SPECIFICATION
FOR
MAIN TRANSFORMER WITH STEEL TANK FOR 3-Phase, 6000HP WAG-9 Class Electric Locomotives for 25 KV AC 50Hz system

TENDER SPECIFICATION

ALT	A					
SHEETS						

ENCLOSURES:

1. Drawing nos.- CLW/ES/3/SK-1 to SK-6/0456 except SK-3
2. Spec. No. CLW/ES/3/0069 Alt-D.
3. Drawing no-1209-18.406-089 Alt-5.
4. HSTN 612192, 612193.

I**SSUED BY:**
DY. CHIEF ELECTRICAL ENGINEER/D-I
CHITTARANJAN LOCOMOTIVE WORKS
P.O. CHITTARANJAN, 713331
DIST. BURDWAN, WEST BENGAL, (INDIA)

Prepared By	Checked By	Issued By
SSE-Design	SEE -Design	Dy.CEE/D-I

INDEX

ALTERATION RECORD SHEET

Amendt. Number	Date of Amendment	Page number	Alteration	Descriptions	Authority
1			A	i) New clause no.1, General description has been added. ii) In Clause no. 3, Climatic and environmental condition has been modified. iii) Clause no 4.1 has been modified. iv) In clause no. 5.1, remarks that manufacturers may declare weight of oil, if any variation then same shall be indicated. v) In clause no. 5.2, weight of the transformer has been modified. Cover Transformer Tank has been modified. Color has been modified. vi) In clause no. 5.3.2, remarks added that resistance data of the transformer windings shall be declared by manufacturers. Capacitive screening has been added. vii) In clause no 5.4, remarks added this is for guidance only. viii) In clause no. 6.1, latest version of IECs are incorporated wherever applicable. ix) Clause no. 6.2 has been modified. x) In clause no. 8, test program has been elaborated. xi) In clause no. 10, scope of supply has been modified. xii) Clause no. 12 has been modified as label and marking and subclause 12.2, note has been added.	

Note: Specification has been thoroughly revised and digitized as per latest format. Drawing sheet no. CLW/ES/3/SK-1/0456, SK-2, SK-4,SK-5 ,SK-6 and specification no. CLW/ES/3/0069 Alt D, Drawing no-1209-18.406-089 Alt-5. And HSTN 612192,612193 enclosed.

Prepared By	Checked By	Issued By
SSE-Design	SEE -Design	Dy.CEE/D-I

1. GENERAL DESCRIPTION

SPECIFICATION FOR MAIN TRANSFORMER WITH STEEL TANK FOR 3-Phase ,6000HP WAG-9 class Electric Locomotives for 25 KV AC 50Hz system

2. SCOPE:

This specification applies to MAIN TRANSFORMER for 3-phase, 6000 HP WAG-9 class locomotive for 25 KV AC 50Hz system.

3. CLIMATIC AND ENVIRONMENTAL CONDITION

SL. No	Description	Remarks
3.1	Maximum atmospheric temperatures	• Under sun : 70°C • In shade : 50ºC • Minimum Temperature -10°C (also snowfall in certain areas during winter season).
3.2	Humidity	100% saturation during rainy season
3.3	Reference site conditions	• Ambient Temperature max 55°C • Min -10°C • Humidity: 100%. • Altitude: 1776m above mean sea level against USBRL project condition
3.4	Rainfall	Very heavy in certain areas. The locomotive shall be designed to permit it's running at 10 Km per hour in flood water level of 200 millimeter above Rail level.
3.5	Atmosphere during hot weather	Extremely dusty and desert terrain in certain areas.
3.6	Coastal areas	Locomotive and equipment shall be designed to work in coastal areas in humid and salt laden atmosphere.
3.7	Vibration	The equipment and subsystem and their mounting arrangement will be designed to withstand vibrations and shocks encountered in service as per IEC 61373 or latest unless otherwise prescribed.

4. DESCRIPTION

4.1 SUBJECT

SHORT DESCRIPTION

Transformer for supply of the bogie related traction converters and the auxiliary converters from the catenary (25kV/50Hz). In order to connect a passive filter, the transformer includes an additional filter winding.

NUMBER OF ITEMS (within transformer)

Each loco requires one transformer, which consists of following components:

- 4 Traction winding
- 1 Primary winding
- 1 BUR winding
- 1 Filter winding
- Series resonance choke unit (2 chokes)
- BUR choke unit (3 double chokes)
- Transformer oil

4.2 FUNCTION/PRINCIPLE

The transformer tank contains main transformer, the series resonant & auxiliary converter chokes. External cooling of oil is designed with two independent oil circuits. Note, that there is no separation wall in the tank. The cooling units are located within the machine room.

5. TECHNICAL DATA

5.1 GENERAL DESIGN

The transformer shall generally confirm to specification No: CLW/ES/3/0456 (latest version) for main transformer for WAG-9 (Co-Co) electric locomotives unless otherwise specified.

ASSEMBLY

The transformer tank should be suspended horizontally at the middle of the under frame (under floor transformer). The HV – supply connected through a high voltage cable with CHT plug.

COOLING

Type	Forced oil cooling with two circuits
Oil flow rate (nom)	2 X1000Lt./min
Pressure drop, transformer tank (max)	1000 mbar at 1000 Lt./min
Pump type	Plumettaz TA08-2174/15 or equivalent
Oil temperature, tank drainage(max)	80°C at Pverl max = 240 kW
Oil temperature, tank drainage (max)	84°C
Oil temperature rise (max)	4°K at 1000Lt./min

Maximum temperature of the winding and oil according to standard IEC 60310 minus 20°C.

COOLANT

Type	Mineral Oil
Make	Oil confirming to IEC 60296 class -II
Oil weight	1850kg or to be declared by manufacturer

FIXED ELECTRICAL CONNECTIONS

- Preferably pressed –on
- Not soldered (brazed)

SHOCK AND VIBRATIONAL STRESS

Transformer shall confirm to class-A, Category-1 Body Mounted of the latest version of IEC 61373.

INFLAMMABILITY AND TOXICITY OF THE MATERIALS

-NO PCB
-Non Toxic
Avoid any flammable prone materials.

5.2 TRANSFORMER UNIT

Assembly : Dimension according to HSTN003359P0001(CLW/ES/3/SK-1/0456/K), Interface Dimensions (Electrical + Mechanical) shall be matched according to HSTN003359P0001. The new transformer should be 100% interchangeable with the existing transformer without any changes at car body level.

Estimated total weight including Oil : **9500kg ± 3%**

Transformer Tank

Material Transformer Tank	Steel (Grade S355) as per EN 10025 or equivalent Indian standard
Cover Transformer Tank	Welded cover and bushing plate
Shock resistance	According to latest version of IEC 61373
Color	RAL 7030
Finish	Silky

Electrical Connections: Connection for winding and chokes according to outline drawing HSTN003359P0001.

Additional Apparatus of the Transformer

- Overflow valve (in case of over pressure the tank must not be damaged and overflowing oil shall be drained off the transformer cover)
- Oil drain tap, oil level screw
- Slide for oil drainage and intake
- Transformer tank fastening
- 2 Expansion tanks, RAL 7030
- Earthing

Additional Apparatus of the Expansion Tank

- Air dehumidifier including valve
- Oil level gauge
- Connection to the transformer including rapid action coupling
- Oil filler tap
- Oil drainage screw

5.3 MAIN TRANSFORMER

Type	LOT 6500
Required number	1
Outline drawing	HSTN003359 P0001

Application:

Supply from	Number of windings
2 traction converters	4
3 Auxiliary converters	1
1 filter winding	1

The traction converters (02 per loco) use IGBT technology with a two point circuit and a link circuit. In order to reduce harmonic, traction converters are phase shifted (frequency 250 Hz, K=5). On the other hand auxiliary converters are controlled according to requirements and they are independent of each other.

Outline drawing HSTN003359P001 (Necessary part drawing shall be provided to successful tenderer).

5.3.1 Catenary

Catenary Supply	
Frequency f_{nom}	50 Hz ± 3%
Voltage	
Maximum	30 KV
Minimum	17.5 KV

5.3.2 Power Data

Ratios:

U = U_{Inom} : U_x Tolerance +0.5% (accordance to IEC 60310)

Secondary no load voltage U1 = 25 kV

Winding	Des.	Voltage	Ratio
Traction 4X	U_T	1269V	19.7
Auxiliary winding	U_B	1000V	25
Filter winding	U_F	1154V	21.7

Thermal Design:

Calculated at U_{Imin} = 22.5 kV

Winding	Power (kVA)	Voltage (V)	Rated current (A_{eff})	Maximum current (A_{eff})
Primary	5878	22500	261	261
Traction per winding	1304	1142	1142	1142
Auxiliary winding	301	900	333	333
Filter winding	361	1039	347	347

Inrush current

Maximum inrush peak load: I_{peak} (25KV) = 1400 A (line impedance not taken into account)
Peak load 35 periods after turn on: I_{peak} (25 KV) = 400 A

Rated Power

At U_{nom} (25 KV) and I_{nom} (261A) : 6531 kVA

Power Loss

At U_{1def} (22.5kV): 195 KW + 15% (Max)

Magnetizing current:

At	
U_{Inom} (25 KV)	0.7 A
U_{Imin} (22.5 KV)	0.5 A
U_{Imax} (27.5 KV)	1.3 A
U_{Imax} (17.5 KV)	0.3 A
U_{Imax} (30 KV)	3.5 A

Winding data:
- Values, secondary side related
- Values, measured on the terminal
- Values, at an operational temperature Tcu= 75ºC

Winding	**Resistance value (in mΩ)**	**Resistance tol (%)**	**Inductance value (in mH)**	**Inductance tol (%)**
Primary winding				
Traction winding	37		2.1	+15%
Auxiliary winding HB	60		0.43	
Filter winding	19		0.29	

Note: Resistance to be declared by the manufacturers.

