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Ref. No. : ABB/4118/CLW/PE/0080 Date: 26.06.2024

To,
Dy Chief Electrical Engineer,
Centre for Design & Development
Chittaranjan Locomotive Works
Chittaranjan - 713 331

Kind Attn: Shri Pankaj Kumar (Dy CEE/D&D/CLW)

Subject: Request for approval of software version 55 in redesign Traction Converter in P7,G9 & P5 loco .

Ref : -

- CLW request letter no. C-D&D/T/21, Vol.II dated 10.04.2024 and ELS/ ED request letter no. SA/A/RS/ED/Tech 43 dated 6.04.2024.
- technical Note and letter no. ELS / GZB – 230-ELS/GZB/P-5/T-6(ABB-SR) on dated- 8.5.24
- RDSO Minutes of Meeting held at CLW on 09 &10.05.2024 on reliability issues of IGBT based Propulsion System equipment fitted in of 3 Phase electric locomotives.

Dear Sir,

With reference to the above subject matter, we are pleased to submit the software release note for releasing the software version 55 in redesign Traction Converter in P7,G9 & P5 loco's.

Modifications in software version 55

1. **Plausibility Check between two channels of transformer oil temperature sensor** as per CLW request letter no. C-D&D/T/21, Vol.II dated 10.04.2024 and ELS/ ED request letter no. SA/A/RS/ED/Tech 43 dated 6.04.2024.
(For Train Type P5, P7 and G9)

Solution: Transformer oil temperature plausibility check is done. If difference between temperature of two sensors is > 25 degree C then plausibility check will fail and minimum of the two values will be decisive for operation.

2. **VCB will not close** : Holding circuit logic restricts closing of VCB if only faulty converter line contactor opens during a trip of type priority 2 in running loco condition. (For Train Type P5, P7 and G9)

Solution: Holding circuit logic adapted and line contactor operation of both converters synchronized during a trip in either converter during loco running condition.

3. **Harmonic Filter current high popup** : During harmonic current high, popup of 'F0201P1 Disturbance in converter 1' was appearing. (For Train Type P5, P7 and G9)

Solution: Mapped with appropriate fault message 'F0401P1 Filter current > maximum'.

ABB India Ltd

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4. **MUB temp too hot** : Transient high energy on the VLU above 130 kmph Speed during consecutive Panto bounce. (For Train Type P5 only)

Solution: Improvement in the Motor backup braking during Panto bounce (absence of Line voltage) to damp the DC oscillations below VLU activation level.

5. **No pop-up message in case of reduction in traction power due to high coolant temperature**. (For Train Type P5, P7 and G9)

Solution: Correct Pop-up Message mapped in case their is power reduction from any of the SR.

6.As per technical Note and request letter no. from ELS / GZB – 230-ELS/GZB/P-5/T-6(ABB-SR), to improve the transformer oil cooling, the temperature threshold triggering the **ventilation demand level 3 is reduced from 48 degree C to 45 degree C**. (For Train Type P5, P7 and G9)

Based on the satisfactory performance of trial loco no – 37180 on dated 24.5.24 ELS ED , we now request you to provide for approval of software version 55 in redesign Traction Converter in P7,G9 & P5 loco .

Request to CLW – D&D - plz modified Micas VCU DDS Message HEX file(DIA File) to compatible with SW V 55 implementation as per point no – 1 both channel of Plausibility Check between two channels of transformer oil temperature sensor in DDU message.

Yours Sincerely,
For ABB India Ltd.,

Mohit Sharma
Service Manager – Traction (India)
Mob- +91- 9686841604

Attached – Software V 55 release note

Reference letter's

Copy to- DSE/TPL/RDSO :For your kind information.

1 Introduction

Aim of this document is to summarize the solution/ updates and test results for the issues reported from the field on **Bordline CC1500 AC 25 kV M 2300 fitted in 1500A IGBT based redesigned traction converter system equipped with PEC Trac controller**.

