Government of India
Ministry of Railways
Research Designs & Standards Organisation
Manak Nagar , Lucknow - 226011

No. EL/3.2.70 Dated : -10- 1992

SPECIAL MAINTENANCE INSTRUCTION NO. RDSO/EL-RS/SMI/149

1. **TITLE :**

SPECIAL INSTRUCTION FOR SURGE TEST ON 3 PHASE AUXILIARIES.

2. **Application :**

All electric locomotives fitted with 3 phase Induction motor.

3. **Object :**

3.1 A large number of auxiliary motor failures have been reported by Railways on account of inter turn shorts and earth fault. After detailed investigation into the failure pattern it has been decided by RDSO to introduce special test on this motor before put into service. The test which shall be conducted on the stator of three phase motors, is known as 'SURGE COMPARISION TEST'.

3.2 Test on the motors would weed out the following types of faults, thus preventing the entry of defective motor into the traction service. (Refer. Fig. 2)

a) Turn to turn short in the same phase.
b) Coil to coil short in the same phase.
c) Phase to phase short complete.
d) Improper coil connection.
e) Open coil connection
f) Earth fault

4. **Instruction Drawing :**

SK. EL. NO.

5. **Instruction :**

5.1 The controls for the JABBAL surge tester shall be as follows —

5.1.1 The tester is operated as described below :-

5.1.1.1 Turn the main power switch off.

5.1.1.2 Connect the tester line card to 220 V AC out-let

Precaution : This tester must be grounded to prevent possible hazards due to static build up in winding under test and to ensure proper operation of the tester.

5.1.1.3 Set all switches and controls present on tester model 5000 as listed below :

INTENSITY	MID Scale
FOCUS	MID Scale
VER POS	MID Scale
HOR POS	MID Scale
SWEEP	Fully Center Clockwise
VOLTS/DIV	500 for model 5000

Precaution : Contact with the test leads on this equipment can cause harmful or fatal electrical shock. Do not touch the test leads while a test is in process.

Test : Not pressed

% output : 0 (Zero)

Test Select : Any position

5.1.1.4 Turn the unit on by placing POWER ON switch in the on position. RED LIGHT will glow. After few seconds a trace will appear on the oscilloscope screen and allow the unit several minutes to warm up and stabilize prior to proceeding.

5.1.1.5 Adjust the INTENSITY, FOCUS VER POS, HOR POS and sweep controls to obtain a sharp oscilloscope trace centered on the screen and about 75 mm long.

5.1.1.6 Connect the test leads to the winding to be tested. Refer Para 5.1.2 for information on how to connect test leads.

5.1.1.7 Set the TEST SELECT switch to the proper position for the test to be performed. Refer Para. 5.1.2.

5.1.1.8 Press the TEST BUTTON. The red TEST ON lamp will light. Rotate the % output control slightly clockwise and a pattern is obtained as mentioned in Fig.1 Wave form thus obtained is for two good or defective winding under test. Adjust the sweep control to obtain the proper duration display.

5.1.1.9 Adjust the % output control and the VOLT/DIVISION Switch to the desired test voltage.

Precaution : Do no operate the TEST SELECT or VOLT DIVISION switch while a test in progress.

5.1.1.10 Release the test button and rotate the TEST SELECT switch to the next position or connect the test leads to the next windings to be tested.

Precaution : Contact with the test leads on this equipment can cause harmful or fatal Electrical shock. Do not touch the test leads while a test is in progress.

5.1.1.11 Applied voltage determination.

The actual voltage applied to the winding under test is affected by the inductance of the winding.

Applied Voltage = No. of scale division between the top of the highest peak and the lowest negative peak X volts/division.

5.1.2 **Test Procedure :**

5.1.2.1 **GENERAL**

The JABBAL Surge Tester will check single phase or three phase winding with either iron or air cores. The tester operates by discharging energy storage capacitors into the two output leads and alternately displaying the waveshapes of the voltages present in the windings under test. By means of the TEST SELECT Switch, a pair of single phase winding or an entire three phase winding set may be tested without changing the test lead connections to the windings under test. In the table below 'Hot' is an energised lead and 'Gnd' is a grounded or return lead.

