Detailed Project Report for "KAVACH" Implementation in Indian Railways

Mission Raftaar- 160 KMPH

भारतीय रेल

Indian Railways

Detailed Project Report of

KAVACH Works in

NDLS-CPYZ and NDLS-PWL

Section of

Northern Railway

2022

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ABBREVIATIONS:

Abbreviation	Description
AIP	Approval In Principle
ATP	Automatic Train Protection
BIU	Break Interface Unit
DCF	Discounted Cash Flow
DEMU	Diesel Electrical Multiple Unit
DMI	Driver Machine Interface
DRACAS	Defect Reporting and Corrective Action System
EMU	Electrical Multiple Unit
GTKM	Gross Tonne Kilometre
IBS	Intermediate Block Signal
IR	Indian Railways
LC	Level Crossing
LED	Light Emitting Diode
LHS	Limited Height Subway
LP	Loco Pilot
LTCAS	Locomotive Train Collision Avoidance System
MCB	Miniature Circuit Breaker
MEMU	Mainline Electric Multiple Unit
MMTS	Multi Modal Transport System
NTKM	Net Tonne Kilometre
OHE	Over Head Equipment
PSR	Permanent Speed Restriction
QCRA	Qualitative Cost Risk Analysis
RAM	Reliability, Availability and Maintainability
RFID	Radio Frequency Identification

Abbreviation	Description
RIU	Remote Interface Unit
ROB	Road Over Bridge
ROR	Rate of Return

1. EXECUTIVE SUMMARY:

1.1 Background

Indian Railways is experiencing phenomenal growth in gross turnover. Since 1950 Railways Passenger Kilometre, Freight Train Kilometre, Revenue earning freight traffic (NTKM), Gross Ton Per Km (GTKM), Wagon and Coach utilization is continuously increasing. In the year 2012-13, Indian Railways joined the exclusive club of billion-ton freight loading countries with China, Russia and USA. In terms of Passenger Km carried, IR is second largest passenger carrier in the word next only to Chinese Railways. Despite its phenomenal growth in terms of traffic, there has been no substantial improvement in the average speed of passengers as well as freight trains.

"***In order to reverse this trend, Indian Railways has embarked upon the speed enhancement plan along with removing the capacity constraints by doubling, tripling and quadrupling of railway sections".***

Although performance of the Indian Railways on the safety front is showing continuous improving trend with zero passenger casualty during 2019-20 & 20-21. Yet in view of the enhancement of speed, doubling, tripling and quadrupling of track, this safety performance without any technical aid to loco pilots is difficult to sustain. Signal Passing at Danger, Breach of Block rules and failure to observe the prescribed speed by loco pilots are potential hazards.

"In order to mitigate the risks arising out of these incidents and provide aids to loco pilots for confident driving at higher speed, Indian Railways has planned to deploy the Modern Train Control System on its entire network in a time bound manner."

In this context successful trial of indigenously developed Automatic TrainProtection system has been carried out in 265 Kms section on Secunderabad Division of South Central Railway. In addition to this, further deployment of this system in contiguous section of Bidar – Prabhani, Manmad – Parbhani - Mudkhed – Secunderabad – Dhone – Guntakal (1200 RKMs) has been sanctioned and the work in that section is ongoing successfully.

Encouraged with the results, a conscious decision to have all Modern Train Control system works with indigenously developed Train Collision Avoidance System (TCAS) now named as **KAVACH** has been taken.

1.2 Project Overview

The section under consideration of this DPR i.e. New Delhi- Tilak Bridge- Chipiyana Buzurg (NDLS-TKJ-CPYZ) and New Delhi- Tilak Bridge- Palwal (NDLS-TKJ- PWL) Section of Northern Railway, which is a part of the Delhi - Howrah and Delhi-Mumbai HDN (High Density Network) Route respectively, has to be provided with the ATP system "KAVACH" (TCAS) under "Mission Raftar" for increasing the speed to 160 kmph from the present 130 kmph and enhancing safety at the same time.

Delhi- Howrah and Delhi- Mumbai route of Indian Railway is one of the busiest routes on Indian Railways. Of this New Delhi- Chipiyana Buzurg and New Delhi-Palwal section of NR is a major component.

