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MINISTRY OF RAILWAYS

REPORT ON INVESTIGATION OF AXLE SEIZURE CASES DUE TO TRACTION MOTORS (TM) BEARINGS OF 6FRA6068

Report No. RDSO/2021/EL/IR/0194(Rev '0')

October' 2021

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REPORT ON INVESTIGATION OF AXLE SEIZURE CASES DUE TO TRACTION MOTORS (TM) BEARINGS OF 6FRA6068

1. INTRODUCTION

DG(Elect)/RDSO vide letter no. EL/2.2.13, dt. 16.02.2021 formed a committee of following four officers to investigate into axle seizure cases due to bearings of TM type 6FRA6068:

- Shri Ganesh, CELE/ER and Convenor
- Shri M K Sinha, CEE/Loco/PTA
- Skri K Thourya, CELE/SCR
- Shri Anurag Agrawal, DSE/TM/RDSO

The term and reference of the committee was:

- Technical audit of Pus/Manufacturers of 3-phase traction motor type 6FRA6068.
- Root cause analysis of bearing seizures
- Deliberation of SMIs/MSs issued by RDSO to address the issue.
- Compliance of STRs with respect to capacity of manufacturers of associated components (CLW approved sources as well as BHEL/CGL/Saini suppliers).

With the mandate to investigate into the axle seizure cases of TM Bearings of TM type 6FRA6068, the committee deliberated on 08.03.2021 and necessity of other failures of TMs are required to be addressed which are affecting its reliability. These failures are listed as under:

a) Electrical failure of stators
b) Deliberation on performance of both schemes of rotors.
c) Use of right grade of carbon brushes in earth return circuit including its spring pressure.
d) Use of right lubricants for Gear Cases, TM bearings, etc.
e) Failures of TM type 6FXA7059
f) Manufacturing issues with armature shafts
g) Implementation of Modified MSU Drive System and MSU Bearings of WAP7/WAG9 locomotives.
h) Any other pending policy related issues affecting reliability of traction motors.
i) Study of contemporary designs of traction motors and their possibility of adoption.

The same was communicated to Railway Board vide ER's letter no. No. EL/TRS/02, 09.03.2021, which in turn was accepted by Railway Board vide Railway Board's letter no. 2005/Elect. (TRS)/440/18/5(3-ph), dt.11.03.2021.

The problem of seizure of TM bearings are not new and, in the past, following two committees worked on it and recommended series of measures to solve the problem:

1.1. Railway Board, vide letter no. 2005/ Elec. (TRS)/440/2, dated 27-06-2005 constituted a committee of three officers on technical requirements for vendors of important components of traction motors. Committee members were:

- Shri M.K.Singhal, DSE-3 RDSO and Convener
- Shri Ganesh, Sr DEE(RS)CNB
- Shri A.K.Rastogi, Dy GM/CLW

1.1.1. The committee studied the problem in detail, visited the manufacturers of MSUs and magnet frames and submitted a report along with their recommendations to Board.

1.1.2. After examination of the report of the committee of three officers, to formulate technical requirements for vendors for vital components of traction motors of conventional as well as

three phase locomotives and considering the importance of quality and dimensions of various mechanical assembly components (i.e labyrinth, end frames, etc.) of Traction Motors and MSU tubes and hence requirement of accountability of a single agency, Railway Board vide its letter **2005/Elect.(TRS)/440/2 , dt.04.04.2007** decided that:

1.1.2.1. The magnet frames shall be procured along with its associated components by the workshops and CLW. For maintenance requirement in electric loco sheds and workshops, driving end and non-driving end components of magnet frames shall be procured as separate sets and replaced as per the requirement.

1.1.2.2. The MSU tube shall be procured along with its associated components by the workshops and CLW. However, for overhauling MSU assemblies in workshops their components should be procured and replaced in sets.

1.1.3. Accordingly, RDSO vide letter no. 3.2.172, dt. 26.06.2007 and 3.2.182, dt. 31.07.2007 issued detailed Policy on" Sources on Vital Components of Traction Motors of Conventional as well as Three Phase Electric Locos".

The following Schedules of Technical Requirements may be adopted for approval of sources for various requirements:

a) Schedule of Technical Requirements for magnet frames of Hitachi Traction motors and assembly components (STR-17)
b) Schedule of Technical Requirements for MSU tubes of Hitachi TMs and WAG9/WAP7 loco TMs and assembly components (STR-18).
c) Schedule of Technical Requirements for mechanical rehabilitation/ reconditioning of magnet frames of TAO659 and Hitachi TMs (STR-19).
d) Schedule of Technical Requirements for manufacture, supply of mechanical assembly components of three phase electric loco traction motors (STR-21).

Among other recommendations, important recommendations pertain to the terms of reference of the committee are listed below:

1.1.4.Machining requirements

- All critical machining operations should be carried out on CNC bed machines of appropriate accuracy levels.
- Use of three-dimensional Coordinate Measurement Machines of required accuracy levels by the manufacturers may be made mandatory during inspection of the end products. Alternatively, sensor probe attachment on a CNC set up can be used for carrying out three-dimensional measurements.
- The manufacturer should submit manufacturing/machining process along with measurement plan as a part of Quality Assurance Plan (QAP). The approval of the vendor should be subject to approval of the proposed QAP by RDSO and clearance of prototype units manufactured and inspected as per the QAP.

1.2. From 2007 onwards, based on above STRs, vendors were approved. But in 2009, there was spate of seizure of drive and non-drive end labyrinths of traction motors type 6FRA6068. Use of mild steel in place of SGCI (Spheroidal Graphite Iron Castings) casting for assembly components was

attributed to main cause of seizure of bearings. SGCI, the originally recommended material by OEM has got less thermal expansion than that of mild steel and so it has been found more appropriate for this application where tolerances are of the order of few microns.

1.2.1. Before CLW could have cut in the adoption of SGCI castings for end fittings, there had been a surge of labyrinths seizure. CLW and RDSO jointly investigated the reason of labyrinths seizure and found the mild steel material with in-adequate clearances along with run out of concentricity of bores of stators and parallelism of spigots with respect to stator axis are the main reasons of bearing seizure. There had been cases of bearing seizure due to labyrinths with improper dimensions.

1.2.2. Railway Board, vide Letter No. 2002/Elect(TRS)/441/14 dated 19.02.2009 constituted another committee of two officers to investigate into the problem of seizure of bearings and recommend action plan to eliminate the same:

- Shri Ganesh, Director Standard Electrical/TM /RDSO
- Shri Ajai Goswami, Dy.CEE/TMM/CLW

1.2.3. After joint investigation, major causes of bearing seizures were identified and an action plan to eliminate the same was prepared. Important recommendations are reproduced as under:

1.2.4. Major recommendations of the committee which were implemented are as under:

1.2.4.1. CLW already changed the material of labyrinths from mild steel to SGCI & clearances between the labyrinths had also been re-worked out as 0.75 mm-0.94 mm in addition to increased interference between labyrinth & rotor shaft in line with RDSO's MS 314. SGCI Labyrinths of revised clearances were cut-in from loco no TPP-45 (WAP-7:30245) & TG-185(WAG-9:31206) and onwards.

1.2.4.2. CLW to use proper fixtures to ensure concentricity and parallelism for manufacturing of stators while machining.

1.2.4.3. Machine needs to be calibrated and a practice should be evolved to calibrate the same with test bar, whenever a new job is taken.

1.2.4.4. CLW to commission a double-ended horizontal boring machine with rotating bed under M & P program of year 2009-10.

1.2.4.5. CLW to cut-in the NDE End frames with grease escape hole for NDE bearings in traction motors on receipt of material from trade.

1.2.4.6. RDSO issued a MS to all zonal railways to incorporate grease escape hole for NDE bearings.

1.2.4.7. Strict compliance of STR 21 for assembly components of three phase traction motors must be ensured while carrying out inspections of these materials and any non-compliance shall be immediately communicated to RDSO for suitable action.

1.3. Modified design of MSU drive system for WAP7/WAG9 class of locomotives with use of taper roller bearings having segregation of lubrication of gear and pinion from MSU bearings

1.3.1. In order to address the perpetual problem of ingress of gear case oil into traction motor DE bearings, RDSO and CLW took a joint project for segregation of lubricants of gear case and DE of Motor Suspension Unit (MSU). Accordingly, a Specification No. RDSO/2006/EL/SPEC/0047 (Rev.'0') was prepared for design, manufacturing, supply, and fitment of modified motor suspension unit drive system for WAP7/WAG9 class of locomotives.

1.3.2. It is intended to develop a modified design of MSU drive system for WAP7/WAG9 class of locomotives with use of taper roller bearings having segregation of lubrication of gear and pinion from MSU bearings and higher expected life.

1.3.3. Railway Board in turn placed POs on M/s TIMKEN and M/s SKF in 2008, but the field trial could not commence, mainly because of wrong supply of gears.

2. BACKGROUND

2.1. In the recent past, there has been surge in drive end (DE) bearing seizure cases of TMs and these cases of irrespective of the makes of TM. Majority of the loco sheds have taken preventive actions after observing various stages of seizure of bearings of TMs. These sheds have identified TMs where there is gear case oil ingress in TM DE bearings and washing out its grease. Such TMs have been removed from the service and measurements of critical dimensions of labyrinths were found to be out of tolerances. These are potential bearing seizure cases which have been prevented by good maintenance practices followed by the sheds. In fact, in TMs it is practically impossible to carry out root cause analysis (RCA), once the bearing seizure takes place. Sheds which have been weeding out TMs where gear case oil ingress has already occurred, have got relatively less, even nil line failure of TM bearing seizure.
Hence, the stage before DE bearing seizure is gear case oil ingress in TM DE bearings.

2.2. System of common lubrication of gears and DE bearings of motor suspension unit (MSU) has led to use of less viscous gear case oil unlike the more viscous oil used in tap changer locomotives, where gears are lubricated with more viscous oil and DE bearing of MSU is lubricated with grease, i.e. there is segregation in lubrication system of gears and DE bearings of MSUs. Because of less viscous gear case oil, the accuracy of dimensions of labyrinths become more critical and without the precise machining of labyrinths, resulting in excess clearances leads to gear case oil ingress in DE bearings of TMs. This phenomenon was understood in the early days of introduction of 3-phase drive locomotives and so a project was taken by RDSO for segregation of lubrication of gears and DE bearings of MSU, which couldn't be implemented as the materials were not supplied after placement of Pos by CLW.

2.3. In the past, two committees investigated the problems of bearing seizures of TMs and inaccuracy in dimensions of mechanical components were attributed to be the main reason of TM bearing seizures, Subsequently, as long as these recommendations were adopted and dimensions of mechanical components have been kept within tolerances, seizures don't take place. It has been seen that with passage of time slackness in maintenance of dimensions in the name of meeting targets of production, leads to seizure of TM bearings after certain intervals. In order to meet periodic phenomena of slackness in quality is required to be addressed which has been deliberated by the committee.

3. METHODOLOGY

3.1. Because of lockdowns and restrictions ongoing pandemic of COVID-19, the committee could not carry out technical audits of the manufactures of traction motors. Therefore, the committee decided to carry out investigations virtually.