With the exception of the traction inductance, the above given values are for information only
All winding should be inductance decoupled as far as possible.

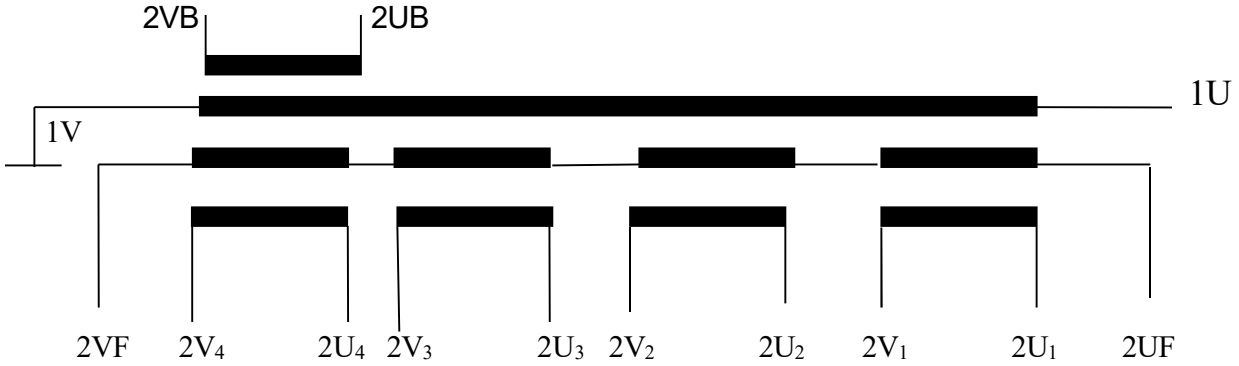
Measures against eventual over voltage transformer (e.g. system resonance)
- Appropriate arrangement of the winding.
- Capacitive screening if required can be provided based on transformer design topology with appropriate reasoning.

Preventive measures against blow-outs (e.g. contamination of the coil circuit with metallic particles).
- Insulated bus bar within the transformer.

Short circuit Resistance : According to IEC 60310 latest version.
Minimum insulation resistance between windings and earth at 20ºC shall be 150 MΩ. The insulation resistance shall be measured by a megohmmeter applying at least 1000V DC.

5.4 ARRANGEMENT OF THE WINDING, TERMINAL DESIGN

(i) Transformer



This is for guidance only

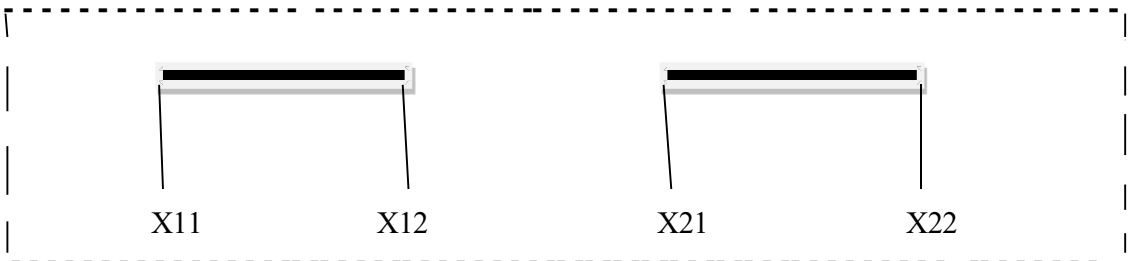
5.5 Series Resonant Inductor Unit:

Scheme position	15.3
Type	2 SOD 240
Required Number	2

(i) Electrical Data

Inductance	2x0.551 mH (± 15%) (until I_{peak} = 1391Amp)
Thermal Current	2x 984 A_{eff}
Resonance frequency	100Hz
Voltage Stress	
Between terminals Max	482 V AC (maximum)
Against Earth Max	3471 V
Power Loss	12.5 KW + 15%

(ii) TERMINAL ARRANGEMENT and DESIGNATION



5.6. AUXILIARY CONVERTER CHOKE UNIT: (3 Double Choke)

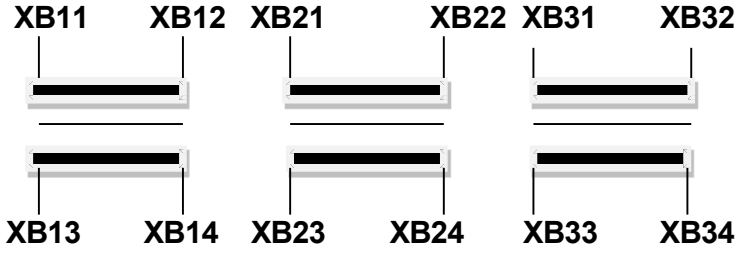
Scheme position	51.3
Type	6 GOD 120

5.6.1 Electrical Data

Inductance per BUR – Choke

0 A	30mH
120 A	30mH
155 A	26mH
190 A	20mH
Tolerance	- 0% + free
Frequency	100HZ
Current	
Rated	155 A
Maximum	190 A
Ripple	
Nom	38.6%
Max	50.2%
Voltage Stress	
Voltage Stress against Earth Rated	1153 V
Voltage Stress against Earth Max	2000 V
Dissipation Power at I_{nom}	12 KW + 15%

5.6.2 TERMINAL ARRANGEMENT and DESIGNATION



BUR-1 BUR-2 BUR-3

Each choke consists of a magnetic frame, which contains a part choke. Due to asymmetrical voltages all chokes shall be completely decoupled from each other.

6. STANDARDS/ QUALITY

6.1 Standards

IEC 60038	Standard voltage
IEC 60077	Electrical traction devices
IEC 60310	Rules for traction transformers and reactors
IEC 60296	Transformer Oil
IEC 61373	Shock and Vibration
ISO 9606	Qualification testing of welders
EN15085	welding of railway vehicles and components
EN12663	Railway Application, Structural requirement of railway vehicle bodies
IEC 61133	Railway application- Rolling stock testing of rolling stock on completion construction and before entry into service

6.2 Quality

QS-qualification (according to quality management manual 3EHQ600002 Rev. C)

Transformer complete : Q-class 3
Main transformer : Q-class 3
Series resonant choke : Q-class 3
BUR-Choke : Q-class 4
Transformer tank : Q-class 4

Execution : ISO: 9001 must be from NABCB approved body or TS16949 or ISO /TS 22163 or equivalent QS system must be used at least.

7. Reliability Requirement

7.1 Life Time:

Operational Time

Daily	Approx 16 Hrs. (at approx. 330 days per year)
Yearly	5280 Hrs
Within 40 years	211200 Hrs

7.2 Reliability:

Under operational condition given in clause 7.1 (Life Time) MTBF of $11x10^6$ hrs. is expected.

8. Test Programme: Type test procedure will be submitted in line with HSTN 612192.

8.1 Type Test: A type test according to IEC 60310 or latest version is required. The type test procedure according to HSTN 612192 has to be submitted to the project management for approval.

8.2 Routine Test: A Routine test according to IEC 60310 or latest version is required. The Routine test procedure according to HSTN 612193 has to be submitted to the project management for approval.

8.3 Special Test: The first serial (prototype) transformer must be tested fully. The measurement includes the short circuit impedance of all windings and cross coupling.

8.4 Time Schedule: Type and routine test take place in presence of inspecting officers of Indian Railways. In order to inform the client, a schedule must be submitted to the project management for approval at least 7 weeks before start of the test.

8.5 DGA of each new, repaired/rehabilitated transformer at transformer manufacturer's end shall be carried out for record/reference purpose.

8.6 Following tests to be carried out on transformer:

Sl. No	Test Description	Type Test	Routine Test
8.6.1	Dimensions & preliminary check	Y	Y
8.6.2	Measurement of insulation Resistance	Y	Y
8.6.3	Measurement of winding Resistance	Y	Y
8.6.4	Measure of voltage Ratio	Y	Y
8.6.5	Measurement of no-load current and no- load losses	Y	Y
8.6.6	Measurement of impedance voltage and load losses	Y	Y
8.6.7	Measurement of short circuit reactance	Y	Y
8.6.8	Induced voltage withstand test	Y	Y
8.6.9	Separate source voltage withstand test	Y	Y
8.6.10	Oil BDV measurement test	Y	Y
8.6.11	DGA analysis of Oil	Y	Y
8.6.12	Impulse test	Y	No
8.6.13	Temperature rise test	Y	No
8.6.14	Weight Measurement test	Y	No
8.6.15	Oil leakage test	Y	Y

8.7 TEST ON REACTORS: 2 SOD 240

Sl. No	Test Description	Type Test	Routine Test
8.7.1	Preliminary checks	Y	Y
8.7.2	Measurement of insulation resistance	Y	Y
8.7.3	Measurement of winding resistance.	Y	Y
8.7.4	Measurement of winding inductance and losses	Y	Y
8.7.5	Separate source voltage withstand test	Y	Y
8.7.6	Temperature rise test	Y	No

8.8 TEST ON REACTORS: 6 GOD 120

Sl. No	Test Description	Type Test	Routine Test
8.8.1	Preliminary checks	Y	Y
8.8.2	Measurement of Insulation resistance	Y	Y
8.8.3	Measurement of winding resistance.	Y	Y
8.8.4	Measurement of winding inductance and losses	Y	Y
8.8.5	Separate source voltage withstand test	Y	Y
8.8.6	Temperature rise test	Y	No

8.9 Prototype inspection will be carried out by the authorized representative of Indian Railways. All type test & Routine test will be carried out as per tendered specification.

9. DOCUMENTATION

- QAP
- Design Data sheet
- Technical data sheet
- GA drawing
- Bill of material
- Maintenance manual
- Installation and commissioning manual
- Standard/Units: Only IEC standards wll be accepted.Internally used BBC/ ABB/Adrantz Standards may only be mentioned together with corresponding IEC standard. Only SI units will be accepted.

