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भारत सरकार
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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

डीजल इलेक्ट्रिक लोकोमोटिव्स हेतु एफ आर पी कन्टेनर एवं
पी.पी.सी.पी. सेल असेम्बली के साथ
लो मेंटिनेंस लेड एसिड बैट्री के लिए विशिष्टि

**SPECIFICATION FOR LOW MAINTENANCE LEAD
ACID BATTERIES WITH PPCP CELL ASSEMBLY
HOUSED IN FRP OUTER CONTAINER FOR DIESEL
ELECTRIC LOCOMOTIVES**

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SPECIFICATION FOR LOW MAINTENANCE LEAD ACID BATTERIES WITH PPCP CELL ASSEMBLY HOUSED IN FRP OUTER CONTAINER FOR DIESEL LOCOMOTIVES (NO. MP.00.24.65 (Rev.00) Dec'2009)

1.0 FOREWORD

1.1 Earlier lead acid flooded type batteries were in use and the common problems were frequent topping up, cleaning, sulphation of terminal posts and leakage of electrolyte. To overcome these problems, low maintenance batteries have been developed. In order to further improve energy density and solve transit damage, sealing compound leakages problem etc, it is now proposed to develop cell assembly in PPCP container and housed in F.R.P outer container.

1.2 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS:2-1960. The number of significant places retained in the rounded off value should be the same as that of the specified value in this specification.

1.3 The supplier shall furnish information on performance of battery as given Appendix 'A' and 'B' while submitting the tenders.

2.0 SCOPE

2.1 This specification covers methods of tests, performance and other requirements of low maintenance batteries with cell assembly in PPCP container and housed in F.R.P outer container used as a source of energy for starting diesel engines, lighting and other normal auxiliary purposes in diesel locomotives.

3.0 TERMINOLOGY

3.1 For the purpose of this specification, the definitions given in IS:1885 (part 8) – 1986 and IS: 8320-1982, in addition to the following shall apply

3.2 LOW MAINTENANCE BATTERY

A battery which requires very less topping up in actual service and topping up is required at least not earlier than 6 months, when fitted on a diesel locomotive. Hereinafter this battery shall be termed as Low maintenance battery

3.3 MICRO-POROUS VENT-CUM-FILLING PLUG

A micro-porous vent-cum-filling plug having dome/filter made of ceramic or any other suitable fire retardant material and meeting the requirements specified in clause 5.2.2.2

3.4 **TYPE TEST:** - Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general quality and design of a given type of battery.

3.5 **ACCEPTANCE TESTS:-** Tests carried out on samples selected from a lot for the purpose of verifying the acceptability of the lot

3.6 **LOT:-** All batteries of the same type design and rating, manufactured by the same factory during the same period using the same process and materials offered for inspection at a time shall constitute a lot

3.7 **ELECTROLYTE:-** Aqueous solution of sulphuric acid for ionic conduction and electro-chemical reaction during passage of current through a cell

3.8 **TERMINAL POST (lug):-** A post (lug) of cell or battery to which an internal electrical circuit is connected

3.9 ***FLOAT:-** A device for indicating the level of electrolyte in the cell container **(Optional)**

3.10 ***SEALED FLOAT GUIDE:-** A removable bush of anti-splash and sealed type to facilitate easy vertical movement of float stem **(Optional)**

