MINUTES OF THE MEETING HELD WITH SHORTLISTED FIRMS FOR FINALISING THE SPECIFICATION OF TRAIN COLLISION AVOIDANCE SYSTEM (TCAS) ON 23rd & 24th JANUARY 2012

PRESENT:

RDSO:  
Shri Mahesh Mangal, Sr. ED/ Signal  
Shri A.K. Jain, Executive Director/ Signal  
Shri P.K. Bhagchandani, Dy. Director/Signal  
Shri Ashutosh Chaubey, JE/ Signal

FIRMS:

1. Dr. M.R. Verma, P. System Engineer, Invensys Rail Systems India  
2. Shri Indranil Majumdar, C&M, R&D, HBL Power System  
3. Shri Satish Mohanram, Business Deve. Manager, National Instruments  
4. Shri R. Balamurugan, Director/ DSMU, TSTS, Bangalore  
5. Shri Venkatesh, Director/ SSMU, TSTS, Bangalore

The draft specification of TCAS version 3.0 was put up on website on 30.12.2011. During the meeting, the comments related with the draft specification and any other issues which required further clarifications to be incorporated in the specification were discussed. Based on the discussion during the meeting, following decisions were taken:

Date - 24.01.2012

1. Whenever any loco TCAS does not have the signal ID of a signal being approached either due to restart of TCAS or due to passing of a Signal At Danger (after following operating procedure of IR) or after passing RFID tag (which is 2000m from FSS) at the start of TCAS territory or due to any other reason, it will make a request to station TCAS by sending the packet as shown in Annexure-II of TCAS specification version 3.0 with ‘011’ as the emergency status. Station TCAS on getting such request & based on TIN, Loco ID, location and direction as received from Loco TCAS shall identify the signal on approach pertaining to this train and accordingly will start sending signaling information as in Annexure-I alongwith destination loco ID.

2. Loco TCAS shall have interface for taking input form BTM/ Ballise reader and from GSM-R so that the Loco TCAS could be made interoperable with ETCS L1 and L2 at later stage.

3. The algorithm of calculation of train length has now been modified. Now in place of 2 packets i.e. start marker & end marker as in Annexure-IV of TCAS specification version 3.0, TCAS will send only one packet combining the information of both the packets in one and shall also send the start location (the location of boundary of AT & BT). The Loco TCAS on getting such packet
shall compare its own time at start location (as per its log which is recorded every 10ms for last one minute) with that sent by Station TCAS. Any difference in these timings shall be used by loco TCAS for making corrections in the end marker time sent by station TCAS.

4. For train length measurement, the start and end time markers will be depending on pick up and dropping of track relays. The input to station TCAS may be from different repeater relays at different stations. Therefore, there should be a provision in the station TCAS so that depending upon the total drop away and pickup time of track circuit relays, time correction factor can be fed at the time of installation, to achieve higher accuracy in train length measurement. The lower and higher limits of time correction factor shall be specified in the specification.

5. As RS232 ports may not qualify for SIL-4 and the signal level is also low, it was decided to use RS485 ports in place of RS232.

6. There are two options of connecting RFID reader to Loco TCAS viz. Ethernet and RS485. It was decided to use RS485 connectivity.

7. The storage capacity of Loco TCAS data logger shall be 90 days and that of station TCAS shall be 30 days minimum.

8. As per draft TCAS specification version 3.0, indications of all points taking off from main line are to be interfaced with station TCAS for deciding whether the points are set for main line or not and also for cross-checking with signal aspect. As there may be large number of points taking off from main line, interfacing each point indication to the station TCAS will make station TCAS bulky and complicated. It was, therefore, decided that the only two inputs for each main line of the station shall be given to station TCAS as shown in the diagram below and depending upon the status of these two inputs, station TCAS shall decide whether the line is set for main line or not.
<table>
<thead>
<tr>
<th>Status of A</th>
<th>B</th>
<th>Decision of Station TCAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Main line set</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>Main line not set</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>No status available</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>No status available</td>
</tr>
</tbody>
</table>

Similar to as shown above, there shall be inputs like A & B for each main line of the station.