9.1 All drawings and descriptions which are necessary for design, assembly and commissioning of the transformer. A part list/ composition list of each drawing has to be given. Within the individual lists- all parts of the corresponding drawing have to be mentioned, including consumable items.

9.2 Design Data: -

- Make and type
- Type of construction
- Particular of winding with their continuous rating
- Permissible duty cycle
- Percentage impedance voltage of each winding with other winding opened no - load magnetization current.
- Transformer losses and efficiency
- Permissible temperature rise.

- Details of insulation of winding
- Dielectric levels
- Overall dimensions and weight of the transformer without conservator and cooling equipment, details of devices associated with the transformer.
- Design calculations
- Reliability predictions for transformer
- Drawings
- List of materials used in construction of the transformer general arrangement of transformer, windings and core and connected auxiliaries.

9.3 Manual

The manual includes all necessary information for correct operation, maintenance, fault-finding and repair of the transformer, including spare part catalogue and instructions for assembly, dismantling and replacement of the individual components. An overview of function and work order has to be given. The chapters of the manual must belong to the individual sub-assembly components. All drawing and documents, which are used as reference documents, have to be given as annexure to the manual.

9.4 REFERENCE DOCUMENTS

Main power circuit : 3EHP281141
Auxiliary Scheme : 3EHP281142
Cooling system : 3EHP510077
Specification for Main Transformer for WAG-9 (Co-Co) electric locomotives: CLW/ES/3/0456 latest version.

10. SCOPE OF SUPPLY

Sr. No	Item Description	Qty/Loco
1	Transformer winding inside the Tank	1 No.
2	Series Resonant Choke (SOD)	2 Nos. Within the Transformer Tank
3	D.C. Link circuit choke aux. Converter (GOD)	6 Nos. Within the Transformer Tank
4	High voltage bushing mounted on transformer	1 Set
5	RTD - PT 100 mounted on transformer	1 No
6	Conservator Tank with Breather and Min./ Max. Oil level scale in conservator tanks.	2 Nos.
7	Hose with nipple as per drawing no CLW/ES/3/SK-2/0456/K	2 Nos.
8	Connecting hose complete with nipple as per drawing no CLW/ES/3/SK-2/0456/K	1 No
9	Quick -Coupling as per drawing no CLW/ES/3/SK-4/0456/K	6 Sets (one set consists of one male and one female)
10	Elbow Union as per drawing no CLW/ES/3/SK-5/ 0456/K.	2 Nos.

11	Transformer Oil : Confirming to IEC- 60296 Class II.	The transformer tank should be completely filled with Oil 350 liters. Oil should be separately provided for filling in conservator tank and Oil pipes and other accessories
12	Set of Transformer fixing bolts and plates as per Spec. No. CLW/ES/3/0069 Alt-D.	01 Set
13	Self-Gripping sealing Rubber Gasket as drawing no-1209-18.406-089 Alt-5.	09 mtrs. (4.5 mtrs. x 2)
14	Transformer Tank	1 No

Note: Supply should also confirm to drawing no. CLW/ES/3/SK-1/0456/K to CLW/ES/3/ SK-6/0456/K except CLW/ES/3/SK-3/0456/K, Spec. No. CLW/ES/3/0069 Alt-D and drawing no-1209-18.406-089 Alt-5.

11. Document to be supplied by the tenderer

The tenderer shall furnish the following documents with the bid:

(i) Clause wise comments on the specification and test program.
(ii) Detailed dimensional drawings.
(iii) Past experience with supporting papers (if any).
(iv) Quality assurance program.
(v) Machinery and plant for such job.
(vi) Testing facilities available.

12. Label and Marking :-

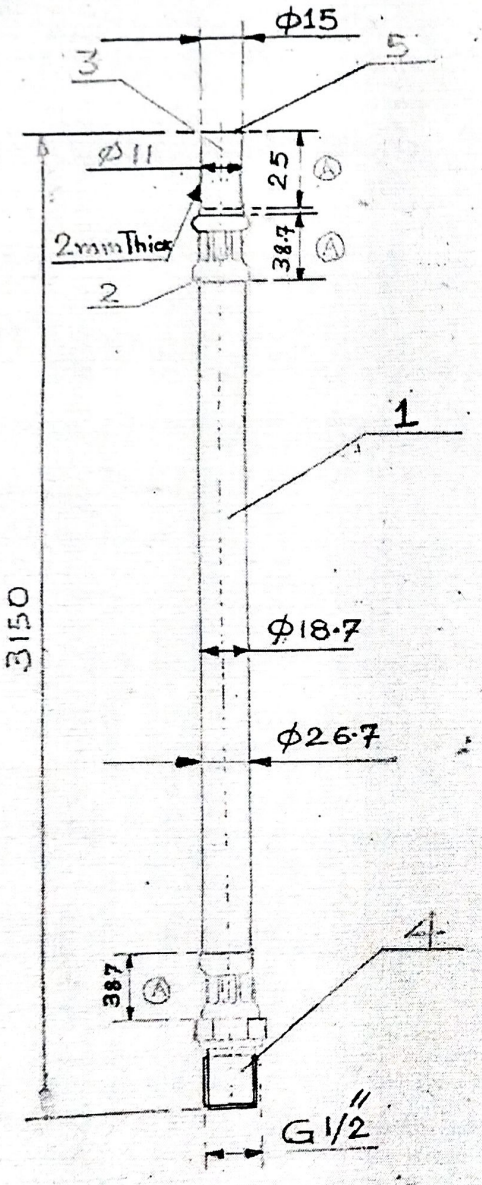
12.1 The firm should emboss following data in their products.

(i) Make
(ii) Year and month of manufacturing
(iii) * Sl. No.
(iv) Trade mark, if any
(v) Specification No**.**
(vi) Order No.

12.2 * SL. No as per format “XXXX-65-MM-YY-ZZZ” where XXXX-Firm’s Name in three or Four letters, 65-capacity of TFP for LOT6500kVA transformer, MM-02 digit for Month of Dispatch, YY- last 02 digit of Year of Manufacturing and ZZZ- Serial Number of Transformer.

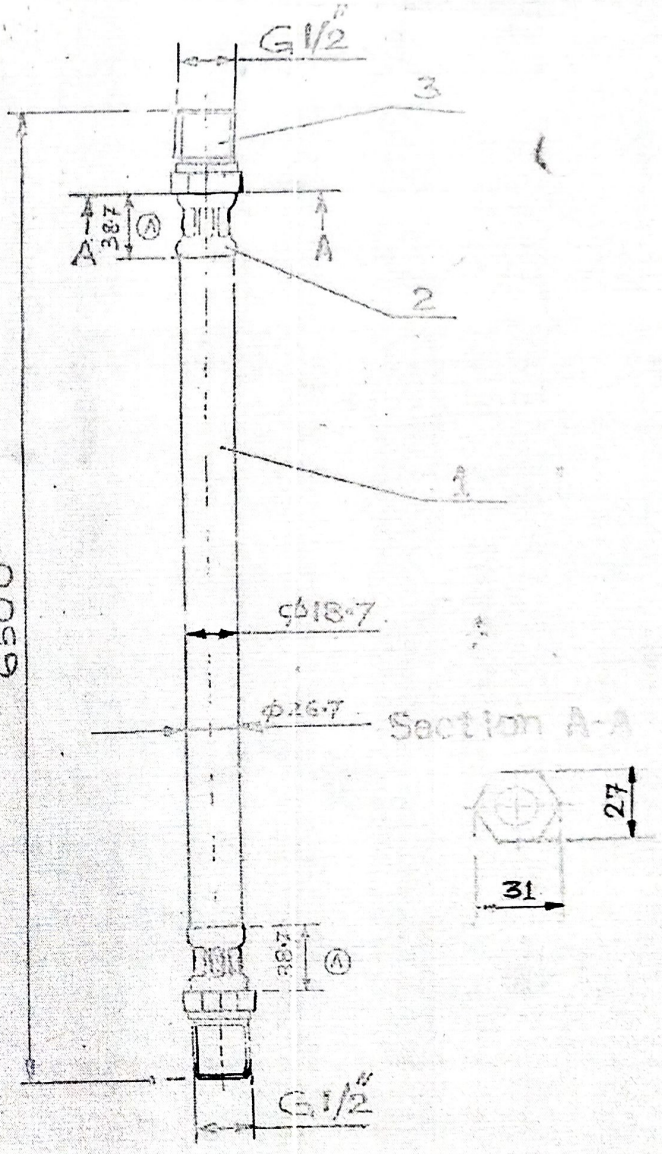
Note: Standard Hardware and fasteners of CLW/BLW/RDSO approved source only to be used.

SL NO. 1 HOSE



1. HOSE, NEOPRENE
2. CRIMP SLEEVE (ASTM269 Gr.321)
3. CRIMP NIPPLE (ASTM269 Gr.321)
4. CRIMP NIPPLE (ASTM269 Gr.321)
5. PIPE END OD :- 15 mm.
6. OPERATING PRESSURE :- 30 kg/cm.
7. USED FOR CARRYING OILS
8. ALL DIMENSIONS ARE IN MM.

