



सत्यमेव जयते

भारत सरकार GOVERNMENT OF INDIA  
रेलवे विभाग MINISTRY OF RAILWAYS

केवल कार्यालयीन उपयोग हेतु  
एसी ईएमयू/ एमईएमयू के इलेक्ट्रो मैग्नेटिक कॉन्टेक्टर  
के  
अनुरक्षण की लघु पुस्तिका

# MAINTENANCE HANDBOOK ON ELECTRO MAGNETIC CONTACTORS OF AC EMU/MEMU

TARGET GROUP - TECHNICIANS & SUPERVISORS OF AC  
EMU/MEMU CAR SHEDS, WORKSHOPS

कैमटेक / 2007 / ई / ईएमयू-ईएमसी / 1.0  
CAMTECH/2007/E/EMU-EMC/1.0

जनवरी , 2007  
January, 2007

Centre  
for  
Advanced  
Maintenance  
TECHnology



*Excellence in Maintenance*

रेलवे विभाग, नई दिल्ली-474

एसी ईएमयू/एमईएमयू के इलैक्ट्रो मैग्नेटिक कॉन्टेक्टर  
के  
अनुरक्षण की लघु पुस्तिका

**MAINTENANCE HANDBOOK  
ON  
ELECTRO MAGNETIC CONTACTORS  
OF AC EMU/MEMU**

# FOREWORD

With increasing passenger traffic in Metropolitans & their connected cities, reliability of AC EMU/MEMUs has become very important. Proper maintenance of electromagnetic contactors is vital to ensure trouble free operation of EMU/MEMUs.

CAMTECH has prepared this handbook to cover all essential aspects of maintenance and overhauling of electromagnetic contactors of AC EMU/MEMUs. It describes various maintenance schedules, overhauling procedure, failures, causes and their remedial measures.

I am sure the handbook will prove to be very useful to our maintenance staff in EMU car sheds/ workshops.

***CAMTECH, Gwalior***  
***Date:27.04.07***

***Pramod Kumar***  
***Executive Director***

# PREFACE

The electro-magnetic contactors are used in AC EMU/MEMUs to make and break electrical circuits of main compressor, auxiliary compressor, lights and fans. Proper maintenance of these contactors is necessary to ensure reliability of AC EMU/MEMUs in service.

This handbook on maintenance of electro -magnetic contactors has been prepared by CAMTECH with the objective of making our maintenance personnel aware of correct maintenance and overhaul techniques to be adopted in field.

It is clarified that this handbook does not supersede any existing provisions laid down by RDSO or Railway Board. The handbook is for guidance only and it is not a statutory document.

I am sincerely thankful to Director (PS & EMU) RDSO/LKO for his valuable comments. I am also thankful to all field personnel who helped us in preparing this handbook.

Technology upgradation and learning is a continuous process. Hence feel free to write to us for any addition or modification in this handbook. We shall highly appreciate your contribution in this direction.

***CAMTECH, Gwalior***  
***Date: 26.04.2007***

***JAIDEEP GUPTA***  
***DIRECTOR/ELECT***

# CONTENTS

Chapter No.	Description	Page No.
	<i>Foreword</i>	<i>iv</i>
	<i>Preface</i>	<i>vi</i>
	<i>Contents</i>	<i>viii</i>
	<i>Correction Slip</i>	<i>xii</i>
<b>1.</b>	<b>GENERAL DESCRIPTION</b>	<b>01</b>
	1.1 INTRODUCTION	01
	1.2 TECHNICAL DETAILS	02
	1.3 CONSTRUCTIONAL FEATURES	05
<b>2.</b>	<b>MAINTENANCE SCHEDULES</b>	<b>10</b>
	2.1 TRIP INSPECTION	10
	2.2 IA SCHEDULE	10
	2.3 IC SCHEDULE	11
<b>3.</b>	<b>OVERHAULING</b>	<b>14</b>
	3.1 GENERAL	14
	3.2 INCOMING INSPECTION	14
	3.3 OVERHAULING OF CC1 CONTACTOR	15
	3.4 OVERHAULING OF CC2 CONTACTOR	19
	3.5 OVERHAULING OF LC/VC CONTACTOR	23
<b>4.</b>	<b>FAILURE, CAUSES AND REMEDIAL MEASURES</b>	<b>29</b>
	4.1 COIL FAILURE	29
	4.2 CONTACT WELDED (in CC1 Contactor)	30
	4.3 KNUCKLING PRESSURE LESS	31

<b>Chapter No.</b>	<b>Description</b>	<b>Page No.</b>
4.4	BLOW OUT COIL OPEN CIRCUIT	31
4.5	CONTACT FLASH OVER	32
4.6	CONTACT GAP MORE	32
4.7	CONTACT STICKING	33
4.8	TRIP COIL PLUNGER JAM/ STICK UP [in LC/VC(FC)]	33
4.9	CONTACT FLASH WHILE CLOSING	34
<b>5.</b>	<b>DO'S AND DON'TS</b>	<b>35</b>
5.1	DO'S	35
5.2	DON'TS	35
	<b><i>ANNEXURE 'A'</i></b>	<b>36</b>
	<i>SPECIAL MAINTENANCE INSTRUCTIONS ISSUED BY RDSO FOR EM CONTACTORS</i>	
	<b><i>REFERENCE</i></b>	<b>37</b>



# CHAPTER 1

## GENERAL DESCRIPTION

### 1.1 INTRODUCTION

In AC EMU/MEMU, electro-magnetic contactors are used to make and break electrical circuits of main compressor, auxiliary compressor, lights and fans. These types of contactors operate on energisation of operating coil. Arc quenching is performed by means of blow out coil, which along with arc box guarantees the safe opening and closing of contacts.

The following electro-magnetic contactors are used in AC EMU/MEMU.

<b>S.No.</b>	<b>Description</b>	<b>Abbreviation</b>
1.	E.M. contactor for main compressor.	CC1
2.	E.M. contactor for auxiliary compressor.	CC2
3.	E.M. contactor for Light circuit.	LC
4.	E.M. contactor for fan circuit.	VC (FC)



## 1.2 TECHNICAL DETAILS

### 1.2.1 Main Compressor Contactor CC-1

Make	-	BHEL
Type	-	19EC
Continuous Current	-	200A
Circuit Voltage	-	110 V dc.
Control Voltage	-	110V dc.
Main contact gap	-	10.32 mm (min.)
Main contact pressure	-	2.27 to 3.18 Kg
Operating coil	-	ES853011
Resistance at 20°C	-	468 ohms. $\pm$ 8%
Blowout coil turns	-	4
Min. pick up voltage	-	55V dc.