9. In radio communication, scrambling of data and its encryption, both are not required as both carry out almost similar functions. For SIL-4 system, encryption is compulsory. It may be examined if scrambling could be done away.

10. Loco TCAS, in no-communication zone or when transmitting emergency messages, shall be inverting its frequency alternatively every 1 second. If the same thing is being done by another locomotive in the same time slot then these two locomotives may not be able to listen to each other. Some time slots have been reserved for this purpose. Out of these reserved time slots, some may be further reserved for UP trains and remaining for DN trains.

11. The station VDU capable of displaying yard layout and all train movements over it shall be required only for maintenance and diagnostic purpose. Therefore, this may not be part of Station Master's room. SM shall be provided with small OCIP having few buttons and LCD display which are required purely for operational purpose.

12. It was suggested that permanent speed restriction should also be covered by TCAS.

13. The Loco TCAS whenever entering in the zone of any Station TCAS shall establish the communication with station TCAS through random access within the reserve time slots for this purpose. The signaling information transmitted by station TCAS shall also have a preferred window for each Loco TCAS and therefore, further communication by Loco TCAS shall be done in particular window only, in order to avoid any collision of packets during the entire territory of that station TCAS. Here also, the slots reserved for random access may further be reserved for UP and DN line separately. As at a wayside station at a time only one UP train and one DN train may be approaching, even during random access there may not be any possibility of collision of packets.
14. On 3 level braking by Loco TCAS, it was clarified by RDSO that NB shall be used only for ABT. SB shall be used as first line of control and EB shall be as fall back or when distance to the target is not enough for SB to be applied. It is to be checked if ABT could be done with SB then we need not use NB at all.

15. When two Loco TCAS’ find their TIN as same then based on their speed, location, direction, Train length shall decide the target for stopping the train. As loco TCAS may be of different manufacturer, clarity in determining the target is required. One of method for calculation is given as under & needs to be examined:-

For Head On Collision situation (their direction is opposite to each other)-
Let S1 be the speed & L1 be the location of Loco-1 and S2 be the speed & L2 be the location of Loco-2. The direction is opposite to each other & TIN is same as they are approaching head-on.
The distance between the two Locos, \( D = |L1-L2| \)
& D shall be divided between them such that
\( D = D1 + D2 + 200m \) (200m is the safety margin after stopping of both locos)
\( (D1/D2) = (S1/S2)^2 \)
Where D1 is the distance available for Loco-1 to stop & D2 is the same for Loco-2.

For Rear End Collision situation (their direction is same)-
Assuming Loco-1 is the train ahead & Loco-2 is following it from behind. Let TL1 is the train length of Loco-1 train. There shall be no target to stop for Loco-1 on account of Loco-2 coming from behind. The distance available for Loco-2 to stop, D2 may be as under:

\[ D2 = |L1-L2|-TL1-200m \]

16. The distances D1 & D2 as calculated in item 15 above shall be calculated & speed profile calculated/ updated dynamically & the braking shall be initiated or changed to higher level by Loco-1 or Loco-2 trains according to dynamically updated speed profile/ brake curve. The formulae for calculation of D1 & D2 may be thoroughly examined & reviewed.

17. The Loco TCAS shall also make speed profile/ brake curve based on movement authority, speed restriction etc. Loco TCAS shall follow the most restricted speed profile/ brake curve at any point of time.

18. In order to have full advantage of hot standby radio, it was decided to have separate cable and antenna for the standby radio.

19. The type of antenna and antenna cable may also be considered for incorporating in the specification.
20. The train length measurement is based on dropping and picking up of a track circuit. Due to failure of track circuit it may remain down for longer period therefore, a limit shall have to be defined in the station TCAS and if track circuit does not pick up during that period station will not transmit the train length packet to Loco TCAS. Loco TCAS shall retain the earlier stored train length.

21. Station TCAS shall transmit train length packet 5 times so that even missing of some packets does not result into non-calculation of train length by loco TCAS.