2 Release Notification

2.1 Modifications in software version 55

- Plausibility Check between two channels of transformer oil temperature sensor as per CLW request letter no. C-D&D/T/21, Vol.II dated 10.04.2024 and ELS/ ED request letter no. SA/A/RS/ED/Tech 43 dated 6.04.2024.
  (For Train Type P5, P7 and G9)

  Solution: Transformer oil temperature plausibility check is done. If difference between temperature of two sensors is > 25 degree C then plausibility check will fail and minimum of the two values will be decisive for operation.

- VCB will not close : Holding circuit logic restricts closing of VCB if only faulty converter line contactor opens during a trip of type priority 2 in running loco condition.
  (For Train Type P5, P7 and G9)

  Solution: Holding circuit logic adapted and line contactor operation of both converters synchronized during a trip in either converter during loco running condition.

- Harmonic Filter current high popup : During harmonic current high, popup of 'F0201P1 Disturbance in converter 1' was appearing.
  (For Train Type P5, P7 and G9)

  Solution: Mapped with appropriate fault message 'F0401P1 Filter current > maximum'.

- MUB too hot : Transient high energy on the VLU above 130 kmph Speed during consecutive Panto bounce.
  (For Train Type P5 only)

  Solution: Improvement in the Motor backup braking during Panto bounce (absence of Line voltage) to damp the DC oscillations below VLU activation level.

- No pop-up message in case of reduction in traction power due to high coolant temperature.
  (For Train Type P5, P7 and G9)

  Solution: Correct Pop-up Message mapped in case their is power reduction from any of the SR.

2.2 Improvements in software version 55

- As per technical Note and request letter no. from ELS / GZB – 230-ELS/GZB/P-5/T-6(ABB-SR), to improve the transformer oil cooling, the temperature threshold triggering the ventilation demand level 3 is reduced from 48 degree C to 45 degree C. **(For Train Type P5, P7 and G9)**

All the modifications of the new SW release are verified by testing the new functionalities comprehensively on the real time setup.

3 Field Action

With the RTS test results of version 55 it is recommended to upload the software into Locomotive and test the application for improved converter reliability and to address the different issues reported by zonal railways.

दक्षिण रेलवे
Southern Railway
सेलम मंडल
Salem Division

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Joint Report Made On : 24.05.2024

Firm's Name : ABB India Pvt.Ltd

Name of the Equipment : SR1 & 2

Make : ABB

Equipment Serial No : 703 & 704

Loco No. : 37180 / WAP7

Software Version : **SR: 55**

M/S.ABB released the SR-SW version 55 on date 23rd May to improve the Transformer temperature sensor improvements and Harmonic filter pop up corrected.

SN	Test	Observation
1	Transformer temperature sensor plausibility check	According to CLW letter, when any one channel of the transformer oil temp sensor >85^{0}C and when the temperature difference between the higher and lower channel of the sensor is <25^{0}C, then the SR takes the higher temp. If the difference is > 25^{0}C, then the lower temp is considered. This requirement has been satisfied in 55V. When Temperature of one element crossed 85^{0}C, DJ was not tripping only pop-up came "Transformer oil temp or pressure not ok", TE/BE not changed and BPFA was glowing. After acknowledgement, BPFA extinguished, loco working normal. Traction effort achieved and there is no abnormality in TE/BE. If both elements crossed more than 85^{0}C, DJ trips with pop-up "Transformer oil temp or pressure not ok" and corresponding SR isolates.
2	Harmonic filter current too high simulated	Previously, when Harmonic filter current is too high, DJ tripping with fault message F0201P1 "Disturbance in Converter 1 try to close the VCB again if tripped" came. This pop up is addressed in 55V – When tested, DJ was tripped by SR1 with message F0401P1, with pop-up "Harmonic Filter Current Too High", message logged. After acknowledgement, when DJ closed second time with same simulated fault, Harmonic filter got isolated.

(E. HARIKRISHNAN)
SERVICE ENGINEER
ABB

(GANESH M)
SSE/E8/ELS/ED

(R PRASHAANTH)
DEE/RS/ED

Copy to Sr.DEE/RS/ED.