SL.NO.2 CONNECTING HOSE COMPLETE



1. HOSE, NEOPRENE
2. CRIMP SLEEVE (ASTM269 Gr.321)
3. CRIMP NIPPLE (ASTM269 Gr.321)
4. OPERATING PRESSURE :- 30 kg/cm.
5. USED FOR CARRYING OILS
6. ALL DIMENSIONS ARE IN MM

DRN CHKD/REVIEWED SEE/DSED

DRN JE-I

WAG-9 (CC9) | APPROVED BY

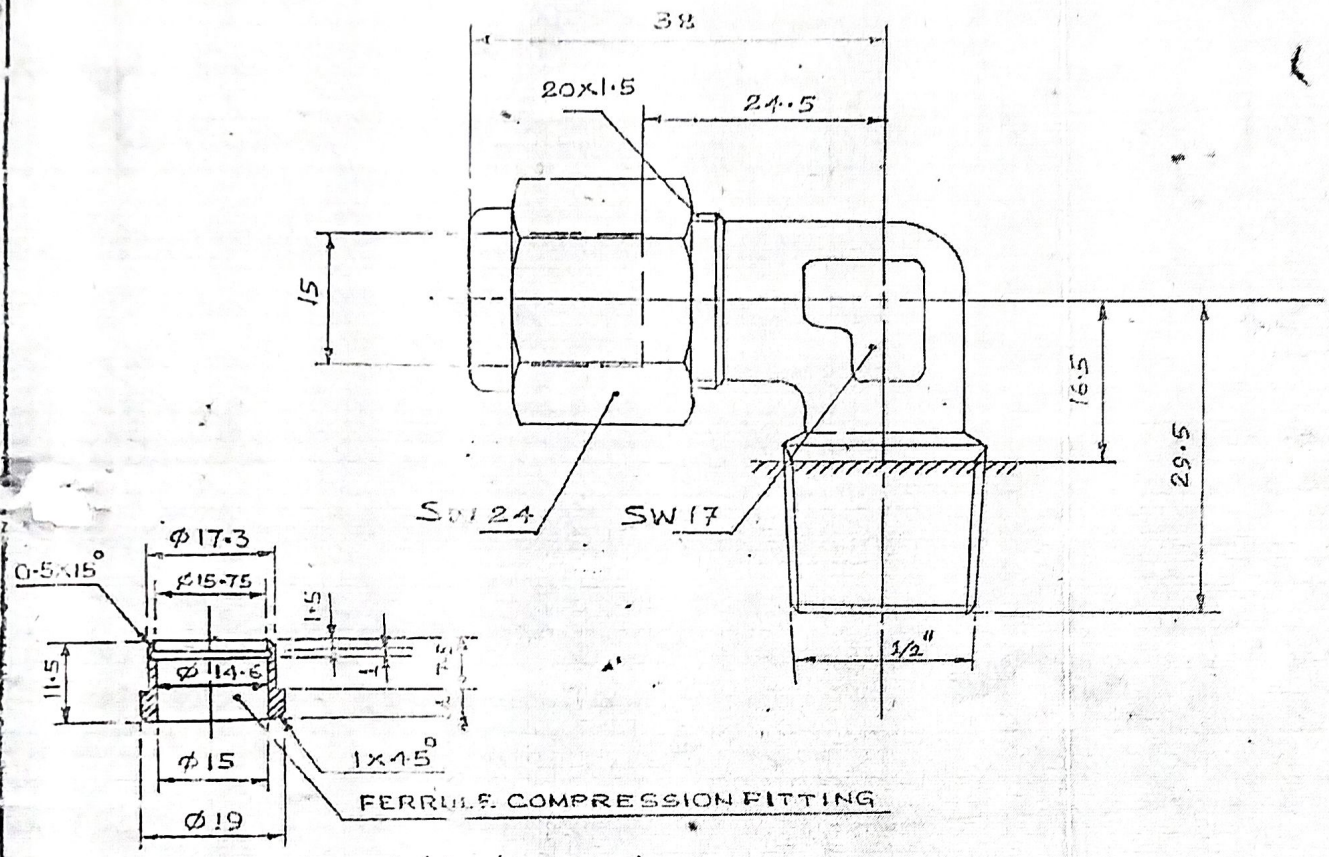
SET OF HOSES FOR MAIN TRANSFORMER

DY.CEE/CON/TL 3/2/2001

CHITTARANJAN LOCOMOTIVE WORKS.

DRG NO.:- CLW/ES/3/SK-2/0456

NOT | A | B | C | D | E | F | G | H | I | J



Note:- i) All dimensions are in mm (Except Otherwise Stated)

ii) Material :- SST, Grade 321

iii) Qty/Loco :- 2 Nos

iv) ABB Identification No. HBTB 416410P0016.

परिवर्तन संख्या ALT. NO.	प्राधिकार AUTHY	वर्णन DESCRIPTION	दिनांकित आद्यक्षर DATED INITIAL

सतह-रुक्षता मान भा.मा. 3073 के अनुसार SURFACE ROUGHNESS VALUE TO IS : 3073												
ग्रेड संख्या GRADE NUMBER	N1	N2	N3	N4	N5	N6	N7	N8	N9	N10	N11	N12
Ra µm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
चिह्न SYMBOL	▽▽▽▽		▽▽▽			▽▽			▽			~

संदर्भ संख्या REF. NO.	ड्राइंग एवं नियंत्रण संख्या C & D NO.	वर्णन DESCRIPTION	संख्या रेल इंजन NO/LOCO	पदार्थ MATL	विनिर्देश SPECN

ELBOW UNION

SET OF UNION FOR MAIN TRANSFORMER

आरेखित DRAWN: SSDM/Elect

जांचा CHECKED: JE-I

SEE/D&D

उप मु.वि.अ (नि.) DY. CEE/CON/TU-I

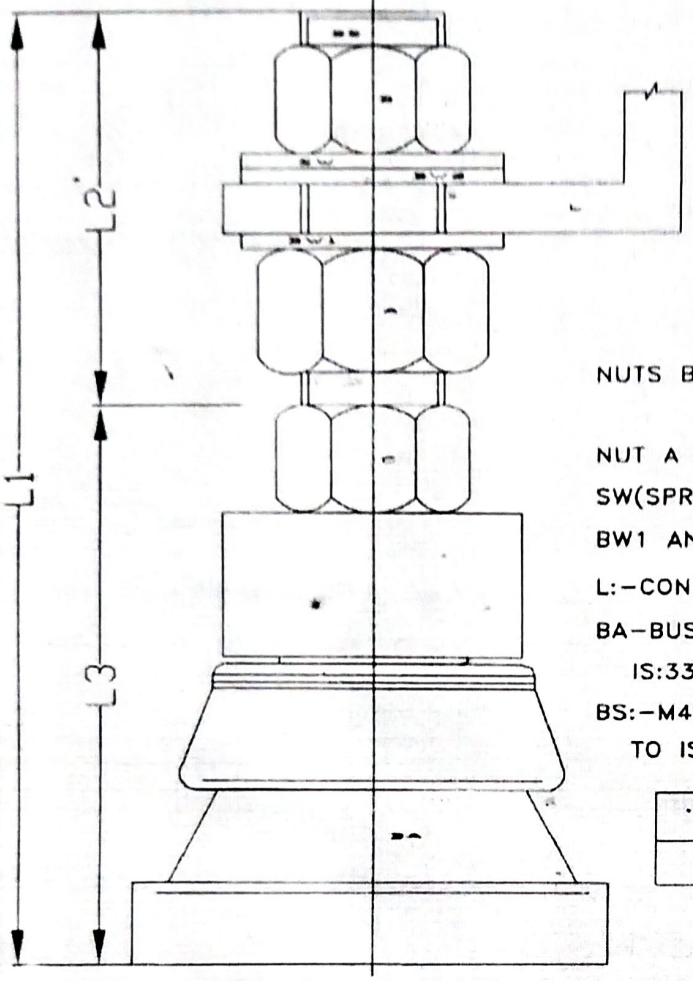
दिनांक DATE: 31-01-2001

पैमाना अनुपात SCALE :-

चित्तरंजन रेल इंजन कारखाना
CHITTARANJAN LOCOMOTIVE WORKS

प्रयोग में
USED FOR LOCOS - WAG-9

आरेखण संख्या
DRAWING NO.
CLW/ES/3/SK-5/015



LEGEND

NUTS B&C 25.6MM Max.
24.3 MM Min.
NUT A M 42X3 HEIGHT 34 MM Max. AND 32.4 MM
SW(SPRING WASHER THICKNESS 7MM)
BW1 AND BW2 BRASS WASHER THICK 7MM MACHINED
L:-CONNECTION--COPPER 8.0MM THICK
BA-BUSHING ASSEMBLY (3.6KV/2000A)
IS:3347(PT.II/SECTION-2)-1979
BS:-M42X3 BUSHING STUD-COPPER
TO IS:3347(PT.II/SECTION-2)-1979

L1	L2	L3
257±5	103±6.5	154±4

NOTE:- REVISED DRAWING OF CONNECTION AT TRACTION BUSHING/SOD BUSHING FOR LOT 6500/7500kVA Ref RDSO DRG SKEL-4630 & RDSO LETTER NO. EL/3.2.1/3-PHASE DATE 22/11/2002

DRN.	CHKD.	SSE/D	AEE/
P.P.DAS			

GENERAL ARRANGEMENT OF CONNECTION AT TRACTION BUSHING OF LOT 6500/7500 KVA

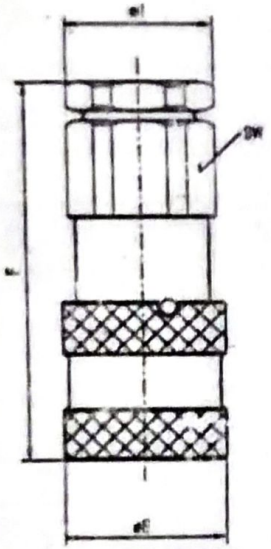
DY.CEE.(D-I)

CHITTARANJAN LOCOMOTIVE WORKS
WEST BENGAL, INDIA
NO. CLW/ES/3/SK-6/456/315
DATE:- 20-01-2011

POS. '3'