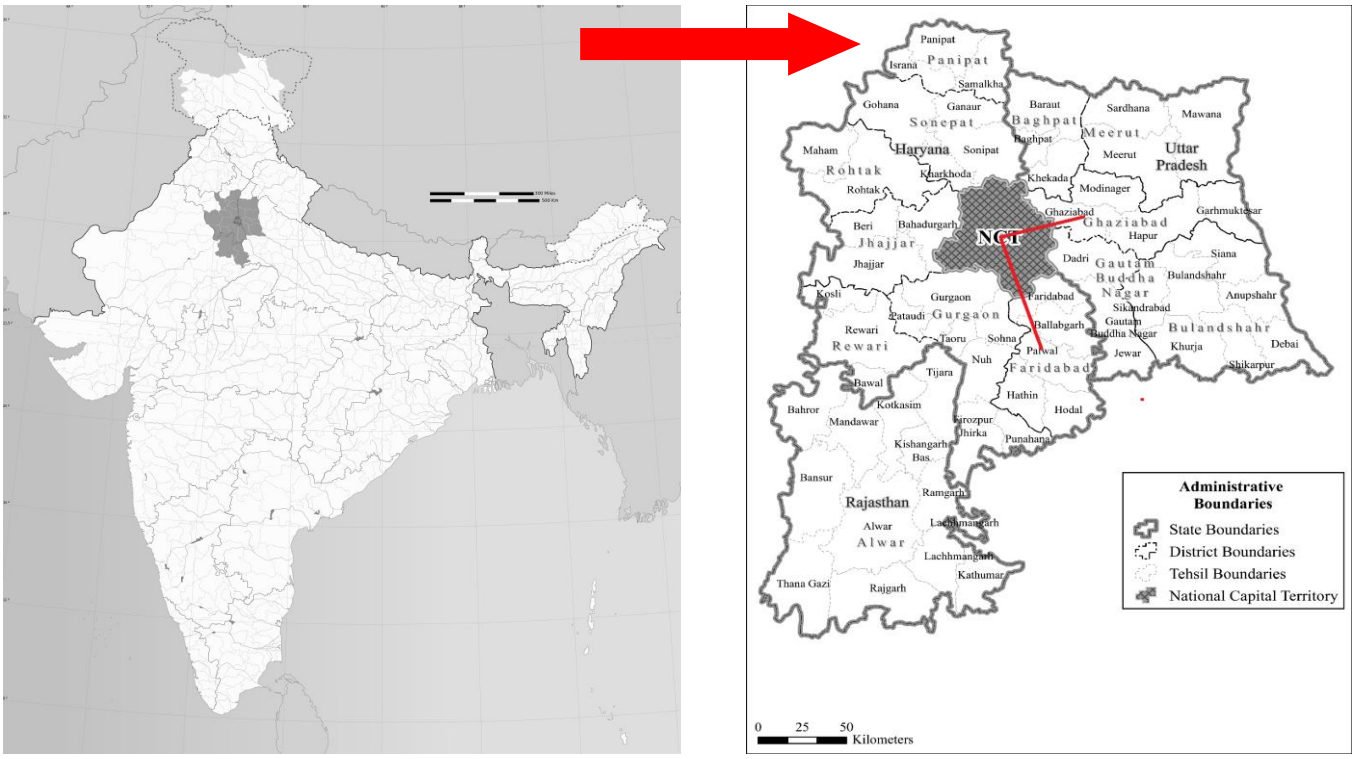
On this busy route, it will enable the Loco Pilots of KAVACH fitted Locomotives to take the experience and advantage of confident driving in a continuous long stretch of about more than 83.64 Kms of NDLS-TKJ-CPYZ and NDLS-TKJ-PWL section on Northern Railway which is the site of this Project.

1.3 Project Location and description of section

The NDLS-TKJ-CPYZ and NDLS-TKJ- PWL section of Delhi Division, Northern Railway is a part of Delhi – Howrah and new Delhi-Mumbai HDN Route of Indian Railways respectively.

The Ex. TKJ-CPYZ section is of 26.46 Route Km length and passes through the state of Uttar Pradesh, Haryana and union Territory of Delhi running parallel/crossing major rivers like Yamuna, Hindon etc. and their tributaries. The NDLS-TKJ-PWL section is of 57.18 Route Km length and passes through the state of Haryana and union Territory of Delhi running parallel/crossing major rivers like Yamuna etc. and their tributaries. The terrain of the sectionis mostly flat with ruling gradient of 1 in 200. The section is mostly in the gangetic plains with alluvial soil as the major soil type.

NDLS-TKJ-CPYZ and NDLS-TKJ- PWL section of Delhi Division, Northern Railway



NDLS-TKJ- CPYZ Section:

The Ex. TKJ-CPYZ section comprises of 02 stations and 03 Junction stations totaling to 05 numbers of stations, 04 numbers of Level crossing Gates, no Intermediate Block Signals and in addition an Automatic signaling territory having 07 numbers of Auto Relay Huts and carries mix traffic of all kinds, viz. freight, mail / express, passenger and suburban trains.

NDLS-TKJ- PWL Section:

The NDLS-TKJ-PWL section comprises of 07 stations and 05 Junction stations totaling to 12 numbers of stations, 05 numbers of Level crossing Gates, no Intermediate Block Signals and in addition a mix of Absolute and Automatic signaling territory having 13 numbers of Auto Relay Huts and carries mix traffic of all kinds, viz. freight, mail / express, passenger and suburban trains.

Number of Passenger and freight trains in one direction and maximum permissible speeds of various categories of trains in the section are given in table below.