INDIAN RAILWAYS
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No: C-D&D/T/21, Vol. II **Date: As signed**

M/s ABB Ltd.,
Survey No. 88/3-4,
Basavanahalli, KasabaHobli,
NelamangalaTaluk, Bangalore

Sub: Issue with software-55 in M/s ABB make Propulsion system.
Ref.: ELS/ED letter no. SA/A/RS/ED/Tech 43 dated 06.04.2024

1.0 ELS/ED vide letter under reference, mentioned that in M/s ABB make propulsion system with software ver. 55, both the channels of temperature sensor are being used and if any one temperature sensor detects temperature more than 84°C in one bogie, then tractive of circuit is being cut off fully and loco is unable to move and results in failure due to traction converter not producing TE. The same problem was faced previously by other propulsion manufacturer. After deliberation with various loco sheds, logic had been changed as "Plausibility check and detention logic": If difference between temperature of two sensors is >25°C, plausibility check will fail and lower of the two readings will be decisive and only P2 fault will come with temperature sensor failure.

2.0 It is requested to examine and implement the above logic in Software. Test and Trials, if required may be conducted at one loco at ELS/ED before final release.

D.A.: Letter under reference.

10-4-2024
(Pankaj Kumar)
Dy.CEE/D&D-I

दक्षिण रेलवे
Southern Railway

सेलम मंडल
Salem division

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ISO 9001, 14001, 45001, 50001,
5S & GreenCo Certified
JAS-ANZ

No. SA/A/RS/ED/Tech 43 DT: 06-04-24

Dy. CEE/D&D/CLW
Email: dyceedd@clw.railnet.gov.in

Sub: Software corrections.

ABB propulsion system provided Software -55 started using both the channels of temperature sensor.

1. The logic used by ABB at present is, if any one temperature sensor detects temperature more than 84°C in one bogie Tractive of circuit is being cut off fully and loco is unable to move and results in failure due to traction converter not producing TE.

2.The same problem was faced previously by BT propulsion. After long deliberation with various loco sheds, BT propulsion logic had been changed as,

Plausibility check and detention logic.

If difference between temperature of two sensors is >25°C, plausibility check will fail and lower of the two readings will be decisive. Only a P2 fault will come with temperature sensor failure.

Example:

Temperature Sensor A	Temperature Sensor B
50°C	90°C

Temperature considered is 50°C by SR for logic.

3.The same was corrected vide BT software version 1.4.10. In this regard to above, it is hereby requested to advice M/s ABB to follow the same BT logic and issue software correction.

Sr.DEE/RS/ED
Digitally Signed by
Sathiyia Rathan K.m
Date: 06-04-2024 14:56:19
Reason: Approved

कार्यालय
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पत्रांक:-230-विद्युत कर्षण चल स्टाक/गाज़ि/P-5/T-6 (ABB-SR)

दिनांक:- 08.05.2024

मुख्य विद्युत् लोको अभियंता,
नॉर्दर्न रेलवे, बड़ौदा हाउस,
नई दिल्ली।
ई-मेल:-celenr304@gmail.com

Sub:- 'Technical Note' for identify problem of 'Converter Coolant Temperature' greater than limit in 'ABB' based propulsion / traction converter.

In reference to above and after analyzing recent failure cases, a 'Technical Note' to identify the problem of 'Converter Coolant Temperature' greater than limit in 'M/s ABB' based 'Propulsion / Traction Converter' is prepared, in which, design issues of M/s ABB converter has been identified and attached herewith for your kind perusal.

This is for your kind information and onward submission to RDSO and CLW please.

DA:- 'Technical Note' (06 Pages).

08.05.24

(गौरव गोयल)
वरिष्ठ मंडल विद्युत अभियंता (कर्षण चल स्टॉक)
उत्तर रेलवे, गाज़ियाबाद

Technical Note for Identifying problem of converter coolant temperature greater than limit in ABB based propulsion/ traction converter

ELS/GZB is holding 111 Locomotives (Propulsion: 42, Traction converter: 69) equipped with M/s ABB traction converter system. In April 2024, there are 3 arisings (2 Punctuality) in ABB traction converters, details of same are furnished below:

Loco No.	Date	Train No.	DDS Message
37170	13.04.24	12801	Conv Coolant temp > Limit
30654	26.04.24	15658	Conv Coolant temp > Limit
39044	28.04.24	02564	Conv Coolant temp > Limit