Muffe Steckkupplung
mit Dichtung PTFE

Manchon
avec joint PTFE

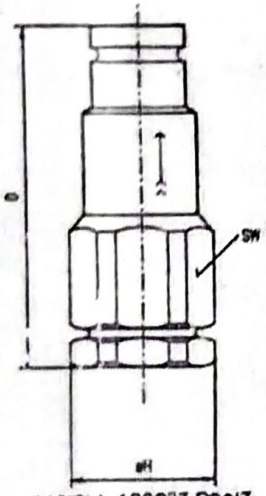


HSTN 422023 P0003

POS. '13'

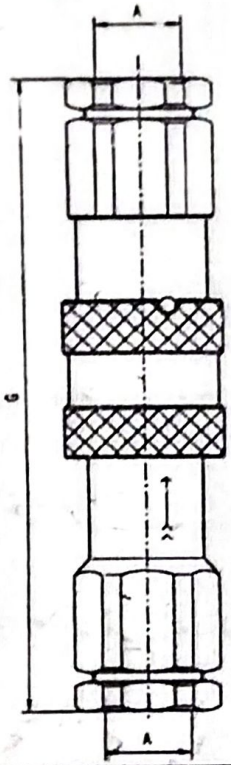
Stecker Steckkupplung
mit Dichtung PTFE

Embout
avec joint PTFE



HSTN 422023 P0013

Gekuppelt
Assemblage



Pos	Type	Fillet A	d nominal	G	F	SW	E	I	N°
3	OF 1/2	Rp 1/2"	8	116	89.5	27	32	29	03.7085.0031

Pos	Type	Fillet A	d nominal	G	D	SW		H	N°
13	OM 1/2	Rp 1/2"	9	116	62.5	27		89	03.7085.0030

–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–
		DESCRIPTION					

DGN. 23m/11/07
SUPDT.
REVIEWED SEE/DLD 31-01-2007

ABB IDENTIFICATION NO:- P0003 & HSTN 422023 P0013

4/2007

QUICK-COUPLING
FOR
MAIN TRANSFORMER.

WAG-9

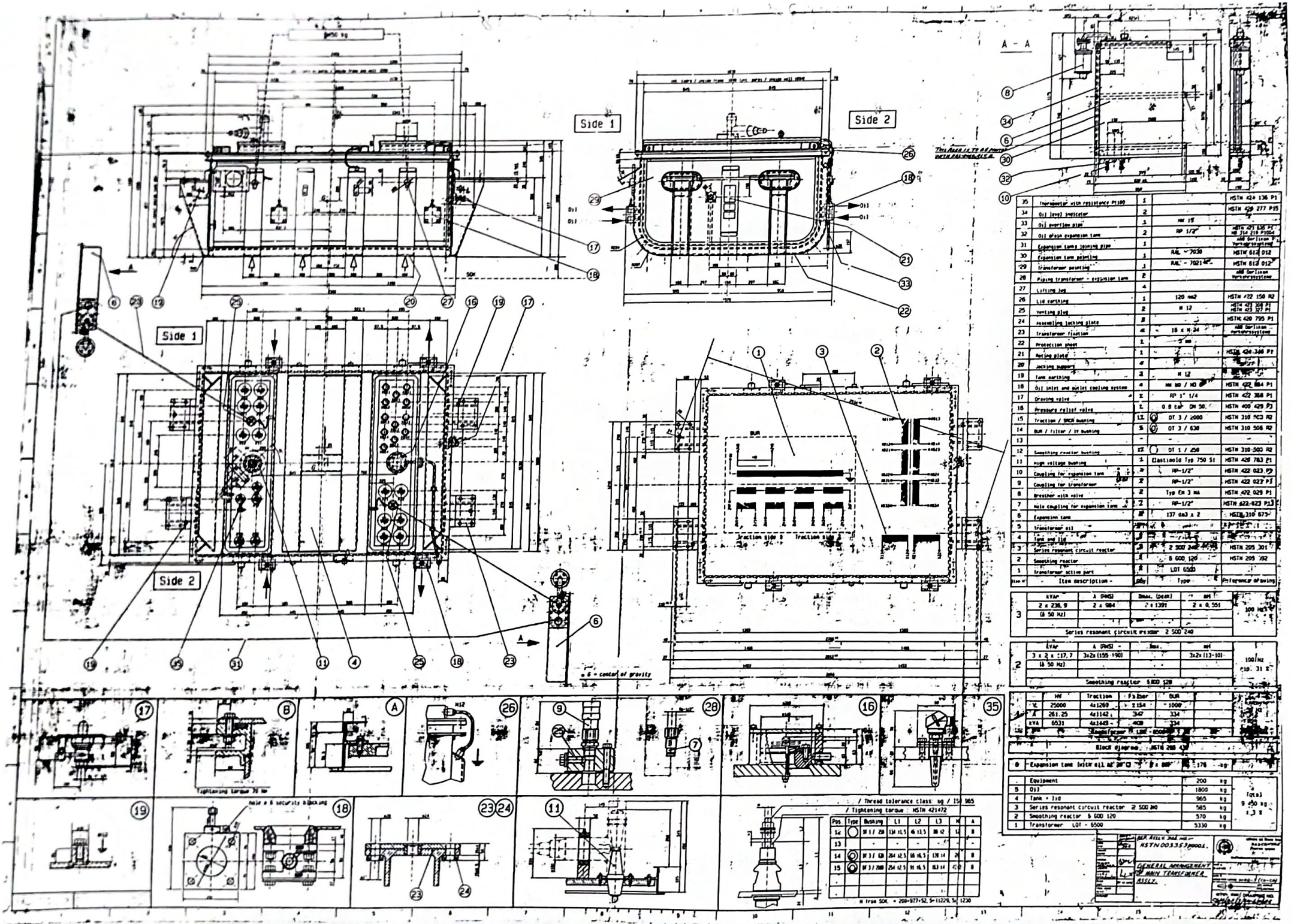
CLW/ES/3/SK-4/0456

ALT:- A, B, C

		DESCRIPTION	

वेल्ड-चिन्ह भिन्न भा. मा. 813 के अनुरूप / WELDING SYMBOLS TO IS : 813

			d1	d2	d3	d4	d5	d6	d7	d8	d9	d10	d11	d12
			0.01	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50


Side 1
Side 2
Side 1
Side 2
A - A
Traction side 1
Traction side 2
Thread tolerance class 6g / ISO 965
Tightening torque : HSTN 421472
Hole ø 6 security blocking
Tightening torque 70 Nm
ø G = center of gravity

(3)

TENDER SPECIFICATION

NO. CLW / ES/3/0069

ALT	0	A	B	C	D				

ENCLOSURES :

DRG. NOS. : 1) CLW/ES/3/SK-1/0069
2) CLW/ES/3/SK-2/0069

TOTAL NO. OF SHEETS : 7

ALT	0	A	B	C	D		
SHEETS	6	7	5	7	7		

SPECIFICATION
FOR
Set of Transformer fixing Bolts and plates.
FOR WAG-9(CoCO)ELECTRIC LOCOMOTIVE

ISSUED BY :
DY.CHIEF ELECTRICAL ENQUINEER/CON/TJ
CHITTARANJAN LOCOMOTIVE WORKS
P.O. CHITTARANJAN - 713331
DIST: BURDWAN.WEST BENGAL (INDIA)

PREPD. BY	CHKD BY	REVIEWED BY	APPROVED BY	WAG—9 (CO-CO)	CENTRE for D & D CHITTARANJAN LOCOMOTIVE WORKS CHITTARANJAN-713331
23/6/99 JDM/Elect.	23/6/99 SSE (Elect.)	23/6/99 SEE/CON/TU-II.	23/6/99 DY. CEE/CON/TU-I	Specification for Set of Transformer fixing Bolts and plates.	NO. CLW/ES/3/0069, Alt. A B C D DATE 23/6/99.

SPECIFICATION FOR SET OF TRANSFORMER FIXING BOLTS & PLATES FOR 3-PHASE,6000HP; WAG-9 AC ELECTRIC LOCOMOTIVE.

1. Scope.

1.1 This specification applies to Transformer fixing Bolts & Plates for 3-Phase.6000 HP WAG-9 class locomotive for 25 KV AC 50HZ system.

2. Climate and Environment conditions :-

* Maximum Atmospheric temperature : Under Sun : 70°C

* Humidity : 100% saturation during rainy season.

Ambient temperature ranges : 0°C — 55°C(motor in air flow)
Humidity normal : 60%
maximum 100% (during rainy season)
Altitude normal 160 m a. s. l
Cooling Power dissipation in air flow

Locomotive and equipment will be designed to work in costal areas (humid and salt laden atmosphere possible) and in desert areas (extremely dusty and dried atmosphere).

3. Technical requirement

All the items shall be manufactured, tested & supplied as per standard property and material indicated at CL.No.6.

4. Quality assurance

ISO 7040, style -1 for Nut & Bolts.Other material details in the drg. sheet.

5. Guarantee :-

Fastener/hardware shall be guaranteed for 6 years from date of supply and 5 years from which ever is earlier. Any fastener/Hardware failing during the above period shall be replaced free of cost.

PREPD. BY	CHKD BY	REVIEWED BY	APPROVED BY	Specification for Set of Transformer fixing Bolts and plates for WAG-9 (CoCo) ELECTRIC LOCOMOTIVE.	CENTRE for D & D CHITTARANJAN LOCOMOTIVE WORKS CHITTARANJAN-713331 Date:- 23.6.99 NO. CLW/ES/3/0069.
23/4/99 JDM/Elect.	23/6/99 SSE(Elect.)	23/6/99 SEE/CON/TU-II.	23/6/99 DY. CEE/CON/TU-I		ALT NO. 0 A B C D

SL. NO.	DATE	DESCRIPTION	ALT	APPROVED BY
1.	23-6-'99	Special Note is added in the sheet no. 4 for make of bolts & nuts.	A	23/6/99
2.	26-11-99	The clause surface:- zinc Platted (Passivated) deleted and property Class of Nut & Bolt should be 8.8 minimum Special note extended for the Hex nut (Nylone Insert.	B	27/11/99
3.	05-02-2002	(I) The Make of Hex. Bolt M24 & Hex. Nut has been changed on sheet NO. 4 and the name of new makes are given on Same sheet. (II) Welding of M 24 HEX. BOLT With BASE PLATE will not be done, Therefore welding details has been deleted from sheet NO: 6	C	4/2/2002
4	5-4-2003.	Supplier should produce following documents while supplying the materials (I) certificate about standards grade, property class, material etc. (II) OEM test certificate regarding Chemical Composition and Metallurgical / Mechanical properties. (III) Guarranty certificate of OEM (IV) Supplier other than OEM should deliver the material alongwith supporting documents of material being purchased from OEM.	D	10/4/03

SPECIFICATION FOR
Set of Transformer Fixing Bolts & plates.