#### Overall size and weight

70 width x 228 depth x 191 Height (without insulating panel)

120 width x 228 depth x 350 Height (with panel)

Weight of contactor: 4.5Kg

### 1.2.2 Auxiliary Compressor Contactor CC2

Make	-	BHEL
Type	-	50EC
Current	-	10Amps
Circuit voltage	-	110V dc
Control voltage	-	110V dc
Contact gap	-	6.15 to 7.35 mm
Contact pressure	-	100–150grams (Initial) 180–280 grams (Final)
Contact over travel	-	0.8 to 1.6mm
Operating coil	-	ES 851107
Resistance at 20°C	-	1122 ± 8% ohms
Blowout coil	-	ES850134
Resistance	-	0.01648 ohms
Min. pick up voltage	-	55V dc

#### Overall size and weight

Size	-	60.0 width x 108 height x 139 depth.
Weight	-	2.0 Kg

### 1.2.3 Light & Fan Contactor LC/VC (FC)

Make	-	BHEL
Type	-	8EC4 (Lights) 8EC5 (Fans)
Light Contactor Current RH	-	100 A
Current LH	-	12 A
Fan Contactor Current RH	-	12 A
Current LH	-	12 A
Control voltage	-	110V
Operating coil	-	ES851019
Resistance at 20°C	-	102 ohms. $\pm$ 8%
Trip coil	-	ES851016
Resistance at 20°C	-	105 ohms. $\pm$ 8%
Main contact gap	-	10.3 mm min.
Main contact pressure	-	0.9 to 1.8 Kg.
Gap between top of latching lever & mating plate	-	0.48 to 0.56mm
(With set coil energized & latching lever in anticlock wise position)		

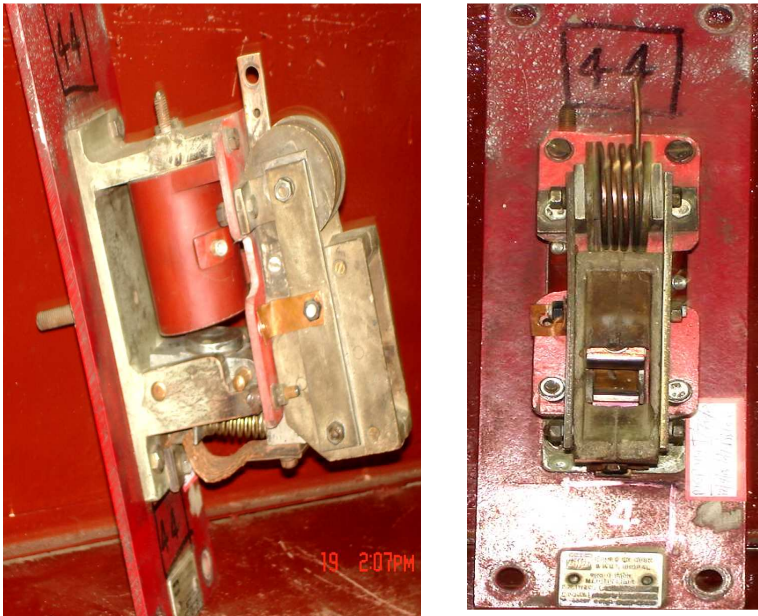
#### ***Blow out coil***

Light Contactor LH coil resistance at 20°C	-	0.012 ohms
RH coil turns	-	4
Fan Contactor both blowout coil turns	-	10
Overall size of contactor	-	343 height x 178 width x 175 depth
Weight of contactor	-	9.1 Kg
Fixing centers	-	317.5mm

## 1.3 CONSTRUCTIONAL FEATURES

### 1.3.1 Main Compressor Contactor (CC1)

CC1 contactor is used to open and close the main compressor circuit. This contactor mainly comprises of an operating coil assembly, blow out assembly and arc box assembly.



**Figure 1.1 Side & Front View of CC1 Contactor**

#### **Operating coil assembly**

It mainly comprises of an operating coil, and armature, which is hinged between two ribs welded on the magnet frame itself. The moving contact carrier, which has a knuckling device, is attached to the armature. A flexible shunt is connected between the moving contact carrier and the magnet frame.

### **Blowout assembly**

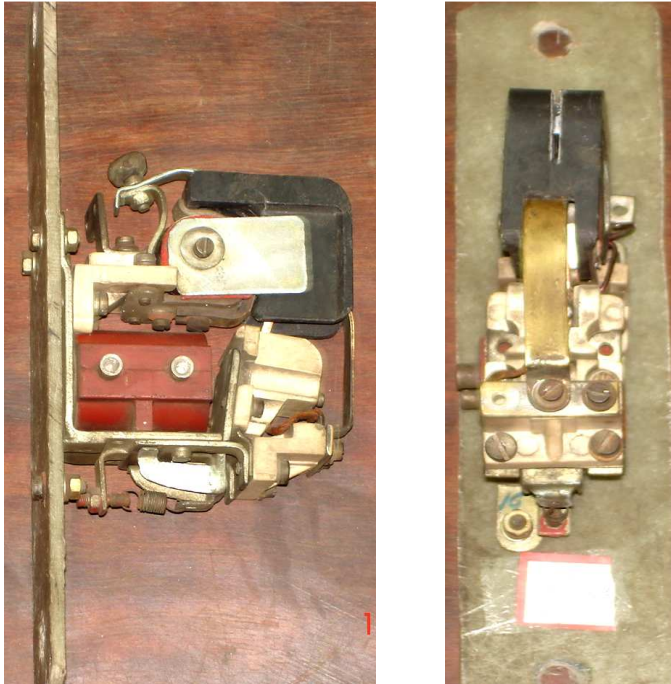
This assembly is mounted on epoxy panel and secured to the magnet frame by means of four screws. It carries the fixed contact.

### **Arc box assembly**

This assembly is hinged on the blowout coil.

