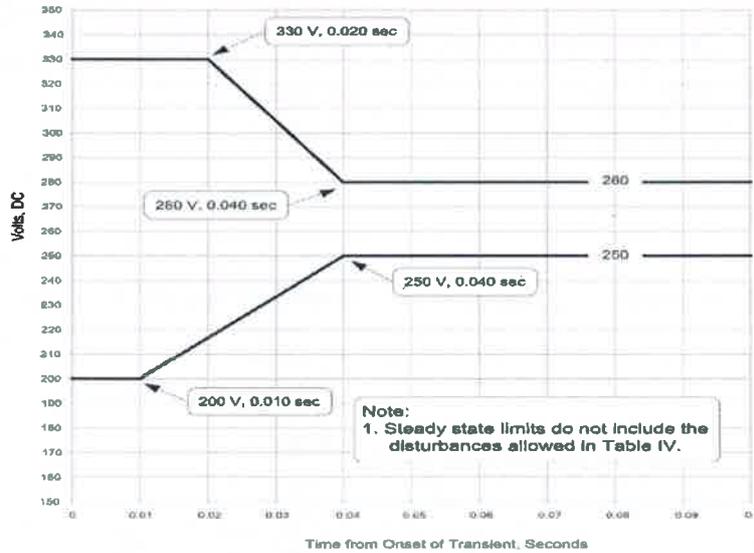


Fig A.11 Envelope of normal voltage transient for 270 volts DC system.

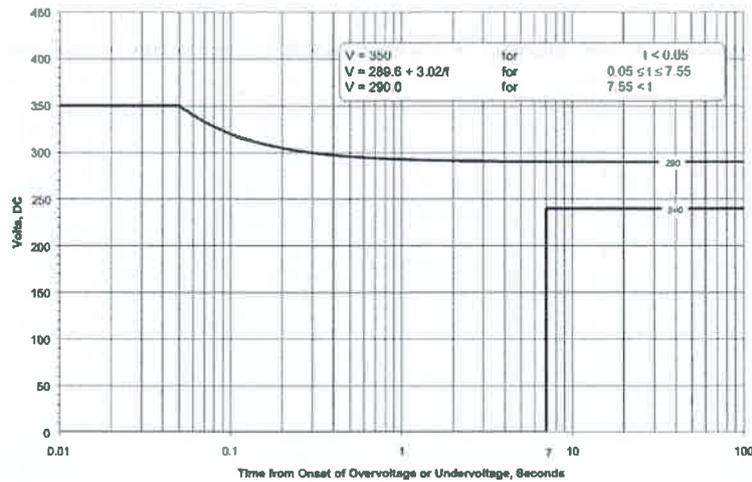


Fig A.12 Limits for DC overvoltage and under voltage for 270 volts DC system.

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### 13. Grounding

For sub assemblies working at 28V DC, -ve wire to be connected to the chassis. For sub assemblies working at 270V DC, separate +ve and -ve wires to be provided. Proper isolation to be ensured between 28V DC and 270V DC.

### 14. Standards

The applicable standards referred and used in general are:

MIL -STD-1275E	Land Vehicles Electrical Power Characteristics
MIL -STD-704F	Aircraft Electrical Power Characteristics
MIL -DTL-38999	Electrical Connectors
MIL -STD-461G	EMI/EMC requirements for Equipment
JSS 55555 L2J	Environmental Specifications
SAE J1939	CAN communication
DSSD	Software development and Quality Assurance
MIL-HDBK-2164A	ESS
JSS 0251	Technical Documents
IEC/IS 60529	IP ratings

**15. Quality Assurance Plan:** Shall comply as per Doc No: **CVRDE/DOC/RQA/QT-AT/03**  
dated 03/07/2019

### A.III. Scope of Work for Development of Dual Voltage APU

The work to be carried out by the vendor for development of DVAPU is broadly given below:

- **Phase-I** - Development, functional testing and validation of alternator:
  - a. Design (modelling, simulation and analysis) of DVAPU alternator as per CVRDE configuration and specifications.
  - b. Prototype realisation of DVAPU alternator to meet the specification as per the details finalised during DDR.
  - c. Functional testing of DVAPU alternator using test rig.
  - d. Preparation of design documents for alternator.
  - e. Selection of all critical components of DVAPU, viz engine, etc.
  - f. Configuration of automatic power converter and control panel.
  - g. Overall configuration of DVAPU

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**The following shall be carried out as mandate to PDR (T0+2 months):**

- Preparation of preliminary Layouts and sizing of all subassemblies viz. Engine, Control panel, APC, Enclosure, etc.
- Design of Dual Voltage PM alternator
- Analytical & Software calculations for arriving at the major & critical dimensions shall be carried out
- CAD Models of Parts & Assembly in CREO 3.0 M170 format (.prt & .asm) shall be prepared
- Shall carryout Mechanical, Electrical and Data Interface requirements
- Shall carryout Control panel and APC configuration design
- Shall identify controller in consultation from CVRDE for Control Panel
- Shall prepare APC and Control Panel schematic
- Shall carryout software development planning and requirement analysis activities.

**The following Documents shall be prepared by the vendor for PDR (T0+2 months):**

- Preliminary design document and sizing of all subassemblies of Dual Voltage Auxiliary Power Unit
- Detailed design document of Dual Voltage PM alternator
- Analytical & Software calculations for arriving at the major & critical dimensions document
- Cooling design and coolant circuit design document
- CAD Models of Parts & Assembly in CREO 3.0 M170 format (.prt & .asm)
- APC, control panel configuration and design document
- Software requirements specifications
- Software development plan and software quality assurance plan documents.

**The following Documents shall be prepared by the vendor at T0+5 months:**

- Design documents and test reports of Dual Voltage PM Alternator prototype.

**The following shall be carried out as mandate to DDR (T0+6 months):**

- Preparation of detailed Layouts for Assembly & Cooling circuit
- CAD Models of Parts & Assembly in CREO 3.0 M170 format (.prt & .asm) shall be

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prepared

- Shall carryout Finite Element Analysis namely Static Structural, Modal, Random Vibration, Shock Response Spectrum & Harmonic Analysis & their respective project files in ANSYS or Abaqus (Abaqus is preferred)
- Shall carry out Thermal analysis both (Static & Transient) of major & critical components.
- Shall carryout CFD analysis in ANSYS Fluent.
- Detailed Electromagnetic analysis of Dual Voltage PM alternator on all stages shall be carried out.
- Realisation of Dual Voltage PM alternator
- Design of APC and Control Panel electronics involves :
  - Preparation of schematic and Bill of Material (BOM) document
  - Shall carry out thermal analysis
  - Shall carry out Power Budget, DC-DC analysis of communication interface
  - Shall carryout software design for the APC and Control Panel.
- Design of Control Panel mechanical enclosure shall be carried out with the following details:
  - BOM and drawing document
  - Anodizing/ coating/ etc. details & requirements
- The detailed test plan for development tests, qualification tests and acceptance tests shall be prepared.
- Details of test jig requirements, drawings and specifications shall be finalised

**The following Documents shall be prepared by the vendor for DDR (T0+6 months):**

- Preliminary Layout document for Assembly & Cooling circuit
- CAD Models of Parts & Assembly in CREO 3.0 M170 format (.prt & .asm).
- Electromagnetic analysis reports for stator and rotors of alternator.
- Prototype Dual voltage PM alternator test reports.
- Finite Element Analysis namely Static Structural, Modal, Random Vibration, Shock Response Spectrum & Harmonic Analysis & their respective project files in ANSYS or Abaqus (Abaqus is preferred)
- Thermal analysis both (Static & Transient) of major & critical components.

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- Cooling circuit analysis report.
- CFD analysis in ANSYS Fluent.
- Design of APC and Control Panel Electronics
- Schematic and Bill of Material (BOM) document
- Thermal analysis report
- Power Budget, DC-DC analysis reports of communication interface
- Design documents of Control Panel mechanical enclosure
- BOM and drawing documents
- Anodizing/ coating/ etc. details & requirements document
- The detailed test plan documents for development tests, qualification tests and acceptance tests.
- Details of test jig requirements, drawings and specifications
- Software Design Description (SDD) and Hardware software integration test plan documents.

#### **AIII-2 Realisation of Dual voltage APU (prototype(s))**

- The vendor shall carryout realisation and functional testing of Dual Voltage PM Alternator prototype by T0+5 months, realisation and development testing of DVAPU prototype by T0+8 months.
- The vendor shall develop Dual voltage APU prototype(s) after the approval of DDR to meet the specifications and shall validate the same by testing. If required, the vendor shall develop additional prototype(s) to meet the specifications and the same will be tested.
- Realisation of various subassemblies shall be carried out sequentially, i.e., vendor shall realise Automatic Power converter only after successful realisation and performance evaluation of Engine and alternator. Similarly, Control Panel shall be realised only after performance evaluation of APC (integrated with alternator & engine).
- The outcome of the prototype testing will be discussed in CDR to finalise the design and necessary modifications/ improvements will be incorporated in the prototype to meet the specifications by the vendor.
- The vendor shall develop the APC and Control Panel software as per the documents

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submitted in PDR and DDR.

- The vendor shall develop all necessary rigs, special tools and fixture if any required for the realisation and testing of prototype

#### **AIII-2a Development Testing of Dual voltage APU (prototype(s))**

- List of tests to be performed on Prototype Unit (Development Tests) is given below:

##### **1. Pre-assembly tests on prototype unit:**

- Visual Inspection and Physical parameter measurement of all the sub assemblies.
- Electrical parameter measurements (inductance, resistance, insulation measurement, etc.) for alternator
- Dielectric test at sub assembly level for alternator
- Performance checks on subassemblies such as engine, alternator, etc.(as per the detailed test plan to be submitted by the firm during PDR)
- PCB testing and Board level testing for APC and Control Panel
- Software testing for control panel and APC
- Testing of APC and Control Panel

##### **2. Performance and functional tests on Dual Voltage APU are as follows:**

###### **2.1 Visual Inspection and Physical parameter measurement**

- Check for finishes, workmanship defects etc. and record the observations.
- Proper mountings of all sub assemblies shall be checked
- Names of all controls, switches, fuses, indicators and connectors shall be marked properly with stickers.
- Measure the weight and dimensions of the Dual Voltage APU and Control Panel. Record the value.
- The dimensions shall be as per the drawing approved by CVRDE.
- The weight of the DVAPU shall be  $300 \pm 10$  kg (excluding control panel) and weight of Control Panel shall be  $\leq 5$  kg.

###### **2.2 Insulation measurement**

- All mutually insulated terminals shall be measured for insulation resistance
- Electronic devices shall be disconnected, prior to testing. Insulation resistance (IR) test is to be conducted at 500 VDC (for generator) except for semiconductor devices. The measured value should be  $\geq 20M\Omega$ .
- The values shall be recorded and documented

###### **2.3 Load test on Dual Voltage APU**

The generator will be tested along with the Control Panel for the load test

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observations shall be recorded as given in Table A.9.

Speed (RPM)	OUTPUT POWER IN kW		Efficiency (%)	Voltage regulation (%)	Ripple voltage (peak to peak)	Noise Level	Time
	28 V Output	270 V Output					
3600							10 minutes

**Table A.9** Load Test schedule

The regulation and efficiency of the DVAPU shall be calculated and recorded. Transients shall be observed for load variation.