DRN 23/6/99 SSE/Elect.

CHKD/REV 23/6/99 SEE/CON/TU-II

APPROVED BY 23/6/99 DY. CEE/CON/TU-I

CENTRE FOR D & D
CHITTARANJAN LOCOMOTIVE WORKS, WEST BENGAL, INDIA

DATE: 23.6.99
NO: CLW/ES/3/0069.

ALT | A | B | C | D | | |

6. Drawings.

1.a) Assambly drawing of Fixing plate - CLW/ES/3/SK-2/0069 – FIG.-E.

b) Dimentional drawing of Hex Bolt - CLW/ES/3/SK-1/0069 – FIG.-B.

c) Dimensional drawing of Base plate - CLW/ES/3/SK-1/0069 – FIG.-C.

2. Dimensional drawing of locking Tab - CLW/ES/3/SK-2/0069 – FIG.-D.

3. Dimensional drawing of Jacking plate - CLW/ES/3/SK-2/0069 – FIG.-F.

4. Dimensional drawing of Hex Nut - CLW/ES/3/SK-1/0069 – FIG.-A.

PREPD. BY	CHKD BY	REVIEWED BY	APPROVED BY	Specification for Set of Transformer fixing Bolts and plates for WAG-9 (CC&I) ELECTRIC LOCOMOTIVE.	CENTRE for D & D CHITTARANJAN LOCOMOTIVE WORKS CHITTARANJAN-713331 Date :- 23.6.99 NO. CLW/ES/3/0069.
23/6/99 ADM/Elect.	23/6/99 SSE (Elect)	23/6/99 SEE/CON/TU/II	23/6/99 DY. CEE/CON/TU-I		ALT NO. 0 A B C D

SCOPE OF SUPPLY

Sl No.	Designation	Identification No.	QTY/Loco	Materials	Remarks
1.	Fixing Plate Assly. Consisting of 1(a)&1(b).	IBU2501045			CLW/ES/3/SK-2(E)/0069
1a.	Hex Bolt M24(Class 8.8)	182-00018-019	16Nos.	Steel Zinc plated (Passivated) Ⓑ	CLW/ES/3/SK-1(B)/0069
1.b	Base plate	IA022-00242	8Nos.	Steel Plate	CLW/ES/3/SK-1(C)/0069
2.	Locking Tab	IA026-00542	8Nos.	HUI steel Sheet	CLW/ES/3/SK-2(D)/0069
3.	Jacking Plate	IA022-00242	8Nos.	Steel Plate	CLW/ES/3/SK-2(F)/0069
4.	Hex Nut (Class 8.8)	182-00047-009	16Nos.	Steel Zinc Plated (Passivated) Ⓑ	CLW/ES/3/SK-1(A)/0069

ALT Ⓒ

~~SPECIAL NOTE:- The make of Hex. Bolt M24 & Hex. Nut Should be of make TVS/GKW/Lakshmi precision, Hex Nut with nylone Insert from any reputed Co~~

The tenderer shall confirm that the materials are as either used in 3-Phase A.C. Locomotive manufactured by ABB for Indian Railways or similar.

NOTE.(I) The make of Hex. Bolt M24 & Hex. Nut should be of make M/S TVS, M/S LPS & M/S UNBREAKO.

(II) The firm should emboss make, Trade mark etc in their products.

(III) Supplier should produce following documents while supplying the materials.

(a) Certificate about standards, grade, property class, material etc.

(b) OEM test certificates regarding chemical composition and Metallurgical/Mechanical properties.

(C) Guarranty certificate of OEMs.

(d) Supplier other than OEM Should deliver the material along with supporting documents of material being purchased from OEM.

ALT "D"

PREPD. BY	CHKD BY	REVIEWED BY	APPROVED BY	SPECIFICATION FOR SET OF TRANSFORMER FIXING BOLTS & PLATES.	CENTRE for D & D CHITTARANJAN LOCOMOTIVE WORKS CHITTARANJAN-713331
~~23/6/99~~ JDM(Elect.)	23/6/99 SSE(Elect.)	23/6/99 SEE/CON/TU-II	23/6/99 DY. CEE/CON/TU-I		Date:- 23/6/99 NO. CLW/ES/3/0069. ALT NO. 0 A B C D

SHEET NO:-5

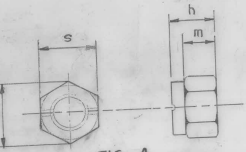


FIG.-A.

IDENT. NO.	NOM. DIA.(d)	PITCH OF THR'D	s	e	h	m	MASS Kg/1000
122-0004 47-003	M24	3·0	36·0	46·6	28·0	20·2	127

NOTE :- MATERIAL :- STEEL

~~(B) SURFACE :- ZINC PLATED (PASSIVATED)~~

PROPERTY CLASS :- 8.8

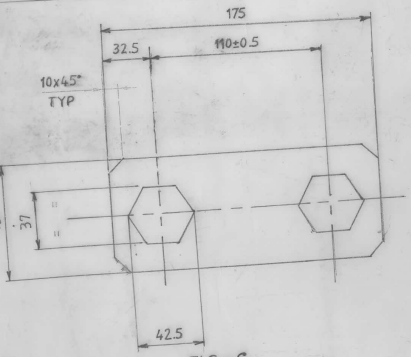


FIG.-C.

NOTE :-

MATERIAL :- STEEL PLATE

IS : 2062 GR. C.

IDENT. NO.:- IA022-00242.

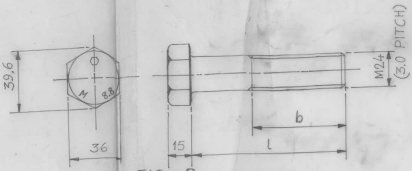


FIG.- B.

IDENT. NO.	l	b
122-00018-019.	220	73

NOTE :- HEXAGON HEAD BOLT

TO IS : 1364, P-8.8

MATERIAL :- STEEL

AS PER IS : 1367 PT. III.

(B) ~~SURFACE :- ZINC PLATED (PASSIVATED)~~

		C	SEE SHEET 6.					
		B	SEE SHEET 6.					
		A	122-00047-002.	HEXAGON NUT WITH NYLON INSERT	16 Nos.			
C.I.D NO.	ITEM NO.	FIG. NO.	ABB DRG. NO.	DESCRIPTION				
DGN			REF. ASSLY. DRG. NO.					
CHD								
STUDD								
SEE								
DRN								
APPVD								
TRACED								
DATE								
SCALE			SET OF TRANSFORMER FIXING BOLTS & PLATES.					
REF.								

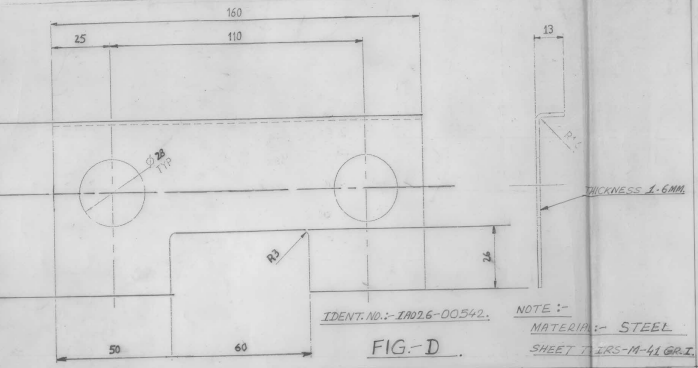
CHITTARANJAN LOCO WORKS

USED ON LOCO W1G-3(EE:C9)

1ST. ANGLE PROJECTION

DRAWING NO. CLW/EE/3.SA-1/1963

D.B.-



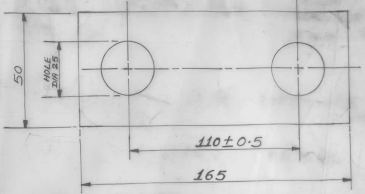
IDENT. NO.:- IA02.6-00542.

NOTE :-
MATERIAL :- STEEL
SHEET TO IRS-M-41 GR.I.

FIG.- D.

SHEET NO:-6

ALT NO	DESCRIPTION	SIGN	DATE



NOTE :-

FIG.- F, IDENT. NO.:- IA022-00242.
THICKNESS :- 15 mm. FINISH SIZE.
MATERIAL :- STEEL TO IS: 2062 GR.C.

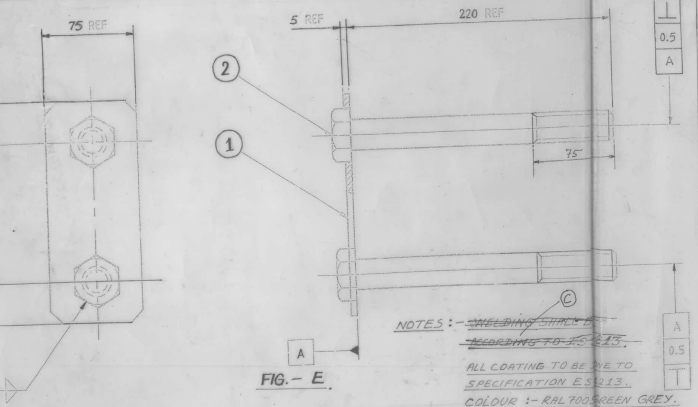


FIG.- E.