* The float guide shall be provided after gaining field experience

4.0 GENERAL REQUIREMENTS

4.1 General:

4.1.1 The requirement of batteries for different diesel locomotives as specified in APPENDIX-C shall be applicable.

- 4.1.2 The battery shall be able to supply for the specified engine, initial cranking current and rolling load current to crank the diesel engine of the locomotive as specified in APPENDIX-C. The battery shall also be able to supply control and lighting loads specified for the respective locomotive for a period of not less than six hours.
- 5.0 **MATERIALS & CONSTRUCTION:**
- 5.1 **General :**
The battery shall comprise of 32 cells in 8 battery units, each battery unit being of 4 cells and shall normally be floating on 72V charging circuit
- 5.2 **Container and Lid:**
- 5.2.1 **Container**
- 5.2.1.1 The battery cell container conforming to IS:1146-1981 shall be made of polypropylene and the lid shall be heat sealed with the container to make it leak proof. The battery cells shall be housed in rugged, durable and heat tolerant HDPE or FRP container.
- 5.2.2 **Micro-porous vent plug:** - Each cell shall be provided with adequate mean, both for venting and for servicing of the electrolyte. The vent-cum-filling plug shall generally conform to RDSO drawing no.4020/A sheet no.2 alt.3 with the dome/filter made of ceramic or any other suitable fire retardant material. The vent-cum-filling plug shall allow free escape of gases evolved during service and shall not permit electrolyte to come out on the surface of the lid. On removal of vent-cum filling plug, drawing of the electrolyte sample, servicing and checking of electrolyte shall be possible.
- 5.2.2.1 The material used for micro-porous vent plug shall have uniform porosity. It shall also be free from abnormalities such as crack, breakage, foreign matter, and dent and shall conform to the following. The following test shall be applicable on Micro porous dome of the vent plug only and dome shall be taken out for this purpose.
- a) **Porosity** : $35 \pm 5\%$
Porosity of micro-porous filter shall be calculated as given below:-
Weigh the sample in air (W1) – keep the sample in boiling water with few drops of wetting agent (Teepol) for 30 minutes. Weigh the sample in water (W2). Next weigh the wet sample outside water (W3). Calculate porosity as under:
- $$\text{Porosity}\% = \frac{(W3 - W2) - (W1 - W2)}{(W3 - W2)} \times 100$$
- b) **Breaking strength:** Shall not be brittle. To test this, a steel ball of 200g shall be dropped two times from the height of 400 mm on the top and side of micro porous dome
- c) **Acid resistance:** Dry and weigh the (micro-porous body) dome (W1), Keep the dome in sulphuric acid of specific gravity 1.3 at 40°C for 100 hours. Remove it from acid, wash free of acid, dry and weigh (W2). Calculate the percentage loss as follows:
- $$\frac{W1 - W2}{W1} \times 100$$
- The loss of weight shall not be more than 0.5%
- d) **Permeability:** The full charged cell shall be fitted with vent plug and charged at 2.5 times of C10 rate for 4 hours. All sealed float guides shall be in position properly except the one where manometer with water is fitted. The cell shall not develop positive pressure more than 2 mm of water column inside the cell
- e) **Dimension:** Shall generally conform to RDSO's drg.no.SKEL-4020/A Alt.3 or as approved by RDSO
- f) **Plastic component** : Plastic component to which the micro-porous top is bonded shall be free from crack, flash, pin hole, air bubble, uneven shrinkage, foreign particles etc. and shall conform to the following (Ref.Drg.SKEL-4020 Alt.3)
Material : HIP/Polypropylene or superior quality
Acid resistance : No perceptible change
Heat : No deformation at 70°C
- 5.2.2.2 **DIA AND PITCH THREAD:** The micro-porous vent-cum-filling plug and sealed float guide dia shall be 27mm and pitch of thread shall be 3mm as per drawing no.SKEL-4020/A Alt.3

6.0 TERMINAL POSTS & CONNECTIONS:

6.1 Terminal posts:

Positive and negative terminal posts shall be clearly and unambiguously identifiable.

6.2 Inter unit connectors:

The inter unit connector of flexible single core elastic cable of RDSO's approved make shall only be used. The inter unit connectors shall conform to fig.1 of IS:7624-1990

6.3 The type, size and number of inter-unit connectors shall be in accordance with table 1 of IS: 7624-1990. Terminal bolts, nuts and washers shall be lead coated to prevent corrosion and shall be in accordance with fig.2 of IS: 7624-1990

6.4 Electrolyte:

6.4.1 The sulphuric acid and water used for electrolyte preparation should conform to IS: 266-1993 and IS: 1069-1964 respectively

6.4.2 The level of electrolyte shall be at least 40 mm (min) up to the top edge of the separator in fully topped up condition

6.4.3 The specific gravity of electrolyte when the battery is in fully charged condition at 27°C shall be between 1.240 and 1.250

6.5 Overall dimensions and weight: The maximum dimensions and weight of each unit shall not exceed the figures given in Appendix – C

6.6 SEPARATOR: - Separator shall be microporous rubber, PVC or any other material conforming to IS: 6071-1986.

6.7 RATING

6.7.1 Rated Capacity: The rating assigned to the battery shall be capacity 450Ah and 290Ah at 10hrs. rate of discharge at 27°C temp

6.7.2 Actual Capacity: Since the actual C10 capacity of battery is generally higher than the rated C10 capacity the manufacturer will advice the actual C10 capacity of the battery

6.7.3 Obtained Capacity: Obtained capacity is the capacity obtained during discharge of cell up to 1.75V at 10 hours rate of the rated capacity of battery. The variation between actual capacity and obtained capacity shall not be more than 93%

6.7.4 TESTS AND PERFORMANCE

6.7.4.1 Classification of tests: The following test shall be done as per IS: 7624-1990 and the test results shall generally meet the laid down requirements.

6.7.4.2 Type tests - The following shall constitute the type tests. All these tests shall be started after 3 cycles of charge/discharge at 10 hours rate. All these tests shall be conducted at 27±5°C unless and otherwise specifically mentioned.