## **1.3.2 Auxiliary Compressor Contactor (CC-2)**

CC2 contactor is used to open and close the aux. compressor circuit. It mainly comprises of an operating coil assembly, blow out coil assembly and the arc box assembly.



**Figure 1.2 Side & Front View of CC2 Contactor**

### **Operating coil assembly**

It comprises of an operating coil, armature and moving contact. Armature is hinged on a spring bracket and is held in position by the tension of the spring. On the armature, is fitted a contact carrier moulding which is having a knife-edge. The moving contact is held in position on the moulding by the tension of knuckling spring.

### **Blow out assembly**

Complete assembly is fitted on a bakelite moulding which is in turn fitted on the magnet frame. A contact bracket is fitted on moulding, which encircles the Blow out coil and also having a projection to guide the arc box. Fixed contact is fitted on the contact bracket.

### **Arc box assembly**

Arc box is provided with a groove, which is provided for engaging the contact bracket. Arc box is tightened firm in position to the retaining plate by means of a wing nut.

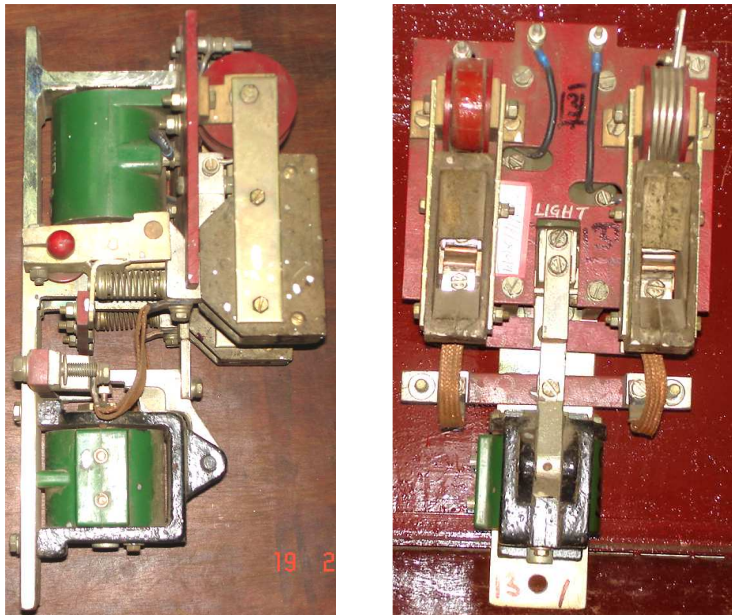
## **1.3.3 Light/ Fan Contactor [LC/VC(FC)]**

This is a double pole electro magnetic contactor with the mechanically latched type set and trip coils.

This contactor mainly comprises of fixed and moving contact assemblies, operating coil assembly, trip coil assembly, blow out assembly and arc box assembly. A latching lever associated with the operating coil moves anti-clock wise to latch the contacts closed.

When the trip coil is energized, its armature and rod move upwards, to strike the latching lever which moves clockwise and unlatches the contact, and thus allows them to open. The operating and trip coils are short time rated.

This contactor is used for closing and opening the light and fan circuit on substation trains.



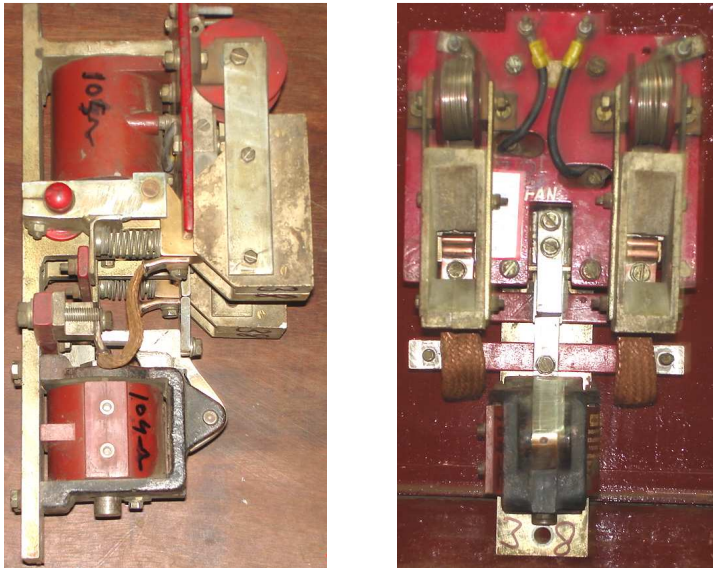
**Figure 1.3 Side & Front View of Light Contactor**

### **Operating coil assembly**

It comprises of an operating coil and armature, which is hinged between two ribs welded on the magnet frame. Armature assembly also carries two moving contact carriers, which have knuckling devices and moving contacts.

## Blow out assembly

Two blow out assemblies for the two poles are mounted on left and right side of a epoxy panel and secured to the magnet frame by means of four screws. It also carries fixed contacts.



**Figure 1.4 Side & Front View of Fan Contactor**

## Arc box assembly

This assembly is hinged on the blow out assembly.

## Trip coil assembly

This assembly is mounted on the main frame beneath the operating coil assembly. It comprises of a trip lever hinged on the trip coil frame and a latch fixed to the lever. Also a plunger and plunger rod are provided in the magnetic circuit. When the coil is energized, the plunger rod moves up and hits the trip lever and unlatches the contacts.



## CHAPTER 2

# MAINTENANCE SCHEDULES

Following maintenance schedules are to be followed for safe and reliable working of electro magnetic contactors.

### 2.1 TRIP INSPECTION (10 days)

Carry out the following inspections.

S.N.	Inspection & work to be carried out	Standard value
1.	Make a quick visual examination of all electro magnetic contactors for any overheating, flashing marks etc.	No abnormality.

### 2.2 IA SCHEDULE (45 days)

Carry out the following inspections.

S.N.	Inspection & work to be carried out	Standard value
1.	Remove the arc chutes and inspect all E.M. contactors visually for any flash marks, contact wear etc. Clean moving and fixed contacts if required.	No abnormality.
2.	Blow all EM contactors by dry compressed air thoroughly and provide the arc chutes.	Blown provided

<b>S.N.</b>	<b>Inspection &amp; work to be carried out</b>	<b>Standard value</b>
3.	Examine visually all flexible shunts for fraying or discolouration caused by heat or stiffness. Replace the shunts if required.	No abnormality.
4.	Check all power connections and coil connections for proper tightness.	OK
5.	Manually operate all E.M. contactors and ensure their free operation.	OK.
6.	Check operation of all E.M. contactors electrically by switching 'ON' 110V dc control supply during L.T. testing.	OK.