Table 1.1

NDLS-CPYZ Section- UP Direction Traffic

SN	Type of Train	Numbers	Maximum Permissible Speed (KMPH)
	Express	136	Sectional Speed: 110KMPH
	Passenger		
	DEMU	27	
	MEMU		
	EMU		
	Freight	45	

NDLS-CPYZ Section- DN Direction Traffic

SN	Type of Train	Numbers	Maximum Permissible Speed (KMPH)
	Express	131	Sectional Speed: 110KMPH
	Passenger		
	DEMU	28	
	MEMU		
	EMU		
	Freight	45	

NDLS-PWL Section- UP Direction Traffic

SN	Type of Train	Numbers	Maximum Permissible Speed (KMPH)
	Express	65	Sectional Speed: 130KMPH
	Passenger	1	
	DEMU	-	
	MEMU	11	
	EMU		
	Freight	40	

NDLS-PWL Section- DN Direction Traffic

SN	Type of Train	Numbers	Maximum Permissible Speed (KMPH)
	Express	65	Sectional Speed: 130KMPH
	Passenger	1	
	DEMU	-	
	MEMU	11	
	EMU		
	Freight	40	

The Site of the Railway Project comprises NDLS-TKJ-CPYZ and NDLS-TKJ-PWL section in the State of Uttar Pradesh, Haryana and union territory of Delhi on Delhi Division of Northern Railway. The land and other structures comprising the Site are described below

1. RAILWAY : Northern Railway
2. DIVISION : Delhi Division
3. SECTION : Ex. TKJ-CPYZ and NDLS-TKJ-PWL Section
4. LENGTH of Section : Ex. TKJ-CPYZ (26.46KM) and NDLS-TKJ-PWL (57.18KM)
5. Max Speed : 130 Kmph

6. No. Of Lines :

A. Quadruple Lines: As mentioned in Table 1.2 below

B. Triple Lines : As mentioned in Table 1.2 below

C. Double Line : As mentioned in Table 1.2 below

D. Single Line : NIL

E. Any Other : NIL

F. Electrification : The total Route is Electrified

G. Block Working :

1. Absolute Block Working: As mentioned in Table 1.2 below
2. Automatic Signaling Directional: As mentioned in Table 1.2 below
3. Automatic Signaling Bi Directional: As mentioned in Table 1.2 below

H. A sub – section wise detail of the Route, including the sub – section length, Singe / Double / Triple / Quad Line details, RE / Non RE details, number of Stations, IBS, Auto section signals and number of LC gates are tabled below:

Table 1.2

SN	Div	Section	Sub-Section	Sec. Length (Rkm)	Single/ Double Line/ No of Lines	Block Working	RE/ Non-RE	Stn (No)	IBS (No)	Auto Section (KMs)	Auto Huts (No and Name)	LC Gates (Nos and Name)
1	Delhi Div	Ex TKJ-CPYZ (26.46Km)	Ex TKJ-Anand Vihar	10.42	2	Automatic	RE	5	-	10.42	AH1, AH2,AH3	-
2			Anand Vihar - BPNL	2.12	4	Automatic	RE		-	2.12	-	-
3			BPNL-SBB	3.84	4	Automatic	RE		-	3.84	-	-
4			SBB-GZB	6.72	4	Automatic-Bidirectional	RE		-	6.72	AH1,AH2 AH3,AH4	-
5			GZB-CPYZ	3.36	3	Automatic	RE		-	3.36	-	-
7		NDLS-TKJ-PWL (57.18Km)	NDLS-TKJ	2.6	6	Automatic; Bidirectional: 4 Lines Unidirectional: 2 Lines	RE	12	-	2.6	AH1	-
8			TKJ-HNZM	4.63	6	Automatic; Bidirectional: 4 Lines Unidirectional: 2 Lines	RE		-	4.63	AH1	-
9			HNZM-	3.66	4	Automatic-	RE		-	3.66		-

			OKA			Unidirectional						
10			OKA-TKD	6.85	4	Automatic-Unidirectional	RE		-	6.85	-	-
11			TKD- JNC	6.05	4	Automatic-Unidirectional	RE		-	6.05	-	579A, 579B
12			JNC-FDB	4.24	4	UP&DN M/L: Automatic unidirectional 3rd&4th Line: HASSDAC with UFSBI (TWIN Single Line)	RE		-	4.24	PH1, PH2	-
13			FDB-FDN	4.01	4	UP&DN M/L: Automatic unidirectional 3rd&4th Line: HASSDAC with UFSBI (TWIN Single Line)	RE		-	4.01	PH3	576 SPL - Stn
14			FDN-BVH	4	4	UP&DN M/L: Automatic unidirectional 3rd&4th Line: HASSDAC with UFSBI (TWIN Single Line)	RE		-	4	-	-
15			BVH-PYLA	6.46	4	UP&DN M/L: Automatic unidirectional 3rd&4th Line: HASSDAC with UFSBI (TWIN Single Line)	RE		-	6.46	PH4, PH5	-
16			PYLA-AST	3.45	4	UP&DN M/L: Automatic unidirectional 3rd Line: DUAL SSDAC with UFSBI (TWIN Single Line) 4th Line: SSDAC with UFSBI (TWIN Single Line)	RE		-	3.45	PH6, PH7	571 SPL-PH7
17			AST-PWL	11.23	4	UP&DN M/L: Automatic unidirectional 3rd Line: HASSDAC with UFSBI (TWIN Single Line) 4th Line: HASSDAC with UFSBI (TWIN Single Line)	RE		-	11.23	PH8, PH9, PH10, PH11	568 SPL-PH10

1.4 Project Objectives

Safe and incident free operation of trains not only results in satisfied customers but improve the productivity of costly fixed and movable assets, viz. track, OHE, signalling systems, locomotives, rolling stock and human resources. Automatic Protection System (ATP) contributes to achieve above objectives of a transport system.