Similarly, there are similar arising also in FY 2023-24 also. The detailed analysis of the issue has been taken up by ELS/GZB. Initially the issue has been attributed due to lesser cooling by OCB. OCB provides cooling for converter coolant as well as transformer oil. Air cooling mechanism used in locomotive is given below:

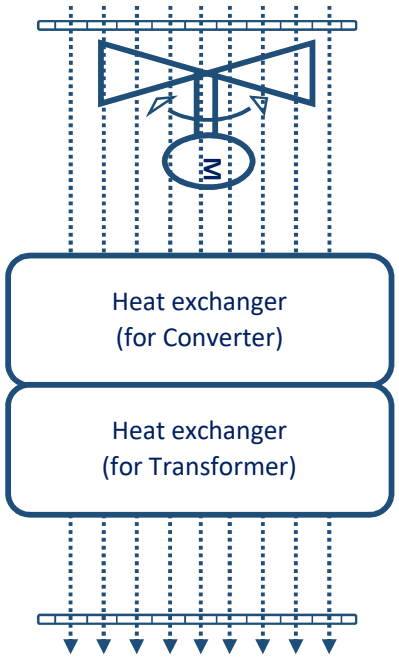

Fig 1: OCB cooling mechanism in Locomotive

Different message generation generated during rise in coolant/transformer oil temperature rise:

SLG1: 0018-Conv Coolant temp > Limit	For SR-1 Coolant
SLG1: 0020-Transformer temperature > Limit	For TF Pump -1
SLG2: 0018-Conv Coolant temp > Limit	For SR-2 Coolant
SLG2: 0020-Transformer temperature > Limit	For TF Pump -2

Generally, fault message generated due to lesser air delivery consists of both SR coolant messages and Transformer temperature messages. **But, in ABB traction converter, it is found that message related to only SR coolant got generated.** On further analysing cases of other propulsion, it has been found either both (SR & Transformer) message are logged or only transformer temperature > limit logged. **Failure due to only 'Conv coolant temp > Limit' found mostly in ABB traction converter as compare to other make traction converter.**

Background data of reported locomotives at the instance of fault checked and found SR coolant temperature breaching the limit while Transformer temperature found within the limit (Power reduction starts at 80 °C).

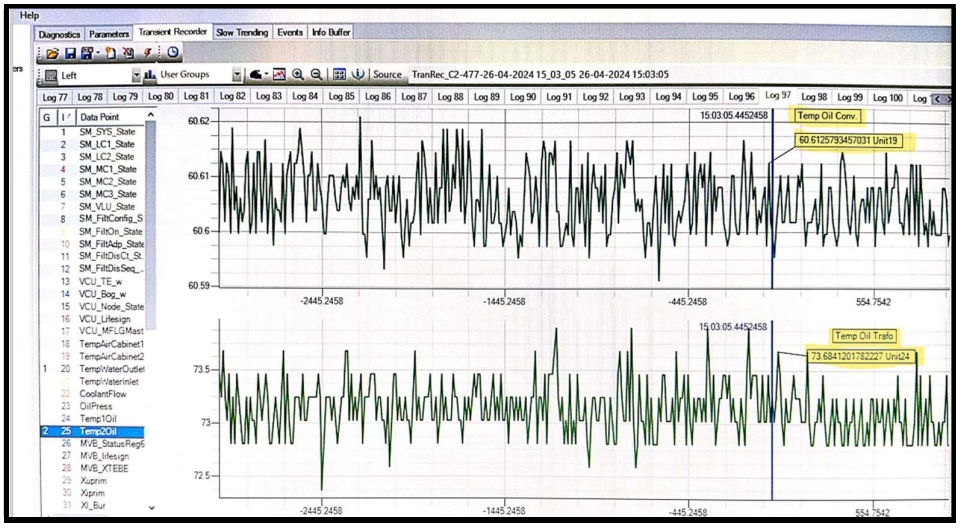

Figure 2: Loco No. 30654 SR -2 background data

Fault generation Logic Analysis

A comparative study of logic implemented for cooling and generation of fault messages done to analyse the issue as shown below:

Traction Converter	Ventilation Status	Level -1	Level-2	Level -3	T/E reduction
ABB	Start	T > 45 °C	T > 50 °C	T > 55 °C	**58 °C (100 %)**
	Stop	T < 42 °C	T < 47 °C	T < 52 °C	**60 °C (0%)**
Medha	Start	T > 46 °C	T > 50 °C	T > 55 °C	80 °C (100 %)
	Stop	T < 42 °C	T < 47 °C	T < 52 °C	84 °C (0%)
BHEL	Start	T > 45 °C	T > 50 °C	T > 55 °C	83 °C (100 %)
	Stop	T < 42 °C	T < 47 °C	T < 52 °C	85 °C (0%)

In ABB traction converter, power reduction starts at much lower temperature (58 °C) in comparison to other make propulsion. Power output from traction converter reduces to zero when coolant temperature reaches 60 °C, while in other propulsion this limit is more than 80 °C.

Power isolation logic in different make traction converter:

ABB
*VCB opens if Coolant Temp. (Inlet) >= **60 °C** for 5s OR Coolant Temp. (Outlet) >= **65 °C** for 5 s*
BHEL
VCB opens if Coolant Temp. >= 90 °C for 10s
MEDHA
Line Converter and TM Isolation if Coolant Temp. >= 84 °C for 10s

As mentioned above, **power isolation also happens at much lower temperature in ABB traction converter than in other make traction converter.** Therefore, fault in Locomotive is due to coolant temperature>limit in ABB is much higher as during peak summer season ambient temperature itself reaches 50 °C.

Traction Converter Cooling System

Traction converter cooling system provides cooling for the power supplying power modules present in traction converter. Coolant exchanges heat taken from power modules with atmospheric air through radiator. In this way it keeps temperature rise in high power equipment of traction converter within limit. Machine room blower air is used to keep control electronics temperature within limit via provided heatsink. Churning fan is used for forcing hot air from traction converter to outside.

ABB composite traction converter has **unique design** in which complete traction converter is sealed and **same coolant is used in two small radiators (one in case of standalone traction converter).** These are mounted inside traction converter to keep temperature of control electronics and traction converter within limit.

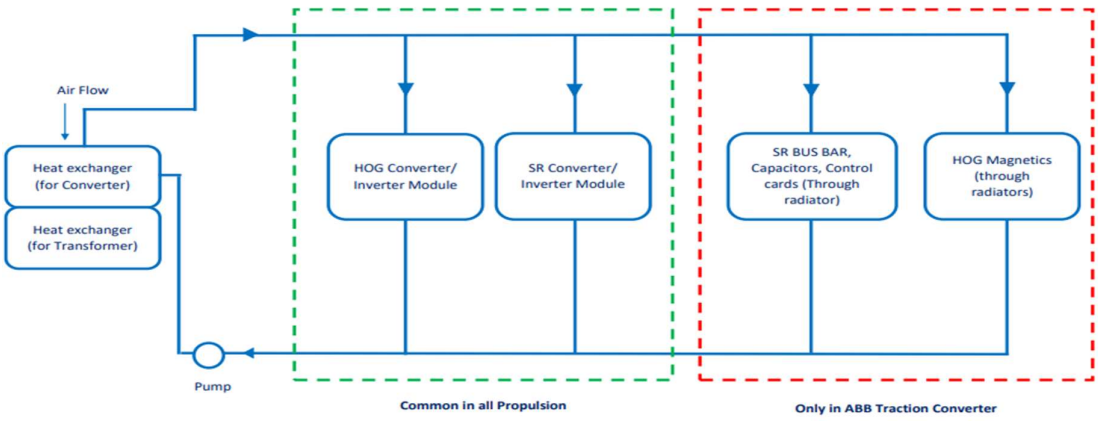

Fig 3: Cooling System in different make traction converter (* HOG part only in composite converter)