**Note:**

- a. The coolant oil, drive requirements, load bank, etc. to be provided by the vendor.
- b. The above mentioned speeds are for guidelines only. Actual testing speeds may vary as per test requirement (3000-3600). One test cycle is to be conducted which is 8 hrs.

**2.4 Load Dump test and differential loading test**

The Dual Voltage APU should be subjected to load dump and differential loading test by switching/variation of low voltage and high voltage loads. Load voltages, currents, voltage response to load variation, etc. to be recorded during the test.

**2.5 Testing of Control Panel**

The following conditions shall be simulated and the performance of Control Panel shall be monitored using suitable test rig & equipment.

**Protections:**

- i) Over voltage
- ii) Under voltage
- iii) Under Speed
- iv) Reverse Polarity
- v) Over load
- vi) Engine low lubricating oil pressure
- vii) Engine coolant temperature

**Indications:**

- i) Output voltage
- ii) Output current

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- iii) Output power in kW
- iv) Fuel flow
- v) LED indications

**Functional checks**

Check the proper functionality of enclosure doors, switches, LED indications, and display parameters.

**a. Detection of faults**

External faults (over current, overvoltage, under voltage, under speed, etc.) shall be simulated and the performance of Control Panel shall be monitored using suitable testing equipment.

**b. Data logging and storage**

The Control Panel shall store parameters/data during occurrence of faults and DVAPU operating hours in non-volatile memory. The memory shall be sufficient to store data of 100 operational hours. Data shall be logged using suitable interface and verified.

**c. Voltage recovery time**

The time required for system voltages to reach nominal value after occurrence of a disturbance shall be recorded and verified that they comply with MIL-STD-1275E (for 28 V DC) and MIL-STD-704F (for 270 V DC).

**2.6. Testing of APC**

Automatic Power converter shall be connected in the test rig and apply various voltage in the input and measure the output voltage, it should be 28 V DC  $\pm$  0.3 V and 270 V DC  $\pm$  3 V and record result in Table A.10 .

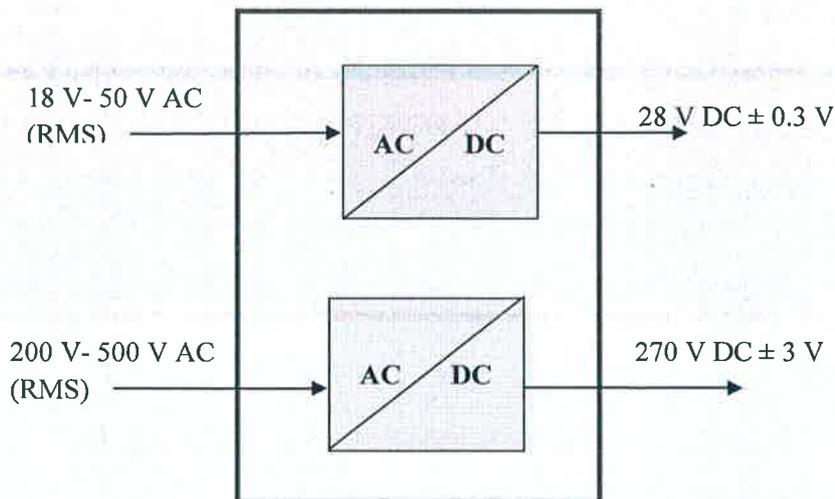


Fig A.13 Block diagram for testing of APC

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S.No	Input Voltage to the APC From 18 V to 50 V AC (RMS)	Output Voltage It should be 28 V DC $\pm$ 0.3 V	Remarks
1.	18 V		

S.No	Input Voltage to the APC From 200 V to 500 V AC (RMS)	Output Voltage It should be 270 V DC $\pm$ 3 V	Remarks
1.	200 V		

Table A.10 Testing of APC

## 2.7. Wave form and Ripple test

These tests are conducted with DVAPU and control panel. The equipment shall be tested for waveform and ripple test with load bank.

### Procedure:

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Check the waveform display in scope at no load condition. Should not have any spikes in output waveform and record the result in Table A.11.
- d) Check the ripple in scope at no load condition. Should be within limit and record the result in table.
- e) Make the DVAPU load contactor ON so that generator output shall be connected to the load bank.
- f) Apply the 100% load current i.e. 161 A @ 28 VDC and 24.1 A @ 270 VDC
- g) Check the waveform display in scope at load condition. Should not have any spikes in output waveform and record the result in Table A.11.

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**Wave Form and AC ripple test**

28 V DC output of DVAPU					
S.No	Parameter	Specified	No load	On load	Ok/Not Ok
1	Waveform	Output shall be free from spikes			
2	AC Ripple				
270 V DC output of DVAPU					
S.No	Parameter	Specified	No load	On load	Ok/Not Ok
1	Waveform	Output shall be free from spikes			
2	AC Ripple				

**Table A.11** Waveform and AC ripple test

**2.8. Transient Voltage Drop (TVD) / Transient Voltage Rise (TVR) Test & Response time test**

These tests are conducted with DVAPU and control panel. The equipment shall be tested for TVD / TVR & response time test with load bank.

**Procedure:**

- a. Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b. Ensure the test setup connected as per Fig A.14.
- c. Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- d. Click the power analyzer start button and after 5 seconds time delay apply the load. Mean time analyzer will capture the test result and test result data will display on screen. Record the test result in Table A.12.
- e. Click the power analyzer start button and after 5 seconds time delay remove the load. Mean time analyzer will capture the test result and test result data will display on screen.
- f. Record the test result in Table A.12.
- g. The TVD/TVR % should not be more than +/-15 and recovery time should not more than 500milli second.

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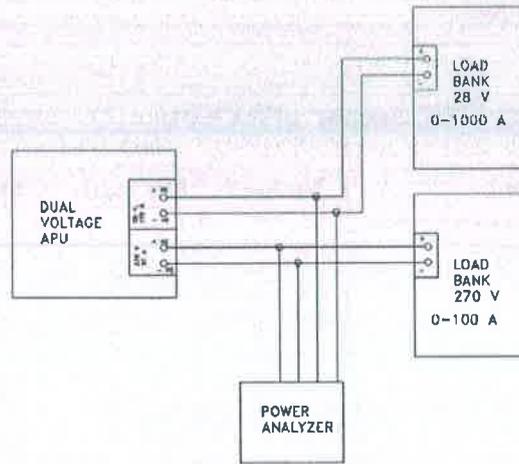


Fig A.14 TVD/TVR test & Response time test setup

**2.9. TVD / TVR Test & Response time test**

<b>DVAPU : 28 V DC Output</b>				
Load	Specification	Voltage (V)	TVD / TVR %	Recovery Time (ms)
No load	The TVD / TVR % Should not be more than +/-15% and recovery time should not more than 500 milli second.			
0% to 50 %			TVD:	
50% to 100%			TVD	
100% to 50%			TVR	
50% to 0%			TVR	

<b>DVAPU : 270 V DC Output</b>				
Load	Specification	Voltage (V)	TVD / TVR %	Recovery Time (ms)
No load	The TVD / TVR % Should not be more than +/-15% and recovery time should not more than 500 milli second.			
0% to 50 %			TVD:	
50% to 100%			TVD	
100% to 50%			TVR	
50% to 0%			TVR	

Table A.12 TVD/TVR test & Response time test

**2.10. Voltage recovery time**

The time required for system voltages to reach nominal value after occurrence of a disturbance shall be recorded and verified that they comply with MIL-STD-1275E (for 28 V DC) and MIL-STD-704F (for 270 V DC).

**2.11. Fuel consumption test**

These tests are conducted with DVAPU and control panel. The equipment shall be tested for fuel consumption test with load bank. This test shall be checked during endurance run of the APU at full load. After 4/8 hrs of running, the consumption per hour shall be noted.

Record the results in Table A.13.

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**Fuel Consumption Test**

S.No	Time (hr)	Load (KW)	Fuel Consumption (Ltrs)
1			
2			
3			
4			

Table A.13 Fuel consumption test

**2.12. Load sharing test with batteries (only on 28 V DC output)**

DVAPU 28 V DC bus shall be connected in parallel with 24 V DC batteries and 150% of rated load to be applied. Total load should be shared between DVAPU and batteries. The parameters shall be recorded as per Table A.14.

Speed (RPM)	Total Load on 28 V DC bus (kW)	Load shared by DVAPU (kW)	Load shared by batteries (kW)	Output voltage of DVAPU	Time duration
3600					

Table A.14 Load sharing test on DVAPU

**3. Inspection of Harnesses**

The following tests shall be conducted at the manufacturer's premises-

- a. Physical inspection to check construction of the Harnesses as per specifications.
- b. Continuity test
- c. Insulation Resistance test
- d. Dielectric strength test
- e. Conductor resistance test

**3.1 Continuity Test**

Check the continuity between respective connector pins in the stator and rotor as per wiring diagram, using a continuity tester.

**3.2. Insulation Resistance Test**

Measure the insulation resistance between

- a) body and single pin of high power connectors.
- b) body and each pin of power / signal connectors
- c) Any two pins which are not connected electrically, using a 500 V DC insulation tester.

The insulation resistance measured shall not be less than 20 Mega ohms.

**Caution: Care should be taken to disconnect the negative leads, if they are earthed.**

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### 3.3. Dielectric Strength Test

Apply 500V AC RMS, 50 Hz for duration of one minute. All cores of a complete harness assembly shall be subjected to this test as mentioned below:

- a) between any one pin/socket (non – earthed core) and all other pins/sockets (non – earthed cores) connected together. Repeat the test between each pin / socket and the remaining pins/sockets (non-earthed cores) connected together.
- b) between all non-earthed cores connected together and the braid, metallic conduits, plug and/or socket shells.

These harnesses shall satisfactorily withstand the test without arcing or puncture. There should not be any breakdown of insulation or surface spark over. These indicate failure of insulation and warrant rejection after investigation for the cause of failure.

### 3.4. Conductor Resistance Test

The conductor resistance shall be measured by using milli ohmmeter / micro ohmmeter for each and every cable and wire size. The measured values of single core shall not exceed the resistance values prescribed by the cable manufacturer. Record the result in Table A.15

Sl.No	Assy Harness Part No	Resistance in milliohm	Remarks

Table A.15 Conductor resistance test

### 4. Indicating and functionality Tests

Check for satisfactory performance of indicating lamps and switches during the operation of DVAPU. These tests are conducted with DVAPU and Control panel. Record the result in Table A.16.

- Checks for Display and indicators for Fault and Status monitoring.
- Start/Stop Control facility checks.
- Functionality of relays and contactors.
- Accuracy of all digital displays by a calibrated meter.

Sl.No	Description	Observation	Remarks
1	Check for Displays and Indicators for Faults and status monitoring.		
2	Automatic start/stop Control facility checks.		
3	Accuracy of all digital displays by a calibrated meter.		
4	Checks for mode of operation selection, Auto/manual.		