Table - 1

Switch Position	**Test Leads**			
	1	**2**	**3**	**GND**
1↓	HOT	GND	HOT	GND
C	GND	HOT	HOT	GND

B	HOT	GND	HOT	GND
A	HOT	HOT	GND	GND

Test lead potential vs. Test Select Switch Position most testing performed is comperison testing where the inductance of two identical windings, for two windings of a three phase. Windings are tested simultaneously and the output waveshapes are compared against each other. The tester can be used to test for voltage breakdown of a single winding, but results are difficult to judge due to lack of a comparison. When two matched windings with no faults are being tested, a single waveshape such as shown in Fig. 1 will result (Ref. Figure. 1)

If the windings are mismatched, a dual waveshape such as shown in Figure a(b) (Ref. Figure.1) will appear or one trace will be erratic. The dual waveshape indicates the two windings under test have different inductances, e.g. the winding generating the higher frequency waveshape has less turns or shorted turns. An erratic waveshape indicates that the insulation in one coil is momentarily breaking down.

Note : Irregularities or discontinuities in the first cycle of the wave shape may occur, particularly when testing small windings at low voltage. This is normal and should be ignored.

If one or both tester channels are operating into a short circuit a flat trace will appear. The test leads should be checked for inadvertant shorting and the setting of the TEST SELECT Switch should be checked before rejecting the winding as totally shorted.

If one or both tester channels are operating into an open circuit, a step function waveshape will appear, as mentioned in Fig. 1(C) (Ref. Figure. 1) Again test leads and TEST SELECTION switch settings should be checked prior to rejecting the winding.

A test is performed as follows :-

1. The unit is turned on and adjusted as described in Para 5.0

2. The test leads are connected to the windings to be tested. Table 1 & para 5.13 will aid in explaining test lead connections.
3. The % OUTPUT control is set at zero, and the TEST SELECT Switch is set at the proper location for the test lead connections and test to be performed. (See table 1 and para 5.13)
4. The TEST Switch is engaged and the % OUTLET control and the VOLTS/DIV switch are set for the proper test voltage.
5. Upon test completion, the TEST is released and the TEST SELECT Switch is moved to the next test position or new windings are connected to the test leads.

NOTE : For repetitive testing the % OUTPUT control may be a preset value and not returned to zero between tests.

5.1.3 **TESTING OF THREE PHASE WINDING TESTING :**

Three phase winding assemblies are tested by comparing each winding with the other two windings in the assembly. Only TEST SELECT Switch positions, A,B, or C may be used for three phase testing. 'Hot' is an energized lead, and "Gnd" is a grounded or return lead. The diagram on the tester front panel shows typical winding connections for 3ϕ. delta or star testing.

When testing star winding with the switch in position, A, test leads 1 and 3 are energized and 2 is grounded. Channel 1 test current flows through windings U and W and Channel 2 test current flows through windings V and W. Since winding W is common to both channels, any fault in winding W will show on both CRT traces. If winding W is open , both traces will be flat or a step function as shown in figure (C) (Ref. Figure.1) If winding W has a momentary type short both traces will be erratic. Other types of faults in winding W will be difficult to notice in this switch position as both CRT traces will be identical but these faults will show in switch position B and C. If a fault is present in either winding U or V, the two traces will not be identical and the fault can be isolated. The following ground rules can be used in conjunction with Figure. 2 (Ref. Figure. 2) to determine which winding in a three phase winding is defective.

5.1.3.1 **INDICATION :**

ONE ERRATIC TRACE

Try each switch position (A, B and C) until both traces become erratic. When both traces are erratic the defective winding is in the common leg. If both traces are erratic in position A, the winding tied to test lead 3 is defective.

5.1.3.2 **INDICATION :**

ONE FLAT OF STEP FUNCTION (OPEN) TRACE :

Try each switch position (A, B and C) until both traces show the open, and the defective winding is in the common leg. If the switch is in A, the winding tied to test lead 3 is defective.

5.1.3.3 **INDICATION :**

TWO TRACES AT DIFFERENT FREQUENCIES :

Try each switch position, (A, B & C) until both traces are identical which indicates that the defective winding is in the common leg. If the switch is in position A, the winding tied to test lead 3 is defective.

5.1.3.4 **INDICATION :**

ONE FLAT (GROUND) TRACE :

Try each switch position (A, B & C) until both traces are identical which indicates that the defective winding is in the common leg. If the switch is in position A, the defective winding is in the leg tied to test lead 3.