NOTES :- ~~WELDING SHALL BE~~
~~RECORDING TO IS: 815.~~
ALL COATING TO BE DONE TO SPECIFICATION IS 213.
COLOUR :- RAL 7009 GREEN GREY.
THREADED PORTION WILL NOT BE PAINTED.
MATERIAL :- STEEL
IDENT. NO.:- IA02 0104-5.

CID NO.	ITEM NO.	FIG. NO. / ABB DRG. NO.	DESCRIPTION				WT. EACH IN KG.
		FIG:F IA022-00242.	JACKING PLATE	8 NOS.			0.14
		FIG:D IA026-00542.	LOCKING TAB	8 NOS.			0.3 kg.
	2	FIG:B IA022-00241-019	M24 HEX. BOLT (CLASS 8.8)	16 NOS.			0.4 kg.
	1	FIG:C IA022-00242.	BASE PLATE	8 NOS.			2 kg.
		FIG-E IA026-01045	FIXING PLATE ASSY.	8 NOS.			

DGN
CHD
SUPDT
SEF
CONST
CORES
DATE 25/6/97
SCALE
REF.

REF. ASSLY. DRG. NO.

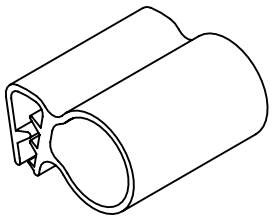
SET OF
TRANSFORMER FIXING
BOLTS & PLATES.

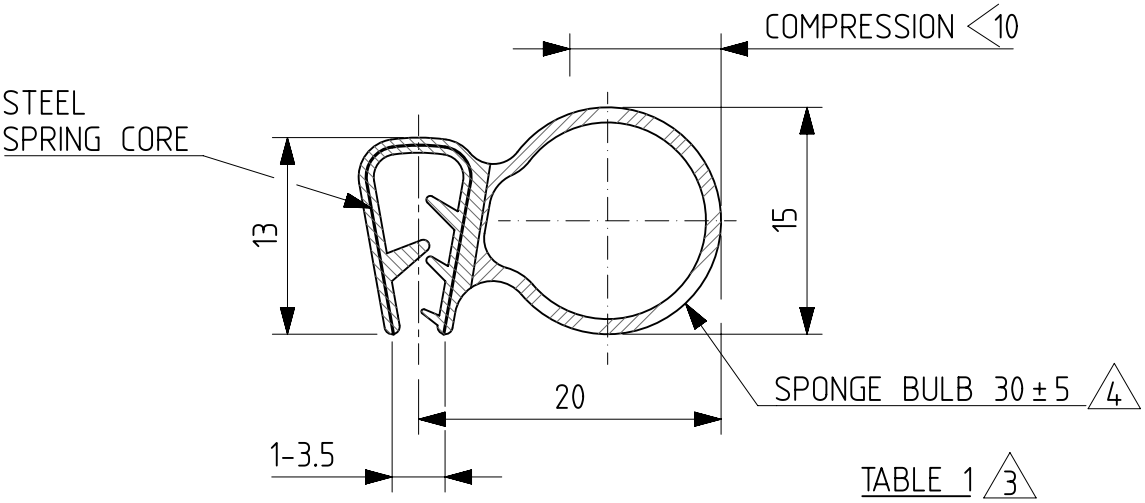
आयोजना एवं निर्माण केन्द्र
D & D CPE
चितरंजन लोकोमोटिव वर्क्स
CHITTARANJAN LOCOMOTIVE WORKS

USED FOR LOCOS WAG-5/WAG-7
1ST ANGLE PROJECTION

आरेखन संख्या DRAWING NO.
CLW/ES/3/DK-2/0069 Rev.

ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.





NOTE:-
1. REFER TECH. SPECN. NO. CLW/MS/3/034
   SHORE-A HARDNESS 30 ± 5 (FOR SPONGE BULB)
2. i) THIS DRG. IS ALSO APPLICABLE FOR WAP-5 LOCO.
   ii) FOR OTHER TECHNICAL DETAILS REFER TECH. SPECN. NO. CLW/MS/10/022.

TABLE 1 3

C&D NO.	QTY/LOCO		C&D NO.
	WAP-5	WAG-9HC	
B315/170	51 mt	17 mt X 4 PCS.	T315/154
B318/030	2 mt	12 mt X 1 PCS.	
TOTAL	53 mt	62mt 5	

1. ALL DIMENSIONS ARE IN mm
2. NEXT LEVEL ASSEMBLY DRG. NO. 1209-10.037-001, 1209-11.039-070, 1209-11.044-100, 1209-11.044-111, & 1210-01.037-001
3. USED FOR LOCO- WAG-9HC, WAP-7 & WAP-5

C&D NO.	QTY./LOCO	C&D NO.	QTY./LOCO
T315/154	62 mt	T323/117	1.7 mt
B315/170	51 mt	T324/121	2.2 mt
B315/233	16 mt	B323/007	5 mt
B318/030	2 mt	B324/025	2 mt

4. UNSPECIFIED TOLERANCE IN THE DIMENSIONS MENTIONED AT DRAWINGS TO BE FOLLOWED AS PER IS;2102(PART 1):1993-TOLERANCE CLASS-MEDIUM OF TABLE-1

1

परिवर्तन संख्या ALT.NO.	प्राधिकार AUTHY	वर्णन DESCRIPTION	दिनांकित आद्याक्षर DATED INITIAL
5	Dy.CEE/D/Conv	QTY./LOCO FOR WAG-9/WAP-7 REDUCED FROM 80m TO 62m	27-09-18
4	DY. CEE/PROJ /CON	SHORE- A HARDNESS 30 ± 5 (FOR SPONGE RUBBER) SHOWN	23-07-14
3	DY. CEE/PROJ /CON	TABLE 1 ADDED FOR DISTRIBUTION OF LENGTH	25-04-13
2	DY.CEE/ CON.TU.1	REF. 4 ADDED.	23-02
1	DY.CEE/ CON./TQ	NOTE 2 ADDED FOR WAP-5 LOCO & LENGTH 68.0 METERS WAS 63.6 METERS.	

सतह – रुक्षता का मान भा. मा. 3073 / अ. मा. सं. 1302 SURFACE ROUGHNESS VALUE TO IS:3073 / ISO:1302

अनिर्दिष्ट सह्य – सीमा भा. मा. : 2102 / अ. मा. सं. : 2768 UNSPECIFIED TOLEARANCE TO IS : 2102 / ISO : 2768

धातु–वेल्डन चिन्ह भा. मा. : 813 / अ. मा. सं. :2553 WELDING SYMBOLS TO IS:813 / ISO:2553

TOL. CLS.

पदांक GRADE NO.	सं1 N1	सं2 N2	सं3 N3	सं4 N4	सं5 N5	सं6 N6	सं7 N7	सं8 N8	सं9 N9	सं10 N10	सं11 N11	सं12 N12
Rz	0.16-0.3	0.5-0.7	0.9-1.1	1.5-2.0	2.5-3.8	5.0-6.3	9.0-12	16-25	30-40	50-63	75-100	160-250
Ra μm	0.025	0.05	0.1	0.2	0.4	0.8	1.6	3.2	6.3	12.5	25	50
चिन्ह SYMBOL												

अभिकल्पित DGN	
जाँचा व.अ.अ. CHD SSE	
समीक्षित स.वि.अ. / व.वि.अ. REVIEWED AEE / SEE	
अनुमोदित उ.मु.वि.अ. APPROVED DYCEE	
दिनांक DATE	01-06-2022
रैखिक अनुपात SCALE	1:1
संदर्भ / REF.	182-00663 ALT.-

चित्तरंजन रेलइंजन कारखाना
CHITTARANJAN LOCOMOTIVE WORKS, INDIA

पदार्थ MATL	EPDM BLACK
प्रति भार कि. ग्रा. WT. EACH IN KG	
विशिष्टि SPECN	SEE NOTE
वर्णन DESCRIPTION	SELF-GRIPPING SEALING RUBBER (FOR ROOF HATCH ASSLY.)
आरेखण संख्या DRAWING NO.	1209-18.406-089
परिवर्तन संख्या ALTERATION. NO.	5
पर्ण SHEET	1 OF 1
	A4

REDRAWN BY TCS

Technical Instruction

Routine Test Procedure for Indian Co'Co' Locomotive (WAG-9) Transformer Unit

Routine tests are carried out according to IEC 310 publication (ed. 1991) however with a reference temperature of 75 °C.

I. Transformer LOT 6500

Rated values :

Winding	Power [kVA]	Voltage [V]	Current [A]
Primary	6531	25000	261,25
Traction	4 x 1449 1776	4 x 1269 5076	4 x 1142
Filter	400	1154	347
BUR	334	1000	334

Frequency : 50 Hz

I.1 Preliminary check (IEC 310 - 18)

I.2 Measurement of winding resistance (IEC 310 - 19)

Made for each winding of the transformer.
No guaranteed values.

I.3 Measurement of voltage ratios (IEC 310 - 20)

Guaranteed values :

Primary / each Traction : 19.70
Primary / Filter : 21.66
Primary / BUR : 25.00

Tolerance : ± 0.5 %

I.4 Measurement of no-load primary current and losses (IEC 310 - 21.2)

The no-load primary current and losses shall be measured at rated frequency and voltage (50 Hz, 25 kV) on the primary winding.

Maximum guaranteed losses (at 25 kV) : 3.5 kW + 15 %

I.5 Measurement of the reactive part of the short-circuit impedance (IEC 310 - 22)

All values are reported to Traction side (1449 kVA).