Table A.16 Indicating and functionality tests

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**4.1. Protections and indications:**

Following protections and indications shall be checked on the display. Record the result in Table A.17 and Table A.18 respectively.

**Protections:**

S.No	Protection	Trip limit	Observation	Remarks
1	Over Voltage			
2	Under Voltage			
3	Reverse Polarity			
4	Over Load			
5	Engine Low lubricating oil pressure			
6	Engine coolant temperature			

Table A.17 Protection parameters

**Indications:**

S.No	Description	Observation	Remarks
1	Output Voltage		
2	Output current		
3	Output Power in KW		
4	Reverse Polarity		
5	Fuel indication		

Table A.18 Indication parameters

**5. EMI/EMC tests**

EMI/EMC on Dual Voltage APU (with Control Panel)	CE 102, RE 102, CS 101, CS 114, CS 115, CS 116, CS 118 and RS 103	Refer MIL-STD-461G tests for Ground Army.
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Table A.19 EMI/EMC tests

**6. Prototype has to be subjected for endurance test for total duration of not less than 40 hrs (cumulative). Details as given below:**

**Endurance test**

Total duration - 40 hrs (cumulative)

Time for each cycle of Endurance test - 8 hrs (excluding rest time)

No. of cycles on prototype unit - 5 cycles

These tests are conducted with DVAPU and control panel. The equipment shall be tested for endurance test with load bank.

During this test all the APU doors shall be in closed condition.

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Sr. No	Description	Condition	Duration
1	DVAPU	100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 V DC	3 Hours
		75% load current. i.e. 121±1 A @ 28 V DC and 18.1±1 A @ 270 V DC	2 Hours
		50% load current. i.e. 80.5±1 A @ 28 V DC and 12±1 A @ 270 V DC	2 Hour
		25% load current. i.e. 40.2±1 A @ 28 V DC and 6±1 A @ 270 V DC	1 Hour

Table A.20. Endurance test

**Procedure:**

- Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- Measure the parameters mentioned in given Table and record.
- Make the DVAPU load contactor ON so that generator output shall be connected to the load bank.
- Apply the load as mentioned in the above Table A.20.
- Record the parameters mentioned in below Table A.21.

**Endurance Test of DVAPU**

Started Time:

End Time:

Cycle No:

APU

Time	Voltage (V)	Current (A)	Power (KW)	Temp	
				Ambient	Inside Enclosure

Table A.21. Endurance test observations

Note:

- Test procedure given above for Dual Voltage Auxiliary Power Unit is very broad in nature and the vendor shall prepare and submit detailed document to check the compliance of the system for AFV requirements. Any tests deemed necessary to

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evaluate the system which is not listed above will be included in the test schedule during any stage of the contract.

- During individual stage and system level load tests of all DVAPU units, critical parameters shall be recorded such as:
  - i. Output voltages
  - ii. Load currents
  - iii. Ripple of output voltages

**7. Checks for Quality of Fabrication**

All the assemblies should be inspected such that the following are ensured.

- a) All holes shall be accurately drilled and shall have the burrs removed.
- b) Welds shall transmit stress without deformation or failure when the parts connected by welds are subject to proof and service loading. Spot, tack or intermittent welds for strength shall not be permitted.
- c) Machined components should be free from kinks and bends.
- d) Metals having pitted or corroded surface are not acceptable.
- e) The method of straightening or bending of materials shall be in such a way that they do not injure the basic material.
- f) Shearing and chipping shall be done neatly and accurately.
- g) All sharp edges and burrs shall be removed. Burred surface and flared out materials shall be ground smoothly.
- h) Washers and lock washers/spring washers shall be incorporated on bolts, studs.
- i) All bolts and nuts should be properly tightened. Matching thread areas, securing bolts or cap screws shall be of sufficient strength to withstand the tensile strength of fastener.
- j) The surface of parts to be welded shall be free from rust, scale, paint, grease and other foreign matter.

**8. Checks for Corrosion of metals**

All metallic sheets, channels, angles bolts, nuts, etc. used in the system should be checked for free from rust. Treatment and finishing would be inspected such as to protect the metal parts from corrosion during operation/ storage in the field.

**9. Checks for Leakages**

Checks to be carried out to ensure no leakages of fuel/oil in the generator compartments. Assemblies should be checked such that Rain water should not leak inside the generator compartments as well as control cabin.

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## 10. Checks for Quality of painting

All the assemblies are inspected to ensure the following:

The entire metal to metal surface inaccessible after construction due to being in contact shall be coated with one coat of appropriate primer before assembly. Interior of the diesel tanks should be coated with anti-corrosion paint so as to prevent the surface from corrosion. Base platform, chequered plate, acoustic enclosures, skid, control cabin should be painted with red oxide iron/zinc primer and finished with two coats of OG paint by air drying brushing & spraying.

## 11. Tests for Sound Proof Enclosure Unit:

### 11.1. Visual and mechanical inspection

The enclosure shall be examined as per the list of drawings and the specification document. The Dimensions, Cut-outs, sizes and positions, Appearance, fit, finish and painting, Fasteners, rivets, welds on frame etc, Attachment of lifting and lashing points, Ease of door operation, provision of latch for locking the door and sealing gasket for door etc to be checked.

### 11.2. Load on floor test

The purpose of the load test is to verify the resistance of floor under the effect of static load. The enclosure resting with its skids on a level surface the floor is loaded with 2000 kgs uniformly distributed load for 30 minutes over the floor area. The enclosure should not present any sign of deformation or de-lamination after withdrawing the applied load. Record the result in Table A.22.

S.No	Load test on floor	Duration	Ok/Not Ok	Observations
1.	2000 Kgs	30 minutes		

Table A.22. Load on floor

### 11.3. Rigidity tests of lifting eyes

The aim of this test is to verify the capability of the lifting eyes, which will be used for lifting the enclosure with a load of 2000 Kg. Each lifting eye shall be subjected to a load of 1000 kg applied at an angle of 45 degrees to the line joining the diagonally opposite lifting eyes. There shall be no visible cracking or permanent deformation to the lifting eyes or the enclosure. Record the result in Table A.23.

S.No	Description of test	Load to be applied	Duration	Ok/Not Ok	Observations
1.	Rigidity of lifting eyes	2000 Kgs	30 minutes		

Table A.23 Rigidity of lifting eyes

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- The vendor shall submit 1 set (soft copy and hard copy) of the following (at T0+8 months) :

1. Development test reports and design documents of DVAPU prototype (including software design document and testing reports)
2. Modelling, simulation and Analysis reports of DVAPU prototype.

The following shall be carried out as mandate to CDR (T0+9 months):

- Modelling, simulation and design analysis (if any modifications carried out based on the outcome of prototype) reports of Dual Voltage APU sub-assemblies (Main frame assembly, Diesel Engine, Alternator, Silencer, Control panel, etc.)
- Shall prepare all drawings (includes winding diagram, stator and rotor geometry etc), process sheets and manufacturing documents of mechanical components.
- Tolerance stackup analysis shall be carried out
- Stage wise inspection and testing (includes Diesel Engine, Alternator, Silencer, Control panel, etc.) plan shall be prepared.
- Interconnecting harnesses design shall be carried out.
- Following shall be carried out at each stage of Control Panel development :
  - i. Component level inspection shall be carried out
  - ii. Board level screening shall be carried out
  - iii. Shall carry out burn in test
  - iv. Design analysis reports
- PCB to be manufactured at MIL grade approved facility and following to be prepared:
  - i. PCB group A reports
  - ii. PCB Group B report and Coupons
- Following Board level screening tests to be conducted on PCB boards
  - i. Stabilization bake test
  - ii. Thermal shock test
  - iii. Burn in test (Power OFF condition)
- All the source code (softcopy) as well as software for retrieving fault codes and data in the Control Panel shall be finalised.

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**The following Documents shall be prepared by the vendor for CDR (T0+9 months):**

- Following Reports/Documents shall be prepared at each stage of Dual Voltage APU development:
  - i. Modelling, simulation and design analysis reports of Dual Voltage APU sub-assemblies (Main frame assembly, Diesel Engine, Alternator, Silencer, Control panel, etc.)
  - ii. CoC for raw material from manufactures
  - iii. Schematic and Bill of Material(BOM) document
  - iv. Illustrated Parts Catalogue.
  - v. All drawings (includes winding diagram, stator and rotor geometry etc), process sheets and manufacturing documents of mechanical components.
  - vi. Tolerance stack up analysis reports.
  - vii. Test reports of Dual Voltage APU testing.
  - viii. Effect of different electrical loading conditions (High voltage and Low voltage sides are loaded fully) on the rotor of Dual Voltage APU, due to the absence of either loads, partial loads etc.
  - ix. Stage wise inspection and testing report (includes Diesel Engine, Alternator, Automatic Power converter, Control panel, etc.)
  - x. Drawings of inter connecting harnesses shall be prepared
- Following reports shall be prepared each stage of Control Panel development :
- The following reports shall be prepared with approval by the vendor's quality control department:
  - i. Design analysis reports
  - ii. Test reports
  - iii. CoC for raw material from manufactures
  - iv. Details of test instruments- make, model no., calibration details etc.
  - v. Component level inspection report
- PCB to be manufactured at MIL grade approved facility and following to be prepared:

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- i. PCB group A reports
- ii. PCB Group B report and Coupons
- Following Board level screening tests to be conducted on PCB boards
  - i. Stabilization bake test
  - ii. Thermal shock test
  - iii. Burn in test (Power OFF condition)
- PCB component population reports
- Conformal coating on the PCB assembled boards
- Integration of PCB and mechanical chassis
- Development of Test rig for Control Panel testing
  - i. Test rig technical specification document
- Control Panel testing with Test rig
- Design of APC & Control Panel
  - i. Schematic and Bill of Material (BOM) document
  - ii. Thermal analysis report
  - iii. Power Budget, DC-DC analysis of communication interface
- Design of Control Panel mechanical enclosure
  - i. BOM and drawing document
  - ii. Anodizing/ coating/ etc. details & requirements
- All the source code (softcopy) as well as software for retrieving fault codes and data from Control Panel

**A.IV Scope of Supply**

- All Design Documents and related drawings of Dual Voltage APU System required for PDR, DDR and CDR (shall be submitted two weeks in advance).
- Detailed test plan for development tests, qualification tests and acceptance tests.
- Test jigs, fixtures and special tools developed (if any) for manufacturing of Dual Voltage APU, related drawings, etc.
- Detailed cost breakup shall be provided for each subassembly of prototype unit , viz.,

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cost of alternator, Engine, APC, Control Panel, Enclosure (development, fabrication, integration costs, etc.) after successful realisation and testing of the sub assemblies.

- Cost breakup details shall be provided (manufacturing cost, integration, testing cost, etc.) during the supply of respective units.
- Development test reports and design documents
- Modelling, simulation and Analysis reports
- Technical documents
- **The vendor shall supply 2 sets (soft copy and hard copy) of the following (at T0+16 months) :**
  1. Modified design documents and analysis reports (generated for QT units)
  2. Bill of Material document
  3. All drawings (includes winding diagram, stator and rotor geometry etc), process sheets and manufacturing documents of mechanical components.
  4. Stage wise inspection and testing report (includes engine, alternator, APC, Control Panel, etc.)
  5. Component level inspection reports
  6. PCB test reports
  7. Drawing of interconnecting harnesses
  8. Source code for the control panel and APC software

Note:

- The vendor shall submit all the input and output files used in simulation, design, modelling and analysis (in softcopy) to CVRDE.