### 2.3 IC SCHEDULE (180 days)

Carry out the following inspections.

<b>S.N.</b>	<b>Inspection &amp; work to be carried out</b>	<b>Standard value</b>
1.	Remove the arc chutes and inspect all E.M. contactors visually for any flash marks, contact wear etc. Clean moving and fixed contacts if required.	No abnormality.
2.	Blow all EM contactors by dry compressed air thoroughly and provide the arc chutes.	Blown provided

S.N.	Inspection & work to be carried out	Standard value
3.	Examine visually all flexible shunts for fraying or discolouration caused by heat or stiffness. Replace the shunts if required.	No abnormality.
4.	Check all power connections and coil connections for proper tightness.	OK
5.	Check all hinge pins and pivots for sluggish operation. Do not lubricate the pivot pins.	OK.
6.	Check flexible shunts, contacts, arcing horns and arc chutes for erosion.	OK.
7.	Examine knuckling springs to make sure that the stiffness have not developed in the hinge pins and the spring have not weakened.	OK.
8.	Check and ensure proper crushing and effective bedding of contact tips and if required, replace contact tips in pair.	OK.
9.	<p>Check air gap between moving and fixed contacts of all E.M. contactors at the narrowest points.</p> <p>i. For CC1 contactors</p> <p>ii For CC2 contactors</p> <p>iii For LC/VC(FC) contactors</p>	<p>10.32mm (min)</p> <p>6.15 to 7.35 mm</p> <p>10.30mm (min)</p>

<b>S.N.</b>	<b>Inspection &amp; work to be carried out</b>	<b>Standard value</b>
10.	Check main contact pressure of all E.M. contactors. i. For CC1 contactor  ii. For CC2 contactor  iii. For LC/VC(FC) contactor	2.27 to 3.18 Kg. 100-150gms (initial) 180-280gms (final) 0.9 to 1.8 Kg.
11.	Manually operate all E.M. contactors and ensure their free operation.	OK.
12.	Check operation of all E.M. contactors electrically by switching 'ON' 110V dc control supply during L.T. testing.	OK.

## CHAPTER 3

# OVERHAULING

Overhauling of all electro-magnetic contactors is to be carried out during every POH (18 months)

### 3.1 GENERAL

- Overhauling comprises repairing and reconditioning of the equipment i.e. dismantling, replacing worn or defective parts, repairing, re-assembling and testing.
- Cleanliness is essential to good maintenance and trouble free service. Therefore work of cleaning must be carried out thoroughly during overhauling.
- Remove all EM contactors and bring them along with arc boxes to repairing room.

### 3.2 INCOMING INSPECTION

- Carry out visual inspection for any damage, defect and deficiency and note the same.
- Connect the E.M. contactor's coil to 110V dc variable supply on test bench.
- Check the operation of E.M. contactor manually and electrically for any abnormality.
- Remove the contactor from test bench.

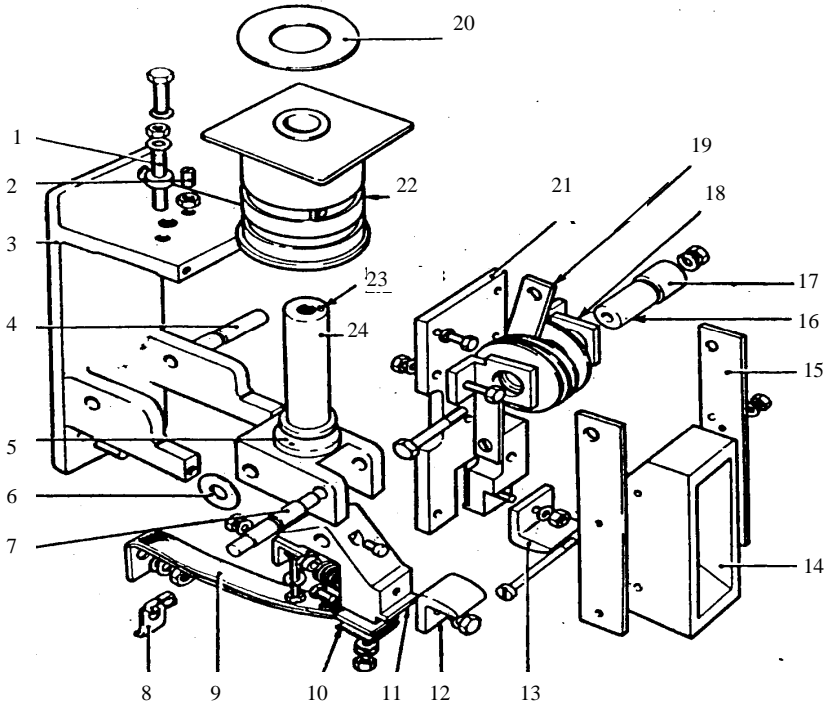
### 3.3 OVERHAULING OF CC1 CONTACTOR

#### 3.3.1 Dismantling

- Remove the arc box from main assembly by removing hex. head steel screws.
- Remove the blow out assembly along with the bakelite panel from the main assembly by unscrewing the four hex. head steel screws from the magnet frame.
- Dismantle one end of the shunt, fixed to the moving arm and unscrew cup point set screw holding the hinge pin to the armature.
- Remove hinge pin, now remove the armature assembly from main assembly.
- Dismantle all the parts of blow out assembly and armature assembly.

#### Details of Figure 3.1

1	Terminal stud	13	Fixed contact
2	Locking screw	14	Arc box
3	Frame	15	Blow out cheek
4	Armature hinge pin	16	Core
5	Pole piece	17	Tube
6	Anti stiction washer	18	Bracket
7	Knuckling hinge pin	19	Terminal connection
8	Shunt clip	20	Coil clamping washer
9	Shunt	21	Bakelite panel
10	Shunt guard	22	Operating coil
11	Moving arm	23	Locating pin
12	Moving contact	24	Core



**Figure 3.1 Exploded view of CC1 Contactor**

### 3.3.2 Cleaning & Inspection

- Clean all the components with petrol thoroughly and blow them with dry compressed air.
- Examine visually arc box for any damage/ crack etc. Use a fine file or glass paper to remove loose dirt and any copper globules.
- Examine visually the blow out coil for any defect/ damage.
- Replace the top and bottom contacts and tighten the screws firmly. Ensure the contacts sit square on the ledge.