- a) Capacity at 10 hrs rate (clause 6.12)
- b) Watt-hour and Ampere-hour efficiency tests according to clause 6.13. Watt hour efficiency shall not be less than 80% and Ampere hour efficiency shall not be less than 93%. While conducting this test a minimum rest of 12 to 24 hours shall be given between each charge/discharge
- c) Internal resistance test (clause 6.14)
- d) Initial cranking current (clause 6.15)
- e) Sustained cranking current (clause 6.16)
- f) Retention of charge (clause 6.17). Loss of capacity shall not be more than 5% of the OTC after 14 days. For this battery can be stored at room temp. but not less than 22°C.Charge/discharges for this test shall be conducted at 27±5°C
- g) Life test clause 6.19.The number of life units shall not be less than 8 units. After completion of life cycle test the battery shall be cut opened and examined to arrive at the reason for reduction in capacity
- h) Storage test clause 7.14 of IS: 7624-1990
- i) Air pressure test according to clause 7.5 of IS:7624-1990
- j) Vibration test according to clause 7.16 of IS:7624-1990
- k) Electrolyte retention test according to clause 7.5 of IS:7624-1990
- l) Checking of dimensions, mass, marking and workmanship according to clause 5.5

- m) Loss of water as per clause 6.9 of this spec
- n) Test of Micro-porous vent plug as per clause 5.2.2 of this specification.
- o) Equilibrium float current test as per clause 6.10 of this specification
- p) Resistance to over charge (clause 6.18)

Note: During these tests the discharge shall be stopped when the closed circuit voltage across the battery fall to 'd' x n volts of the voltage across any one of the cells of the monoblock falls down to 'd' volts whichever is earlier where 'n' is the number of cell in the battery and 'd' is the end voltage 1.75V for each cell

6.7.5 SEQUENCE OF TYPE TESTS

The sequence of type tests and the number of samples required shall be in accordance with Appendix 'D'.
Note: - The cell shall be covered by the type approval certificates from an appropriate authority. Significant variations in the design shall be covered by separate type approval certificates. The cell of new design shall be proto-type tested for which samples offered by the manufacturer shall be accepted. The type testing should be repeated after every 5th year for revalidation and samples shall be drawn from mass production at random. In case of unsatisfactory performance of cells in field, retype testing either part or full can also be done earlier at the discretion of the approving authority.

6.8.5.1 If any of the samples fails in the relevant type tests. The testing authority may call for fresh samples not exceeding twice the original number of cells tested in that particular test and subject them again to the test (s) in which failure occurred. If there is any failure in the retest (s), the type shall be considered as not having passed the requirements of this standard

6.8.5.2 **Duration of type test-** Type tests as per clause 6.7.4 shall be completed within six months (Maximum) from the date of starting the type test. Except storage test which shall be started within six months (max)

6.8.5.3 **Inspecting authority** – The type test as per clause 6.7.4 of cells/monoblock batteries shall be conducted by the representative of RDSO/Lucknow, India at the works of manufactures for which all the test facilities shall be made available by the manufacturers at their cost.

6.8.5.4 **RENEWAL OF TYPE TEST:** After successful prototype testing and fulfilling requirements of specification, approval shall be given by RDSO. At any time during the period of approval of the vendor, depending upon adverse feedback from user railways/ PUs or deterioration of FRPCPY/MTBF or any other compelling reason, which comes to light, RDSO may re-evaluate the performance including QAP, manufacturing facility and bill of material for further continuance/ withdrawal of approval. In case any discrepancy is observed, the case shall be taken up for renewal of registration. Manufacturer shall apply 5 nos. of samples for renewal of type test approval. During renewal of type test, following tests shall be carried out by RDSO:

- a) Rated Ah capacity test at 10 hr rate (as per clause 6.12)
- b) Ah and Wh efficiency test (as per clause 6.13)
- c) Initial cranking current test (as per clause 6.15)
- d) Sustained cranking current test (as per clause 6.16)
- e) Equilibrium float current and water loss test (as per clause 6.10 & 6.9 respectively)

The manufacturer shall offer the battery for retype testing. For this purpose 5 samples shall be picked up from any production lot at random. It shall be checked for dimension, mass, marking/workmanship and components verifications by RDSO representative. RDSO representative shall then witness the above test. The full report of testing shall be submitted to RDSO for the purpose of evaluation as per latest specification. After successful completion of above renewal of type approval shall be issued.

6.9 LOSS OF WATER TEST

After fully charging the battery it should be cleaned and dried. It should be weighed immediately but not exceeding one hour after drying with an accuracy of 0.05% or maximum least count of 50 g for the balance used. Then all vent-cum-filling plugs should be closed tightly and connected to constant voltage charger keeping the voltage 2.4V / cell i.e. 9.6 q 0.05 V for 21 days in water bath at a temperature of 50 q 2 deg. C. Therefore battery is removed from circuit and dried. After this it is weighed accurately.

6.9.1 The water loss shall not exceed 0.75 g/Ah/cell of the obtained capacity

6.10 EQUILIBRIUM FLOAT CURRENT TEST

This test shall be conducted during the initial three days (72 hours) of water loss test. The battery under test shall be kept in water bath at 50 q 2 deg.C. Charging voltage shall be 2.4 q 0.05V / cell. The float current shall be measured and recorded. It shall not be more than 3mA/Ah of the obtained capacity.

6.11 Acceptance tests:

The following shall constitute the acceptance tests:

- a) Initial cranking current test (6.15)
- b) Sustained cranking current test (6.16)
- c) Electrolyte retention test (cl 7.15 of IS:7624-1990)

Note: The initial cranking current and sustained cranking current shall not be less than during prototype testing.