#### **A.V Time line for development of Dual Voltage APU system:**

List of major activities involved in the development along with timeline are as given below:

<b>Activity</b>	<b>PDC</b>
Placement of S.O	T0
PDR	T0 +2 months
Manufacturing of prototype alternator	T0 +4 months
Functional testing and validation of alternator prototype using test rig.	T0 +5 months
DDR	T0 +6 months
Development testing on DVAPU (includes	T0 +8 months

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alternator, engine, APC and Control panel etc) and delivery of prototype	
CDR	T0+9 months

Note: T0- Placement of S.O.

**A.VI Responsibility Matrix:**

Details of Activity	Responsibility	Remarks
Conducting PDR, DDR, CDR and Review meetings	CVRDE	CVRDE will coordinate the meeting with the committee members at mutually agreed venue.  Vendor has to make his own arrangements for attending the meeting.
Development of Alternator for DVAPU	Vendor	CVRDE shall provide overall configuration of alternator. The firm shall carryout detailed design, analysis, manufacturing and prototype testing within 5 months from the date of placement of SO.
Realisation, integration and testing of DVAPU subassemblies	Vendor	Realisation, testing and integration of shall be carried out by the firm so as to meet CVRDE specifications
Design, Analysis and preparation of all documents (design documents, test plan, test reports, etc.) and drawings for the Dual Voltage Auxiliary Power Unit	Vendor	
Preparation of test plan, test schedule for development test, acceptance and qualification tests	Vendor	Shall be submitted for DDR for approval.
Carrying out qualification tests, environmental tests, acceptance tests, development testing, performance tests, functional tests, etc. and preparation of test reports.	Vendor	In the presence of CVRDE Reps or nominated reps

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Requirement of test rigs, equipments, instruments and other accessories for performance and functional testing	Vendor	
Any additional equipment, jigs and fixtures required for the manufacturing and testing of Dual Voltage APU	Vendor	
Coordination with Testing Centres	Vendor	

**A.VII Special terms and conditions:**

1. Comprehensive technical specification requirement document of the proposed Dual Voltage APU is enclosed. The supplier shall support the design by Performance analysis, Electromagnetic analysis, Stress analysis, Vibration analysis and Thermal analysis. The criteria to be followed for modelling, simulation and analysis is given in Appendix-A1. Suggestions for improvement will be considered during PDR, DDR and CDR.
2. It is the vendor responsibility to meet the overall DVAPU functional and operational requirements by way of design, manufacturing and testing. Any additional tests deemed necessary to check the specifications shall be added at any stage of the development.
3. The supplier shall generate and supply all drawings for parts, sub assembly and assembly giving full details of any documents related to material specification, heat treatment process and standard of preparation, protective plating, and painting specifications. The supplier will also be responsible for preparation and delivery of maintenance and overhaul manual.
4. **In case of occurrence of any failure during Qualification Testing, the vendor shall carryout necessary design modification & implementation on the QT units and ensure successful completion of Qualification tests.**
5. On successful completion of the development, the vendor shall submit all relevant drawings and documents. CVRDE shall have all rights to modify or change the drawings and documents if required.
6. The Dual Voltage APU is proprietary to CVRDE, and the supplier cannot supply the same to any company/organization without the prior written permission from the Director, CVRDE. **IPR should be with Director, CVRDE.**
7. The vendor shall enter into non-disclosure agreement with CVRDE about the design and development of the subject Dual Voltage APU.

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8. All the electronic components used shall comply to MIL Standards and should not become obsolete for a minimum of 10 years. PCBs shall be MIL Certified (Group A and Group B certificates to be submitted).
9. Test Rig and jigs required for the manufacturing and testing shall be developed by the vendor and the same shall be supplied to CVRDE on final delivery.
10. The vendor shall provide detailed cost breakup for DVAPU including details such as development cost of alternator and other subassemblies, per unit cost of subassemblies, per unit cost of DVAPU, testing cost, test rigs, etc. Necessary supporting documents shall be provided for validating the costs.

**A.VIII Prevailing guidelines for nomination of Development Cum Production Partner (DcPP)**

1. The winner of the bid would also be nominated as Development cum Production Partner (DcPP) subject to success in Technical trials.
2. Although the instant contract shall be for quantities required during the development stage, the winner of the bid would also be nominated as Development cum Production Partner (DcPP) subject to success in Technical trials.
3. The Dual Voltage APU System developed under this contract or its upgrades may find application in future Armoured Fighting Vehicle.
4. The Nodal Agency (NA) shall submit "unit cost during bulk production stage of Dual Voltage APU system" without Non Recurring Expenditure (NRE), considering quantity 10 / 50 / 100 Nos. per year. This cost will be basis for calculating the unit cost during the production phase and will be used for future procurement reference. This shall be submitted in "price bid undertaking" of CPP portal in pdf format. However, this cost will not be considered to arrive at lowest bidder against this RFP.
5. During the production phase and thereafter, the nominated DcPP shall be the Single Point of Contact (SPoC) and shall be responsible for supply, maintenance and support during entire life cycle of the system i.e. 30 years.
6. It shall be ensured that the supply chain of subsystems established during the development of system be continued by DcPP during future production phase. Any change in the supply chain shall be with the approval of CVRDE.

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## Appendix-A1

**Guidelines to be followed for simulation, modelling, design and analysis**

	Specification
<b>1.</b>	<b>General</b>
a)	Electromagnetic analysis shall be carried out using Flux or MagNet (preferably MagNet) software.
b)	Structural analysis (shock and vibration) shall be carried out using Abaqus software.
c)	Thermal analysis shall be carried out using ThermNet software.
d)	Heat transfer analysis shall be carried out using CFD (Ansys Fluent) software.
e)	For front end template design, Motor Solve software is preferable.
f)	All the 2D models and drawings should be created from CREO 3D models only.
g)	Cabling, wiring and harness routing shall be carried out using CREO tools.
h)	All standard parts involved shall be properly modelled in CREO 3.0 M170 and supplied.
<b>2.</b>	<b>Solid model for CAE (FEA/CFD) analysis:</b>
a)	Solid models to be made in CREO 3.0 M170 format as per CREO best practices
b)	Geometry checks, assembly checks, material data, unit system, mass and inertia as per CVRDE standards/input to be ensured.
c)	Solid model exportable to parasolid/ STEP format and water tight, in case of CFD analysis to be ensured.
<b>3.</b>	<b>Preprocessing for CAE (FEA/CFD):</b>
a)	Loads, boundary conditions, contacts, load cases etc. to be done in consultation with CVRDE.
b)	Solid or shell elements to be made based on geometry and loading configuration. In case of solid elements, minimum 3 elements across thickness to be ensured.
c)	Feature removal to be carried out with CAUTION based on loading scenario and system functionality.
d)	In case of implicit FEA solver, higher order solid or shell finite elements to be used in the model.

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e)	Element size and quality check to be carried out based on given geometry.
f)	Structural analysis model compatible with Abaqus/CAE or Hypermesh or ANSYS mechanical. Abaqus software is preferable. CFD analysis model compatible with ANSYS Fluent, as per compatible version available in CVRDE, to be made.
<b>4.</b>	<b>CAE (FEA/CFD) solvers:</b>
a)	The following solvers to be used preferably for carrying out the analysis: <ul style="list-style-type: none"> <li>• Structural static/ non-linear static/ dynamic implicit analysis: Abaqus / ANSYS / NASTRAN / OPTISTRUC. Abaqus solver is preferable.</li> <li>• CFD analysis: ANSYS Fluent solver</li> </ul>
b)	NO CHANGE to be carried out in the solver settings in case of non-convergence of the solution.
c)	Appropriate fluid / solid properties and default convergence criteria to be used based on the type of simulation.
d)	Non-linear analysis carried out wherever required.
<b>5.</b>	<b>Post – processing CAE (FEA/CFD) results:</b>
a)	The simulation results to be made in line with respective load cases. Output data with appropriate variable name and location information to be made.
b)	Analysis report should be CVRDE acceptable format.
c)	Significant modes highlighted and mode shapes to be captured at higher scale factors, wherever applicable. The frequency spectrum in terms of FFT or PSD of the input loading and output parameters to be reported.
d)	All analysis related files (input/ output / diagnostic files) to be submitted to CVRDE to verify the correctness of results independently.

**Note:**

All the assumptions made during modelling, design and analysis shall be validated and justified.

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Appendix-B

Supply of Dual Voltage Auxiliary Power Unit

B.I Scope of work

The vendor shall supply the Dual Voltage Auxiliary Power Unit as follows:

S.No.	Activity	Timeline
1.	Supply of one prototype unit (developed as per specifications mentioned in Appendix-A and approved by CVRDE)	T0+8 months
2.	Two QT units to be developed and tested (after CDR)	T0+15 months
3.	Three AT units to be developed, tested and delivered with technical documents and reports	T0+20 months

Note: T0- Placement of S.O.

B.II Scope of Supply

The vendor shall supply 6 sets of Dual Voltage Auxiliary Power Unit along with necessary reports. Each set consists of:

- a. Dual Voltage APU and related sub assemblies (Control Panel, harnesses, etc.)

The details of harnesses are given in the following Table B.1:

S. No	Nomenclature (Harness)	Type	Connector specification	Length* (metres)
1.	Dual Voltage APU LV (28V DC) output to Bulk Head Plate	Power (+ve)	MIL-DTL-38999	3
2.	Bulk Head Plate (LV) to Junction Box	Power	MIL-DTL-38999	3
3.	Dual Voltage APU HV (270V DC) output to Bulk Head Plate	Power (+ve & -ve)	MIL-DTL-38999	3
4.	Bulk Head Plate (HV) to HVJB	Power (+ve & -ve)	MIL-DTL-38999	3
5.	Control panel to Bulk Head	Signal	MIL-DTL-38999	3
6.	Bulk Head to DVAPU	Signal	MIL-DTL-38999	3
7.	Junction Box to Control Panel (28 V DC)	Power (+ve)	MIL-DTL-38999	3

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8.	Communication (Ethernet/CAN) between Control Panel and IPMS	Signal	MIL-DTL-38999	3
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Table B.1 List of Harnesses

\* Will be finalized during PDR

• **The vendor shall prepare and supply technical manual and other documents (3 sets in hard copy and soft copy) as indicated below (T0+20 months):**

- Manufacturing drawings of all electronic cards, including Gerber files.
- Comprehensive Design document with detailed modelling and simulation results along with Analysis/Simulation source files in the original format (for example in Abaqus - .cae and .inp .odb and ANSYS -Ansys work bench files like .cas ,.dat , CREO- .prt and .asm format)
- Documents related to protective plating, painting specifications, etc. The supplier will be responsible for preparation of maintenance and overhaul manual.
- User handbook/Operator Manual, Covering brief description, Operating Instructions, specifications, photographs, routine maintenance and troubleshooting procedure.
- Technical manual, Covering technical description, schematics, block diagram, wiring diagram/list, General Assembly diagram, Bill of materials, Harness & Connector (Mechanical and Electrical) diagrams, Manufacturing & Part drawings for all sub assemblies/sub units, components, and all hardware items.
- Over hauling manual and ISPL document.
- Documents and Drawings related to All the jigs, fixtures, prime mover and Test rig used for Qualification testing of Dual Voltage APU.
- List of Special Maintenance Tool (SMT) / Special Test Equipment (STE) and Test Jigs.