- Examine visually the copper shunt for any loose strands, fraying or discolourisation caused by heat or stiffness. Replace the shunt if required.
- Replace the knuckling spring with new one.
- Visually examine the condition of armature hinge pin, coil-locating pin, knuckling hinge pin and other components of armature assembly for any defect or damage. Replace the defective parts.
- Measure the ohmic value of the operating coil, it should be  $468 \pm 8\%$  ohms at 20 degree C.
- Carry out the short turn test with the help of shorted turn indicator as per RDSO SMI no. RDSO/ ELRS/ SMI/ 59/ dt. 12.12.1979.
- Carry out the surge comparison test with the help of surge comparison tester as per RDSO SMI no. RDSO/ ELRS/ SMI/ 157/ dt. 16.07.1993.
- Follow the measures of reliability improvement for the operating coil (solenoid) as per RDSO SMI No. RDSO/ ELRS/ SMI/ 0224-2001 (Rev. 0)/ dt. 15.05.2001.

### **3.3.3 Re-assembly**

- Reassemble the contactor in reverse order of dismantling.
- After tightening the coil and core on the magnet frame, ensure that the coil does not turn by hand.



- To ensure proper contact mating of main contacts, loosen the screws holding the contact tips slightly and operate the contactor manually, now fully tighten the screws. This ensures proper contact between top and bottom contact.
- Check the contact bedding by carbon paper method.
- Ensure that the knuckling spring is properly housed in the spring locaters on either end. Improper sitting of spring may cause damage to the spring and will result in improper knuckling.
- Check the main contact gap, it should be 10.32 mm min.
- Check the main contact pressure, it should be 2.27 to 3.18 Kg.
- Check the gap between core bottom and armature bedding in contactor close condition. It should be 0.8mm minimum.

### **3.3.4 Testing of Contactor After Reassembly**

- Operate the contactor by hand to ensure that it moves freely on hinges and operation is not sluggish.
- Connect the operating coil to 110V dc variable supply on test bench and check the operation electrically at 110V for any sluggish operation.
- Energise the coil at the minimum operating voltage of 55V dc. The contactor should close.
- De-energise the coil. The contactor should fully open.

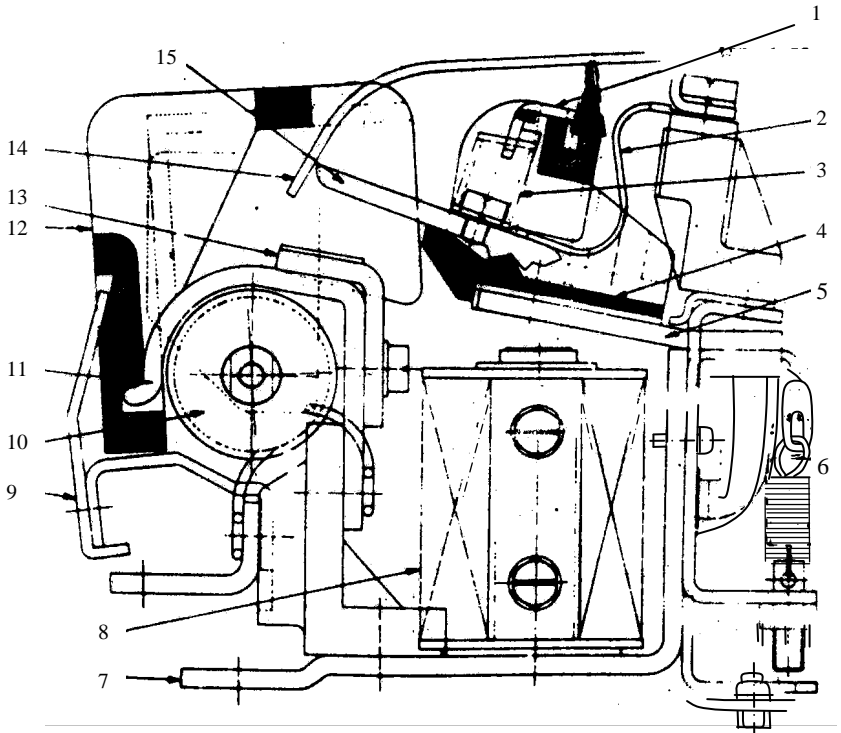
## 3.4 OVERHAULING OF CC2 CONTACTOR

### 3.4.1 Dismantling

- Remove the arc box by loosening the wing nut holding the retaining bracket with the arc box.
- Remove the complete blow out assembly from the magnet frame by unscrewing the holding screws.
- Remove the complete armature assembly from the magnet frame by unscrewing the holding screws.
- Remove the spring bracket along with spring from the contact carrier moulding.
- Remove the shunt from moving contact by unscrewing the cheese head steel screw.
- Dismantle all the parts of blow out assembly, armature assembly as shown in figure 3.2.

#### Details of Figure 3.2

1	Spring bracket	9	Retaining plate
2	Shunt	10	Blow out coil
3	Knuckling spring	11	Contact bracket
4	Contact carrier moulding	12	Arc box
5	Armature	13	Fixed contact
6	Spring	14	Arc shield
7	Magnet frame	15	Moving contact
8	Operating coil		