3.2. Study of two old reports of the Committees constituted by Railway Board (vide letter no. 2005/ Elec.(TRS)/440/2 , dated 27-06-2005 and 2002/Elect(TRS)/441/14 dated 19.02.2009) on the

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Ganesh **M K Sinha** **K Thourya** **Anurag Agrawal**

bearing seizure of traction motors and gap in the compliance of the recommendations circulated to all concerned by RDSO vide letters no. 3.2.172, dt. 26.06.2007 and 3.2.182, dt. 31.07.2007.

3.3. Once the seizure of bearings take place, it is almost impossible to identify the exact cause of failure. Gear case oil ingress into TM through DE bearings is **a stage prior to seizure of bearings.** Analysis of critical dimensions of traction motors, which have been removed from the locomotives due to oil ingress.

3.4. EDIE/RDSO at Bhopal was also requested to, carry out measurements of at least six stator frames and all assembly components, ready for assembly at BHEL, Bhopal and CGL selected randomly, as per respective drawings on 3-D CMM, jointly witnessed (vendor and RDSO), vide letter no. EL/TRS/02/EDIE, dt. 26.04.2021.

3.5. Study of Failure details from Railways.

3.6. Study of approved QAPs of BHEL, SAINI, CGL and other approved sources of traction motors with details of their vendors with respect to relevant STRs.

3.7. RCA shall rule out if components are manufactured as per drawings before recommending any modifications.

3.8. Study of capacity of the approved sources with respect to machinery and plants available as per respective STRs.

3.9. Study of documents on procurement of raw materials, if the materials used for manufacturing of TMs, are from approved sources.

3.10. Study of RDSO's report no. 189 on Technical Report on Scheme I and Scheme II rotors of Traction Motors type 6FRA6068 of 3-phase drive Locomotives.

3.11. In addition to the above all other aspects related to seizure of TM bearings like correct usage of earth return brushes, compliance of CLW's STR 0349 for manufacturing of armature shafts, gear case oil, grease used in TM bearings, etc.

3.12. Following letters were sent to all manufactures of TM, manufacturers of mechanical components of TMs, armature shafts, VPI resin manufactures:

- Compliance of CLW's STR no. CLW/2008/3PHTM/STR/001, Aug 2008, for manufacturing TMs
- Compliance of RDSO's STR no. 21 for manufacturing mechanical components of TMs
- Compliance of CLW's STR no. 0394 for manufacturing TMs
- Compliance of CLW's STR no.0394/Rotor Shaft (Finished) ALT-1, Nov 2009
- Supply details of VPI Resins

3.13. The committee, during meeting on 08.03.2021 through a video conference (VC), planned to carry out detailed technical audits of approved sources of traction motors (TM) and their associated components, which could not be done because of pressure of production targets in Production Units, followed by COVID-19 infections to members, etc. During ongoing pandemic, lockdowns and other associated restrictions, the committee is not able to move out for the technical audits. Apart from regular discussions, deliberations and interactions, the committee met on 24.05.2021, 16.07.2021 and 10.10.2021 through a VC.

3.14. Major highlights of the meetings were as under:

3.14.1. A Report of RDSO (No. RDSO/2009/EL/IR/0138(Rev. '0') of July 2009 on Seizure of Bearings in Three Phase Traction Motors and Action Plan to Eliminate the Same was circulated among committee members on 19.04.2021. The report was studied carefully.

3.14.2. CELE/ER explained the members about the activities carried out in last two months for root cause analysis (RCA)of the subject problem.

3.14.2.1. Once the seizure of bearings take place, it is almost impossible to identify the exact cause of failure. So, 26 TMs of ELS, HWH, which were weeded out from the service, because of gear case oil ingress into TM and thus washing out of grease, were subjected to measurements of critical dimensions. **This is a stage prior to seizure of bearings.**

3.14.2.2. Two stator frames and with their associated components were randomly picked up and were subjected to measurements of various dimensions on 3-D CMM.

3.14.2.3. Measurements of critical parameters of labyrinths are out of tolerances. Parallelism & concentricity of both these stators are also out of limits.

3.14.2.4. These aberrations in manufacturing of assembly components and stator frames are responsible of gear case oil ingress. Exception report of measurements of these machines were sent to BHEL, Bhopal, vide letter no. EL/TRS/02/BHEL, dt. 26.04.2021 and BHEL was asked to send their representative for the joint inspection, which couldn't be done because of ongoing pandemic. BHEL replied to the letter and blamed excessive greasing as the root cause of bearing seizure which was suitably replied by RDSO and the committee on 10.05.2021. BHEL and other approved sources have never carried out any measurement of TM and its components involved gear case oil ingress.

3.14.2.5. In addition to this, as a part of root cause analysis, EDIE/RDSO at Bhopal was also requested to, carry out measurements of at least six stator frames and all assembly components, ready for assembly at BHEL, Bhopal and CGL selected randomly, as per respective drawings on 3-D CMM, jointly witnessed (vendor and RDSO), vide letter no. EL/TRS/02/EDIE, dt. 26.04.2021. Report of EDIE/RDSO was submitted vide his letter no. Inspn/BPL/Tech/05, dt. 27.05.2021 for measurements of mechanical components on 3-D CMM at BHEL, Bhopal and CGL. Measurements were within prescribed limits.

3.14.2.6. While investigating the problem of gearcase oil ingress in TM bearings, it has been observed that many of assembly components are not having details of manufacturers whereas some are having embossing of manufacturers, which are not approved by CLW.

3.14.2.7. For root cause analysis, following information was sought from CLW, vide letter no. EL/TRS/02/CLW, dt. 26.04.2021:

a) Approved QAPs of BHEL, SAINI, CGL and other approved sources of traction motors with details of their vendors.

b) Report of Compliance of RDSO's STR no. 21 for manufacturing of Traction Motors and its assembly components, vide letter no. CLW/TM/17281, dt. 05.03.2021 addressed to BHEL, Bhopal, with a copy to DSE/TM/RDSO, a committee member, technical audits of 11 sub-vendors of BHEL, Bhopal was undertaken by CLW.

3.14.2.8. CLW provided all the documents vide CEE/TM/CLW's letter no. CLW/TM/17280, dt. 05-07.05.2021 and the same can be summarised as under:

Out of nine approved vendors of mechanical components of BHEL, Bhopal, only four (one approved conditionally) were considered complying STR-21 for manufacturing of mechanical components of TMs. Hence, quality of components manufactured by these five firms is under cloud and these traction motors are likely to fail online sooner or later.

3.14.2.9. BHEL was asked to provide list of TMs manufactured with components, supplied by vendors which have not complied STRs, so that these TMs can be weeded out from the service before they fail online, vide letter no. EL/TRS/02/BHEL, dt. 10.05.2021, which is yet to be replied by BHEL.

3.14.2.10. BHEL is not following RDSO's letter no. EL/3.2.172 Dated 26.06.2007 on Procurement of Vital Components of Traction Motors of Conventional as well as

Three Phase Electric Locomotives, where BHEL is supposed to buy all TM components in Kit form from approved vendors instead BHEL is buying assorted components from different vendors. This was evident from the "Discrepancy Observed" in the summary of CLW's Technical audit report of 11 sources of BHEL.

3.14.2.11. QAP of CG specifies list of non-approved sources from which CG are sourcing assembly components, CLW was asked if an audit of these firms were also carried out.

3.14.2.12. There is no standard format of QAPs, such as activities in Final Inspections are not the same. CLW's Quality Procedure shall have guidelines on Standard Format of QAPs, CLW has been asked to share its copy.

3.14.2.13. There might be series of quality improvement measures taken by BHEL/CG/SAINI in last two years, for improvement in quality of assembly components, their testing, assembly procedure, final testing, etc. As per ISO9001 standards, these measures are to be incorporated in QAPs, which appears to be static since 2018. This appears that the quality is person oriented not system oriented.

3.14.2.14. With measurements of critical parameters of labyrinths and stator frames out of tolerances, prima facie, excessive clearances are leading into ingress of gear case oil into DE bearing and thus flushing out grease.

3.14.2.15. One of the manufacturers of assembly components of TM, which were having problem of gearcase oil ingress at ELS, HWH, confessed that only 20% of total components manufactured, were measured on 3-D CMM. The firm also agreed that proof marching of these components is done on normal lathe, where there is a possibility of excessive cuts, leading to excessive clearances in labyrinths. These activities are not in line with approved QAP.

3.14.2.16. Two Inspectors of CLW, who are involved in inspection of TM stators and its assembly components were also interviewed and the quality of inspection was sub-standard because of ignorance and workload.

3.15. CELE/SCR provided a list of 88 TMs which are having either dimensional issues or rubbing issues. Problem is common in all makes of TMs and all approved sources of assembly components.

3.16. All Railways were asked to provide data on various aspects of TM bearing seizure and maintenance practices, vide letter no. EL/TRS/02, dt. 01.06.2021. Data have been received from all Railways and the summary of the data is placed as Annexure I.

3.17. While analysing the data of electrical failures of data of traction motors, one of the reasons attributed by TMW, NK was quality of VPI resins and so M/s Wacker Chemie AG, Germany, the only source of VPI resin was asked to give the supply details of Wacker make silicon resins, vide letter no. EL/TRS/02/Wacker, dt. 19.06.2021 and 05.08.2021. Finally, the firm replied on 05.08.2021.

3.18. The same resin is being used by TMW, NK and other approved manufacturers of TMs for VPI of stators, while repairing. Therefore, to ascertain quantity of silicon resins from approved sources, number of stators repaired in last three years were asked by all concerned vide letter no. EL/TRS/02/BHEL, dt. 19.06.2021. Data from TMW, NK kas been received and the same is placed at Annexure IV.

3.19. Through the letter EL/TRS/02/BHEL, dt. 19.06.2021, the data on various types of rotors, repaired by TMW, NK and other approved manufacturers of TMs was sought which was replied by TMW, NK and the same is placed at Annexure V.

3.20. CLW has a good practice of running traction motors mounted on wheel sets for hours before the bearing temperature gets stabilized. In this process, a few traction motors/MSUs are rejected because of excessive temperature rise or improper meshing of gears. This practice prevents large number of line failures. In order to conclude the investigation, CLW was requested to provide data of rejection of TM/MSUs for FYs 2018-19, 2019-20, 2020-21 and 2021-22(till date), vide letter no. EL/TRS/02/CLW, dt. 30.06.2021. CLW sent the reply vide letter no. Mech/Loco/37, dt. 05.07.2021.

3.21. The committee has collected the data of failures of traction motors which are required to be compared with respect to total population of TMs in the service. It is therefore CLW was requested to provide total numbers of traction motors, type 6FRA6068 inducted into the system in since 2016 onwards, vide letter no. EL/TRS/02/CLW, dt. 15.07.2021, which was replied by CLW vide letter no. CEE/TM/Tech.Misc/21, dt. 17.07.2021.

3.22. With above background, the committee investigated further with following preliminary inference

a) Prima facie, lack of lubrication due to gear case oil ingress into DE bearing is one of the major reasons of seizure DE bearing of TMs type 6FRA6068.
b) Poor quality of Stator frames and its assembly components which are not being manufactured with M&Ps as recommended in STR-21 even by the approved vendors, may be because of gap in between increased requirements and their capacity.
c) Non-standard QAP with documents specific to a vendor without document number, etc. are forcing Inspecting agencies to be at the mercy of vendors, affecting the quality of inspection.
d) Machining of taper bore of Armature shafts of TM is critical in nature, if dimensions not as per drawings has resulted in loose racers, less radial clearances, or crack in racers. There is a CLW's STR no.0394 which lists out machinery and plants but does not mention plug gauge which is an essential tool for fitment of pinions. TOT documents will be referred.
e) Because of non-availability of proper grade of carbon brush used in earth return circuit, sheds are at times using sub-standard materials. RDSO's letter on grade of carbon brushes doesn't include grade of carbon brush used in earth return circuit in three phase locomotives, however the same is specified for Hitachi and TAO TMs.