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### Qualification Testing of Dual Voltage Auxiliary Power Unit

#### C.I Scope of work

- Two Dual Voltage Auxiliary Power Units (QT) developed for qualification testing shall be subjected for tests as follows:
  - i. One unit (QT unit-I) will undergo EMI/EMC and endurance test
  - ii. Second unit (QT unit-II) will undergo environmental tests
  - iii. ESS shall be carried out on above two units.
- Performance tests will be carried out before and after environmental tests (Pre environmental (PREET) and Post environmental (POET)).
- The QT unit which undergoes environmental tests shall be checked for readiness by carrying out performance test before commencement of environmental testing.
- The QT unit after completion of environmental tests shall undergo performance test for conclusion of Qualification testing.
- The details of test plan shall be finalised during DDR. Final QT plan with detailed procedure to be prepared by the vendor and will be approved by CVRDE.
- Sufficient critical spares to be planned by the vendor for QT testing
- The harnesses shall be subjected to Qualification Tests along with other sub assemblies.
- The specifications for Qualification Testing (QT) plan for Dual Voltage APU and Control Panel are given in section C.V.

#### C.II Scope of supply

1. All test reports related to Qualification testing (two sets to be supplied at T0+15 months)
2. All test rigs/jigs used for Qualification testing of Dual Voltage Auxiliary Power Unit (to be supplied at T0+20 months).

#### C.III Timeline for QT testing

Activity		PDC
Start of Qualification testing	-	T0 +9 months
Completion of Qualification Testing on QT units	-	T0 +15 months

Note: T0- Placement of S.O.

#### C.IV Special terms and conditions

1. Quality assurance procedure will be prepared by the vendor and vetted by CVRDE.

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Certifying agencies viz., DGQA may be involved during product development and test certifying stages.

2. The Dual Voltage Auxiliary Power Unit will be subjected for extensive testing. It is the vendor's responsibility to develop all the rigs, jigs and fixtures required for the testing. All the equipments, instruments and accessories required for testing is under the responsibility of the vendor.
3. The vendor is responsible for conducting and successful completion of Qualification Testing.

## **C.V Qualification Test Specifications**

### **1. Physical Inspection**

The system physical inspection shall be carried out for outer dimensions as per the GA Drawing. All physical and Functional tests covered in this section shall be carried out at ambient atmospheric condition. Mounting arrangement, rigid fitment of connectors and internal sub-assemblies, Quality check of finish/ workmanship in respect of painting, wiring and assembly shall also be carried out. All the observations shall be recorded.

#### **1.1. Physical Inspection of Major Sub-systems**

Vendor shall submit Inspection report of major sub systems like Engine, Alternator, Automatic Power Converter, harnesses & Sound-proof enclosure unit.

##### **1.1.1. Diesel Engine**

Acceptance of Engine shall be based on Test Certificate / COC / Manufacture's Test reports.

##### **1.1.2. Alternator**

The Acceptance of Alternator shall be based on Manufacture's Test reports based on CVRDE approved test plan.

##### **1.1.3. Automatic Power Converter**

The Acceptance of APC shall be based on Manufacture's Test reports based on CVRDE approved test plan.

##### **1.1.4. Control Panel**

The Acceptance of Control Panel shall be based on Test Certificate / Manufacture's Test reports based on CVRDE approved test plan.

##### **1.1.5. Assy Harnesses**

The Acceptance of Assy Harnesses shall be based on Test Certificate / Manufacture's Test reports based on CVRDE approved test plan.

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**1.1.6. Overall Dimensions and Weight of DVAPU**

S.No.	Parameter	Specified value
1.	Overall Dimensions of DVAPU	As per Fig. A.2
2.	Overall weight of the system	300 ± 10 kg

Table C.1 Overall Dimensions and weight of DVAPU

**1.2. Insulation Resistance (Megger test)**

Insulation Resistance between input terminal and earth, Output terminal and earth shall be checked by applying 500V DC in megger and value shall be ≥20 MΩ.

Sl.No	Description	Specification	Observation	Ok/Not Ok
1	Between output leads and body.	Insulation resistance value shall be greater than ≥20 MΩ.		

Table C.2 Insulation resistance test

**2. Testing DVAPU**

**2.1. Voltage Regulation test**

These tests are conducted with DVAPU and control panel. The equipment shall be tested for voltage regulation test with load bank.

**Procedure:**

- a) Ensure that the DVAPU is in working condition with a fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the Dual voltage generated by the APU and records the readings in Table C.3.
- d) Make the DVAPU load contactor ON. So that DVAPU output shall be connected to the load bank.
- e) Apply the 100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 VDC.
- f) Measure the voltage, frequency and current and record it in Table C.3.
- g) The Voltage should be 28V DC ±0.3 V DC and 270V DC ±3 VDC  
(Refer MIL-STD-1275E for 28 VDC and MIL-STD-704 F for 270 VDC for compliance)

$$\text{Voltage regulation} = \frac{\text{No load voltage} - \text{full load voltage}}{\text{Full load voltage}}$$

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Sl.No	Parameter	Specified	On No load	On load	Voltage Regulation ( $\pm 1\%$ )	Ok/Not Ok
1	Output Voltage	28 V $\pm$ 0.3 V				
	Load Current	161 A $\pm$ 1 A				
2	Output Voltage	270 V $\pm$ 3 V				
	Load Current	24.1 A $\pm$ 1 A				

Table C.3 Voltage regulation test

## 2.2. Rating Test

These tests are conducted with DVAPU and control panel. The equipment shall be tested for rating test with load bank.

### Procedure:

- Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- Make the DVAPU load contactor ON. So that DVAPU output shall be connected to the load bank.
- Apply the 100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 VDC.
- Measure the voltage and current and record it in Table C.4.
- Run the APU for 10 minutes.
- Measuring the voltage and current and record it in Table C.4

S.No	Parameter	Specified	On No load	On load	After 10 mins on load	Ok/Not Ok
1	Output Voltage	28 V $\pm$ 0.3 V				
	Load Current	161 A $\pm$ 1 A				
2	Output Voltage	270 V $\pm$ 3V				
	Load Current	24.1 A $\pm$ 1A				

Table C.4 Rating test

## 2.3. Voltage Stability

These tests are conducted with DVAPU and control panel. The equipment shall be tested for stability of voltage with load bank.

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**Procedure:**

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the voltage generated by the DVAPU and record the readings in Table C.5. During measurement voltage should be stable.
- d) Make the DVAPU load contactor ON. So that DVAPU output shall be connected to the load bank.
- e) Apply the 100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 V DC.
- f) Measure the voltage generated by the DVAPU and record the readings in Table C.5 during measurement voltage should be stable.

S.No	Parameter	Specified	On No load	On load	After 10 mins on load	Ok/Not Ok
1	Output Voltage Load Current	28 V±0.3 V 161 A±1 A				
2	Output Voltage Load Current	270 V ± 3V 24.1 A ± 1 A				

Table C.5 Voltage stability test

**2.4. Over load Test**

These tests are conducted with DVAPU and control panel. The equipment shall be tested for over load test with load bank.

**Procedure:**

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the voltage generated by the DVAPU and record the readings in Table C.6. During measurement voltage should be stable.

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d) Make the DVAPU load contactor ON. DVAPU output shall be connected to the load bank.

e) Apply the load current according to the table C.6 given below.

f) Measure the voltage generated by the DVAPU and record the readings in Table C.6.

During measurement voltage should be stable.

Output Voltage	Overload current	Time duration	Observation	Ok/Not Ok
28 V DC	110% of rated	60 min		
270 V DC	110% of rated	60 min		

Table C.6 Overload test

### 2.5 Charging of batteries using Alternator Output of 28 V DC

Eight batteries of 12V, 100Ah are connected in series and parallel connection to achieve 24V, 400Ah. These batteries are being charged simultaneously when the power source is 'ON', note down the charging current. Record the result in Table C.7.

S.No	Battery		Remarks
	V	I	
1			After 1 Min.
2			After 5 Min.
3			After 10 Min.
4			After 15 Min.
5			After 20 Min.

Table C.7 Charging of batteries

### 2.6 Tilt Test:

Tilt test to be conducted on DVAPU and performance should be evaluated.

#### Test Conditions:

1. Front and Back 30°, Lateral 15°
2. 25% load with 30 minutes\* on each axis.

\*The duration of Tilt test will be finalised during PDR.

### 2.7 Testing of Control Panel

The following conditions shall be simulated and the performance of Control Panel shall be monitored using suitable test rig & equipment.

#### Protections:

- i) Over voltage
- ii) Under voltage
- iii) Under Speed
- iv) Reverse Polarity
- v) Over load
- vi) Engine low lubricating oil pressure

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vii) Engine coolant temperature

**Indications:**

- i) Output voltage
- ii) Output current
- iii) Output power in kW
- iv) Fuel flow
- v) LED indications

**Functional checks**

Check the proper functionality of enclosure doors, switches, LED indications and display parameters.

**a. Detection of faults**

External faults (over current, overvoltage, under voltage, under speed, etc.) shall be simulated and the performance of Control Panel shall be monitored using suitable testing equipment.

**b. Data logging and storage**

The Control Panel shall store parameters/data during occurrence of faults and DVAPU operating hours in non-volatile memory. The memory shall be sufficient to store data of 100 operational hours. Data shall be logged using suitable interface and verified.

**c. Voltage recovery time**

The time required for system voltages to reach nominal value after occurrence of a disturbance shall be recorded and verified that they comply with MIL-STD-1275E (for 28 V DC) and MIL-STD-704F (for 270 V DC).

**3. Unit identification and Major components weight:**

**3.1. Unit Identification**

<b>Customer</b>		
Unit Identification S.No		
Type		
Rating		
Model		
<b>Engine</b>		
Make		
Model		
S.No		
<b>Alternator</b>		
Make		
Model		

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S.No		
<b>Control Panel</b>		
Make		
S.No		

Table C.8 Unit identification

### 3.2. Major Components Weight test

S.No	Item	Specified value in kg	Measured value in kg
1	Engine (Dry)		
2	Alternator		
3	Automatic Power Converter		
4	Sound proof enclosure unit		
5	Control Panel		
6	Harnesses		
7	Overall System		

Table-C.9 Major components weight test

### 3.3. Enclosure Dimension Test

Dimensions of enclosure shall be as per Fig. A.6.

### 4. ESS:

ESS to be conducted for DV APU with Control Panel as per Appendix-E.