KAVACH is an indigenously designed Automatic Train Protection system in line with the vision of Hon'ble PM of "Aatma Nirbhar Bharat" and "Make in India" initiative. KAVACH would benefit Indian Railways enhancing its performance in a cost-effective way through improvements in both safety and efficiency. At times when Railway control systems around the world has traditionally evolved in response to external pressures (such as accidents, technology advancements, customer satisfaction etc.), Modern train control systems such as KAVACH are an important milestone in Indian Railways' "VIKAS YATRA". Implementation of KAVACH will play a significant role in safer and efficient working of trains on Indian Railways.

1.5 Features of KAVACH

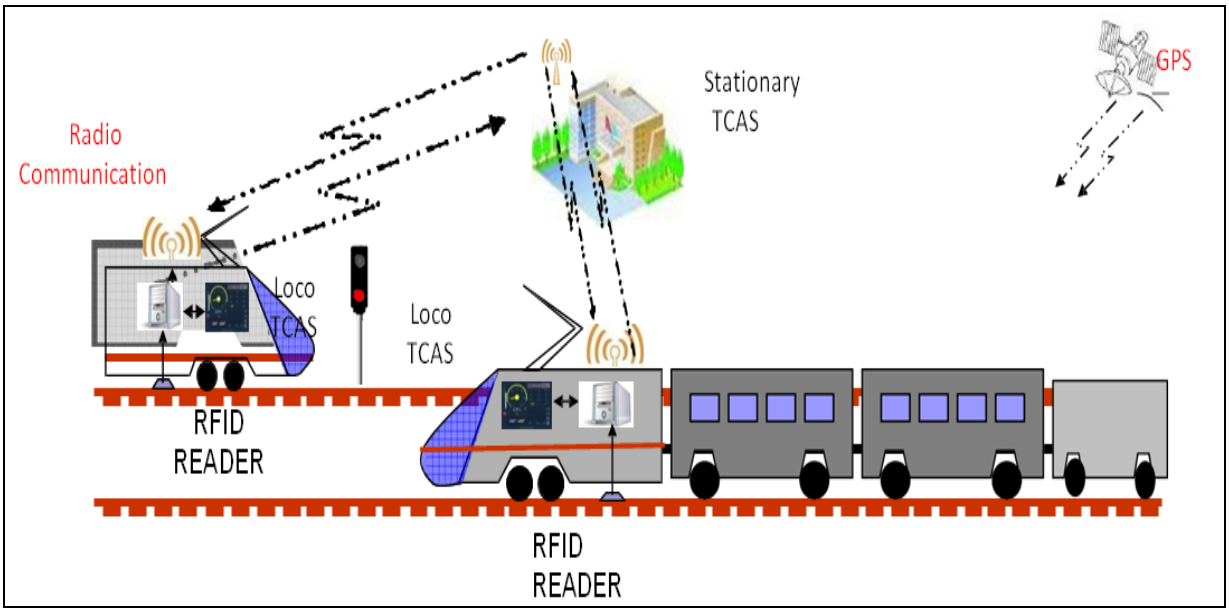
Train Collision Avoidance System KAVACH is an indigenous Automatic Train Protection System validated to SIL 4, highest level of Safety Integrity, developed by RDSO. The system alerts the Loco Pilot while approaching the signal about their aspects, Permanent Speed Restrictions (PSR) and requires him to acknowledge the warning in case of over speeding. In case the Loco pilot does not responds, the system initiates the brake application after a pre-defined delay. Salient features of the system are as follows:

- System is interfaced with existing signaling system and provides continuous update of Movement Authority.
- Prevention of Over speed: Section Speed & Loco Specific Speed
- Displays aspect of Signal on the DMI in the Locomotive.

- Manual SOS facility both from Loco and from Station in case of emergencies.
- Prevention of Side-collision, Head on collision, Rear end collision under certain specified conditions.
- Protection of roll back/ forward and reverse movement.
- Automatic whistling in the approach of LC Gates.

Components of KAVACH

The Train Collision Avoidance system shall comprise of track side equipment including Stationary TCAS Unit and On-board equipment.



The Trackside subsystem shall be comprised of

a. Stationary TCAS Unit to Interface with Signaling at Station EI / RRI / panel or LC Gate or IB or LSCs of Auto Signaling

b. Tower and Antennae along with the Radio Equipment.

c. RFID tag.

The On-board subsystem shall be comprised of

a. Loco TCAS Vital Computer

b. RFID readers consisting of two RFID Reader Antenna in hot standby

c. Loco TCAS Radio Unit consisting of two Radio Modems in hot standby with separate cables and antennae for each radio or LTE unit.

d. Driver Machine Interface (DMI) for each locomotive CAB or one DMI for each Driving motor coach of EMU/DMU/MEMU/DEMU etc.

e. Brake Interface Unit (BIU), where required.

The Communication Back – Bone: The System will also require a Back – Bone of a Optical Fiber Network in redundancy for the connectivity of the various Stationary Station TCAS / LC & IB TCAS / RIUs units in the Automatic Signaling section as per requirement.