3.23. Based on committee's decisions, following actions were taken:

3.23.1. RCA was carried out to rule out if components are manufactured as per drawings before recommending any modifications. End components of traction motors which were involved in oil ingress were measured on 3-D CMM. Measurements of critical parameters of labyrinths were out of tolerances. Parallelism & concentricity of stators are also out of limits. Higher clearances of labyrinths fail to work as mechanical seals for DE bearings of TM against gear case oil. Further, Parallelism & concentricity of stators out of limits results in rubbing of end components, excess clearances at certain locations, axial component of forces on DE bearings and air gap eccentricity between stator and rotors throughout the axis.

3.23.2. An air gap eccentricity results in increased levels of vibration due to the uneven magnetic pull it creates between the circumference of the rotor and stator bore. Over time, these elevated levels of vibration can result in excessive movement of the stator winding, which could lead to increased friction and eventually a turn-to-turn, coil-to-coil, or ground fault.

3.23.3. Sudden increase in electrical failure of stators can be attributed to this air gap eccentricity.

Increases in mechanical vibration accelerate bearing failure, which could seize the shaft and overheat the windings or allow additional movement of the shaft leading to a rotor/stator rub. The uneven magnetic stresses applied to the rotor, coupled with the increased vibration, will also contribute to mechanical looseness developing in the rotor assembly. This is one of the reasons of rotor bar crack. Risk of rotor pull-over increases exponentially with the amount of air gap eccentricity.

3.23.4. CLW maintains the data of total number of traction motors inducted in the system and the same was collected for last five years.

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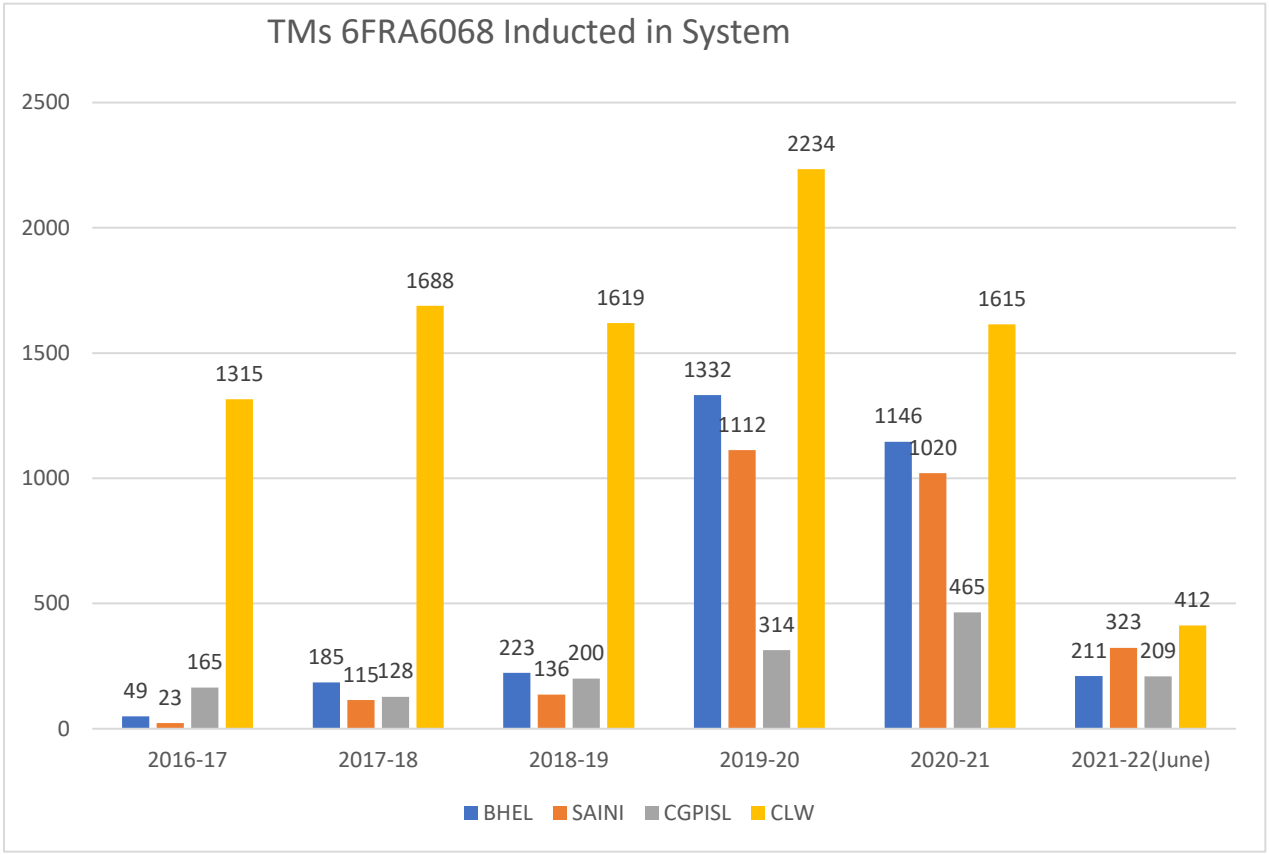
YEAR	BHEL	SAINI	CGPISL	CLW	TOTAL
2016-17	49	23	165	1315	1552
2017-18	185	115	128	1688	2116
2018-19	223	136	200	1619	2178
2019-20	1332	1112	314	2234	4992
2020-21	1146	1020	465	1615	4246
2021-22(June)	211	323	209	412	1155



Following observations can be made from the above

a) Requirement of TMs has increased almost two folds since 2018-19 onwards.
b) BHEL's supply has increased about six times since 2019-20 onwards
c) CGPISL's supply has increased about two times since 2019-20 onwards
d) SAINI's supply has increased about eight times since 2019-20 onwards
e) CLW's production has been almost consistent nearly 1500-1600 and it was once 2234 in 2019-20.

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Decision to suddenly increase in requirement of traction motors has not commensurated with the increase in capacity of manufacturing of mechanical components of TMs. It is evident from the compliances of STRs received from various approved sources of TMs.
Permission given to BHEL to use mechanical components from nine BHEL's approved sources without ensuring compliance of STR-21 has been detrimental. Out of nine approved vendors of mechanical components of BHEL, Bhopal, only four (one approved conditionally) were considered complying STR-21 for manufacturing of mechanical components of TMs. Hence, quality of components manufactured by these five firms is under cloud and these traction motors are likely to fail online sooner or later.

3.23.5. CLW and DMW test of TMs mounted on wheel sets. During these tests, there are rejection of TMs on various accounts. Data from CLW has been collected which are given as under:

TM FAILED DURING TESTING IN 2018-19

SL	Make of TM	No. of TM tested on wheel sets	FAILURE REASON				Total TM Failed
			No. of TM failed/ rejected due to DE bearing Temp. High	No. of TM Failed/ rejected due to NDE bearing Temp. High	Inadequate Meshing of gears (Backlash Low/High)	Any other reasons (Abnormal Sound/IR value zero/Helicoil Problem)	
1	CLW	1682	2	0	23	213	238
2	BHEL	170	0	0	1	23	24
3	SAINI	101	0	0	0	1	1
4	CGL	153	0	0	0	7	7

TM FAILEDDURING TESTING IN 2019-20

SL	Make of TM	No. of TM tested on wheel sets	FAILURE REASON				Total TM Failed
			No. of TM failed/ rejected due to DE bearing Temp. High	No. of TM Failed/ rejected due to NDE bearing Temp. High	Inadequate Meshing of gears (Backlash Low/High)	Any other reasons (Abnormal Sound/IR value zero/Helicoil Problem)	
1	CLW	1920	7	0	22	247	276
2	BHEL	201	0	0	1	14	15
3	SAINI	223	0	0	0	0	0
4	CGL	14	0	0	0	1	1

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TM FAILEDDURING TESTING IN 2020-21							
SL	Make of TM	No. of TM tested on wheel sets	FAILURE REASON				Total TM Failed
			No. of TM failed/ rejected due to DE bearing Temp. High	No. of TM Failed/ rejected due to NDE bearing Temp. High	Inadequate Meshing of gears (Backlash Low/High)	Any other reasons (Abnormal Sound/IR value zero/Helicoil Problem)	
1	CLW	1476	1	0	15	164	180
2	BHEL	343	3	0	1	35	39
3	SAINI	223	0	0	0	0	0
4	CGL	38	0	0	0	1	1

TM FAILEDDURING TESTING IN 2021-22(Till June2021)							
SL	Make of TM	No. of TM tested on wheel sets	FAILURE REASON				Total TM Failed
			No. of TM failed/ rejected due to DE bearing Temp. High	No. of TM Failed/ rejected due to NDE bearing Temp. High	Inadequate Meshing of gears (Backlash Low/High)	Any other reasons (Abnormal Sound/IR value zero/Helicoil Problem)	
1	CLW	378	0	0	0	92	92
2	BHEL	17	0	0	0	2	2
3	SAINI	14	0	0	0	0	0
4	CGL	10	0	0	0	0	0

Percentage of TMs rejected during Internal Tests at CLW				
Make	2018-19	2019-20	2020-21	2021-22 (June)
CLW	14.15	14.38	12.20	24.34
BHEL	14.12	7.46	11.37	11.76
SAINI	0.99	0.00	0.00	0.00
CGL	4.58	7.14	2.63	0.00

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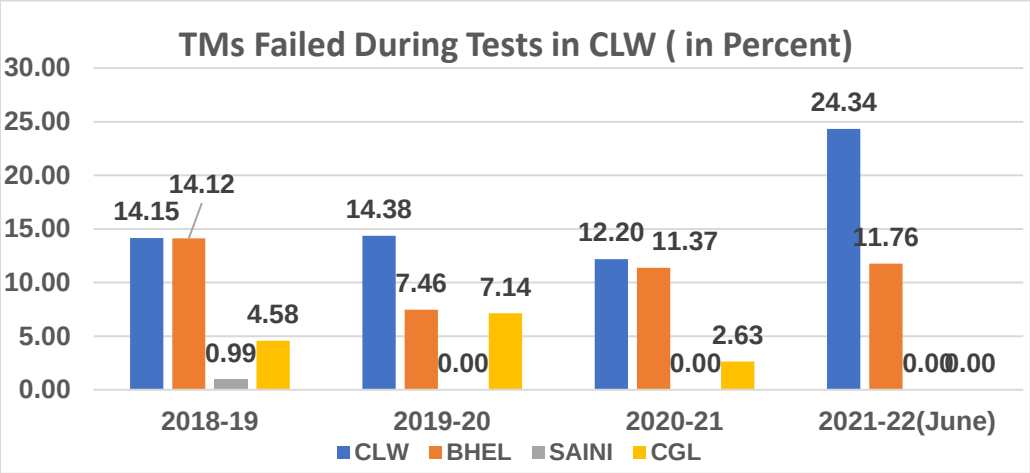

Above data of internal tests statistics at CLW reveals that rejection of CLW's manufactured TMs has increased in last years. Rejection of BHEL TMs has been consistently high since 2018-19.