6.11.1 SAMPLING SCHEME AND CRITERIA FOR ACCEPTANCE

The sampling scheme and criteria for the acceptance of the lot for various lot sizes shall be in accordance with column 1 and column 2 of the table 2 as per clause 7.1.2.1 of IS:7624-1990

6.11.2 TEST EQUIPMENT

The voltmeters, Ammeters, Thermometer and hydrometer etc. required for the tests specified in this standard shall meet the requirements given in clause 10.2 of IS: 8320. Use of a digital ammeter/voltmeter is preferable for testing. Chart recorders shall be used for life cycle testing with continuous logging facility of voltage, current, Ah input/output with reference to time.

6.11.3 Temperature for test: Unless otherwise specified the temperature for tests shall be between 20°C and 30°C

6.11.4 Physical examination:

The batteries shall be examined for conformity with the requirements of 3,4 and 6

6.11.5 The battery shall be so designed that the initial charging of battery shall be completed with 75 hours as per the charging method to be prescribed by the manufacturers for the battery. These details shall be furnished by the manufacturers to the type testing authority as well as in the Maintenance manual. Subsequent charging for conducting various tests shall be restricted to 15 hours.

6.12 AMPERE HOUR CAPACITY TEST AT 10 Hr RATE

The capacity at 10 hr rate of discharge when tested in the manner prescribed in Appendix-E shall be not less than the capacity declared by the manufacturer

6.13 Ampere-hour and Watt hour efficiency test:

Ampere-hour and watt hour efficiencies as described in Appendix-F shall be not less than 93% and 80% respectively.

6.14 Internal resistance test:

The internal resistance when measured in the manner described in Appendix-G shall not be more than the value specified in Appendix-C for the respective class of diesel locomotives

6.15 Initial cranking current test:

6.15.1 After standing on open circuit for not less than 12 hrs and not more than 24 hrs from the completion of a full charge, the battery unit shall be subjected to cycles of discharge at the rate of initial cranking current given in Appendix-C. Each discharge shall be of 15 secs duration with an intermittent rest of 15 secs.

6.15.2 Requirements:

The battery unit tested shall meet the minimum requirements specified in Table-1

TABLE – 1				
INITIAL CRANKING CURRENT TEST				
Ambient temperature	Discharge current (15 sec. with 15 sec rest)	Min no of 15 sec cycles	Battery terminal voltage	
			Initial at 5-7 secs (volts)	Final (Volts)
27 ± 2	Column 8 Appendix – C	8	1.1 x n	0.80 x n
			Where n - no of cells in Series per battery unit	

6.16 Sustained cranking current tests:

6.16.1 After standing on open circuit for not less than 12 hrs and not more than 24 hrs on the completion of full charge, the battery unit shall be subjected to a continuous discharge at the rate of sustained cranking current as given in Appendix-C

6.16.1.1 This discharge may not be taken immediately after initial cranking current test but may be proceeded by one C10 discharge

6.16.2

Requirements:

The battery unit tested shall meet the minimum requirements specified in Table-II

TABLE – II				
SUSTAINED CRANKING CURRENT TEST				
Ambient temperature (C)	Discharge current (Amps)	Min discharge time (min)	Battery terminal voltage	
			Initial at 5-7 secs (volts)	Final (Volts)
27 ± 2	Column 9 Appendix – C	5	1.4 x n	1 x n
			Where n - no of cells in Series per battery unit	

6.17

Test for retention of charge:

The object of this test is to determine the loss of capacity of a battery unit on open circuit during a specified period

6.17.1

The battery unit shall be fully charged at the current specified by the manufacturer and it shall then be subjected to two consecutive capacity tests in accordance with 5.12, the value of the initial capacity 'C' being calculated as the mean of the two results thus obtained

6.17.2

After a complete recharge and after cleaning the surface, the battery unit shall be left on open circuit for a period of 14 days without disturbance at ambient temperature

6.17.3

After 14 days of storage the battery unit shall be discharged in accordance with 6.12. The value of the capacity measured after storage shall be denoted by C1

6.17.4

After the discharge the battery unit shall be fully charged at the normal charging rate recommended by the manufacturer

6.17.5

The loss of capacity 'S' expressed as a percentage, shall be calculated from the formula

$$S = \frac{C - C_1}{C} \times 100$$

6.17.6

Requirement: The loss of capacity calculated as in 6.17.5 shall not be more than 5% over 14 days storage period

6.18

Resistance to over charge test:

6.18.1

Resistance to over charge as tested to clause 7.12 of IS:7624-1990

6.18.2

Requirements: On each of the 8 checking discharges, the duration of discharge before the voltage drops to 1V x n shall not be less than 3 minutes

6.19

LIFE TEST:

6.19.1

Battery unit shall be subjected to 8 test units of life test as prescribed in Appendix-H

6.19.2

The duration of the rapid discharge on each test unit under the conditions prescribed in Appendix 'H' shall not be less than 3 min

7.0

MARKING:

7.1

Marking- Both the shorter sides of FRP container shall have the following details embossed on the container

- a) Manufacturer's name, trade mark and place of manufacturing.
- b) Rating at 10 hrs, discharge rate and
- c) Specific gravity of the electrolyte in the fully charged condition at 27°C

7.1.1

The year and month of manufacture shall be punched on the terminal lug base

7.1.2

Manufacturer name or trade mark and rating of battery will be impressed on the connector.