**Figure 3.2 Contactor CC2**

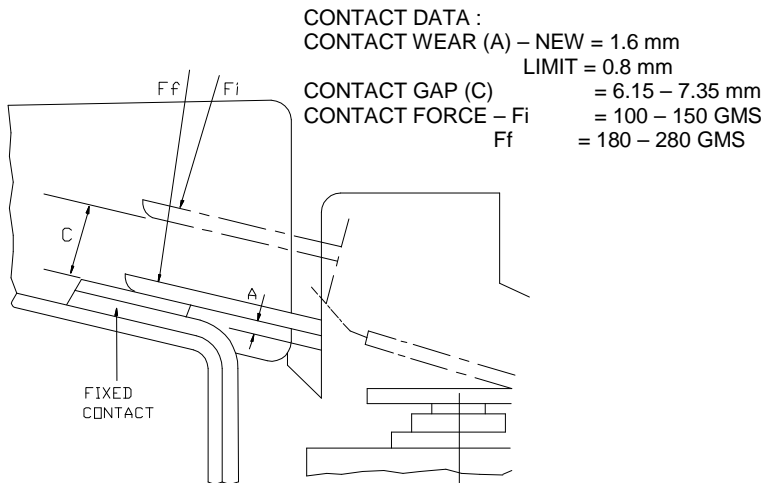
### 3.4.2 Cleaning & Inspection

- Clean all the components with petrol thoroughly and blow them with dry compressed air.
- Examine visually arc box for any damage/ crack etc. Use a fine file or glass paper to remove loose dirt and any copper globules.
- Check the blow out coil and cheeks for any damage/ crack etc.

- Check the condition of moving and fixed contacts and clean them.
- Check the thickness of fixed contact tip, it should be 1.6 mm (for new) and condemning limit is 0.8mm. Replace the contact if required.
- Check the condition of flexible shunt for any over heating, loose strands etc., replace if required.
- Check the spring & knuckling spring for stiffness or weakened, replace with new one if required.
- Check the condition of armature plate, contact carrier moulding, arc shield etc. for any defect/ damage. Replace the defective part.
- Measure the ohmic value of the operating coil. It should be  $1122 \pm 8\%$  ohms at 20 degree C.
- Carry out the short turn test with the help of shorted turn indicator as per RDSO SMI no. RDSO/ ELRS/ SMI/ 59/ dt. 12.12.1979.
- Carry out the surge comparison test with the help of surge comparison tester as per RDSO SMI no. RDSO/ ELRS/ SMI/ 157/ dt. 16.07.1993.
- Follow the measures of reliability improvement for the operating coil (solenoid) as per RDSO SMI No. RDSO/ ELRS/SMI/0224-2001 (Rev. 0) dt. 15.05.2001.

### 3.4.3 Re-assembly

- Reassemble the contactor in reverse order.
- Ensure that the spring is properly fitted and moving contact is free on the knife-edge of the contact carrier moulding, otherwise this may give improper contact pressure.
- Check that the armature is moving freely on the hinge.
- Check that the operating coil is held sufficiently tight and is not turning by hand.
- Check that all securing bolts and nuts are tightened properly.
- Check the main contact gap, it should be 6.15 to 7.35mm as shown in figure 3.3.
- Check the main contact pressure (force), it should be 100-150gms (initial) and 180-280 gms (final) as shown in figure 3.3.



**Figure 3.3**

### **3.4.4 Testing of the Contactor After Reassembly**

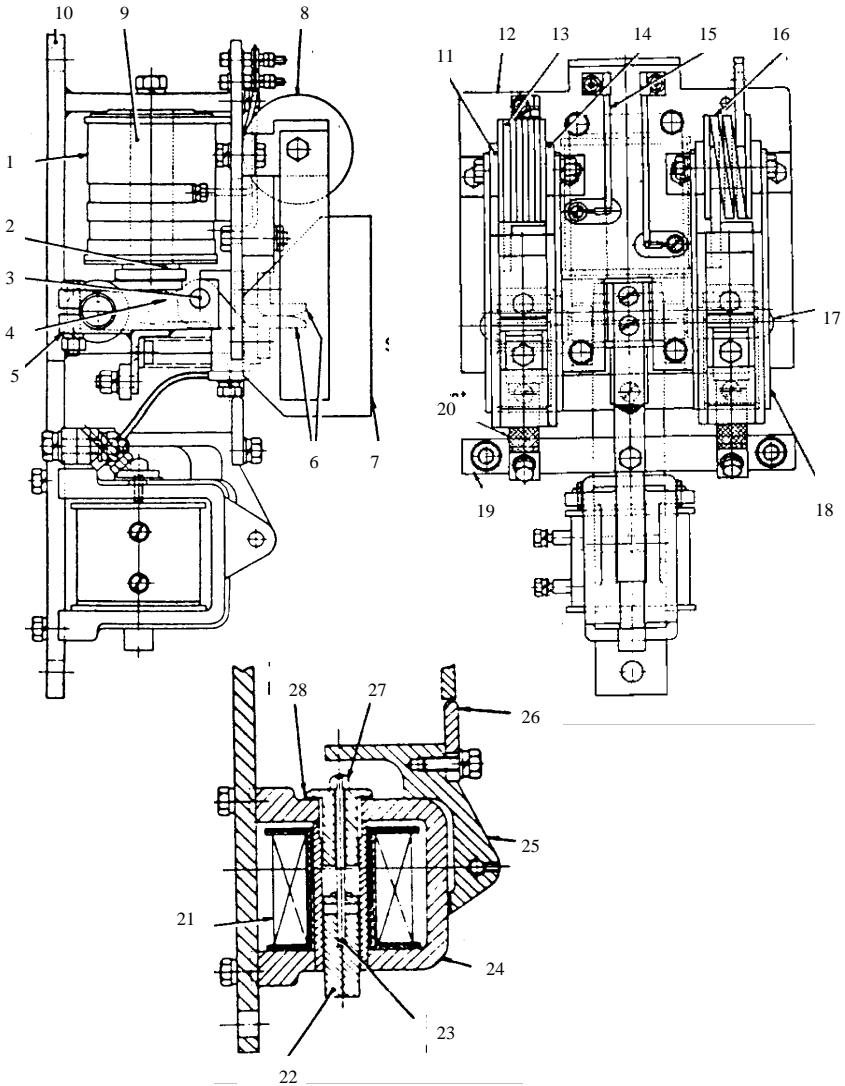
- Operate the contactor by hand to ensure that it moves freely on hinges and there is no sluggish operation.
- Connect the operating coil to 110V dc variable supply on test bench and check the operation electrically at 110V dc for proper operation.
- Check the direction of blow out action by passing a small current in the blow out coil and ensure that the arc is thrown towards the arc box side.
- Check that the contact is picking up and fully knuckling at the minimum pick up voltage 55V dc. Adjust the spring tension, if required.
- De-energise the coil, the contactor should fully open.