These rejection of TMs during tests have prevented seizures of bearings online. Data of DMW also indicates the similar trend. BLW tests TMs mounted in bogies which doesn't reveal some defects such as inadequate meshing of gears/backlash, etc. This facility shall be available with all PUs and manufacturers and repairers of TMs.

CLW's data reveals that there are no design related issues in mechanical components of TMs rather it is just lack of consistency in quality, which can be attributed to non-compliance of STR-21, Work Instructions as per TOT documents and various reliability measures issued by RDSO/CLW.

3.23.6. Letters were sent to all approved sources for compliance of STR-21. For this a format was also circulated which included self-declaration on capacity of the vendors with respect to availability of M&Ps as per respective STRs. Ownership of M&Ps as per respective STRs shall be also declared.

3.23.7. Preparation of Standard Format of QAP with mandatory measurements of critical parameters by Inspecting agencies. CELE/SCR shared a format being used in SCR for measurement of critical parameters, which has been deliberated.

3.23.8. The system of Inspection Plan followed by RITES was deliberated in detail and recommended to be adopted by IR with necessary modifications.

3.23.9. RDSO has shared a Proposal of new Scheme for manufacturing of TMs with rotors – Sch I and Sch-II, vide letter no. EL/3.2.182, dt. 31.01.2020, which has also been deliberated.

3.23.10. In order to check the quality of shafts, compliance of CLW's STR 0394 by approved vendors were also collected. Possibility of use of digital plug gauge shall be explored by RDSO.

3.23.11. Proper grade of carbon brush used in earth return circuit and their sources shall be specified.

3.23.12. TOT documents shall be referred for the maximum number/weight of balance weights for balancing of rotors.

3.23.13. Failure of stators shall be made available by RDSO for further deliberations.

3.23.14. Scope of Technical audits, which could have followed by PUs/RDSO shall be listed out for the Inspecting Agencies to ensure quality of materials.

3.23.15. For this, inspection of few approved sources were carried out.

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4. Discussions:

4.1. Technical Requirement of Quality of Machining

4.1.1. Quality of machining of all of these vital components has been a major concern. The machining operations are complex due to peculiar construction of the components and the tolerances in dimensions are very close. The present set of vendors use manual methods of machining trying to achieve the required precision in dimension through multiplicity of manual operations. Often the accuracy of the machines and skill levels of operators become critical parameters. The end products are not up to the level of accuracy that is desirable for these applications. This has often resulted in problems in assembly of the TMs, premature bearing failures and premature condemnation of the MSU tubes due to fast wear out of the critical dimensions in service. The problem is furthermore serious in three phase loco components due to further lower tolerance levels and complex construction.

4.1.2. In order to obtain required consistency in quality of machining, the committee, nominated by Railway in 2005, was of the view that manufacturing of these components on CNC machines of appropriate accuracy levels was desirable and it would have favorable impact on the quality of these components. All critical machining operations should be carried out on CNC bed machines of appropriate accuracy levels.

4.1.3. Further, making the use of CNC machines mandatory in itself is no guarantee for quality of these components since there is no in-process inspection and individual vendors may manufacture the component on conventional machines even though possessing CNC machines in their premises. As a solution it has been recommended that use of three-dimensional Coordinate Measurement Machines of required accuracy levels by the manufacturers may be made mandatory during inspection of the end products. This will ensure an accurate inspection and verification of all vital dimensions of the components.

4.1.4. In view of above, machining of critical dimensions of these components and their measurements on three-dimensional measuring set up as mandatory requirements have been included as a part of Quality Assurance Plan (QAP) in the Schedules of Technical Requirements.

4.1.5. Since different manufacturers employ different machining operations for the components, submission of manufacturing/machining process along with measurement plan as a part of QAP has been proposed. The approval of the vendor should be subject to approval of the proposed QAP by RDSO and clearance of prototype units manufactured and inspected as per the QAP.

4.2. Technical Requirement of Quality of Castings

4.2.1. The quality of casting plays an important role in TM mechanical components. Only two sources Kharagpur Metals and Simplex have their captive foundry units doing casting themselves. Other vendors procure the castings from their sub-vendors.

4.2.2. In cases where the vendors don't have their captive foundries, they should fulfill the following conditions:

a) They should use castings from foundries certified as Class 'A' by RDSO as per IS : 12117-1996. The certification should be currently valid.

b) The machinist vendor should furnish undertaking from casting manufacturer showing long term commitment to supply castings to the machinist vendor.
c) The Quality Assurance Plan (QAP) of the foundry should formulate part of approval process for the individual machinist vendor.

4.2.3. The committee, nominated by Railway in 2005, observed that very often the castings didn't have any traceability of their makes marked on them making it impossible to trace a failure to the specific foundry from where it was procured by the manufacturers of TM mechanical components/MSUs. It is therefore necessary that all cast items like MSU tubes, TM mechanical components etc are marked with an individual serial number by the foundry for easy future identification and traceability. A marking scheme for the castings has been included in the QAP of cast items. Each cast components should have individual distinct number embossed by the foundry so as to ensure its traceability. A sample marking on suspension tube is given below:

At least two letter initial of the foundry + two digits of year of manufacturing code + 4 digits of unique serial number + at least two digits of customer code for the foundry) (**Example: SMP/06/3991/SMP**).

4.2.4. Since there is no mandatory stage inspection at the casting level, sometimes casting of poor quality with blowholes etc. crept into the system. Since blowholes are detected by the machinist vendors at a later stage, they tend to pass off the item after reworking with welding etc. Stage inspection of the casting at the foundry level itself will help in detecting casting defects and ensuring their quality.

4.2.5. In order to achieve the above objectives, provisions have been made in the STRs for sourcing of the castings only from RDSO approved Class 'A' foundries with QAP of the casting also to be made as a part of QAP of the machined product. Provision in the QAP have also been made to include stage inspection of the casting at the foundry before dispatch to the machinist vendor.

5. Failure Mechanism

5.1. RCA was carried out to rule out if components are manufactured as per drawings before recommending any modifications. End components of traction motors which were involved in oil ingress were measured on 3-D CMM.
a) Measurements of critical parameters of labyrinths were out of tolerances.
b) Parallelism & concentricity of stators are also out of limits.

5.1.1. Higher clearances of labyrinths fail to work as mechanical seals for DE bearings of TM against gear case oil.

5.1.2. Further, Parallelism & concentricity of stators out of limits results in rubbing of end components, excess clearances at certain locations, axial component of forces on DE bearings and air gap eccentricity between stator and rotors throughout the axis.

5.1.3. An air gap eccentricity results in increased levels of vibration due to the uneven magnetic pull it creates between the circumference of the rotor and stator bore. Over time, these elevated levels of vibration can result in excessive movement of the stator winding, which could lead to increased friction and eventually a turn-to-turn, coil-to-coil, or ground fault.

5.1.4. Sudden increase in electrical failure of stators can be attributed to this air gap eccentricity.

5.1.5. Increases in mechanical vibration accelerate bearing failure, which could seize the shaft and overheat the windings or allow additional movement of the shaft leading to a rotor/stator rub. The uneven magnetic stresses applied to the rotor, coupled with the increased vibration, will also contribute to mechanical looseness developing in the rotor assembly. This is one of the

reasons of rotor bar crack. Risk of rotor pull-over increases exponentially with the amount of air gap eccentricity.

5.2. SGCI as Material of casting

5.2.1. Material of casting shall be SGCI, the originally recommended material by OEM has got less thermal expansion than that of mild steel and so it has been found more appropriate for this application where tolerances are of the order of few microns. Use of mild steel in place of SGCI, having more thermal expansion at operating temperature leads of looseness of outer racers of bearings in stator end covers housings, less radial clearances resulting in rubbing of end components. This will lead to heat generation and melting of grease and seizure of bearings.

5.2.2. Very often, such components which rubbed are manually grounded and ends up in uneven clearances/more clearances- ingress of gearcase oil in TM DE bearings.

5.2.3. The problem gets aggravated with stators with higher Run out of concentricity of stator bores and run out of parallelism of spigot and stator axis. To overcome this problem, manufacturers will tempt to supply the labyrinths with higher clearances. This will lead to ingress of gearcase oil in TM DE bearings.

5.3. Non-compliance of STR-21

5.3.1. Recently production of WAG9/WAP7 locomotives has increased more than two folds.

5.3.2. Capacity augmentation by manufacturers of TM mechanical components has not matched with sudden increase in requirement of TMs in last three years. Majority of these manufacturers are also manufacturing MSU and its assembly components which require similar M&Ps. For an approved source for both TM mechanical components and MSUs & and its assembly components, it has been practically four times increase in production.

5.3.3. No assurance of assured business because of existing tendering system and uncertainty of production targets has prevented approved manufacturers not to invest in M&P. In order to meet their supply commitments, they have outsourced the proof/rough machining on conventional lathe machines. Since no drawings of proof machines components exit, there is no checking of dimensions of proof machine components. Any excess cut is given in proof machines can't be rectified in final machining and so the possibility to allowing such materials can't be ignored. Such labyrinths with excess clearances ingress of gearcase oil in TM DE bearings.

5.3.4. Permission given to BHEL to use mechanical components from nine BHEL's approved sources without ensuring compliance of STR-21 has been detrimental. Out of nine approved vendors of mechanical components of BHEL, Bhopal, only four (one approved conditionally) were considered complying STR-21 for manufacturing of mechanical components of TMs. Hence, quality of components manufactured by these five firms is under cloud and these traction motors are likely to fail online sooner or later.

5.3.5. While investigating the problem of gearcase oil ingress in TM bearings, it has been observed that many of assembly components are not having details of manufacturers whereas some are having embossing of manufacturers, which are not approved by CLW.

5.3.6. BHEL is not following RDSO's letter no. EL/3.2.172 Dated 26.06.2007 on Procurement of Vital Components of Traction Motors of Conventional as well as Three Phase Electric Locomotives, where BHEL is supposed to buy all TM components in Kit form from approved vendors instead BHEL is buying assorted components from different vendors. This was

evident from the "Discrepancy Observed" in the summary of CLW's Technical audit report of 11 sources of BHEL.

5.3.7. QAP of CG specifies list of non-approved sources from which CG are sourcing assembly components, CLW was asked if an audit of these firms were also carried out.

5.3.8. Non-compliance of TOT documents on work instructions while welding of stator chambers with laminations for manufacturing of machined stators has led to higher Run out of concentricity of stator bores and run out of parallelism of spigot and stator axis.

5.3.9. Machining of spigots for mounting of end shield is equally critical as both the end shields must be concentric with stator bores. ABB in its TOT documents demonstrated the process of machining of end shield, which is equally critical to ensure concentricity.

5.3.10. It has been found QAPs are not being approved before prototype inspection and so there is no routine test plan for inspecting agencies.

5.3.11. Issues related with current practice of full greasing were also discussed in detail. With full greasing only, it is possible to get sample of old grease, flushed out during re-greasing, which is tested to determine the metal contents giving tell-tale signs of the health of bearings, rubbing of labyrinths, looseness of racers, etc . This practice has prevented large number of bearing seizures on line.

Further, the apprehension that excessive greasing is the cause of bearing seizure is far from reality, reasons being- all our bearing housings are having grease escape hole which provides the escape route for excess grease, secondly since bearings housing are metallic, there is no issue of amount of heat dissipation to ambient, only after few minutes, an equilibrium temperature is achieved.