The details of KAVACH technology are given in Annexure A.

1.6 Factors For Project Engineering

During execution of the project a number of important aspects are to be looked into and planned well in advance. The important planning parameters for KAVACH are:

1. Radio Tele-Communication Sub System UHF/LTE
2. Requirement Of Towers, Tower Structure & Location
3. The Signaling Interface Options
4. Building Requirement if any
5. Communication Back Bone
6. Priority Of Provision Of Loco TCAS and DMI location
7. Maintenance Strategy

1.7 Brief Scope of the Work:

The KAVACH (TCAS) shall be provided to cover entire NDLS-TKJ-CPYZ and NDLS-TKJ-PWL section of Northern Railway.

Design, Supply, Installation, Testing and commissioning of

a. On Board TCAS equipment in locomotives.

b. Track side Stationery TCAS equipment at station / LC TCAS / RIUs in Block section along with associated works including RFID Tags

c. Laying of OFC cable as communication Back Bone.

d. Design and Installation of Telecom Towers

e. Building works as per requirement.

The Train Collision Avoidance System to be procured and installed shall conform to RDSO Specification No. RDSO/SPN/196/2012 version 3.2 or latest.

1.8 Utility Shifting:

While executing the KAVACH work on the section, some of the critical works are like OFC cable laying, Tower erection, additional Relay rooms etc. All these work may require small works of utility shifting specially the existing cables on specific sites.

1.9 Impact of the Project KAVACH:

Land acquisitions are normally a major component of Infrastructure projects. In Project KAVACH the basic land requirement may arise due to installation of new Towers for UHF communication requirement and for construction of buildings for STCAS equipments at the stations and in the Block Section. Apparently in the concerning section under discussion i.e NDLS-TKJ-CPYZ and NDLS-TKJ-PWL section, no Land acquisition is required. However in case at a later stage if this requirement comes up, the same will have to be responsibility of the Zonal Railways and not the contractor.

Project KAVACH as an additional aid to the Loco Pilots is definitely going to enhance the Passenger safety as it monitors continuously the speed and Movement Authority and takes over in case of abnormalities.

The execution of TCAS project does not involve major civil works. As such there are no major Environment concerns.

1.10 Cost Estimation:

The proposed cost of the work is as mentioned in RFPand Details of this cost are elaborated in the Cost Estimate section.

1.11 Project Risk and Assumptions:

Qualitative Cost Risk Analysis (QCRA) with the objective of identifying the projects risks for the KAVACH project with all stake holder is to be done post contract award identifying significant risks to the achievement of the project objectives.

1.12 Project commissioning schedule:

It is proposed to complete the deployment of KAVACH system in 83.64 RKMs of the section within completion period after award of the contract. Different milestones of the project are detailed in the Project Schedule.

2. PROJECT OBJECTIVES:

2.1 Need for deployment of the ATP system

Assets used in railway applications are required to be more and more reliable and safe. The use of computer-based train protection systems is nowadays widespread, as it has been proven to be the most effective, if not the only practicable way to pursue such hard requirements.

Traditionally, train operations in Indian Railways have relied on the train drivers/loco pilots reacting to indications displayed to them by line-side semaphore or color light signals. During the 168 years of the the train operations on Indian Railways, drivers' failures to appropriately respond to the line side signals aspects have led to a number of accidents, some causing very huge loss of life and property.

A majority of train accidents caused by Signal Passing at Danger (SPAD) are attributed to the human error (Loco pilots). Momentary loss of concentration, lack of alertness, assumption of signal aspect, judgement error and overconfidence of loco pilots are among the common reason for occurrence of SPAD. Indian Railways reports on average of 50 cases of SPAD each year (based on the data from 2016 to Mar 2021). Such SPAD cases can create highly unsafe condition and may lead to highly unsafe conditions and collisions.

In response to the continuing need to reduce risks arising out of SPAD, Breach of block Rules and over speeding, an ATP systems have been envisaged.

2.2 Ensuring Safety in Train Operation

KAVACH, the Indian ATP system continuously monitor actual train speed and enforce adherence to a commanded speed pattern in case the loco pilots fail to do so. This commanded speed pattern or allowable speed profile is based on the information received from the wayside signalling subsystem. In case of an erroneous or late intervention by the loco pilot, who interacts with the system by a Driver Machine Interface (DMI), the on-board control system automatically commands the braking procedure, directly acting on train-

borne apparels via a specific interface, namely the BrakeInterface Unit (BIU).

For various reasons, although mainly because of track geometry (curvature, etc.), it is necessary to limit the speed at which trains may travel over certain sections of the railway. These places are subject to what are termed 'Permanent Speed Restrictions' (PSRs). Non-compliance to the designated PSR in the section or yard by loco pilots can often result in derailment, damage to rolling stock or unacceptable discomfort to passengers.

KAVACH has been developed to enforce speed limits, including permanent speed restrictions. KAVACH initiates an intervention through warning message to Loco pilots if over speeding is detected. If the driver fails to react in the stipulated time, braking is initiated to bring the speed within allowable limits. Driving is still manual but speed limits are always enforced.