22. Once collision situation is detected by loco TCAS', the action taken to prevent it shall continue even if there is no further communication available to them. It should discontinue the action only when it has positively received that the collision like situation is over.

23. Electro mechanical, non-resettable counters shall be provided associated with isolation of the system, SPAD prevention by TCAS, collision prevention by TCAS etc.

24. If Loco TCAS of the train fails in the mid-section and the train clears the block section, it would not be able to communicate the block clearance event to station and station TCAS will not allow any other train with same TIN in the block section. Provision should exist in the station TCAS for resetting the block working ensured by these TCAS units. This should have counter. Also the resetting can be done only when the block instruments are in Line closed condition.

25. The input capacity of station TCAS as mentioned in clause 6.4.2 of TCAS specification version 3.0 may be achieved either by providing additional card in the same unit or by cascading various units.

26. The RHC polarization as mentioned in the clause 6.17 of TCAS specification version 3.0 is not clear. This may be examined and modified in the specification accordingly.

Date - 24.01.2012

27. Representative of M/s. Apna Technologies suggested for including the outer dimension of LP-OCIP in the specification. He also suggested for including the dimensions of Loco TCAS but it was decided that the size of Loco TCAS should be as small as possible. As the system is not yet developed even to prototype stage, it would not be possible to specify its size.

28. The packet structure and type of communication between two station TCAS on OFC/Quad is to be incorporated in the specification. The connectivity shall be through RS485 ports.

29. Dr. M.R. Verma suggested for incorporating time out, sequence, number, speed coding, cryptography etc. which may be required for SIIL-4 validation communication as per 50159-2. RDSO shall examine and incorporate in the specification if necessary.
30. Regarding logging of data, it was decided that the record containing following information shall be logged every 1 second and also on occurrence of events as defined below:

(i) Information should be logged in each record:

(A) **Loco TCAS:**
- Event
- Date & Time
- Loco ID
- Speed
- Location
- Last RFID tag passed
- Direction
- Block section or Station section
- Type of Brake application
- Brake release
- Emergency message
- Any other

(B) **Station TCAS:**
- Event
- Date
- Time
- Status of all signalling inputs
- Signalling information packet
- Station emergency message
- Loco's emergency message (redirected)
- Messages to adjacent stationary TCAS
- Any other

(ii) Events which will trigger the logging (in addition to logging at every second):

(A) **Loco TCAS:**
- Initiation of brake application.
- Change of type of braking application.
- Removal of brake application.
- Change in mode.
- Acknowledgement by driver
- SPAD
- Passing of RFID Tag.
- Change in TIN.
- 1 RFID tag missing out of 2.
• Data mismatch between duplicated RFID tags.
• Change in Signal Aspect.
• Passing of signal.
• Permission of emergency messages.
• Reception of emergency messages.
• Collision like situation
• Any other event.

(B) Station TCAS:

• Entry of new train.
• Change in input to station TCAS from interlocking.
• Emergency messages received from Loco TCAS.
• Transmission of emergency messages either generated by station itself or retransmission of such messages received from Loco TCAS.
• Block Entry.
• Block Exit
• Any other event.

Above lists are not exhaustive & may change based on the requirement during the development of product.

31. The data should be logged in ASCII CSV format. The data should be encrypted and could only be decrypted by the PC based software supplied alongwith the system. The fetching of data should be password protected.

32. Representative of M/s. Apna Technologies brought out following issues for consideration of RDSO:

(i) It may not be possible to achieve the required level of accuracy in location, distance and speed measurement based on the existing speed sensors of the locomotives. Provision of additional speed sensor may also be examined.

(ii) The error permitted in distance measurement up to the next RFID tag may be increased ±10 mtrs.

(iii) The approximate size of station TCAS would be two 19” rakes of about 5 -6’ heights.

(iv) The train interface for loco TCAS may be defined in the specification for direction determination, speed sensor input, brake interface, traction cut off etc.

(v) The power supply voltage available in the locomotive alongwith range may be incorporated in the specification.
(vi) The backup duration for Loco TCAS in case of loco supply failure may be specified. RDSO suggested for half an hour backup.

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