Because of tolerances in mechanical components, loss/consumption of grease during service will not be uniform in a given period for all TMs of the same type and so re-greasing with fixed measured amount of grease at a given periodicity will lead to starvation of grease in some bearings where consumption is more. Re-greasing with fixed measured amount of grease can only suggestive when bearings are regularly monitored whereas in locomotive application bearings can be accessed only when the loco come for maintenance.

5.4. Rotor Shafts:

5.4.1. In order to check the quality of shafts, compliance of CLW's STR 0394 by approved vendors were collected. Machining of taper bore of Armature shafts of TM is critical in nature, if dimensions not as per drawings has resulted in loose racers, less radial clearances, or crack in racers. CLW's STR no.0394 which lists out machinery and plants but does not mention plug gauge which is an essential tool for fitment of pinions.

5.4.2. QAPs of manufacturing of shafts don't include salient features of TOT documents.

5.5. Garde of carbon brush used in earth return circuit

Because of non-availability of proper grade of carbon brush used in earth return circuit, sheds are at times using sub-standard materials. RDSO's letter on grade of carbon brushes doesn't include grade of carbon brush used in earth return circuit in three phase locomotives, however the same is specified for Hitachi and TAO TMs.

5.6. Lubricants for Gear Case oil and TM grease:

5.6.1. Railways have reported use of EXXON make gear case oil instead of approved gear case oil **Servo Syn 460RR**.. Similarly, in place of approved grease - Servoplex SHC-120 of IOC,

Railways have used SYNTHPLEX 2 grease of M/s Balmer Lawrie and Co. Ltd/Kol for lubricant of TM bearings.

5.6.2. Seizure of bearings of traction motors and motor suspension tubes will take place due to application of wrong grease and intermixing of greases, leading to derailment & blocking of sections.

5.6.3. Grease/lubricants for a specific bearing is approved after extensive field trials by RDSO. Intermixing of two different brands of greases are not allowed without RDSO's approval. Further, recommendations of bearing manufacturers are considered by RDSO before approving the grease/lubricants even for trial purpose.

5.6.4. This may lead to ingress of gearcase oil in TM DE bearings at higher operating temperature. Intermixing of TM bearing grease will also lead to bearing seizure.

5.7. Electrical Failures of Traction Motors

5.7.1. **Stator Winding Failures :** Now all Stators are being manufactured with modified design as per MS 356 which has brought down failures of traction motors substantially. However, there are still cases of stator winding failures.

Main failures in stators are listed below because not following the insulation scheme recommended in MS356:

a) Inter turn short/flashed in brazed joints at NDE side
b) Stator Winding Earthed/Flashed with Slots (NDE & DE) on account of Insulation Failures
c) Improper VPI of stators

Brazing failures are also on account of lack of area contacts- rectangular cross-section of conductors is brazed with round cross-section of phase rings. This can be avoided by using phase rings with square/rectangular cross-sections.

Failure at Brazed Joints at NDE Side: Following action plan is proposed -

a) Use of phase rings with square/rectangular cross-sections instead of existing round cross-section to increase brazing area of contact.
b) To provide tying between all series joints & interconnection (jumpers) with help of nomex-felt & glass tape to prevent movements.
c) Since the space between two adjacent knuckles is very less, crossing of two parallel copper conductors' end one above other at knuckle portion, leads to rubbing of two coils knuckle and so damaging insulation. To prevent this rubbing two adjacent knulckles should cross on each other in overhang portion in such a way so that there is sufficient space between knuckle & lead. Provision of extra layer of nomex in between is proposed.

Other failures on account of damage to Insulation:

a) Following MS-356 rigorously.
b) Rotating curing is proposed immediately after VPI to ensure uniform distribution of resin followed by stationary curing, as resin will not ooze out during curing statically & bonding will be adequate.

5.8. Use of VPI Resins of Approved Source

TMW/NK reported improper VPI of stators as one of the reasons of failures of stators winding with slots. There has been difference in VPI of failed stators. Type of VPI resin is Silicone resin,

manufactured by only source, i.e. Wacker Chemie AG. The committee asked Wacker Chemie AG to provide supply details of VPI Silicone Resin for last five years. From the data collected from Wacker Chemie AG, which is placed at Annexure II, it is evident that more traction motors were manufactured/repaired in the same period than the actual supply of VPI resins to various manufacturers of TMs. This requires further investigation.

5.9. Rotor Schemes:

RDSO's Proposal of new Scheme for manufacturing of TMs with rotors – Sch I and Sch-II, vide letter no. EL/3.2.182, dt. 31.01.2020, has also been deliberated in detail. Recommendations of the report is accepted. Increasing the share of Scheme, I gradually in total production of rotors is acceptable both from reliability and economy point of view. Hence recommendations are as under:

5.9.1. All future production of TMs at CLW shall be with 80% Scheme I and 20% with Scheme -II design rotors.

5.9.2. Initially all future procurement by CLW/DLW/DMW and Zonal railways with 20% Scheme I and 80% with Scheme -II design rotors. Gradually the procurement may be carried out with 50% Scheme I and 50% with Scheme -II design rotors in the next five years to get the cost advantage. by 2026.

5.9.3. All repairs of rotors shall continue with Scheme I design.

5.9.4. Review of the policy can be carried out after 5 years after implementation of the above recommendations.

5.9.5. RDSO will also examine the modified Zr-Cu stampings developed by TMW.

5.10. Conclusions:

5.10.1. From the discussion above, it is evident that the problem of seizure of TM bearings is not new and already two committee have worked in the recent past. Recommendations of these committee were implemented and necessary STR/MS/SMIs have been issued.

5.10.2. Further, statistics shows there is no design issue in mechanical components of TMs. However, some design improvements have been recommended in stators winding failures.

5.10.3. Despite all available instructions and documents, gradual deterioration of implementation of the same takes place, most of the time out of ignorance in the field levels. Work instructions available in the fields are seldom being referred to. Even field officers/supervisors/staffs are at times ignorant of instructions issued in the past. Formats for recording data/measurements are required to used for quality control. This lack of continuity of implementation of various reliability measures taken in the past shall be arrested. RDSO has made all STR/MS/SMIs and some technical reports on its website, but in PUs it is generally missing.

5.10.4. Inspection of materials is of the paramount importance which is required for better quality control of all the incoming materials. Quality of inspection at PUs takes back seat under the pressure of production targets which allows substandard materials in the system. At times, vendors also take the advantage of such situation and supplies substandard materials. Both quality of inspection and increased production target can go together. Inspecting agencies must be fully conversant about materials and must have approved QAP while inspecting along with approved test plan. Hence, the committee strongly recommends make inspection more system driven which shouldn't get ignored in the name of meeting production targets.

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6. Recommendations

In order to ensure high level of reliability of three phase traction motors in general and to prevent seizure of TM bearings, followings short term and long term measures have been recommended:

6.1. Short Term Measures:

6.1.1. TMs must be checked during all inspections for gear case oil ingress. Such TMs must be removed from the locomotives to prevent bearing seizure on line. Such TMs shall be dismantled, critical dimensions of components shall be measured, rubbing signs must be checked for. Accordingly, all components are to be replaced in the kit form as per RDSO's letter no. EL/3.2.172 Dated 26.06.2007 on Procurement of Vital Components of Traction Motors of Conventional as well as Three Phase Electric Locomotives.

6.1.2. Railways shall ensure only approved lubricants- Servo Syn 460RR of IOC for gearcase oil and Servoplex SHC-120 of IOC for TM bearings.

6.1.3. BHEL and CGL shall be asked to provide list of TMs manufactured with components, supplied by vendors which have not complied STRs, so that these TMs can be weeded out from the service before they fail online, vide letter no. EL/TRS/02/BHEL, dt. 10.05.2021. These TMs are to be monitored closely.

6.1.4. Garde of carbon brush used in earth return circuit along with approved vendors shall be figure in RDSO's approved vendor directory.

6.1.5. Measurements of 100% dimensions of all 100% mechanical components including machined stators of TMs.

6.1.6. Adherence to RDSO's MS-356 for manufacturing/repair of stators and vendor must use raw materials only from approved sources.

6.1.7. Rotating curing as recommended in MS-356, shall be ensured immediately after VPI to ensure uniform distribution of resin followed by stationary curing, as resin will not ooze out during curing statically & bonding will be adequate.

6.1.8. To prevent failure at Brazed Joints at NDE Side,use of phase rings with square/rectangular cross-sections instead of existing round cross-section to increase brazing area of contact is recommended.

6.1.9. CLW's STR no.0394 which lists out machinery and plants must include plug gauge which is an essential tool for fitment of pinions. Possibility of use of digital plug gauge shall be explored by CLW.

6.1.10. TOT documents shall be referred for the maximum number/weight of balance weights for balancing of rotors and RDSO shall bring out a SMI for the same.

6.1.11. A detailed investigation is required to be carried by CLW to ensure all manufacturers/repairers of TMs must use recommended VPI Resin of Wacker Chemie AG and manufacturers/repairers not using recommended VPI resins shall be identified and penalised . A modality in this regard shall be worked out so that only approved raw materials shall be used for manufacturing of TMs.

6.1.12. All manufacturers/repairers of TMs and PUs must have carry out tests of all TMs mounted on wheel sets and eliminate defective TMs.

6.1.13. Existing practice of full regreasing of TMs shall continue as in tis process, the old grease flushed out are providing tell-tale sign giving tell-tale signs of the health of bearings, rubbing of labyrinths, looseness of racers, etc . This practice has prevented large number of bearing seizures on line.

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6.1.14. All STR/MS/SMIs, technical reports, various reliability improvement measures, instructions, work instructions and formats shall be available on intranet with password protection for ensuring their implementation. Regular shop level meeting at technician level exclusively on reliability shall be conducted.

6.2. Long Term Measures:

6.2.1. Standard Formats of QAP for manufacturing of Traction Motors, its mechanical components, shafts, carbon brushes, bearings, stators, rotors, rotor bars, stampings, end rings, resistance rings, etc. shall be as per RDSO's ISO Document no. QM-RF-8.1-3 Guidelines for preparing QAP during registration, copy is enclosed as Annexure-III Section C on "Process Flow Chart/Description of Manufacturing Process" shall be based on TOT Documents of ABB(OEM) whereas Section -H on "Requirement of M&P/T&P as per Specification /STR/IS must be filled in" must have capacity in terms of no. of units of items to be approved, manufactured.

6.2.2. Compliance of STR-21: All vendors to re-submit QAPs with immediate effect as per RDSO's ISO Document no. QM-RF-8.1-3 immediately which shall be provisionally approved. A detailed Technical Audit shall be carried out jointly by RDSO, CLW and DMW based on the provisionally approved QAP for compliance of STR-21 and capacity declared by the firm.

6.2.3. A portal shall be launched by CLW for declaration of incoming materials as per QAP for each PO so that incoming materials along with sources can be traced.

6.2.4. Reports of measurements of mechanical components of TMs shall be made available online by the vendors for the access by authorized Railway Users so that Railways can access the same for verification of measurements.

6.2.5. Proving/calibrations of all CNC, 3-D CMM machines, fixtures, gauges, etc shall be carried out by all the all vendors at regular periodicity as recommended in Section F of RDSO's ISO Document no. QM-RF-8.1-3. This data shall be made available online by the vendors for the access by authorized Railway Users.