2.3 Improving Train Running Performance

In Northern part of the country, a large number of trains are affected every year during foggy weather in winter months. Poor visibility of signal aspect to loco pilots forces Loco pilots

to drive the train at very low speeds even when line clear is granted and signal aspect is Proceed. Such slow speeds results in congestion along the route, train bunching and loss of capacity on the network.

KAVACH displays the aspect of signal ahead on the Driver Machine Interface Unit installed in the loco pilot's cab and conveys the signal indication even when the signal visibility becomes impaired due to foggy weather. The Movement authority monitored by KAVACH controls the safe distance for which the Loco pilots can run the train based on signalling information. This enable Loco Pilots to drive trains even during heavy fog. Loco Pilot can run the KAVACH equipped train confidently.

The delays in clearing the section can be reduced and punctuality performance of trains can be improved through installation of KAVACH system in fog prone regions of Indian Railways.

2.4 Supportive Objectives

The loco pilots suffer from tremendous stress at both personal and organizational level. This tremendous pressure over a long period of time reduces their cognitive capabilities including level of alertness. KAVACH is an additional aid to loco pilots which help them control the train when they are not able to take prompt action and respond in stipulated time. One additional feature of KAVACH which is an assistance to Loco pilots is the Automatic Whistling at Level Crossing Gates.

The Drivers of approaching trains should whistle continuously from the time they pass whistle boards to the time they cross the level crossing.This puts additional load on LP and ALP to continuously give whistle when approaching Level crossing gates.

KAVACH has an in-built feature in which automatic whistling is activated on passing the RFID tag installed on the track and demarcated for this purpose. When the KAVACH equipped trains passed over the gate tag (in KAVACH equipped section) on approach of a level crossing gate, continuous/intermittent whistling is activated till the train crosses the level crossing.

2.5 Speed requirements (SEM para):

As per Para 7.8.9 of SEM, Chapter 7 (Essentials of Signaling), for speeds of 160 Kmph it is essential to have an ATP system. This is due to the fact that at higher speeds it becomes difficult for the loco Pilot to continuously concentrate on line side signal aspects. As such one of the objectives of project KAVACH is as an enabler to run trains at 160 Kmph.

3. DETAILS OF THE SECTION:

3.1 Route details:

The TCAS Line side Equipment has to be provided in the various Yards and Block sections and to be interfaced with the Signaling of the Station.

For the section under consideration i.e. NDLS-TKJ-CPYZ and NDLS-TKJ-PWL Section of Northern Railway, the details of the Various Yards: Station Name, Station Code, Chainage, Standard of Signaling, Type of Interlocking (EI, RRI, PI), Number of Lines and No. of Routes, Junction or not etc. which will require interface with TCAS are detailed in the table below:

Table 3.1

S. N	STATION							No of Lines	No of Route	Junction or Not
	NAME of STN/AH	Latitude	Longitude	INTERLOCKING			Chainage			
				STD	EI/PI/ RRI	Make				
1	**NDLS_CPYZ Section**									
1	**NDLS**	28°38'53.72"N	77°13'6.31"E	III	RRI	SIEMENS	1537.64	20	1278	
2	**TKJ**	28°37'22.84"N	77°14'41.97"E	III	RRI	SIEMENS	10.42 (from ANVR)	7	178	Junction
3	**Anand Vihar**	28°38'45.56"N	77°18'41.59"E	IIR	RRI	BRITISH	7.38 (from HNZM)	10	127	
4	**B' PANEL**	28°39'41.03"N	77°19'44.47"E	IIR	RRI	BRITISH	9.4	2	10	Junction
5	**SBB**	28°40'26.94"N	77°21'51.29"E	IIR	RRI	BRITISH	13.16	8	320	Junction
6	**GZB**	28°39'08.44"N	77°25'43.79"E	III	RRI	BRITISH	19.88	13	623	Junction
7	**CYZ**	28°38'50.65"N	77°27'50.64"E	III	EI	ANSALDO	23.24	5	20	
B	**NDLS_PWL Section**									
1	**NDLS**	28°38'53.72"N	77°13'6.31"E	III	RRI	SIEMENS	1537.64	20	1278	
2	**TKJ**	28°37'22.84"N	77°14'41.97"E	III	RRI	SIEMENS	1535.04	7	178	Junction
3	**HNZM**	28°35'19.42"N	77°15'12.75"E	III	RRI	SIEMENS	1530.41	12	431	Junction
4	**OKA**	28°33'26.5"N	77°15'50.6"E	III	PI	BOMBARDIER	1526.75	6	81	Junction
5	**TKD**	28°30'14.0"N	77°17'49.4"E	III	RRI	SIEMENS	1519.9	24	301	
6	**JNC**	28°27'28.5"N	77°18'13.3"E	IIR	PI	SIEMENS	1514/21-23	4	43	
7	**FDB**	28°24'54.5"N	77°18'23.3"E	IIR	RRI	SIEMENS	1509.61	10	138	
8	**FDN**	28°22'37.83"N	77°18'35.02"E	IIR	RRI	SIEMENS	1505.6	5	67	
9	**BVH**	28°20'21.30"N	77°18'47.90"E	IIR	RRI	SIEMENS	1501.6	9	132	Junction
10	**PYLA**	28°17'13.5"N	77°19'03.5"E	IIR	-	SIEMENS	1495.14	7	-	
11	**AST**	28°15'09.5"N	77°19'24.9"E	IIR	RRI	SIEMENS	1491.14	7	134	Junction
12	**PWL**	28°09'09.2"N	77°20'28.2"E	IIR	RRI	SIEMENS	1480.46	11	203	

3.2 Other Signalling details:

Other than the Station Yard, the TCAS is required to interface with the Signaling Installation in the various Block section. The details of type of Block Signaling in the section under consideration are described below.