### 5. EMI/EMC tests on DVAPU (including Control Panel) and Harnesses (QT unit-I)

EMI/EMC on Dual Voltage APU including Control Panel	CE 102, RE 102, CS 101, CS 114, CS 115, CS 116, CS 118 and RS 103	Refer MIL-STD-461G tests for Ground Army.
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Table C.10 EMI/EMC tests

### 6. List of Environmental Tests on DVAPU on QT unit-II (As per JSS 55555 :

L2J Clause) is given below:

S. NO	TEST NAME	SPECIFICATION			REMARKS
a.	Vibration	<b>1) Initial Resonance Search Test</b> Frequency 10 Hz to 2000 Hz Acceleration: 0.5g Sweep rate: 1 Octave/min			
		<b>2) Random</b> (Performed on Three Perpendicular Axis). (Unit ON)			
		<b>Freq. Range(Hz)</b>	<b>Acceleration (g<sup>2</sup>/Hz)</b>	<b>Test Duration in each Axis (Minutes)</b>	

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		20-500	0.1	120		
		500-2000	Falling from 0.1 at 500 Hz to 0.01 at 2000 Hz			
		To be followed by Visual Inspection and Performance Checks.				
		<b>3) Final Resonance Search Test</b> Frequency 10 Hz to 2000 Hz Acceleration: 0.5g, Sweep rate: 1 Octave/min			Less than 10% variation in resonance frequency between Initial and Final is accepted.	
b.	<b>Shock</b>	Performed on Three Perpendicular Axis with Half Sine Pulse				
		<b>Category of Item</b>	<b>Acceleration (g)</b>	<b>Pulse Duration (ms)</b>	<b>Number of Impacts in each direction</b>	
		Mounted on Ordnance	150	15-20	3 in + direction 3 in - direction	
		Other Articles	15	10-15	3 in + direction 3 in - direction	
		To be followed by Visual Inspection and Performance Checks.				
c.	<b>High Temperature</b>	JSS 55555, Test No. 17, Procedure 6, Condition M (L2J Clause)	<b>Operation</b> • Temp: 65 ± 3°C for 16 hrs. • Functional checks during last 30 minutes.			
			<b>Storage</b> • Raise temp to 85±3°C and maintain for 16 hrs. • Recovery 2 to 4 hrs followed by Performance checks			
d.	<b>Damp Heat</b>	JSS 55555, Test No. 10 (L2J Clause)	• Temp: 40±2°C with RH: 93±5% for 16 hrs. • Functional checks during last 30 min/ last one Hour. • Recovery 2 to 4 hrs followed by Performance checks.			

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e.	<b>Low Temp</b>	JSS 55555, Test No.20, Procedure 4, Condition J (L2J Clause)	<ul style="list-style-type: none"> <li>• Temp: <math>-20\pm 3^{\circ}\text{C}</math> for 16 hrs.</li> <li>• Functional checks during Last 30 min of 16<sup>th</sup> Hour.</li> <li>• Recovery 2 to 4 hrs followed by Performance checks.</li> </ul>	
f.	<b>Rapid Temperature Cycle</b>	JSS 55555, Test No.22, Procedure 1 (L2J Clause)	<ul style="list-style-type: none"> <li>• 3 Cycles:- <ul style="list-style-type: none"> <li>i. <math>55\pm 3^{\circ}\text{C}</math> and RH not more than 30% for 3 hrs.</li> <li>ii. Drop Temp to <math>-20\pm 3^{\circ}\text{C}</math> then maintain for 3 hrs.</li> <li>iii. Change of Temp shall be within 15 min</li> <li>iv. Functional checks during last 30 min of 3<sup>rd</sup> cycle.</li> <li>v. At the end of 3<sup>rd</sup> cycle the UUT removed from cold chamber and subjected for recovery. Recovery 2 hrs followed by Performance checks.</li> </ul> </li> </ul>	
g.	<b>Water immersion (Excluding control panel)</b>	JSS 55555 Test No 19 Test Condition D (L3 Clause)	<ul style="list-style-type: none"> <li>• Immerse the Unit in water to a depth of 1.5 meter for 2 hrs.</li> <li>• Recovery 2 to 4 hrs followed by Visual and Performance checks.</li> </ul>	Mandatory for all Externally Exposed Items fitted up to the height of 2.1 m.
h.	<b>Drip Proof (Only for control panel)</b>	JSS 55555 Test No.11 (N1 Clause)	<ul style="list-style-type: none"> <li>• Water from nozzle vertically fall on the equipment from height of 1 meter for 15 minutes duration</li> <li>• UUT is in operation during the test</li> <li>• Ingress of water examined after test</li> <li>• Performance Checks after recovery</li> </ul>	
i.	<b>Dust Test</b>	JSS 55555, Test No.14 (L2J Clause)	<ul style="list-style-type: none"> <li>i. Temp <math>40\pm 3^{\circ}\text{C}</math> RH&lt;50%, exposed to steam of dust laden air for 1 hr.</li> <li>ii. Visual and Functional checks anytime during the test.</li> <li>iii. Recovery 2-4 hrs followed by Visual and</li> </ul>	

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			Performance checks.	
j.	<b>Tropical Exposure</b>	JSS 55555, Test No.27, Condition C(L2J Clause)	<p>14 Cycles/ 28 cycles (for Pilot/Advance Samples)</p> <p>Acceptance:-</p> <ul style="list-style-type: none"> <li>i. Initial Temp <math>20 \pm 5^{\circ}\text{C}</math>.</li> <li>ii. Raise Temp to <math>35 \pm 2^{\circ}\text{C}</math>, RH 95% over a period of 3 hrs.</li> <li>iii. Duration of 12 hrs to be maintained.</li> <li>iv. Back to Initial Temp in 03 hrs.</li> <li>v. Duration of 6 hrs to be maintained.</li> <li>vi. Visual and Functional checks during first 02 hrs of <math>35^{\circ}\text{C}</math> period of 7<sup>th</sup>, 14<sup>th</sup>, 21<sup>st</sup> and 28<sup>th</sup> cycles.</li> <li>vii. Visual and Functional checks during last 30 minutes of 14<sup>th</sup> and 28<sup>th</sup> cycles.</li> <li>viii. Recovery 2-4 hrs followed by Visual and Performance checks</li> </ul>	
k.	<b>Mould growth Test</b>		<ul style="list-style-type: none"> <li>• Duration 28 days.</li> <li>• To be visually observed with <math>10^{\times}</math> Magnification immediately after taking out of chamber.</li> <li>• Recovery 2-4 hrs followed by Performance checks.</li> </ul>	Dummy units can be used
l.	<b>Corrosion (Salt)</b>	<u>Salt</u> JSS 55555 Test No.9 Procedure 2 (L3 Clause)	<ul style="list-style-type: none"> <li>• <b>3 Consecutive Cycles:-</b> <ol style="list-style-type: none"> <li>1. Salt Spray for 2 hrs.</li> <li>2. Storage in Temp <math>35 \pm 2^{\circ}\text{C}</math>, RH:90-95% for 22 hrs</li> </ol> </li> <li>• UUT removed from chamber after 3<sup>rd</sup> cycle and examined for corrosion and deterioration of metal parts, finishes, materials and components</li> </ul>	Dummy units can be used

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m.	<b>Contamination</b>	JSS 55555, Test No.6 (for Pilot or Advance Sample) (L2J Clause)	<ul style="list-style-type: none"> <li>• Duration 48 hrs. Temp 50°C</li> <li>• Recovery to attain temperature stability followed by Visual and Performance checks</li> </ul>	Dummy units can be used
n.	<b>Drop M*</b>	JSS 55555, Test No 13, Test condition F (for Pilot or Advance Sample) (L2J Clause)	<ul style="list-style-type: none"> <li>• Free fall from 1000 mm height in a concrete floor. 5 no of Drops.</li> <li>• Performance Checks after test</li> </ul>	
o.	<b>Bump</b>	JSS 55555, Test No.5 (for Pilot or Advance Sample) (L2J Clause)	25g @ 4000±10 bumps with 6 ms pulse duration Performance Checks after test	UUT in switched off condition

Table.C.11 Environmental specifications for Dual Voltage APU

### 7. Harness test

The harnesses will be subjected for Environmental tests (climatic and dynamic) along with DVAPU for the above specifications. However in addition to the above tests Bounce Test will be carried out as per JSS 55555 (Test No.4 condition A).

### 8. Endurance test

Shall be carried out on QT unit-I.

Total duration – 400 hrs (cumulative) – excluding rest period

Time for each cycle of Endurance test – 8 hrs ; No. of cycles - 50

These tests are conducted with DVAPU and control panel. The equipment shall be tested or endurance test with load bank.

During this test all the doors shall be in closed condition.

S.No	Description	Condition	Duration
1	DVAPU	100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 V DC	3 Hours
		75% load current. i.e. 121±1 A @ 28 V DC and 18.1±1 A @ 270 V DC	2 Hours
		50% load current. i.e.80.5±1 A @ 28 V DC and 12±1 A @ 270 V DC	2 Hour
		25% load current. i.e. 40.2±1 A @ 28 V DC and 6±1 A @ 270 V DC	1 Hour
		30 Minutes Rest	

Table C.12 Endurance test

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**Procedure:**

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the parameters mentioned in given Table and record.
- d) Make the DVAPU load contactor ON so that generator output shall be connected to the load bank.
- e) Apply the load as mentioned in the above table C.12.
- f) Record the parameters mentioned in below Table C.13.

**Endurance Test of DVAPU**

Started Time:

End Time:

Cycle No:

APU

Time	Voltage (V)		Current (A)		Power (KW)	Temp	
						Ambient	Inside Enclosure

Table C.13 Endurance test observations

**9. Performance check during Qualification Testing:**

The DVAPU will be tested along with the Control Panel (as per requirement) during QT and the following will be recorded:

Speed (RPM)	OUTPUT POWER IN kW		Efficiency (%)	Voltage regulation (%)	Ripple voltage (peak to peak)	Noise Level	Time
	28 V Output	270 V Output					
3600							10 minutes

Table C.14 Functional Test for Dual Voltage APU System

**10. Load sharing test with batteries (only on 28 V DC output)**

DVAPU 28 V DC bus shall be connected in parallel with 24 V DC batteries and 150% of rated load to be applied. Total load should be shared between DVAPU and batteries. The parameters shall be recorded as per Table C.15.

*C. Ingole:*

Speed (RPM)	Total Load on 28 V DC bus (kW)	Load shared by DVAPU (kW)	Load shared by batteries (kW)	Output voltage of DVAPU	Time duration
3600					

Table C.15 Load sharing test on DVAPU

**Note:**

- a. Details of functional tests will be discussed during PDR.
- b. The coolant oil, drive requirements, load bank, etc. required for Qualification Testing to be provided by the vendor.
- c. **Test procedure given above for DVAPU is very broad in nature and the vendor shall prepare and submit detailed document to check the compliance of the system for AFV requirements. Any tests deemed necessary to evaluate the system which is not listed above will be included in the test schedule during any stage of the contract.**
- d. During individual stage and system level load tests, critical parameters shall be recorded such as:
  - i. Output terminal voltages
  - ii. Load currents
  - iii. Ripple of output voltage
  - iv. Harmonics in the output voltage
  - v. Efficiency
  - vi. Inlet coolant temperature
  - vii. Outlet coolant temperature
  - viii. Engine Speed, etc.
  - ix. Noise Level

*C. J. Hughes*

### Acceptance Testing of Dual Voltage Auxiliary Power Unit

#### D.I Scope of work

- The vendor has to carry out Performance tests and ESS test on 3 no.s of DVAPU (Guidelines for carrying out AT is given in section D.IV.)
- Final ATP with detailed procedure and schedule shall be prepared by the vendor.
- The vendor is responsible for providing all the equipments, rigs, jigs, harnesses, accessories like external coolant sump, hose, etc. required for the testing.
- The harnesses shall be subjected to acceptance Tests along with other sub-assemblies.