6.2.6. In order to place order according to the capacity of vendors, it is required to make available orders in hand online by the vendors for the access by authorized Railway Users.

6.2.7. Delivery schedule of materials shall be in line with capacity declared by vendors in Section-H of RDSO's ISO Document no. QM-RF-8.1-3 along with orders in hand.

6.2.8. For routine inspections, standard Test Plans shall be prepared for all items based on QAP as followed by RITES. This shall include all tests to be carried out/witnessed along with measurements, sample size, relevant drawings, specifications, standards, documents to be checked and collected, etc. This will eliminate the discretion of inspections and improve quality of inspections.

6.2.9. TOT documents including process flow charts, work instructions, drawings, specifications and standards of manufacturing of complete TMs, its assembly components, etc shall be made available to all existing vendors and must be ensured at the time of approval of vendors.

6.2.10. RDSO's recommendations on Proposal of new Scheme for manufacturing of TMs with rotors – Sch I and Sch-II, vide letter no. EL/3.2.182, dt. 31.01.2020, has been accepted which are as under:

a) All future production of TMs at CLW shall be with 80% Scheme I and 20% with Scheme -II design rotors.

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M K Sinha

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K Thourya

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b) Initially all future procurement by CLW/DLW/DMW and Zonal railways with 20% Scheme I and 80% with Scheme -II design rotors. Gradually the procurement may be carried out with 50% Scheme I and 50% with Scheme -II design rotors in the next five years to get the cost advantage.

c) All repairs of rotors shall continue with Scheme I design.

d) Review of the policy can be carried out after 5 years after implementation of the above recommendations, i.e. by 2026.

e) RDSO will also examine the modified Zr-Cu stampings developed by TMW.

6.2.11. Modified design of MSU drive system for WAP7/WAG9 class of locomotives with use of taper roller bearings having segregation of lubrication of gear and pinion from MSU bearings shall be pursued. DMW shall be intrusted to manufacturer prototype wheel sets with modified design of MSU.

6.2.12. Before increasing the production of locomotives, vendors shall be taken on board in terms of capacity of manufacturing of TMs, its assembly components, etc. Availability of raw materials shall also be considered.

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Ganesh
exCELE/ER and Convenor
DRM/MAS

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CEE/Loco/PTA

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DSE/TM/RDSO

Annexure I

TM Bearing Seizure Data

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
CR	2018-19																	
	2019-20																	
	2020-21	1				1	4		2				2	1	1	1	2	15
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
ER	2018-19																	
	2019-20																	
	2020-21	6	2	2		2		1		2		5	1					21
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
ECoR	2018-19																	
	2019-20		1						4			1	1				5	12
	2020-21	2												1			2	5
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
NCR	2018-19																	
	2019-20	15	2	17			1	5	3							1		44
	2020-21	4		2			5	2					1					14
	2021-22					1											1	2

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Ganesh **M K Sinha**

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		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
NR	2018-19																	
	2019-20																	
	2020-21	15		3		25	21		32	7	9	26	1	1	0	0	6	146
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
SER	2018-19																	
	2019-20	7	17	15	7	3	3		2									54
	2020-21	5	1	10	4	9	1	4	3	5	5	2	6			1	4	60
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
SR	2018-19																	
	2019-20	5	3	7	6										0	0	0	21
	2020-21																	
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
SWR	2018-19																	
	2019-20	8																8
	2020-21																	
	2021-22																	

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Ganesh **M K Sinha**

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K Thourya

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		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
WCR	2018-19																	
	2019-20																	
	2020-21		6	6	4	4	1	11	7	1		3	8				11	62
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
WR	2018-19																	
	2019-20																	
	2020-21	6	1	3		4		4			1				0	0	0	19
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
ECR	2018-19																	
	2019-20	1		8	3		1		4	2					0	0	0	19
	2020-21	10	4	4	13	12	19	25			5		1				1	94
	2021-22																	

		≤ 1 Year				1 - 2 year				2 - 3years				>3 years				Total
		BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	BHEL	SAINI	CGL	CLW	
SECR	2018-19			2	3			1					5				7	18
	2019-20	6			1					1	1	7	22	2		1	5	46
	2020-21		2		3			1	5		1		2	2			4	20
	2021-22	**91**	**39**	**79**	**44**	**61**	**56**	**54**	**62**	1 **19**	**22**	**44**	**50**	**7**	**1**	**4**	1 **49**	2 **682**

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ANNEXURE II

WACKER

Product Name: **SILRES® H62 C**

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Q1: Quarter 1 (January to March); Q2: Quarter 1 (April to June); Q3: Quarter 1 (July to September); Q4: Quarter 4 (October to December)

Customer Name : **Chittaranjan Locomotive Works**

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	Total
10982232	03.01.2017	08.01.2018	JE110068	1.600																			
10982232	03.01.2017	08.01.2018	JE110068	3.000																			
10982232	03.01.2017	08.01.2018	JE110068	0.400																			
10389744	09.02.2018	06.04.2018	JE110089	1.200																			
10389744	09.02.2018	06.04.2018	JE110090	1.600																			
10389749	09.02.2018	06.06.2018	JE110110		3.000																		
10389749	09.02.2018	06.06.2018	JE110111		1.000																		
10389764	09.02.2018	06.10.2018	JE110148			2.200																	
10389764	09.02.2018	06.10.2018	JE110149			1.800																	
10389769	09.02.2018	20.12.2018	JE110164				0.400																
10389769	09.02.2018	20.12.2018	JE110166				1.400																
10389769	09.02.2018	20.12.2018	JE110167				3.000																
10389769	09.02.2018	20.12.2018	JE110180				1.600																
10389769	09.02.2018	20.12.2018	JE110181				2.600																
10668156	12.03.2018	26.06.2018	JE110217							2.400													
10668156	12.03.2018	26.06.2018	JE110218							2.400													
10668181	12.03.2018	26.06.2018	JE110210							2.600													
10668181	12.03.2018	26.06.2018	JE110211							1.200													
10668208	12.03.2018	26.08.2018	JE110242								1.600												
10668208	12.03.2018	26.08.2018	JE110243								3.000												
10668208	12.03.2018	26.08.2018	JE110244								0.200												
10668759	12.03.2018	26.10.2018	JE110267									0.400											
10668759	12.03.2018	26.10.2018	JE110268									2.400											
10668759	12.03.2018	26.10.2018	JE110269					25.200				2.000	27.200					28.800					11.200
10668782	12.03.2018	16.11.2018	JE110274									1.400											
10668782	12.03.2018	16.11.2018	JE110275									3.000											
10668782	12.03.2018	16.11.2018	JE110276									0.400											
10756463	12.03.2018	16.12.2018	JE110279									1.000											
10756463	12.03.2018	16.12.2018	JE110280									3.000											
10908362	19.06.2020	16.07.2020	JE110368													1.800							
10908362	19.06.2020	16.07.2020	JE110369													3.000							
10908362	19.06.2020	16.07.2020	JE110368													1.600							
10908362	19.06.2020	16.07.2020	JE110370													3.200							
10908362	19.06.2020	16.07.2020	JE110372													1.600							
10908362	19.06.2020	16.07.2020	JE110373													2.000							
10960421	19.06.2020	16.10.2020	JE110374														3.000						
10960421	19.06.2020	16.10.2020	JE110376														3.000						
10960434	19.06.2020	16.11.2020	JE110383														3.000						
10960434	19.06.2020	16.11.2020	JE110384														1.800						
10960469	19.06.2020	16.12.2020	JE110390														1.600						
10960469	19.06.2020	16.12.2020	JE110391														3.000						
10960469	19.06.2020	16.12.2020	JE110392														0.200						
10961208	19.06.2020	16.01.2021	JE110399																3.200				
10961208	19.06.2020	16.01.2021	JE110400																1.600				
10961211	19.06.2020	16.02.2021	JE110413																2.800				
11076622	19.06.2020	16.04.2021	JE110431																	1.600			
11076622	19.06.2020	16.04.2021	JE110432																	2.000			

Customer Name : **Diesel Loco Modernisation Works**

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	Total
10890068	30.11.2018	26.07.2019	JE110234								2.600												
10890068	30.11.2018	26.07.2019	JE110236								1.400												
10897180	02.06.2020	30.07.2020	JE110372					0.000					4.000			1.600		2.400					4.000
10897180	02.06.2020	30.07.2020	JE110386														0.800						
10963810	09.09.2020	10.02.2021	JE110418																2.000				
10963810	09.09.2020	10.02.2021	JE110448																	2.000			

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Ganesh **M K Sinha** **K Thourya** **Anurag Agrawal**

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Product Name: **SILRES® H62 C**

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Customer Name : Bharat Heavy Electricals Limited

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2018 Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2020 Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2021 Total
10269480	30.06.2017	18.04.2018	JE110074	1.000																			
10301604	25.10.2017	30.07.2018	JE110116		1.800																		
10301604	25.10.2017	30.07.2018	JE110118		1.200																		
10580738	19.02.2018	18.01.2019	JE110133				1.600																
10580738	19.02.2018	18.01.2019	JE110142				0.600																
10580738	19.02.2018	18.01.2019	JE110144				0.600																
10580738	19.02.2018	18.01.2019	JE110146				2.400																
10580738	19.02.2018	18.01.2019	JE110193						3.000														
10580738	19.02.2018	18.01.2019	JE110218							2.000	0.400												
10580738	19.02.2018	18.01.2019	JE110221							2.000													
10580738	19.02.2018	18.01.2019	JE110235								1.000												
10580738	19.02.2018	18.01.2019	JE110236								3.000												
10580738	19.02.2018	18.01.2019	JE110237								3.000												
10580738	19.02.2018	18.01.2019	JE110238								3.000												
10580738	19.02.2018	18.01.2019	JE110239								2.400												
10580738	19.02.2018	18.01.2019	JE110261								1.000												
10580738	19.02.2018	18.01.2019	JE110262					9.200			3.000		21.800					15.200					8.000
10728806	14.08.2019	20.08.2019	JE110263								2.000												
10838075	20.04.2020	31.03.2020	JE110306											2.600									
10838075	20.04.2020	31.03.2020	JE110307											0.600									
10838075	20.04.2020	31.03.2020	JE110308											2.800									
10838075	20.04.2020	31.03.2020	JE110317												2.600								
10838075	20.04.2020	31.03.2020	JE110318												0.400								
10838075	20.04.2020	31.03.2020	JE110380														0.800						
10838075	20.04.2020	31.03.2020	JE110381														2.400						
10838075	20.04.2020	31.03.2020	JE110385														2.200						
10838075	20.04.2020	31.03.2020	JE110384														0.800						
11058864	08.07.2021	16.06.2021	JE110438																2.800				
11058864	08.07.2021	16.06.2021	JE110439																1.200				
11130460	22.06.2021	30.06.2021	JE110441																3.000				
11130460	22.06.2021	30.06.2021	JE110442																1.000				
81164006	06.07.2018	06.07.2019	JE110218								-2.000												
81164006	06.07.2018	06.07.2019	JE110221								-2.000												

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Product Name: **SILRES® H62 C**