Absolute Block Signalling: NIL

Block Sections with IB: NIL

Automatic Block Signaling: The section is completely Automatic Signaling section with signals provided approximately at every Km. The section has provision of "Modified Automatic Signaling" during foggy weather.

This will require interfacing of the Auto section Signals with TCAS, with the help of RIUs or LC / IB TCAS units placed in Auto section LSCs / Relay Huts. The details of the various LSCs like LSC Name / Code, Chainage, type of Interlocking (EI or Relay Based) along with the Station details in between which they are placed are given in the table below.

There are in all 17 Stations with Block sections having 20 numbers of total AHs in the Block sections as detailed below:

Table 3.2

S. N	STATION							No of Lines	No of Route	Junction or Not
	NAME of STN/AH	Latitude	Longitude	INTERLOCKING			Chainage			
				STD	EI/PI/ RRI	Make				
1	**NDLS_CPYZ Section**									
1	**NDLS**	28°38'53.72"N	77°13'6.31"E	**III**	**RRI**	**SIEMENS**	**1537.64**	**20**	**1278**	
2	NDLS-TKJ Auto Hut	28°38'4.41"N	77°13'25.83"E	-	-	BRITISH		6	-	
3	**TKJ**	28°37'22.84"N	77°14'41.97"E	**III**	**RRI**	**SIEMENS**	**10.42** (from ANVR)	**7**	**178**	**Junction**
4	AH1-Akshardham Hut	28°37'15.20"N	77°16'38.20"E	-	-	BRITISH	2/14	2	-	
5	AH2-Mandavli Halt	28°37'37.98"N	77°17'8.36"E	-	-	BRITISH	3/19	2	-	
6	AH3-Anand Vihar Halt	28°38'53.30"N	77°18'43.70"E	-	-	BRITISH	7/02	2	-	
7	**Anand Vihar**	28°38'45.56"N	77°18'41.59"E	**IIR**	**RRI**	**BRITISH**	**7.38** (from HNZM)	**10**	**127**	
8	**B' PANEL**	28°39'41.03"N	77°19'44.47"E	**IIR**	**RRI**	**BRITISH**	**9.4**	**2**	**10**	**Junction**
9	**SBB**	28°40'26.94"N	77°21'51.29"E	**IIR**	**RRI**	**BRITISH**	**13.16**	**8**	**320**	**Junction**
10	SBB-GZB Auto Hut 1	28°40'12.67"N	77°23'11.06"E	-	-	BRITISH	15/7-9	4	-	
11	SBB-GZB Auto Hut 2	28°40'4.08"N	77°23'43.29"E	-	-	BRITISH	16/7-9	4	-	