7.2

Manufacturer shall be responsible for safe transportation of Battery. Battery should be delivered in good condition to consignee at his depot. If there is any damage manufacturer shall replace the battery free of cost.

8.0

WARRANTY:

8.1

The batteries shall be under warranty as per the tender conditions

9.0

DRAWING / DESIGN DETAILS -

9.1

The manufacturer shall supply two sets of drawing in A4 size listed as below for approval while offering the cell/monobloc for type testing

- a) Detail drawing with dimensions of front, top and side view of cell / monobloc
 - b) Detailed drawings of container showing different sections with dimensions.
 - c) Part drawings with sectional details of
 - 1) Terminal post (Positive and negative)
 - 2) Container lid
 - 3) Pole (+ve & -ve)
 - 4) Plates (+ve & -ve groups assembly)
 - 5) Separator
 - 6) Micro porous vent plug
 - 7) Inter cell/unit and end cell connectors
 - d) Packing details of cell/monoblock
 - e) General arrangement drawings of 8 units 8V batteries indicating connection for unit to unit
 - f) Any other drawings considered relevant

- 9.2 The manufacturer shall declare the expected life of battery in the offer as well as while submitting the technical details for type test to RDSO

- 10.0 For the purpose of the cells/monobloc supplied against this approval, approval means the approval of general design features. Not with standing the approval, manufacturer is wholly and completely responsible for performance, life and reliability of battery during service.

- 11.0 No design change shall be undertaken by manufacturer from prototype cell / monobloc batteries without prior approval of RDSO

- 12.0 **Design documents and instructions manual**
 Following documents in the spiral bound form will be submitted to RDSO
 - a) One set of drawings. As per clause 8.0 of this specification before offering for type tests for approval and one set for records (bound form) after completion of type tests.
 - b) (i) In house test results as per appendix 'A' and 'B' shall be sent to RDSO before offering for type test
 (ii) Type tests results obtained after testing by testing authority
 - c) Instructions manual-two copy of instruction manual to be sent to consignee along with each lot

- 13.0 After the prototype approval by RDSO of a batteries design, no design change shall be undertaken by manufacturer from prototype batteries without prior approval of RDSO, failing which the proto-type approval may be with drawn/withheld by RDSO at any time
 If considered necessary, RDSO may undertake retesting of some or all prototype tests as per this specification at any time to ensure proper effective quality control being exercised by the manufacturer at different stages of manufacturing
 RDSO may, also undertake some special tests associating manufacturers to validate the design changes to meet the field conditions for which all the necessary testing equipment/instruments etc. shall be arranged by the manufacturer free of cost

- 14.0 **INFRASTRUCTURE FOR QUALITY ASSURANCE**
 The firm/manufacturer shall have the infra-structure facilities like machinery and plants and testing equipments as per Appendix 'I' of the specification. The requirements are considered essential before considering a firm for approval for manufacture and supply of the battery to the Indian Railways.
 In addition to the above, the firms having valid ISO-9000 certificate accreditation or equivalent for ensuring conformance to the laid down quality system requirements for design, manufacturing process, testing, quality control at different stages of manufacturing etc shall only be considered

- 15.0 **INFRINGEMENT OF PATENT RIGHTS**
 Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacture process, use of components, use in design, development and manufacture of batteries and any other factors which may cause such dispute. In this connection, the entire responsibility to settle any issue wholly rest with the manufacturer.

APPENDIX - A
SCHEDULE OF DESIGN PARTICULARS

The following particulars are required to be supplied by the manufacturer with the quotation:

Sl.no.	DESCRIPTION	PARTICULARS TO BE FILLED
1	Make	
2	Type of unit	
3	Manufacturer's nomenclature	
4	Overall dimensions of unit (L x W x Ht)	
5	Mass per unit with acid	
6	Cell container material	
7	Type of positive plate	
8	Type of Negative plate	
9	Separators	
10	Maximum electrolyte temp that the cell/battery can withstand without any damage a) Continuously b) For the short period	Deg C
11	Electrolyte height above the top of the separators	mm
12	Electrolyte height below the bottom plates	mm
13	Quantity of electrolyte per cell	Liters
14	Sp gr. Of electrolyte for initial filling at 27°C	
15	Details of initial treatment recommended	
16	Material of terminal and inter-cell connectors	
17	Normal charging rate	Amps
18	Equilibrium float current	Milliamps