## **3.5 OVERHAULING OF LC/VC (FC) CONTACTOR**

### **3.5.1 Dismantling**

- Remove the shunt from the knuckling casting.
- Remove the arc boxes by unscrewing the screws.
- Dismantle the four fixing screws holding the blow out coil assembly with insulating panel from the frame.
- Remove the blow out coil along with the contact support by removing the screws holding the core to the R.H. and L.H. brackets.
- Remove each moving contact assembly.
- Remove the hinge pins.
- Remove the armature assembly.
- Remove the complete trip coil assembly from base.

- Dismantle armature assembly, blow out coil assembly, trip coil assembly and other components.



**Figure 3.4 LC/VC(FC) Contactor**

### Details of Figure 3.4

1	Operating coil	15	Single core cable
2	Armature	16	Blow out coil
3	Hinge pin	17	Insulator
4	Knuckling casting	18	Blow out cheek
5	Moving arm	19	Terminal block
6	Contacts	20	Shunt
7	Arc box	21	Trip coil
8	Blow out coil	22	Plunger
9	Core	23	Plunger rod
10	Frame	24	Trip coil frame
11	Bracket (L.H.)	25	Trip lever
12	Panel	26	Latch
13	Blow out coil	27	Plunger cap
14	Bracket (R.H.)	28	Locking plate

### 3.5.2 Cleaning & Inspection

- Clean all the components with petrol thoroughly and blow them with dry compressed air.
- Examine visually arc boxes for any damage/ crack etc. Use a fine file or glass paper to remove loose dirt and copper globules.
- Check the blow out coils, blow out cheeks and brackets for any defect/ damage etc.



- Check the condition of moving and fixed contacts and clean them. If the contact tips are discoloured by over heating, examine them for any dirt or copper oxide on conducting surfaces and replace if required.
- Inspect the shunts for fraying or discolourisation caused by heat or stiffness. Replace the shunts if required.
- Check the condition of springs for stiffness or weakness. Replace if required.
- Check the condition of armature, hinge pins, moving arm, core, plungers and other components for any defect/damage. Replace the defective components.
- Measure the ohmic value of the operating coil (set coil). It should be  $102 \pm 8\%$  ohms at 20 degree C.
- Measure the ohmic value of the trip coil, it should be  $105 \pm 8\%$  ohms at 20 degree C.
- Carry out the short turn test with the help of shorted turn indicator as per RDSO SMI no. RDSO/ ELRS/ SMI/ 59/ dt. 12.12.1979.
- Carry out the surge comparison test with the help of surge comparison tester as per RDSO SMI No. RDSO/ ELRS/ SMI/ 157/ dt. 16.07.1993.
- Follow the measures of reliability improvement for the operating coil (solenoid) as per RDSO SMI No. RDSO/ ELRS/SMI/0224-2001 (Rev. 0) dt. 15.05.2001.

### 3.5.3 Re-assembly

- Reassemble the contactor in reverse order.
- Check that the core is bolted solid to the magnet frame and the operating coil is held tight.
- Check that all securing bolts for moving and fixed contacts are tightened firmly.
- Check that the moving contacts are not resting on the arc chutes when the contactor is in open condition.
- Check that the moving system pivot freely on the magnet frame.
- Lift the armature manually and check that moving contacts touch their fixed contacts at the same time and should knuckle together.
- Check that there is gap of 10.0 to 10.5 mm between the plunger and latch of trip assembly.
- Check the main contact gap at the narrowest point, it should be 10.3 mm (min.).
- Check the main contact pressure, it should be 0.9 to 1.8 Kg.

### 3.5.4 Testing of the Contactor After Reassembly

- Connect the operating coil and trip coil to 110V dc variable supply separately on test bench and check the operation electrically at 110V dc for proper operation.
- Energise the operating coil at the minimum. operating voltage of 55 dc. The contactor should close and contacts should latch.
- Energise the trip coil at the minimum operating voltage of 55 Vdc. The contactor should open without any hesitation.
- When the operating coil is energized there should be a clearance of 0.48 to 0.56 mm between the moving and fixed latches of the latch mechanism to allow for the clearance around the latch hinge pin, as the moving latch is lifted by this amount when the frame is magnetised.

\*\*\*\*\*

## CHAPTER 4

# FAILURES, CAUSES AND REMEDIAL MEASURES

Different failures observed/ reported by various EMU Car Sheds are given below.

- Coil Failure
- Contact Welded
- Knuckling Pressure Less
- Blow out coil open circuit
- Contact flash over
- Contact gap more
- Contact sticking
- Trip coil plunger jam/ stick up
- Contact flash while closing

### 4.1 COIL FAILURE

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
Operating coil open/ short circuited due to inter turn short or due to surges.	<ul style="list-style-type: none"> <li>▪ Measure the resistance values of the coils during overhauling, it should be within specified limits at 20°C. CC1 – 468 ± 8% ohms. CC2 – 1122 ± 8% ohms LC/VC – 102 ± 8% ohms</li> <li>▪ Inter turn short testing to be done during every overhauling with the help of shorted turn indicator.</li> </ul>

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
	<ul style="list-style-type: none"> <li>▪ Surge comparison test to be done during every overhaul with the surge comparison tester so that weak coil may be identified before they fail in service.</li> <li>▪ Follow the instructions given in RDSO SMI No. RDSO/ELRS/0224 – (Rv.0) dt. 15.05.2001.</li> </ul>

#### 4.2 CONTACT WELDED (IN CC1 CONTACTOR)

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Welding of CC1 contactor contact tips may be due to residual magnetism in the electromagnetic coil, resulting in continuous working of compressor.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check the mains contact pressure in every IC schedule; it should be 2.27 to 3.18 Kg. If contact pressure found less, check the springs for stiffness and replace if necessary.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Contacts flashed and welded due to weak knuckling spring.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure replacement of knuckling spring by new one during every overhauling.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Contact tips pitted /worn out.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure proper attention to contact tips during every schedule inspection. Replace 100% contact tips during overhauling.</li> </ul>