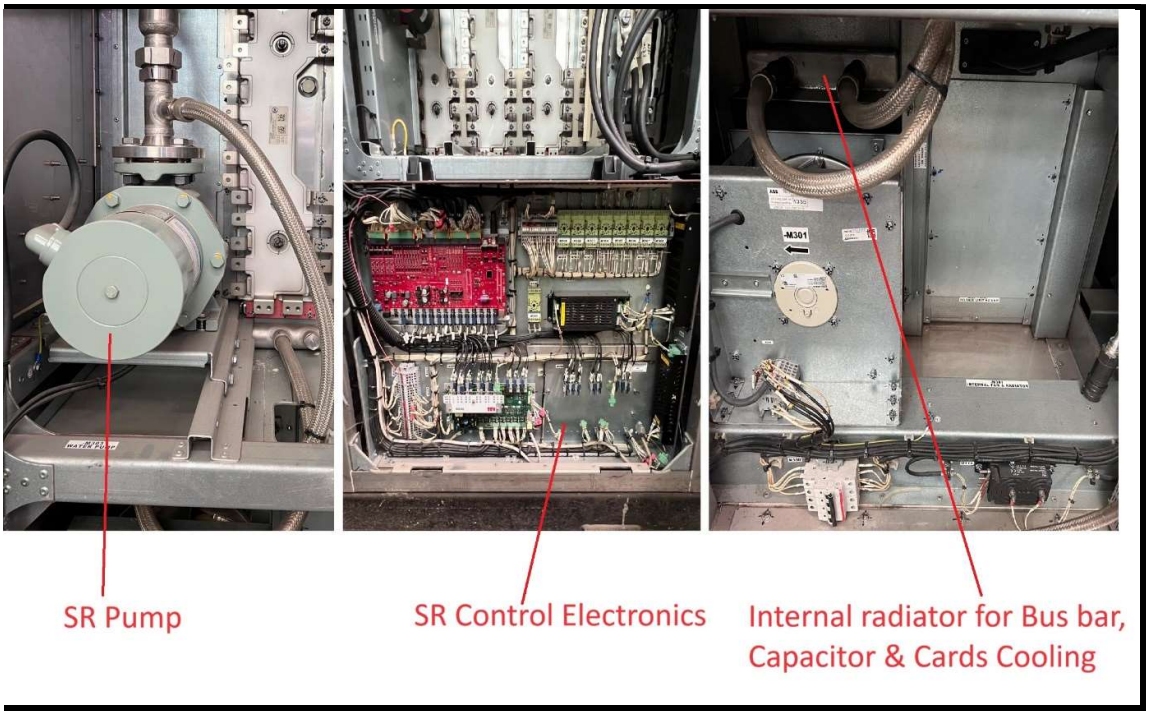

Fig 4: ABB traction Converter Cooling System

Fig 5: BHEL traction Converter Cooling System

In ABB make traction converter as coolant is used for cooling of additional equipment other than power modules also, its temperature will rise more than in other make traction converter. This factor also contributes in more fault messages in ABB make traction converter.

Priority –II fault message generation

In original design of 3 phase locomotive, there was generation of priority II fault 'Power reduction Conv coolant temp > Limit' whenever coolant/transformer temperature crosses the defined limit. Logic defined in GTO locomotive is given below:

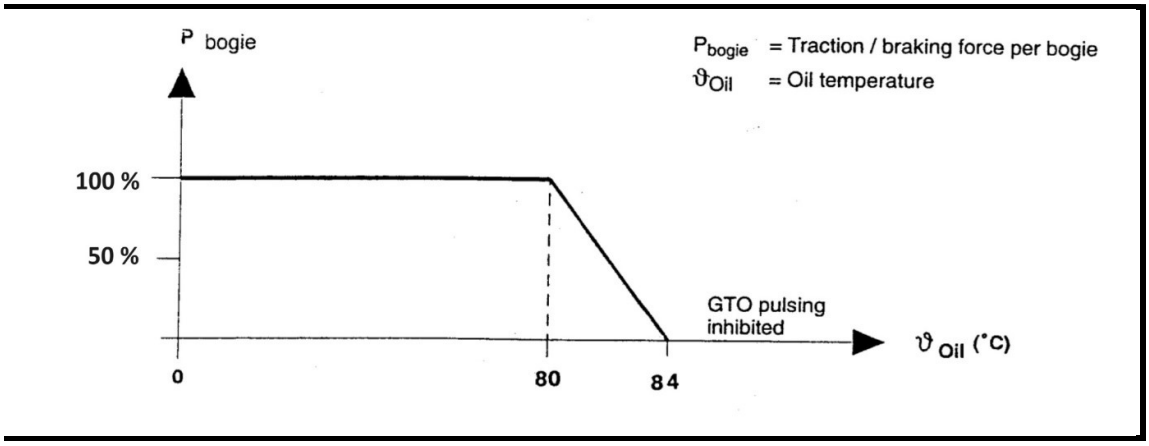

Fig 6: Power reduction logic for transformer oil temperature

This used to alarm crew regarding power reduction and alert TLC for further planning for troubling power. During trip Inspections/destination while checking DDS messages if priority II fault is found necessary preventive check-up is taken by concerned authority.