APPENDIX – ‘B’
SCHEDULE OF PERFORMANCE

Sl. No.	DESCRIPTION	PARTICULARS TO BE FILLED
0.0	Batteries offered according to this standard shall be covered by a type approval certificate from an appropriate authority. All variation in the design shall be covered by a separate type approval certificate. Following particulars regarding the type tests shall be supplied by the manufacturer along with the certificate against any quotation or tender	
1	Ampere-hour capacity	Ah
2	Ampere-hour/watt-hour efficiency	Percent
3	Internal resistance	Milli Ohm
4	Initial cranking current	Cycle
5	Sustained cranking current	Min
6	Retention of charge	Per cent
7	Resistance to overcharge	Hours
8	Loss of water	g/Ah
9	Equilibrium float current	mA/Ah
10	Life	Cycles
11	Storage	Ah
12	Rise in electrolyte temp above the ambient air temp when charged from duly discharged to fully charged conditions at normal rate	Deg C
13	Charge and discharge curves with voltage versus time showing the performance of the cell for discharge at 10 hours rate and charge at normal rate	
14	Recommendations for a reasonable fast charging method without affecting the manufacturer's guarantee	

APPENDIX – C

DESIGN AND CONSTRUCTION

Sl. no.	Class of loco Motive	Type of trans mission	Battery voltage	No of cells	Voltage of each battery unit	No of battery units	Initial cranking current	Sustained cranking current	Control equipment & lighting current	Internal resistance of 8V monoblock
			V		V		Amps	Amps	Amps	M j
1	2	3	4	5	6	7	8	9	10	11
01	WDM1	E	64	32	8	8	2300	1400	45	4.0
	WDM2	E								
	WDP2	E								
	WDG2	E								
(450Ah)										
02	WDM4	E	64	32	8	8	1500	940	35	5.0
	WDS5	E								
	YDM4	E								
	YDM4 A	E								
(290Ah)										
03	WDP 2	E	64	32	8	8	2300	1400	50	3.0
	WDG 2	E								
	WDG 4	E								
(500Ah)										

OVER ALL DIMENSIONS AND WEIGHT

Sl. no.	Ampere hour capacity	Length	Width	Height	Weight per battery unit with electrolyte
	(AH)	mm	mm	mm	Kg
01	8V 450	724	225	470	150
02	8V 290	724	210	470	120
03	8V 500	723	200	494	153

APPENDIX – D

SCHEDULE OF TYPE TESTS

		Cell / Unit numbers					
	Tests	01	02	03	04	05	06
a)	Physical examination (6.11.4)	x	x	x	x	x	x
b)	Air pressure (7.5 of IS: 7624 – 1990)	x	x	x	x	x	x
c)	Rated Ah capacity test at 10 hr rate (6.12)	x	x	x	x	x	-
d)	Ah & Wh efficiency test (6.13)	-	-	x	x	-	-
e)	Internal resistance test (6.14)	-	-	x	x	-	-
f)	Initial cranking current (6.15)	x	x	-	-	-	-
g)	Sustained cranking current (6.16)	x	x	-	-	-	-
h)	Test for retention of charge (6.17)	-	-	x	x	-	-
i)	Test for resistance to overcharge (6.18)	-	-	x	x	-	-
j)	Life test (6.19)	x	x	-	-	-	-
k)	Storage (7.14 of IS:7624)	-	-	-	-	-	x
l)	Water loss (6.9)	-	-	-	-	x	-
m)	Equilibrium float current (6.10)	-	-	-	-	x	-
n)	Vibration (7.16 of IS:7624)	-	-	-	-	x	-

APPENDIX – E

TEST FOR CAPACITY AT THE 10 hr RATE

- E.1 The discharge shall commence not less than 12 hrs. and not more than 24 hrs from the completion of a full charge and the battery unit shall be discharged through a suitable resistance at a current $I = 0.1 \times C_{10}$ amperes. C_{10} being the rated capacity

The discharge shall be stopped when the closed circuit voltage across the terminals falls to $1.80 \times n$ Volts, where 'n' is the number of cells in series or until the voltage across one cell has fallen down to 1.75 volts

- E.2 At this rate of discharge hourly readings may be taken until the battery unit voltage approaches $1.80V \times n$ Volts after which the readings shall be taken every 15 min
- E.3 The battery unit shall be charged at a rate recommended by the manufacturer, immediately after each discharge.
- E.4 The capacity in ampere hours shall be obtained by multiplying the discharge current by the total time of discharge in hours and the products so obtained shall be corrected to a temperature of 27°C by the following formula:

$$C_{27} = C_t / (1 + R(t - 27))$$

Where C_{27} = Capacity at 27°C
 C_t = Observed capacity at t deg.C
 T = Average room temp in deg.C
 R = 0.0043 for 10 hr rate of discharge

APPENDIX - F

PROCEDURE FOR MEASURING AMPERE HOUR AND WATT HOUR EFFICIENCY

F.1 The following method shall be used for determining the maximum ampere hour and watt hour efficiencies

a) Ampere hour efficiency:

A fully charged battery unit shall be discharged at $I = 0.1 \times C_{10}$ ampere to a voltage of $1.80 \times n$ volts, careful measurements being made of the exact number of ampere hours delivered. On the charge the same numbers of ampere hours are put back at the same number of ampere hours are put back at the same current. A second discharge shall then be made to the same cut off voltage as before. The efficiency of the battery unit is then calculated as the ratio of the ampere hour delivered during the second discharge corrected to the ampere hour put in during the charge

b) Watt hour efficiency

The watt hour efficiency shall be calculated by multiplying the ampere hour efficiency the ampere hour efficiency by the ratio of average discharge and recharge voltages calculated from the log sheets for ampere hour efficiency in the following manner:

The average voltage shall be calculated from hourly readings of the 2nd discharge voltage and previous charge voltage including the voltage immediately after (5-7 sec) start of discharge & charge respectively and the last reading of both.