#### D.II Scope of Supply

- All test reports related to Acceptance testing (three sets to be supplied at T0+20 months)
- All test jigs and fixtures used for Acceptance testing of Dual Voltage APU (to be supplied at T0+20 months).

#### D.III. Timeline for AT testing

Activity		PDC
Acceptance Testing on AT units	-	T0 +20 months

Note: T0-Placement of S.O.

#### D.IV Acceptance Test Procedure for Dual Voltage Auxiliary Power Unit

##### 1. Physical Inspection

The system physical inspection shall be carried out for outer dimensions as per the GA Drawing. All physical and Functional tests covered in this section shall be carried out at ambient atmospheric condition. Mounting arrangement, rigid fitment of connectors and internal sub-assemblies, Quality check of finish/ workmanship in respect of painting, wiring and assembly shall also be carried out.

##### 1.1. Physical Inspection of Major Sub-systems

Vendor shall submit Inspection report of Major sub system like Engine, Alternator, Automatic Power Converter, Harnesses & Sound proof enclosure unit.

C. J. [Signature]

### 1.1.1. Diesel Engine

Acceptance of Engine shall be based on Test Certificate / COC / Manufacture's Test reports.

### 1.1.2. Alternator

The Acceptance of Alternator shall be based on Manufacture's Test reports based on CVRDE approved test plan.

### 1.1.3. Automatic Power Converter

The Acceptance of APC shall be based on Manufacture's Test reports based on CVRDE approved test plan.

### 1.1.4. Control Panel

The Acceptance of Control Panel shall be based on Test Certificate / Manufacture's Test reports based on CVRDE approved test plan.

### 1.1.5. Assy Harnesses

The Acceptance of Assy Harnesses shall be based on Test Certificate / Manufacture's Test reports based on CVRDE approved test plan.

### 1.1.6 Sound Proof Enclosure

The Acceptance of Sound Proof Enclosure shall be based on Test Certificate / Manufacture's Test reports based on CVRDE approved test plan.

### 1.1.7. Overall Dimensions and Weight of DVAPU

S.No.	Parameter	Specified value
1.	Overall Dimensions of DVAPU	As per Fig. A.2
2.	Overall weight of the system	300 ± 10 kg

Table D1. Overall Dimensions and Weight of DVAPU

### 1.1.8 Mounting of all sub systems and components

Proper mountings of all sub systems along with control panel shall be checked.

### 1.1.9. System Layout

System layout as per General arrangement drawing shall be provided by the manufacturer and the system shall be inspected as per the same.

### 1.1.10. Bolts and Fasteners

All bolts and fasteners shall be checked for Stainless steel, Zinc/chromium plated and rust proof.

### 1.1.11. Panel Wiring

All the wires shall have identification ferrules/ Sleeves checked for markings corresponding to circuit diagram/ references. Teflon (PTFE) wires shall be checked for its conformity. Conductors which are subjected to bending/twisting shall be formed in to

*C. J. Indhara*

cable looms or wiring harness. Electrical wiring shall be checked for coat of anti-fungus varnish.

**1.1.12. Identification**

Names of all controls, switches, fuses, indicators and connectors shall be checked for markings with stickers.

**1.1.13. Quality of soldering**

All soldered joints shall be checked whether they are made neatly with the use of non-corrosive flame. Check whether all superfluous materials and flux shall be removed after soldering.

**1.1.14. Insulation Resistance (Megger test)**

Insulation Resistance between input terminal and earth, Output terminal and earth shall be checked by applying 500V DC in megger and value shall be  $\geq 20 \text{ M}\Omega$ .

**2. Inspection of Harnesses**

The following tests shall be conducted at the manufacturer's premises-

- a. Physical inspection to check construction of the Harnesses as per specifications.
- b. Continuity test
- c. Insulation Resistance test
- d. Dielectric strength test
- e. Conductor resistance test

**2.1 Continuity Test**

Check the continuity between respective connector pins in the stator and rotor as per wiring diagram, using a continuity tester.

**2.2. Insulation Resistance Test**

Measure the insulation resistance between

- a) body and single pin of high power connectors.
- b) body and each pin of power / signal connectors
- c) Any two pins which are not connected electrically, using a 500 V DC insulation tester.

The insulation resistance measured shall not be less than 20 MΩ.

**Caution: Care should be taken to disconnect the negative leads, if they are earthed.**

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### 2.3. Dielectric Strength Test

Apply 500V AC RMS, 50 Hz for duration of one minute. All cores of a complete harness assembly shall be subjected to this test as mentioned below:

- a) between any one pin/socket (non – earthed core) and all other pins/sockets (non – earthed cores) connected together. Repeat the test between each pin / socket and the remaining pins/sockets (non-earthed cores) connected together.
- b) between all non-earthed cores connected together and the braid, metallic conduits, plug and/or socket shells.

These harnesses shall satisfactorily withstand the test without arcing or puncture. There should not be any breakdown of insulation or surface spark over. These indicate failure of insulation and warrant rejection after investigation for the cause of failure.

### 2.4. Conductor Resistance Test

The conductor resistance shall be measured by using milli ohmmeter / micro ohmmeter for each and every cable and wire size. The measured values of single core shall not exceed the resistance values prescribed by the cable manufacturer.

## 3. Performance and Functional Tests on Dual Voltage Auxiliary Power Unit

### Testing of coupled DVAPU

#### 3.1. Rating Test

These tests are conducted with DVAPU and control panel. The equipment shall be tested for rating test with load bank.

#### Procedure:

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Make the DVAPU load contactor ON. So that DVAPU output shall be connected to the load bank.
- d) Apply the 100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 V DC
- e) Measure the voltage, frequency and current and record it in Table D.2.
- f) Run the APU for 10 minutes.
- g) Measuring the voltage and current and record it in Table D.2.

*C. Indhaya*

Sl.No	Parameter	Specified	On No load	On load	After 10 mins on load	Ok/Not Ok
1	Output Voltage	28 V±0.3 V				
	Load Current	161 A±1 A				
2	Output Voltage	270 V ± 3V				
	Load Current	24.1 A ± 1 A				

Table D.2. Rating test

### 3.2. Load Dump test and differential loading test

The Dual Voltage APU should be subjected to load dump and differential loading test by switching/variation of low voltage and high voltage loads. Load voltages, currents, voltage response to load variation, etc. to be recorded during the test.

### 3.3. Over load Test

These tests are conducted with DVAPU and control panel. The equipment shall be tested for over load test with load bank.

#### Procedure:

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the voltage generated by the DVAPU and record the readings in Table D3. During measurement voltage should be stable.
- d) Make the DVAPU load contactor ON. So that DVAPU output shall be connected to the load bank.
- e) Apply load current according to the table D.3 given below.
- f) Measure the voltage generated by the DVAPU and record the readings. During measurement voltage should be stable.

Output Voltage	Overload current	Time duration	Observation	Ok/Not Ok
28 V DC	110% of rated	60 min		
270 V DC	110% of rated	60 min		

Table D.3. Overload test

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**3.4. Charging of batteries using Alternator Output of 28 V DC**

Eight batteries of 12V, 100Ah are connected in series and parallel connection to achieve 24V, 400Ah. These batteries are charged simultaneously when any of the power sources is 'ON', note down the charging current. Record the result in Table D.4.

S.No	Battery		Remarks
	V	I	
1			After 1 Min.
2			After 5 Min.
3			After 10 Min.
4			After 15 Min.
5			After 20 Min.

Table D.4. Charging of batteries

**4. Control panel Functional checks**

Functional check of control panel switches, LED indications and display of critical parameters

**5. Unit identification and manufacturers test reports**

**5.1. Unit Identification**

<b>Customer</b>		
Unit Identification Sl.No		
Type		
Rating		
Model		
<b>Engine</b>		
Make		
Model		
Sl.No		
<b>Alternator</b>		
Make		
Model		
Sl.No		
<b>Control Panel</b>		
Make		
S.No		

Table D.5 Unit identification

*P. J. Indhira*

5.2. Verification of CoC/Manufacturers Test reports

Sl.No	Components	Ok/Not Ok	Observation
1	Engine		
2	Alternator		
3	Automatic Power Converter		
4	Power cables		
5	Connectors		

Table D.6 Verification of CoC/Manufacturers test reports

6. Load test

Shall be carried out on AT units

Total duration –24 hrs (cumulative) – excluding rest time

Time for each cycle of Load test - 8hrs

No. of cycles - 3

These tests are conducted with DVAPU and control panel. During this test all the doors shall be in closed condition.

S.No	Description	Condition	Duration
1	DVAPU	100% load current. i.e. 161 A @ 28 V DC and 24.1 A @ 270 V DC	3 Hours
		75% load current. i.e. 121±1 A @ 28 V DC and 18.1±1 A @ 270 V DC	2 Hours
		50% load current. i.e.80.5±1 A @ 28 V DC and 12±1 A @ 270 V DC	2 Hour
		25% load current. i.e. 40.2±1 A @ 28 V DC and 6±1 A @ 270 V DC	1 Hour
		30 Minutes Rest	

Table D.7 Load test load details

Procedure:

- a) Ensure that the DVAPU is in working condition with fully charged battery and adequate quantity of fuel.
- b) Start the DVAPU set from the control panel using push buttons provided on the control panel for manual operation.
- c) Measure the parameters mentioned in given Table D.8 and record.
- d) Make the DVAPU load contactor ON so that generator output shall be connected to the load bank.
- e) Apply the load as mentioned in the Table D.7.
- f) Record the parameters mentioned in Table D.8.

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**Load Test of DVAPU**

Started Time:

End Time:

Cycle No:

APU

Time	Voltage (V)		Current (A)		Power (KW)	Temp	
						Ambient	Inside Enclosure

Table D.8 Load test observations

**7. Performance check during Acceptance Testing**

The DVAPU will be tested along with the Control Panel (as per requirement) during AT and the following will be recorded as per Table D.9.

Speed (RPM)	OUTPUT POWER IN kW		Efficiency (%)	Voltage regulation (%)	Ripple voltage (peak to peak)	Noise Level	Time
	28 V Output	270 V Output					
3600							10 minutes

Table D.9. Functional Test for Dual Voltage APU System

**8. Noise level**

The noise level of DVAPU should not exceed 80 dBA (at full load condition), when measured at a distance of 6 meters distances in open space.

**9. ESS**

ESS to be conducted for DVAPU with Control Panel as per Appendix-E.

**10. Load sharing test with batteries (only on 28 V DC output)**

DVAPU 28 V DC bus shall be connected in parallel with 24 V DC batteries and 150% of rated load to be applied. Total load should be shared between DVAPU and batteries. The parameters shall be recorded as per Table D.10.