### 4.3 KNUCKLING PRESSURE LESS

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Stiffness developed in the spring due to ageing or heating.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check the spring for stiffness during schedule inspections and replace the same if required.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Due to weak knuckling spring.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check the knuckling pressure as given below and replace the spring with new one if required. CC1 – 2.27 to 3.18 Kg. CC2 – 180 – 280 gms (Final) LC/VC – 0.9 to 1.8 Kg.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Improper housing of knuckling spring.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure that the spring is properly housed in the spring locators on either end.</li> </ul>

### 4.4 BLOW OUT COIL OPEN CIRCUIT

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Due to cracks developed in blow out coil.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check the blow out coil thoroughly during every overhauling for cracks etc. Replace if required.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Blow out coil internally open circuited.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check the blow out coil for continuity during every overhauling, if found open circuited, replace the same.</li> </ul>

## 4.5 CONTACT FLASH OVER

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>Loosening of contact tip screws.</li> </ul>	<ul style="list-style-type: none"> <li>Check all the securing screws of moving and fixed contacts during schedule inspections for tightness.</li> </ul>
<ul style="list-style-type: none"> <li>Low contact pressure.</li> </ul>	<ul style="list-style-type: none"> <li>Examine knuckling pressure and knuckling spring for weakness. CC1 – 2.27 to 3.18 Kg. CC2 – 180 – 280 gms (Final) LC/VC – 0.9 to 1.8 Kg.</li> </ul>
<ul style="list-style-type: none"> <li>Improper bedding.</li> </ul>	<ul style="list-style-type: none"> <li>Check the bedding of contacts during every IC schedule &amp; over-hauling with each other.</li> </ul>
<ul style="list-style-type: none"> <li>Contacts worn out.</li> </ul>	<ul style="list-style-type: none"> <li>Check the contact air gap during every IC schedule and if found more than specified, fit new contact tips in pairs.</li> </ul>
<ul style="list-style-type: none"> <li>Arc box not provided/ remained in open condition after inspection.</li> </ul>	<ul style="list-style-type: none"> <li>Ensure proper fitting of arc box after every inspection.</li> </ul>

## 4.6 CONTACT GAP MORE

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>Contacts worn out beyond their condemning limits.</li> </ul>	<ul style="list-style-type: none"> <li>Check the contact air gap and contact condition. Replace the contacts in pair if worn out.</li> </ul>

## 4.7 CONTACT STICKING

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Moving contact fouling with arc box.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure that moving contact is not fouling with arc box during every schedule inspection.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Arc box not fitted properly.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure proper fitting of arc box.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Hinge pin movement sluggish/ jam.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Check that all hinge pins and pivots are operating freely and there is no sluggish operation.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Hinge pin locking pin (roll pin) broken.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Replace the roll pin with new one.</li> </ul>

## 4.8 TRIP COIL PLUNGER JAM/ STICK UP [IN LC/ VC(FC)]

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Due to rust/ dust in plunger assembly.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Blow the plunger assembly thoroughly by compressed air during schedule inspections.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Plunger rod bend.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Replace the plunger rod with new one.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Loosening of locking plate.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure proper tightening of locking plate.</li> </ul>



## 4.9 CONTACT FLASH WHILE CLOSING

POSSIBLE CAUSES	SUGGESTED REMEDIAL ACTION
<ul style="list-style-type: none"> <li>▪ Due to sluggish operation.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure proper operation of contactor manually &amp; electrically during every schedule inspection.</li> </ul>
<ul style="list-style-type: none"> <li>▪ Due to poor knuckling pressure/ spring.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ensure proper knuckling pressure and spring condition during every schedule inspection.</li> </ul>

\*\*\*\*\*

## **CHAPTER 5**

### **DO'S AND DON'TS**

#### **5.1 DO'S**

1. Do check every electrical connection and contact carefully for tightness.
2. Do ensure that one solenoid is not used repeatedly as the “standard” for surge comparison test.
3. Do ensure that all SMIs are being implemented during maintenance schedules/ overhauling.
4. Contact gap shall be measured at the narrowest points.
5. Do ensure that moving & fixed contacts are replaced in pairs only.

#### **5.2 DON'TS**

1. Do not lubricate pivots and hinged contact fingers etc. excessively during overhauling to avoid dust accumulation.
2. Don't use rough file to clean arc chutes.
3. Don't use emery or glass paper to clean contacts as particles of these materials which might adhere to the surfaces would cause bad contact.
4. Don't use wire wool to clean contacts or any other electrical apparatus.
5. Don't lubricate pivots and hinged contact fingers during schedule maintenance because it may tend to contaminate other parts of contactor & may form a dirt collecting surface.

\*\*\*\*\*

**ANNEXURE ‘A’****SPECIAL MAINTENANCE INSTRUCTIONS ISSUED BY  
RDSO FOR EM CONTACTORS**

<b>S.No.</b>	<b>SMI No. &amp; Dt.</b>	<b>Brief description</b>
1.	RDSO/ELRS/SMI/59 dt. 12.12.1979	Short turn testing of solenoids with the help of “Shorted Turn Indicator”.
2.	RDSO/ELRS/SMI/157 dt. 16.07.1993	Condition monitoring of solenoids by surge comparison method with the help of surge comparison tester.
3.	RDSO/ELRS/SMI/0224 dt. 15.05.2001	Reliability improvement measures for the operating coil (solenoid).

## REFERENCE

1. Manual of AC Traction Maintenance and Operation Volume III 1994.
2. BHEL Maintenance Manual for 25 kV broad gauge AC and Main Line Electrical Multiple unit (Electrical Equipment). Book Number : MM/AC-M/EMU/003, January, 2001.
3. Field study and literature collected from various car sheds and workshops.
4. Presentations given by participants from various car sheds and workshops during seminar conducted on 25.09.2006 at IRCAMTECH/ Gwalior.

\*\*\*\*\*

## OUR OBJECTIVE

To upgrade maintenance technologies and methodologies and achieve improvement in productivity, performance of all Railway assets and manpower which inter-alia would cover reliability, availability, utilisation and efficiency.

If you have any suggestions and specific comments please write to us.

<b>Contact person</b>	<i>Director Electrical</i>
<b>Postal address</b>	Indian Railways Centre for Advanced Maintenance Technology, Maharajpur, Gwalior, Pin Code - 474 005
<b>Phone</b>	0751 – 2470740 0751 – 2470803
<b>Fax</b>	0751 - 2470841