APPENDIX - G

PROCEDURE FOR MEASURING INTERNAL RESISTANCE

- G.1. The battery unit shall be charged at the normal charging rate. After charging, the battery unit shall be discharged for one hour at 10 hr rate
- G.2 The test shall be continued by increasing the discharge current to approx. equal to 1.5 times the value specified in col.10 in Appendix C (A1) and after an interval not exceeding 5 min, the current shall be decreased to half the value specified in col.10 of appendix-C (A2)

The current A1 and A2 in amperes and the corresponding battery unit terminal voltages V1 and V2 in volts, shall be measured simultaneously.

The internal resistance expressed in milli ohm of the battery unit under test shall be calculated from the formula given below:

$$R = \frac{(V2-V1)}{(A1-A2)} \times 1000 \text{ milli ohm}$$

- G.3 The internal resistance may also be measured by a direct reading meter of agreed to between the manufacturer and the purchaser.

APPENDIX -H

LIFE TEST

- H.1 The life of battery unit is defined by the number of life test units obtained under the following conditions.
- H.2 The life test is carried out on at least two cells/battery an its which have satisfactorily passed the test in accordance with clause 5.11.4, 5.12, 5.13, 5.15 and 5.16
- H.3 The battery units shall be subjected to a series of discharges and charges continuously. The discharges shall be completed in 1 hr. at an average current of $I = 0.035 \times$ sustained cranking current. The charging shall be affected during 5 hr. at an average current of $I = 0.035 \times$ sustained cranking current. Throughout the life test unit the battery units shall be immersed in a tank of water, the temp. of which is maintained at 40 ± 3 deg.C.
- H.4 After the last charge of series of 36 discharge charge cycles the batteries shall be disconnected from the circuit. They shall remain on open circuit for 96 hrs. After this open circuit stand they shall be discharged at the rapid rate $I =$ sustained cranking current. This discharge is continued down to an end voltage of $1V_{xn}$ on completion of this discharge the batteries shall be fully recharged at normal rate. The combination of discharge and recharge cycles as described above together with 96 hrs. open circuit period, the rapid discharge and the subsequent recharge together constitute one complete battery unit of life test.
- H.5 After the final test unit the battery shall not be subjected to any test.

APPENDIX- 'I'

LIST OF MAACHINERIES AND PLANTS FOR MANUFACTUREOF LEAD ACID STORAGE BATTERIESESSENTIAL MANUFACTURING FACILITIES

1. Lead antimony alloying plant to have alloy with different antimony percentages.
2. Lead oxide manufacturing mill.
 - (a) Lead peroxide manufacturing plant.
3. Pressure die-casting machines for Positive/Negative grids Hand moulding process not permitted).
 - (a)Pressure die-casting machines for terminal post, inter unit connector, poles etc.(Hand moulding process not permitted).
4. Automatic pasting plant for negative plates.(Hand pasting process not permitted).
 - (a) Automatic past mixing plant (Manually not permitted).
5. Vibration plant for filling of positive tubular plates.
6. Positive tube bag manufacturing plant.
7. Separator manufacturing plant.
8. Container manufacturing plant with computer controlled rubber mixing for making container.
8. Plate formation plant.
9. Jigs and fixtures to make groups of positive and negative plates.
10. Bitumen compound sealing plant with controlled thermostat.
11. Chemical Laboratory to test various chemical ingredients.
12. Gas burners set for assembly of positive and negative group plates for battery.
13. Distilled water manufacturing plant.
14. Container top lid manufacturing plant.
15. Compressor with dryer.
16. Humidity chamber.
17. Acid chilling plant.

ADDITIONAL LIST OF PLANT AND MACHINERY

- (a) Air pollution control system.
- (b) Water effluent plant.
- (c) Water serabeer for formation room.
- (d) Fork lift.
- (e) Pallet truck.
- (f) Formation rectifier.
- (g) DG Sets.