Internal Document
Wacker Confidential Information

Customer Name : Saini Electrical and Engineering

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2018 Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2020 Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2021 Total
10371080	22.02.2017	13.02.2018	JE110063	0.200																			
10446173	17.02.2018	20.06.2018	JE110114		0.200																		
10446173	17.02.2018	20.06.2018	JE110116		0.200																		
10460420	17.02.2018	18.07.2018	JE110127			0.400																	
10460420	17.02.2018	18.07.2018	JE110128			0.200																	
10460522	17.02.2018	06.06.2018	JE110102			0.400																	
10460537	17.02.2018	06.06.2018	JE110102			0.600																	
10460544	17.02.2018	06.10.2018	JE110108			0.400																	
10460547	17.02.2018	06.11.2018	JE110147			0.600																	
10460660	17.02.2018	06.12.2018	JE110160				0.600																
10516016	10.08.2018	06.01.2019	JE110168				0.600																
10516016	10.08.2018	06.01.2019	JE110168						0.600														
10516016	10.08.2018	06.01.2019	JE110170						0.600														
10516063	10.08.2018	01.04.2019	JE110171						0.600														
10516063	10.08.2018	01.04.2019	JE110187						0.600														
10516063	10.08.2018	01.04.2019	JE110200							0.200													
10690914	05.01.2019	05.06.2019	JE110200							0.600													
10690914	05.01.2019	05.06.2019	JE110218							0.400													
10690914	05.01.2019	05.06.2019	JE110219							0.200													
10690914	05.01.2019	05.06.2019	JE110226							0.600													
10690914	05.01.2019	05.06.2019	JE110236								0.600												
10690914	05.01.2019	05.06.2019	JE110248								0.600												
10690914	05.01.2019	05.06.2019	JE110258								0.400												
10690914	05.01.2019	05.06.2019	JE110261								0.200												
10690914	05.01.2019	05.06.2019	JE110299									0.600											
10718119	19.07.2019	05.01.2020	JE110278					4.400				0.800	8.800					21.000					8.000
10718119	19.07.2019	05.01.2020	JE110287									0.600											
10718119	19.07.2019	05.01.2020	JE110290											0.600									
10718119	19.07.2019	05.01.2020	JE110291											2.000									
10718119	19.07.2019	05.01.2020	JE110297											2.000									
10718119	19.07.2019	05.01.2020	JE110336												1.200								
10823801	14.01.2020	16.04.2020	JE110299											1.000									
10907086	14.01.2020	15.07.2020	JE110339												0.600								
10907086	14.01.2020	15.07.2020	JE110340												1.400								
10907086	14.01.2020	15.07.2020	JE110341													1.400							
10907086	14.01.2020	15.07.2020	JE110342													0.600							
10907086	14.01.2020	15.07.2020	JE110346													2.000							
10912902	25.06.2020	08.06.2020	JE110362														2.000						
10912902	25.06.2020	08.06.2020	JE110367														0.400						
10912902	25.06.2020	08.06.2020	JE110368														1.600						
10912902	25.06.2020	08.06.2020	JE110376														0.600						
10912902	25.06.2020	08.06.2020	JE110377														1.200						
10912902	25.06.2020	08.06.2020	JE110389														2.000						
10912902	25.06.2020	08.06.2020	JE110401																1.000				
10912902	25.06.2020	08.06.2020	JE110402																1.000				
10912902	25.06.2020	08.06.2020	JE110404																1.400				
10912902	25.06.2020	08.06.2020	JE110406																0.600				
10912902	25.06.2020	08.06.2020	JE110407																0.200				
10912902	25.06.2020	08.06.2020	JE110408																1.800				
11076481	28.02.2021	08.06.2021	JE110424																	1.000			
11076481	28.02.2021	08.06.2021	JE110435																	1.000			

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WACKER

Product Name: **SILRES® H62 C**

Internal Document
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Customer Name : Crompton Greaves Power and Industrial Solutions

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2018 Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2020 Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2021 Total
10236717	27.07.2017	01.03.2018	JE110034	0.600																			
10236717	27.07.2017	01.03.2018	JE110036	1.400																			
10236717	27.07.2017	01.03.2018	JE110048	0.600																			
10236717	27.07.2017	01.03.2018	JE110049	1.200																			
10236717	27.07.2017	01.03.2018	JE110068				1.000																
10236717	27.07.2017	01.03.2018	JE110070	1.000																			
10236717	27.07.2017	01.03.2018	JE110119				0.600																
10236717	27.07.2017	01.03.2018	JE110120				0.400																
10236717	27.07.2017	01.03.2018	JE110124				0.600																
10236717	27.07.2017	01.03.2018	JE110132				0.400																
10683207	28.01.2019	20.12.2018	JE110134				2.000																
10683207	28.01.2019	20.12.2018	JE110162				2.000																
10683207	28.01.2019	20.12.2018	JE110166						0.600														
10683207	28.01.2019	20.12.2018	JE110168						0.400														
10683207	28.01.2019	20.12.2018	JE110171						0.800														
10683207	28.01.2019	20.12.2018	JE110174						1.200														
10670982	28.01.2019	20.06.2019	JE110174						1.800														
10670982	28.01.2019	20.06.2019	JE110175						0.200														
10670982	28.01.2019	20.06.2019	JE110187					12.000	0.600				9.000					6.400					7.600
10670982	28.01.2019	20.06.2019	JE110189						1.400														
10670982	28.01.2019	20.06.2019	JE110194							0.400													
10670982	28.01.2019	20.06.2019	JE110195							0.600													
10670982	28.01.2019	20.06.2019	JE110196							1.000													
10900334	09.06.2020	19.07.2020	JE110342														0.600						
10900334	09.06.2020	19.07.2020	JE110343														1.000						
10819483	16.07.2020	19.07.2020	JE110348														1.600						
10861142	26.09.2020	25.10.2020	JE110366															1.000					
10861142	26.09.2020	25.10.2020	JE110368															0.600					
11002249	21.11.2020	25.12.2020	JE110386															1.000					
11002249	21.11.2020	25.12.2020	JE110398															0.600					
11045244	27.01.2021	27.02.2021	JE110410																0.200				
11045244	27.01.2021	27.02.2021	JE110411																1.400				
11045244	27.01.2021	27.02.2021	JE110419																2.000				
11045244	27.01.2021	27.02.2021	JE110437																	1.600			
11045244	27.01.2021	27.02.2021	JE110438																	0.400			
11045244	27.01.2021	27.02.2021	JE110442																	1.800			
11045244	27.01.2021	27.02.2021	JE110443																	0.200			

WACKER

Product Name: **SILRES® H62 C**

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Customer Name : TD Power systems Limited

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2018 Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2020 Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2021 Total
10412412	11.04.2018	15.06.2018	JE110075		0.600																		
10412412	11.04.2018	15.06.2018	JE110077		1.000																		
10412412	11.04.2018	15.06.2018	JE110078		0.200																		
10588686	26.12.2018	05.02.2018	JE110176						1.000														
10841213	20.03.2019	01.06.2019	JE110208							0.400													
10841213	20.03.2019	01.06.2019	JE110209							0.600													
10842118	22.03.2019	01.06.2019	JE110218								1.000												
10766632	30.09.2019	01.03.2020	JE110286									1.000											
10766632	30.09.2019	01.03.2020	JE110288											1.000									
10766632	30.09.2019	01.03.2020	JE110291											0.200									
10766632	30.09.2019	01.03.2020	JE110292											0.800									
10819294	07.10.2020	01.04.2020	JE110301					1.800					4.000	1.400				7.400					3.400
10819294	07.10.2020	01.04.2020	JE110309											0.200									
10819294	07.10.2020	01.04.2020	JE110313											0.600									
10819294	07.10.2020	01.04.2020	JE110314											1.000									
10819294	07.10.2020	01.04.2020	JE110315											0.200									
10972661	26.04.2021	01.01.2021	JE110382														1.000						
10972661	26.04.2021	01.01.2021	JE110384														1.000						
10972661	26.04.2021	01.01.2021	JE110401																1.000				
10972661	26.04.2021	01.01.2021	JE110419																0.800				
10972661	26.04.2021	01.01.2021	JE110428																	0.600			
10972661	26.04.2021	01.01.2021	JE110429																	0.200			
10972661	26.04.2021	01.01.2021	JE110430																	0.600			

Wacker Confidential Information

Customer Name : Medha Traction Equipment Pvt Ltd

Quantity (MT)

Order No	Date of PO	Delivery date	Batch No	2018 Q1	2018 Q2	2018 Q3	2018 Q4	2018 Total	2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2020 Total	2021 Q1	2021 Q2	2021 Q3	2021 Q4	2021 Total
10336248	19.12.2017	17.01.2018	JE110036	1.800																			
10336248	19.12.2017	17.01.2018	JE110066				1.800																
10336248	19.12.2017	17.01.2018	JE110071	0.800																			
10336248	19.12.2017	17.01.2018	JE110072	1.000																			
10336248	19.12.2017	17.01.2018	JE110089		1.800																		
10336248	19.12.2017	17.01.2018	JE110124				1.800																
10336248	19.12.2017	17.01.2018	JE110132						0.600														
10336248	19.12.2017	17.01.2018	JE110134						0.600														
10336248	19.12.2017	17.01.2018	JE110136						0.600														
10336248	19.12.2017	17.01.2018	JE110142				1.800																
10336248	19.12.2017	17.01.2018	JE110148			1.200																	
10336248	19.12.2017	17.01.2018	JE110156			0.600																	
10336248	19.12.2017	17.01.2018	JE110241								1.200												
10336248	19.12.2017	17.01.2018	JE110242					12.600			0.600		4.600					4.800					4.200
10656848	24.06.2020	10.03.2020	JE110249									1.000											
10656848	24.06.2020	10.03.2020	JE110293											0.400									
10656848	24.06.2020	10.03.2020	JE110341													0.800							
10656848	24.06.2020	10.03.2020	JE110344													0.800							
10656848	24.06.2020	10.03.2020	JE110350													0.800							
10656848	24.06.2020	10.03.2020	JE110378														1.000						
10656848	24.06.2020	10.03.2020	JE110387														0.600						
10656848	24.06.2020	10.03.2020	JE110389														0.400						
11032888	11.01.2021	16.03.2021	JE110406																1.000				
11032888	11.01.2021	16.03.2021	JE110416																0.800				
11032888	11.01.2021	16.03.2021	JE110430																	0.800			
11101968	08.04.2021	16.03.2021	JE110433																	0.800			
11101968	08.04.2021	16.03.2021	JE110449																	0.800			

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ANNEXURE III

ISO9001:2015	Document No: QM-RF-8.1-3	Version No: 1.0	Date Effective: 28.08.2018
Document Title: Guidelines for preparing QAP during registration			

RESEARCH DESIGNS & STANDARDS ORGANIZATION

Manaknagar, Lucknow – 226011

QM-RF-8.1-3

Guidelines for preparing QAP during registration

1.0 Amendment History:

S. No.	Amendment Date	Version	Reasons for Amendment
1.	28.08.2018	1.0	First issue under ISO 9001:2015. Approved by ED/QA(Mech) on file No. QAM/ISO-9001:2015/Doc-Approval on date 28.08.2018.

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2.0 Purpose:

These are guidelines for preparing the QAP for product.

3.0 Scope of Application:

Applicable for all vendors registered with QA Mechanical Directorate.

4.0 Details:

Guidelines for preparing QAP during registration is attached as Annexure.