Using the instructions above Table 1 and the diagram on the front panel will allow the operator to isolate a fault in any one winding in a three phase winding. However, if two windings in a three phase have the same fault, erroneous results will be obtained. Therefore, it is advisable to check the windings as single phase windings prior to beginning winding rework.

6. **PERIODICITY OF IMPLEFICATION :**

1. During Annual over-haul

2. After rewinding or any major repair to winding

7. **AGENCY OF IMPLEFICATION :**

All Electric loco sheds, shops and Production Units.

8. **REFERENCE :**

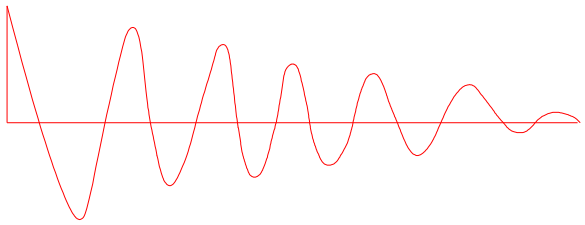
i) Reliability and improve the performance of auxiliary motor in service

ii) SMI No. 98 issued vide RDSO letter No. EL/3.2.70 dated 15.10.1982

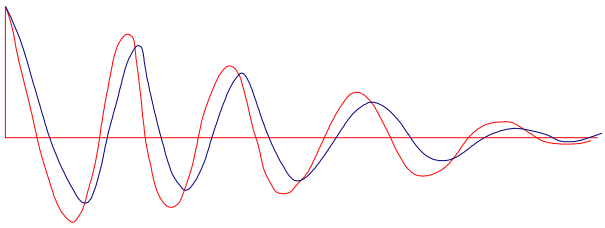
9. **DISTRIBUTION :**

As per enclosed list.

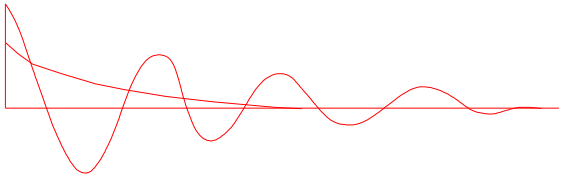
(P.K. Jain)
for Director General /Elect.



a) WAVE FORM FOR TWO GOOD WINDING UNDER TEST



b) WAVE FORM FOR A DEFECTIVE WINDING UNDER TEST



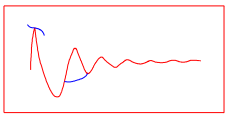
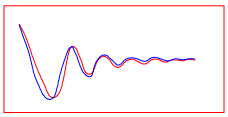
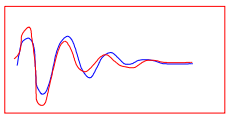
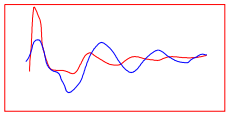
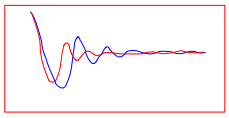
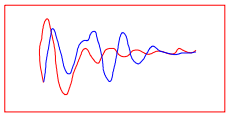
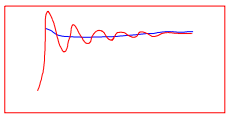
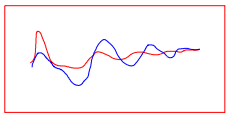
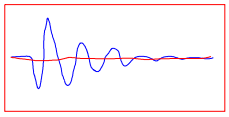
C) WAVE FORM FOR AN OPEN CIRCUIT

REF:–	SCALE:–	APPLICABLE FOR DG.

WAVE SHAPE OF WINDING UNDER TEST

RDSO. ELEC. DTE. FIG–1

Dt	
T	
D	
C	

WINDING DEFECTS	
	TURN TO TURN SHORT SAME PHASE
	COIL TO COIL SHORT SAME PHASE
	PHASE TO PHASE SHORT PARTIAL
	PHASE TO PHASE SHORT COMPLETE
	IMPROPER COIL CONNECTION
	REVERSE COIL CONNECTION
	OPEN COIL CONNECTION
	SHORT TO GROUND– PARTIAL
	SHORT TO GROUND– COMPLETE

REF :–	SCALE:–	APPROVED:– FOR DG.

WAVE SHAPE FOR TYPICAL WINDING FAULTS

RDSO.ELEC. DTE.

FIG–2

Dt	
D	
T	
C	