OTHER FACILITIES

ISO-9000 certificate

ESSENTIAL LIST OF TEST EQUIPMENT

1. Computerized control battery charging/discharging equipment with monitoring and recording system for C10, C5 and C3 testing etc. (Manually not permitted).
2. Fully computerized control life cycle testers with logging, monitoring and recording system. (Recording time, voltage min. 6 channels, current, temp., Ah, Wh, mode and cycle step). (Manually not permitted)
3. Temperature controlled test room.
4. Carbon pile loads of different capacity.
5. Electro-magnetic vibration test set up. (Min. Load - 200 Kgs; Freq. 10 to 30 Hz; displacement - 5mm; Accn. - 5 to 30 m/sec.).
6. Container testing facilities as per IS-1146. (i.e. High voltage tester, Plastic yield test apparatus, electro - magnetic ball drop test apparatus, Izod impact tester, tensile testing machine, digital and chemical testing arrangement etc.).
7. Digital ammeter, voltmeter and thermometers of different ranges.
8. Measurement facility for pore size of separators.
9. Battery/cell internal resistance meter.
10. Atomic absorption spectrometer with cathode lamps and accessories for analysis of various metals.
11. Sulphuric acid and distilled water testing facilities as per IS Specification.
12. Multimeter digital (Min. DCV-1000V, ACV-750V, DC-10A, R - 2 M Ohm).

ADDITIONAL FACILITIES OF TESTING

1. Thermostatically controlled tank for life cycle units.
2. Separator testing apparatus as per IS:6071
3. Bitumen sealing compound testing apparatus as per IS:3116.
4. Distilled water testing arrangement as per IS:1069.
5. Micro-porous vent plug testing arrangement.
6. (i.e. Electro-magnetic ball drop apparatus, weighting digital top pan balance capacity 100 gms (0.05 gms, fire retardant test apparatus, permeability test apparatus etc.).
7. Heating apparatus (Hot air oven: temp. 300 deg. centigrade max.).
8. Electronic balance (capacity 200 kgs with decimal second digit).
9. Shore hardness tester.
10. Manometer.
11. Air pressure testing arrangement.
12. Polarity testing arrangement.
13. Short circuit testing arrangement.

Pre-Qualification requirements)

for “Indented Item “

S. No	Description of requirement	Document to be attached
1	Bidder should submit a self-declaration stating that, “Offered item is same as per enquiry and there is no deviation”.	Self-declaration on letterhead of firm.
2	Data Sheet / Drawings / Catalogues of the product (s) offered in the bid, are to be uploaded along with the bid documents. Buyers can match and verify the Data Sheet with the product specifications offered. In case of any unexplained mismatch of technical parameters, the bid is liable for rejection	Data Sheet / Drawings / Catalogues of the product (s)
3	In case Bidder is not be OEM but its Reseller then bidder to submit valid authorisation certificate from OEM with the bid.	Authorisation certificate
4	Registration / Empanelment Requirement: Contract shall be awarded to only such bidder or their OEM (in case of reseller), who are approved/ provisionally approved by ICF/RDSO/Indian Railways for the Indented item for DETC (Diesel Electric Tower Car) application on the date of bid opening to qualify for this tender.	Supporting document of approval.

Terms Other than PQR to be compiled during Bidding:

Terms	Complied/Not Complied
Quoted SL NO.	
Delivery accepted as per Tender	
Mobile no of concerned Person	
Email ID	

Note: Bidders providing above documents and not meeting above criteria essential for Offer Consideration.

NO DEVIATION CERTIFICATE

Reference: Bid No. _____ Dated: _____

Subject: Self-Declaration for No Deviation

This is to certify that the items/services offered by us against the above-referred enquiry are **fully compliant** with the specifications, terms, and conditions mentioned in the bid document.

We hereby confirm that **there are no deviations** from the stipulated specifications, commercial terms, conditions, and other requirements of the enquiry.

For _____
(Authorized Signatory)

Date: _____

Seal:

OEM SELF-DECLARATION (FOR OEM)

Date: _____

Subject: **OEM Self-Declaration**

Ref: Bid No. _____

We certify that:

1. The bidder **M/s** _____ is the OEM** itself.
2. The product(s) offered are **new, genuine, and comply** with all specifications mentioned in the tender.
3. We shall provide full **warranty support, technical assistance, and spare parts** availability as required.

For **(Name of OEM)**

Authorized Signatory

Name: _____

Designation: _____

Seal:

OEM address:

**** OEM refers to (Original Equipment Manufacturer)**

B. OEM AUTHORIZATION CERTIFICATE (FOR BIDDER AS DEALER)

Date: _____

Subject: **OEM Authorization Certificate**

Ref: Bid No. _____

We, **(Name of Original Equipment Manufacturer – OEM)**, hereby authorize:

M/s _____
(Address: _____)

We confirm that:

1. Bidder is **authorized partner / dealer / distributor / bidder** for participating in the above-mentioned tender
2. The bidder is authorized to **quote, supply, install (if any), and support** our products.
3. The products offered will be **genuine, brand-new, and manufactured by us (OEM)**.
4. We will provide full **warranty support, technical support, and spare parts (wherever applicable)** for the supplied equipment throughout the warranty/AMC period.

For **(Name of OEM)**

Authorized Signatory

Name: _____

Designation: _____

Seal:

**** OEM refers to (Original Equipment Manufacturer)**