*C. J. [Signature]*

Speed (RPM)	Total Load on 28 V DC bus (kW)	Load shared by DVAPU (kW)	Load shared by batteries (kW)	Output voltage of DVAPU	Time duration
3600					

Table D.10 Load sharing test on DVAPU

**Note:**

- a. Details of functional tests will be discussed during PDR.
- b. The coolant oil, drive requirements, load bank, etc. required for Acceptance Testing to be provided by the vendor.
- c. Test procedure given above for DVAPU is very broad in nature and the vendor shall prepare and submit detailed document to check the compliance of the system for AFV requirements. Any tests deemed necessary to evaluate the system which is not listed above will be included in the test schedule during any stage of the contract.
- d. During individual stage and system level load tests, critical parameters shall be recorded such as:
  - i. Output terminal voltages
  - ii. Load currents
  - iii. Ripple of output voltage
  - iv. Harmonics in the output voltage
  - v. Efficiency
  - vi. Inlet coolant temperature
  - vii. Outlet coolant temperature
  - viii. Engine Speed, etc.

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ESS Test

ESS shall be carried out on Q1 and A1 units with Test rig.

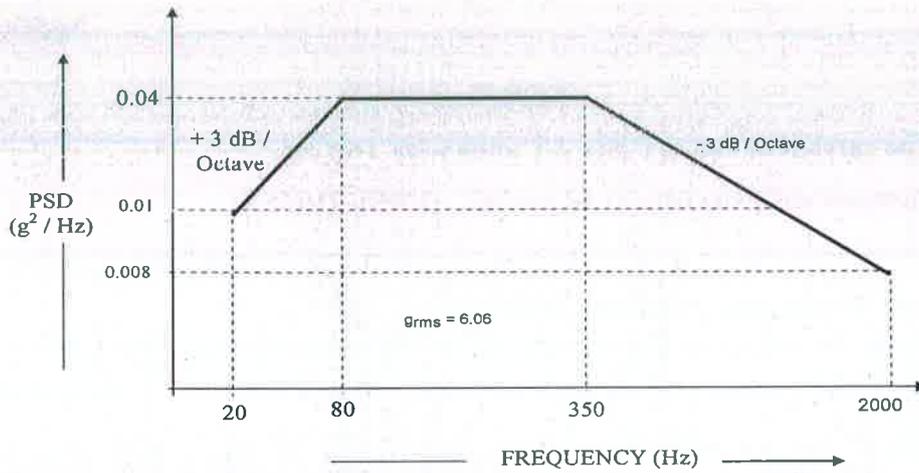
The specifications are given below (As per MIL-IIDBK-2164A):

Vibration - Temperature Cycling - Vibration:

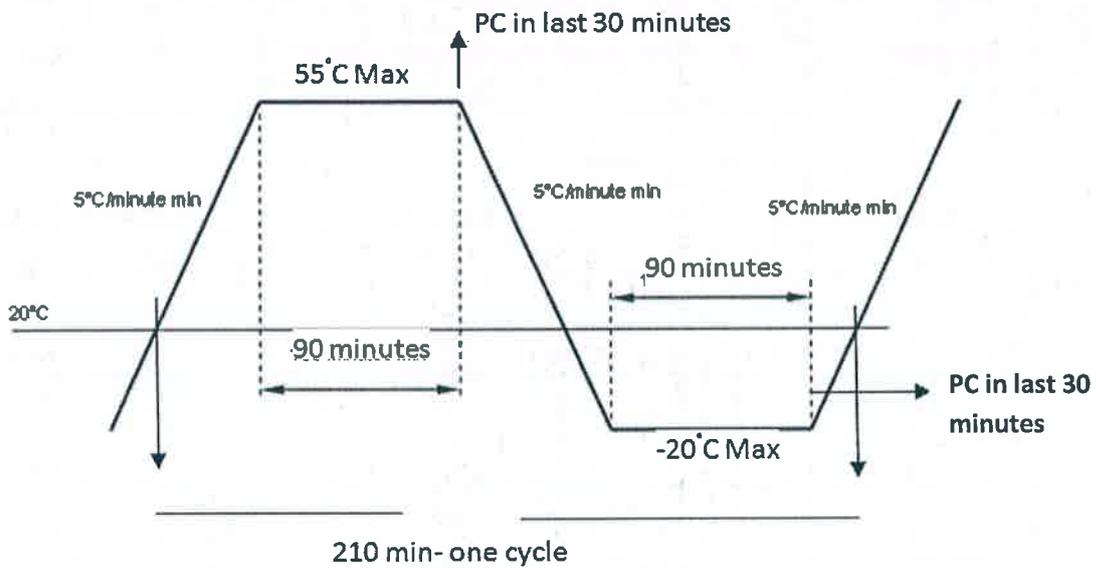
Sl. No.	TEST NAME	PARAMETER & DESCRIPTION	ACTION
01	Vibration	1. Vibration Spectrum Density profile as per Figure E.1. 2. Duration 5 minutes/axis in all 3 axis	1. Equipment ON and continuous performance checks.
02	Temperature Cycling	1. Ten cycles as per profile in Figure E.2 2. Last Four cycles shall be defect free 3. Rate of change of temperature not less than 5°C/min	1. Equipment 'ON' During the test 2. Performance Check Last 30 minutes at 55 and -20 degree Celsius of each cycle
03	Vibration	1. Vibration Spectrum Density profile as per Figure E.1. 2. Duration 5 minutes/axis in all 3 axis	1. Equipment ON and continuous performance checks
04	Final Visual / Physical and Functional Tests.	1. During visual examination Test, check for any physical damages and record the observations.	1. Complete Performance checks at ambient conditions.

Table E1. ESS schedule

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**Figure E.1: ESS – Random Vibration Test Profile**



**Figure E.2: ESS - Thermal Cycling Test Profile**

**Note:** Test plan shall be prepared by the vendor to meet the above specifications.

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**Compliance Sheet**

PART-I	Details	Complied/ Not Complied
Scope of Work for Development of Dual Voltage Auxiliary Power Unit as per Appendix-A		
Scope of supply for Development of Dual Voltage Auxiliary Power Unit as per Appendix-A		
Supply of Dual Voltage Auxiliary Power Unit as per Appendix-B		
Qualification Testing of Dual Voltage Auxiliary Power Unit as per Appendix-C		
Acceptance Testing of Dual Voltage Auxiliary Power Unit as per Appendix-D		
PART-II	Parameters	Complied/ Not Complied
<b>Technical Specifications</b>		
Nominal output voltage of DVAPU	28V DC $\pm$ 0.3 V DC and 270V DC $\pm$ 3 VDC (Refer MIL-STD-1275E for 28 VDC and MIL-STD-704 F for 270 VDC for compliance)	
Nominal output current of DVAPU	161 A @ 28 VDC and 24.1 A @ 270 VDC	
Nominal output Power of DVAPU (Total)	11 kW (4.5 kW at 28 V DC and 6.5 kW at 270 V DC)	
Overall Dimensions of DVAPU	Refer Fig.A.2 for details	
Mass of DVAPU (excluding control panel)	300 $\pm$ 10 kg (with enclosure)	
PM Alternator shall be as per CVRDE configuration	Dual stator single rotor configuration	
Communication	CAN and Ethernet	
Electromagnetic compatibility	As per MIL-STD-461 G	

C. Vishay:

GUI	For downloading the data, sharing the information with other units and analysis.	
Warranty	1 Year from date of delivery and acceptance	

### Vendor Evaluation Criteria

S.No.	Criteria	Complied/ Not Complied	Remarks
1	Registered Indian Vendors Only		
2	a) Experience in design and development and supply of generators/stand alone power supplies etc for defence/aerospace applications		Supporting documents to be submitted
	a) Should have experience in development and supply of rugged electronic controllers with CAN/Ethernet communications.		
3	Minimum facilities (design software tools and test facilities, etc. related to current work) to carry out the work		Vendor shall list out the details of facilities available.
4	Should have executed one crore (minimum) worth order in the last three years in similar field		
5	Should have average and continuous turnover of INR 2 Cr per year (minimum) from 2017-2020		
6	IPR should be with Director, CVRDE		
7	Acceptance of DcPP guidelines		
8	Macro level design approach plan		
9	The vendor shall be ISO-9001:2015 certified (Certificate to be enclosed)		

*E. J. Jadhav:*

**Note:**

- a. All the queries and clarifications in the RFP document to be clarified in the Pre bid meeting.
- b. No queries and clarifications will be entertained after the tender due date.
- c. In case of any queries and clarifications raised by the firm later, the decision of CVRDE is final.
- d. The technical evaluation committee will scrutinise all the bids received and if required, vendors will be called for a meeting to present their capabilities and strengths. The vendors who are not presenting will not be considered for further processing. CVRDE reps will visit the vendor's premises if deemed necessary to access their potential.
- e. Relevant supporting documents shall be submitted along with the tender.
- f. Vendors previously blacklisted, having any adverse remarks on any grounds by any of the departments of Govt. of India or having any negative remarks will not be considered.
- g. The vendor shall prepare macro level design details indicating sizing & make of the engine, preliminary design Automatic Power Converter(rating, configuration, etc.), PMG design as per CVRDE configuration for the development of Dual Voltage APU and controller.
- h. The firm should have minimum in-house test facility to evaluate the DVAPU.
- i. Vendor shall have history of in-time completion of S.Os and proof of the same shall be enclosed.
- j. The vendor shall depute one engineer at CVRDE to provide technical support until the project completion (20 months).

**Techno-Commercial Terms:**

Description of the item		Complied/ Not Complied
Validity of Bid-180 days from the last date of submission of the Bids.		
<b>Payment terms:</b>		
Contract period	20 months	
Payment	10 % will be paid as advance	
<b>Mile stone - I</b>	10 % payment	
<b>Mile stone - II</b>	20 % payment	
<b>Mile stone - III</b>	30% payment	
<b>Final Payment</b>	30% payment	

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Warranty Period	1 Year from the date of acceptance of item.	
I.D clause as per Sl.No 10 of Part II of the RFP		
Registration status/EMD If you are registered vendor, please mention the registration details, also attach a copy of the registration certificate If you enclosed EMD, please give EMD details		
Delivery Schedule/Contract period 20 months from the effective date of contract		
Acceptance of General Terms and conditions as per Part II of RFP		
Acceptance of Special Terms and Conditions as per Part III of RFP		

*C. Inithalgar:*

## **BID SECURITY DECLARATION FORM**

(To be submitted on firm's Letter head)

### **Combat Vehicles Research & Development Establishment (CVRDE)**

**AVADI, Chennai – 600 054**

It is hereby confirmed that bid submitted against **RFP No: CVRDE/MMG/OT/22DCT002/2021-22** will not be withdrawn or modified during the period of validity.

I / we accept that in case our bid is

a) Withdrawn or Modified during the period of validity.

or

b) If we are awarded the contract and fail to sign the contract.

or

c) We fail to submit performance security bond before the deadline defined in the RFP

then our firm will be suspended for a period of **One Year** from being eligible to submit Bid against RFPs issued by CVRDE.

(Authorized Signatory)

Name of the Firm: \_\_\_\_\_