However, **In ABB traction converter there is no message related power reduction comes, only priority 1 fault comes when ever coolant/transformer temperature crosses the upper limit. In this bogie gets isolated or power fails without any warning to Loco crew.**

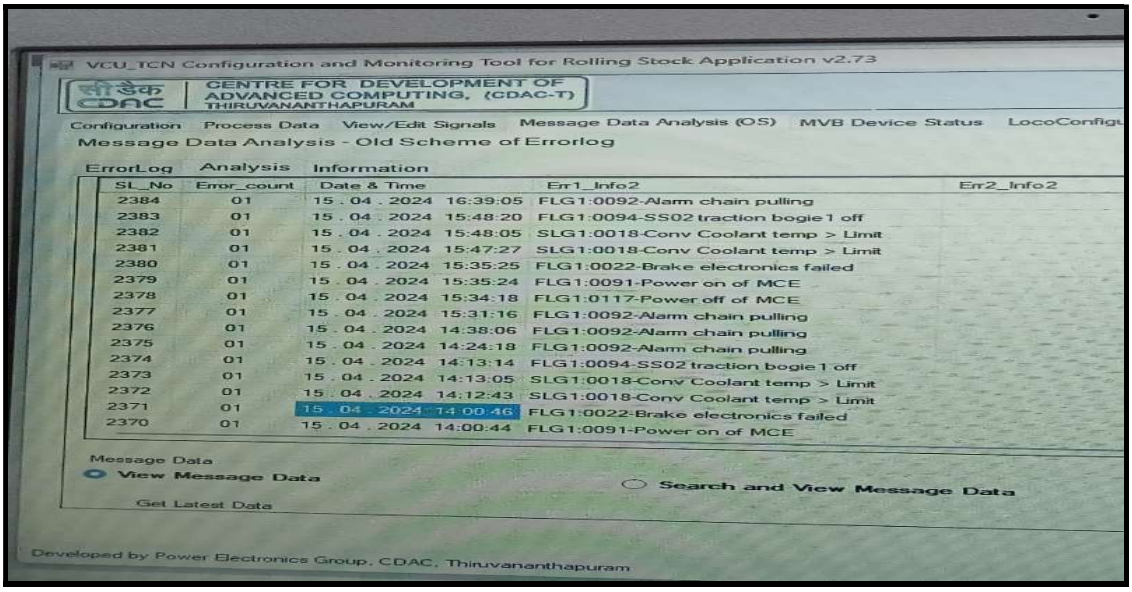

Fig 7: Con coolant temp > limit messages logging in ABB traction converter

Probable Solutions

1. Coolant temperature limit to be reviewed by ABB, these should be brought closer to the limits used by other make traction converters. This will help in reducing failure on this account.

2. **Power reduction messages should be generated by traction converter.** It will act as early warning for Crew/TLC before isolation of traction bogie or complete power. It will also improve preventive maintenance and reliability of ABB make traction converter.

3. Traction converter cooling system adopted in ABB traction converter need to be reviewed. Machine room blower cooling and churning fan cooling like other make traction converter can be used in ABB traction converter also. **This will reduce load on coolant-based cooling of traction converter and there will be lesser rise in coolant temperature.**

4. Since difference between starting temperature of Level-3 ventilation and bogie output power becoming zero temperature is only 5 °C (60 °C – 55 °C), highest level of ventilation is not properly utilised. **The limit of Level -3 ventilation may be brought down to 45 °C so that highest level of cooling starts at the early stage and coolant temperature doesn't cross the troubling temperature limit.**

08.05.24

(Gaurav Goel)
Sr. Divisional Electrical Engineer
Electric Loco Shed, Ghaziabad