5.0 Referenced Documents:

None

6.0 Referenced Documents of External Origin:

None

7.0 Associated Records:

None

8.0 Responsibility and Authority:

Activity	Responsible	Approver	Supporting	Consulted	Informed
Creation, maintenance of this document	Director/I&L/ LKO	ED/QA(Mech)	Staff of QA(Mech) Dte.		All Zonal office of QA(Mech) Dte.
Requirement of deviation from this form template.	Director/I&L/ LKO	ED/QA(Mech)	Respective AIE/I&L	MR/ISO Cell	All Zonal office of QA(Mech) Dte.

9.0 Abbreviations:

QA	Quality Assurance
ED/QA (Mech)	Executive Director/ Quality Assurance (Mechanical)
RDSO	Research Designs & Standards Organisation
M&C	Metallurgical & Chemical
ARO	Assistant Research Officer

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GUIDELINES FOR PREPARING QAP DURING REGISTRATION

The QAP to be submitted by the vendor in triplicate (along with the application form for registration) shall cover the following aspects –

SECTION '0'

Revision Sheet

S.N	Amendment	Version	Reasons for Amendment

SECTION 'A'

ORGANISATION CHART

Organisational Chart, clearly indicating the Quality Control Set-up, role and responsibilities of key personal.

SECTION 'B'

QUALIFICATION / EXPERIENCE OF PERSONNEL

Part I: Details of qualification/experience of the quality control personnel specified in the STR/Specification of RDSO of the items applied for approval/renewal

SN	Requirement as per STR/Spec.				Details of personnel employed				
	STR/Spec Para No		Qualification Specified in Spec. / STR	Experience Specified in Spec. / STR	Name	Dsgn.	Technical Qualification	Experience	Brief scope of responsi bilities
	STR/ Spec	Para							

Part II: Details of Manpower requirements other than quality control section as per Spec./STR/IS

SN	Requirement as per STR/Spec./IS				Details of personnel employed				
	STR/Spec Para No		Qualification Specified in Spec. / STR/IS	Experience Specified in Spec. / STR/IS	Name	Dsgn.	Technical Qualification	Experience	Brief scope of response-bilities
	STR/ Spec/IS	Para							

Part III: Qualification of other key personnel and the officials deployed in Quality Control Cell:

SN	Name	Designation	Technical Qualification	Experience	Brief scope of responsibilities

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SECTION 'C'

PROCESS FLOW CHART/DESCRIPTION OF MANUFACTURING PROCESS

Part I: Process Flow Chart indicating process of manufacture for an individual product, with quality control points.

Note:

i Process flow chart shall indicate all the operation involving manufacturing & testing of product from raw material to finish product, including RDSO/RITES/Consignee inspection/dispatch.

ii There should be separate flow chart for each item.

Part II: Brief description of different manufacturing process mentioned in flow chart :

a) Details of the manufacturing & testing process specially mentioned in the specification.

SN	Para no of spec.	Requirement of manufacturing/testing process as per spec	Details of the process being installed/ follows

b) Brief details of the other manufacturing process.

SN	Name of the manufacturing process	Brief description
.		
..		

Part III: Brief description of ancillaries & additional units (if any):

i Whether all the facilities are available at a single location (or) multiple location –

ii In case of multiple location give details in following formats :

SN	units	Address	Whether unit is covered under factory license	Whether unit is ISO certified	Mfg. processes details

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SECTION 'D'

Details of Sub-assemblies / components manufactured in-house and outsourced.

Part I: Details of in-house manufactured (Components/sub-assemblies)

SN	Item Name	Drawing No
.		
..		

Part II: Details of components/Sub-assemblies purchased from RDSO approved vendors

SN	Item Name	Drawing No	Is it a Primary Item of RDSO	Is it a Sublet Item of RDSO	Name of the source
.					
..					

Part III : Details of items outsourced from other than RDSO approved items

SN	Item Name	Drawing No	Name of the source	Frequency of review of the performance of sublet source
.				
..				

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SECTION 'E'

INCOMING RAW MATERIAL & INPROCESS/FINAL INSPECTION

Stage inspection detailing inspection procedure, inspection parameters, method of testing/test procedure including sample sizes for destructive and non- destructive testing etc.

Part I : Incoming raw materials/parts/sub-assemblies

SN	Incoming Product/ assembly	Sample Size & its Frequency of inspection	Parameters for inspection	Mode of inspection / equipment used	Acceptance limits/ Criteria /specified Value	Rejection & Disposal / Reprocessed / Scrapped	Traceability register no
.							
..							

Part II: In process inspection (of the product)

SN	Name of the process	Sample Size & its Frequency of inspection	Parameters for inspection	Mode of inspection / equipment used	Acceptance limits/ Criteria /specified Value	Rejection / Disposal	Corrective & preventive action	Traceability register no
.								
..								

Part III: Final internal inspection of the product by the firm

SN	Name of the test/ process	Sample Size & its Frequency of inspection	Parameters for inspection	Mode of inspection / equipment used	Acceptance limits/ Criteria /specified Value	Rejection disposal / Reprocessed / Scrapped	Traceability register no
.							
..							

SECTION 'F'

CALIBRATION OF TESTING MEASURING EQUIPMENT

Part I : Inhouse Testing facilities available for calibration with the firm

SN	Name of Master	Make	Range	Frequency of calibration	Traceability to national standard

Part II : Personnel trained for inhouse calibration

SN	Name	Qualification	Experience

Part III : Calibration plan for the items identified for specified calibration in STR/Specification

SN	Measuring Equipment	Ref. para of STR/Spec. / STR/Spec./Para no.	Range/ Accuracy	Frequency Specified in STR/Spec	Inhouse/ Outsourced	Name of agency if outsourced
.						
..						

Part IV : Calibration plan for other measuring equipment

SN	Measuring Equipment	Range/ Accuracy	Frequency	Inhouse/ Outsourced	Name of calibration agency
.					
..					

SECTION 'G'

SYSTEM OF MAINTAINING THE DATE OF CUSTOMER COMPLAINTS/WARRANTY FAILURES

Warranty failures/In-service failures reported from customers

SN	Date of report of complaint	Letter no	Complaint received from	Brief details of complaint	Classification of failure: Warranty failure/ In service failure/ Call for joint inspection / Consignee end rejection / General complaints	Whether any person deputed for collecting field sample	Date of joint inspection	Failure analysis & cause of failure	Date of compliance in case of warranty	C & P action taken
.										
..										

*** The firm shall maintain a complaint register in the above format and the summary required to be given during renewal**

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SECTION 'H'

Requirement of M&P/T&P as per Specification /STR/IS

Sl.No.	IS/STR/ Specification para no	Requirement of M&P/T&P as per IS/STR/Specification		Details of the M&P/T&P available with the firm					
		M&P/T&P name	Range / Capacity of M&P/T&P	Name of M&P/T &P	Model	Make	Machine no.	Year of Built	Range/ Capacity

SECTION 'I'

ANY ADDITIONAL INFORMATION FIRM WISH TO SUBMIT

The firm can furnish any other information which they wish to submit on items other than furnished in annexure A to H.

Note :

1. QAP covering all the information as asked above under section '0' to 'I' must be given in the form of single document indicating name and works address of the firm and page no. 'x' of 'y' on each page. Each page should be signed by Quality Control in-charge. The approved QAP must be a controlled document and a quality record of ISO Quality Control System of the vendor. A certificate to this effect shall be provided along with the QAP by the vendor.

2. One copy of the QAP, after final approval will be given back to the vendor for implementation.

ANNEXURE IV

3. Number of failed Stators received of 6FRA6068 TM

SNo	Types of stators	2016-2017	2017-2018	2018-2019	2019-20	2020-21
1	Unmodified	40	25	36	47	28
2	Modified	52	53	88	90	87
3	Total	92	78	124	137	115

4. Analysis of failed stators received 6FRA6068 TM

SNo	Nature of failures	2016-17			2017-2018			2018-2019			2019-20			2020-21		
		Unmodified	Modified	Total	Unmodified	Modified	Total	Unmodified	Modified	Total	Unmodified	Modified	Total	Unmodified	Modified	Total
1	NDE side winding flashed	10	11	21	5	13	18	12	24	36	15	20	35	9	32	41
2	DE side winding flashed	8	11	19	5	12	17	10	21	31	7	19	26	5	25	30
3	Earth fault/IR zero	4	10	14	2	8	10	5	8	13	16	17	33	4	6	10
4	Inductance more	7	8	15	7	7	14	2	5	7	3	8	11		2	2
5	Winding burnt	1	1	2	1	7	8	4	6	10			0	7	11	18
6	Winding open	-	-	0	-	-	0	-	-	0		-	0			0
7	Core melted/Rubbed.	-	-	0	-	-	0	-	-	0	1	9	10	3	8	11
8	Failed in HV test	-	-	0	-	-	0	-	-	0		-	0			0
9	Others	10	11	21	5	6	11	3	24	27	5	17	22		3	3
10	**Total:-**	**40**	**52**	92	**25**	**53**	78	**36**	**88**	124	**47**	**90**	**137**	**28**	**87**	**115**

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ANNEXURE V

FAILURE DETAILS REPAIR/REHABILIATION DONE BY TMW/NKRD.

Railway C.RLY Shop TMW/NKRD TMW/NKRD

1. Number of failed rotors received of

SNo	Schemes	2016-2017	2017-2018	2018-2019	2019-20	2020-21
1	Older Schemes (V2)	112	86	81	84	66
2	Scheme-I	23	53	64	71	88
3	Scheme-II (without MS-438 implemented)	41	87	92	101	112
4	Scheme-II (with MS-438 implemented)					
Total		176	226	237	256	266

2. Analysis of failed rotors received of

SNo	Nature of failures	2016-17				2017-18				2018-19				2019-2020				2020-21			
		Older Scheme	Sch-I	Sch-II	Total	Older Scheme	Sch-I	Sch-II	Total	Older Scheme	Sch-I	Sch-II	Total	Older Scheme	Sch-I	Sch-II	Total	Older Scheme	Sch-I	Sch-II	Total
1	Rotor bar crack	53	0	21	74	31	0	31	62	34	0	51	85	55	0	34	89	35		57	92
2	Indutance variation	2	8	1	11	7	16	8	31	7	36	2	45	0	40	0	40	7	62	14	83
3	Shaft defects	3	0	0	3	14	5	6	25	10	9	3	22	17	16	26	59	6	14	24	44
4	Stampings detached	10	0	1	11	9	5	3	17	2	2	9	13	7	0	9	16	7		3	10
5	End ring/locking ring	1	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0				0
6	Pinion shaft	20	7	11	38	13	20	24	57	3	3	10	16	4	13	31	48	3	9	13	25
7	UST failed	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0				0
8	Minor works	10	0	0	10	2	2	3	7	8	3	1	12	1	2	0	3	5	1		6
9	Other mechanical defect	13	7	7	27	10	5	12	27	17	10	16	43	0	0	1	1	3	2	1	6
10	Total	112	23	41	176	86	53	87	226	81	64	92	237	84	71	101	256	66	88	112	266

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Ganesh **M K Sinha**

THOURYA KETHAVATH Digitally signed by THOURYA KETHAVATH Date: 2021.10.12 17:02:02 +05'30'

K Thourya

ANURAG AGARWAL Digitally signed by ANURAG AGARWAL DN: cn=ANURAG AGARWAL c=IN o=MINISTRY OF RAILWAYS ou=MINISTRY OF RAILWAYS Reason: I am the author of this document Location: Date: 2021-10-12 18:22+05:30

Anurag Agrawal