Guaranteed values :

Primary / Traction 1 to 4 : 659.7 [mOhms]

Tolerance : ± 15 %

Not guaranteed values (estimated) :

Primary / Filter : 92 [mOhms]
Primary / BUR : 136 [mOhms]

I.6 Measurement of load losses (IEC 310 - 23.1 and 23.3)

Guaranteed maximum at 75 °C and rated Traction load (1142 A) :

Primary / all Tractions series connected : 186.0 kW + 15 %

I.7 Induced voltage withstand (IEC 310 - 26.1)

Test voltage is to be applied to BUR winding in order to get 60 kV on the Primary.

The tank and the coupled windings shall be connected to earth by one of their terminals.

BUR test voltage : 2400 V

Frequency and duration : 200 Hz, 30 seconds (IEC 76 - 3 - 11.1).

I.8 Separate source voltage withstand test (IEC 310 - 26.2)

A separate source voltage should be applied in turn between each of the windings to be tested and all other windings connected together, to the tank and to earth.

Voltage levels are as follows :

Primary (1V) : 5.0 kV
Traction : 8.3 kV
Filter : 5.0 kV
BUR : 5.0 kV

Frequency and duration : 50 Hz, 1 minute (IEC 76 - 3 - 10).

II. Reactor 2 SOD 240

Rated values :

Frequency : 100 Hz

Current : 2 x 984 A_{RMS}

Inductance : 2 x 0.551 mH (± 15 %) (until I_{peak} = 2 x 1391 A)

II.1 Preliminary check (IEC 310 - 31)

II.2 Measurement of winding resistance (IEC 310 - 32)

Reference Temperature : 75 °C

II.3 Measurement of inductance (IEC 310 - 34.1.2)

We measure the AC impedance with 984 A_{RMS} at 100 Hz. We would make this measurement at 16 2/3 Hz if there was any problem with the power of the machine used for the test.

Note that the inductance is independent of the frequency.

II.4 Dielectric test (IEC 310 - 36.2)

Test voltage : 10 kV
Frequency : 50 Hz
Duration : 1 Minute

III. Reactor 6 GOD 120

Rated values :

Frequency : 100 Hz
Current : 3 x 2 x 155 A_{DC}
Inductance : 3 x 2 x 13 mH (- 0%, + free)
Ripple : 38.6% at 100 Hz

III.1 Preliminary check (IEC 310 - 31)

III.2 Measurement of winding resistance (IEC 310 - 32)

Reference Temperature : 75 °C

III.3 Measurement of inductance (IEC 310 - 34.3.2)

As the inductance is independant of the frequency, we choose 16 2/3 Hz in order to minimize additional losses and temperature rise during the test.

A simple reactance measurement with 155 A_{RMS} at the above frequency determines the inductance value to be compared with type test basic value.

III.4 Dielectric test (IEC 310 - 36.2)

Test voltage : 4.2 kV
Frequency : 50 Hz
Duration : 1 Minute

Technical Instruciton

Type Test Procedure for Indian Co'Co' Locomotive (WAG-9)Transformer Unit

Type tests are carried out according to IEC 310 publication (ed. 1991) however with a reference temperature of 75 °C.

I. Transformer LOT 6500

Rated values :

Winding	Power [kVA]	Voltage [V]	Current [A]
Primary	6531	25000	261.25
Traction	4 x 1449	4 x 1269	4 x 1142
Filter	400	1154	347
BUR	334	1000	334

Frequency : 50 Hz

I.1 Measurement of winding resistance (IEC 310 - 19)

Made for each winding of the transformer.
No guaranteed values.

I.2 Measurement of voltage ratios (IEC 310 - 20)

Guaranteed values :

Primary / each Traction : 19.70
Primary / Filter : 21.66
Primary / BUR : 25.00
Tolerance : ± 0.5 %

I.3 Measurement of no-load primary current and losses (IEC 310 - 21.1)

The no-load primary current and losses shall be measured at rated frequency with the following voltages on the primary winding:

17.5, 20.0,22.5, 25, 27.5, 30 kV

Maximum guaranteed losses (at 25 kV) : 3.5 kW + 15 %

I.4 Measurement of the reactive part of the short-circuit impedance (IEC 310 - 22)

All values are reported to Traction side (1449 kVA).

Guaranteed values :

Primary / Traction 1 to 4 : 659.7 [mOhms]

Tolerance : ± 15 %

Not guaranteed values (estimated) :

Primary / Filter	:	92	[mOhms]
Primary / BUR	:	136	[mOhms]

All secondary between each other :

Traction1	- Traction2	:	1330	[mOhms]
	- Traction3	:	1290	[mOhms]
	- Traction4	:	1230	[mOhms]
	- Filter	:	600	[mOhms]
	- BUR	:	730	[mOhms]
Traction2	- Traction3	:	1230	[mOhms]
	- Traction4	:	1290	[mOhms]
	- Filter	:	600	[mOhms]
	- BUR	:	730	[mOhms]
Traction3	- Traction4	:	1330	[mOhms]
	- Filter	:	600	[mOhms]
	- BUR	:	815	[mOhms]
Traction4	- Filter	:	600	[mOhms]
	- BUR	:	815	[mOhms]
Filter	- BUR	:	50	[mOhms]
4 Tractions	- Primary	:	176	[mOhms]
4 Tractions	- Filter	:	90	[mOhms]

I.5 Measurement of load losses (IEC 310 - 23.1 and 23.2)

Guaranteed maximum at 75 °C and rated loads (with internal connections):

Primary / all Tractions series connected	:	186.0 kW + 15 %
Primary / Filter	:	1.8 kW + 15 %
Primary / BUR	:	4.0 kW + 15 %

I.6 Determination of total losses (IEC 310 - 24)

Reference temperature : 75 °C

The total losses are the sum of no-load losses (sect. I.3) and load losses as derived and corrected to the reference temperature.

The load losses are calculated for the combination of rated Tractions, Filter, BUR and HL loads (sect. I.5).

Guaranteed maximum : P_{tot} = 195 kW + 10 %

I.7 Impulse voltage test (IEC 310 - 26.3)

It will be carried out with 150 kV peak value.

I.8 Temperature-rise test (IEC 310 - 25)

I.8.1 Oil temperature-rise

This test is carried out according to the short-circuit method.

The temperature-rise is determined for the maximum losses in service.

Maximum losses : 219.5 kW + 10 % (Transformer + reactors).

In order to produce them, we should supply the primary winding of the transformer (with 4 short-circuited traction windings) and maintain these measured losses (219.5 kW + 10 %) until oil temperature stabilisation.

After stabilisation of oil temperature (1 hour less than 3 K of temperature difference) we can note the oil temperature-rise.

I.8.2 Transformer windings temperature-rise

After the oil temperature-rise measurement, it will be carried out with the rated current on each winding with resistance decrease method.

- Primary (HV) supplied by 261.25 A during 1 hour, traction windings short-circuited; Filter, BUR and HL windings opened.
- Traction winding : 1142 A, HV supplied by 232 A during 1 hour, 4 Tractions short-circuited; Filter, BUR and HL windings opened.
- Filter winding : 347 A, HV supplied by 16 A during 1 hour, Filter winding short-circuited; traction windings, BUR and HL windings opened. (Cooler fans OFF).
- BUR winding : 334 A, HV supplied by 13.36 A during 1 hour, BUR winding short circuited; traction windings, Filter and HL windings opened. (Cooler fans OFF).

Note:
For these tests, only the currents indicated above are important. The supply can be done at the secondary side with the HV winding short-circuited.

II. Reactor 2 SOD 240

Rated values :

Frequency	:	100 Hz
Current	:	2 x 984 A_{RMS}
Inductance	:	2 x 0.551 mH (± 15 %) (until I_{peak} = 2 x 1391 A)

II.1 Measurement of losses (IEC 310 - 33)

Losses are measured at rated frequency and current. If rated current is not reachable (by the machine used) at rated frequency, one shall measure at 16 2/3 Hz and an equivalent current (1258 A_{RMS}) giving rated losses.

Guaranteed maximum : 12.5 kW + 10 % (at 75 °C)

II.2 Measurement of inductance (IEC 310 - 34.1.1)

We measure some points with an alternating current at 100 Hz (including rated current). We would make measurements for high currents at 16 2/3 Hz if there was any problem with the power of the machine used for the test.

Note that the inductance is independent of the frequency.

II.3 Temperature-rise test (IEC 310 - 35)

This test is carried out during the temperature-rise test of the transformer. We measure the temperature-rise with an equivalent current giving the rated losses (2 x 984 A_{RMS} / 100 Hz, 2 x 1258 A_{RMS} / 16 2/3 Hz), with cooler fans OFF.

III. Reactor 6 GOD 120

Rated values :

Frequency	:	100 Hz
Current	:	3 x 2 x 155 A_{DC}
Inductance	:	3 x 2 x 13 mH (- 0%, + free)
Ripple	:	38.6% at 100 Hz

III.1 Determination of losses (IEC 310 - 33)

After measurement of resistance (corrected to 75 °C) we deduce copper losses as RI^2, I is rated current.

$$I = I_{rated\,(DC)} \cdot \sqrt{1 + \left(\frac{Ripple}{\sqrt{2} \cdot 100}\right)^2} = 160.7\ A$$

Guaranteed maximum : 12 kW + 10 %

III.2 Measurement of inductance (IEC 310 - 34.3.1)

We don't use the method of transient inductance because one can't be sure of the accuracy of such a method (wiring...).

We will measure the magnetisation curve with a 16 2/3 Hz a.c. current and deduce the inductance value in using the method described in HSTN 612 037 herewith attached.

The measurement at 155 A_{RMS} determines the basic value for routine test.

III.3 Temperature-rise test (IEC 310 - 35)

Carried out during the transformer temperature-rise test with the rated current and frequency, or equivalent DC current as calculated in III.1. (Cooler fans OFF).