12	SBB-GZB Auto Hut 3	28°39'54.93"N	77°24'17.75"E	-	-	BRITISH	17/7-9	4	-	
13	SBB-GZB Auto Hut 4	28°39'45.17"N	77°24'50.20"E	-	-	BRITISH	18/7-9	4	-	
14	**GZB**	28°39'08.44"N	77°25'43.79"E	**III**	**RRI**	**BRITISH**	**19.88**	**13**	**623**	**Junction**
15	**CYZ**	28°38'50.65"N	77°27'50.64"E	**III**	**EI**	**ANSALDO**	**23.24**	**5**	**20**	
B	**NDLS_PWL Section**									
1	**NDLS**	28°38'53.72"N	77°13'6.31"E	**III**	**RRI**	**SIEMENS**	**1537.64**	**20**	**1278**	
2	NDLS-TKJ Auto Hut	28°38'4.41"N	77°13'25.83"E	-	-	BRITISH		6	-	
3	**TKJ**	28°37'22.84"N	77°14'41.97"E	**III**	**RRI**	**SIEMENS**	**1535.04**	**7**	**178**	**Junction**
4	HNZM-TKJ Auto Hut	28°36'38.06"N	77°15'0.61"E		-	BRITISH	1532.16	4	-	
5	**HNZM**	28°35'19.42"N	77°15'12.75"E	**III**	**RRI**	**SIEMENS**	**1530.41**	**12**	**431**	**Junction**
6	**OKA**	28°33'26.5"N	77°15'50.6"E	**III**	**PI**	**BOMBARDIER**	**1526.75**	**6**	**81**	**Junction**
7	**TKD**	28°30'14.0"N	77°17'49.4"E	**III**	**RRI**	**SIEMENS**	**1519.9**	**24**	**301**	
8	**JNC**	28°27'28.5"N	77°18'13.3"E	**IIR**	**PI**	**SIEMENS**	**1514/21-23**	**4**	**43**	
9	PH1	-	-		-	BRITISH	1512/33-34	4	-	
10	PH2	-	-		-	BRITISH	1511/3-5	4	-	
11	**FDB**	28°24'54.5"N	77°18'23.3"E	**IIR**	**RRI**	**SIEMENS**	**1509.61**	**10**	**138**	
12	PH3	-	-		-	BRITISH	1507-11/13	4	-	
13	**FDN**	28°22'37.83"N	77°18'35.02"E	**IIR**	**RRI**	**SIEMENS**	**1505.6**	**5**	**67**	
14	**BVH**	28°20'21.30"N	77°18'47.90"E	**IIR**	**RRI**	**SIEMENS**	**1501.6**	**9**	**132**	**Junction**
15	PH 4	-	-	-	-	BRITISH	1499/3-1	4	-	
16	PH 5	-	-	-	-	BRITISH	1497/15-13	4	-	
17	**PYLA**	28°17'13.5"N	77°19'03.5"E	**IIR**	**-**	**SIEMENS**	**1495.14**	**7**	**-**	
18	PH 6	-	-	-	-	BRITISH	1495/17-15	4	-	
19	PH 7	-	-	-	-	BRITISH	1493/9-7	4	-	
20	**AST**	28°15'09.5"N	77°19'24.9"E	**IIR**	**RRI**	**SIEMENS**	**1491.14**	**7**	**134**	**Junction**
21	PH 8	-	-	-	-	BRITISH	1489/7-5	4	-	
22	PH 9	-	-	-	-	BRITISH	1487/15-13	4	-	
23	PH 10	28°11'38.79"N	77°20'60.56"E		-	BRITISH	1485/5-7	4	-	
24	PH 11	-	-	-	-	BRITISH	1483/11-13	4	-	
25	**PWL**	28°09'09.2"N	77°20'28.2"E	**IIR**	**RRI**	**SIEMENS**	**1480.46**	**11**	**203**	

3.3 Level Crossing Gates: The section has a number of manned Level Crossing Gates which are both Interlocked and Non – Interlocked. In case of Interlocked Level Crossing Gate the same will have to be interfaced with the ATP system by either with the LC TCAS or with the help of RIU to the nearest station.

Also in case of both Interlocked and Non Interlocked gates the auto whistling feature of the TCAS needs to be activated before the LC gate.

The details of the Level Crossing Gates on the section viz Block section, LC number, Chainage, Classification of LC, TVU of the LC gate and if Interlocked or not are given in the table below. However, in this section all the LC gates are in automatic signaling territory.

Table 3.3

Level Crossing Gate Details						
S.NO	**Block Section**	**LC NO.**	**Chainage**	**Class**	**TVU**	**Interlocked or Not**
A	**NDLS_CPYZ Section**					
1	BPNL-SBB	4C (MLB)	10/27-29	SPL	357696	Interlocked- **Controlled by SBB Stn**
2	GZB	153C (MLB)	21/6-7	SPL	514572	Interlocked- **Controlled by GZB Stn**
3	CPYZ	152A (ELB)	1429/14-16	SPL	652194	Interlocked- **Controlled by CPYZ Stn**
4	CPYZ	152B (ELB)	1428/22-24	SPL	321057	Interlocked- **Controlled by CPYZ Stn**
B	**NDLS_PWL Section**					
1	TKD-JNC	579B (MLB)	1516/8-10	SPL	1,19,212	Interlocked- MLB Independent
2	TKD-JNC	579A (MLB)	1517/25-27	SPL	2,13,890	Interlocked- MLB Independent
3	FDN	576 SPL (ELB)	1504.41	SPL	490000	Interlocked- **Controlled by Stn**
4	PYLA-AST	571 SPL (ELB)	1493.36	SPL	83,456	Interlocked- **Controlled by AH7**
5	AST-PWL	568 SPL (ELB)	1485.19	SPL	53428	Interlocked- **Controlled by AH10**

NOTE: Some of the LC Gates are to be **eliminated**. Parallel design strategy shall be followed for these Level Crossing gates.

3.4 Details of Spare Contacts in Existing Relay rooms

The ATP system "KAVACH" (TCAS) works on top of Existing Signaling system, taking Input from it and utilizing the same for Automatic Train Protection. Presently in the referred section we have

PI/EI/RRI at stations in NDLS-TKJ-PWL, NDLS-TKJ-CPYZ Section and also in the Auto section AH/ LSC.

There are two possibilities of taking the signaling input from the signaling system. Directly through EI using a SIL 4 protocol converter or by using relay contacts of the concerned relays which are ECRs, NWKRs / RWKRs & TPRs. Presently the OEMs have not developed protocol converters as such the provision of taking inputs from relays is being planned.

However it is recommended that inputs to be initially planned with Relay based system and in due course migrate to protocol converters as and when they are developed.

The availability of Spare contacts in existing ECRs, NWKRs / RWKRs and the TPRs of the relays in various Relay Rooms of stations, Relay Huts / LSC of Auto sections and Level crossing gates are enumerated in the table given as Annexure B.

The table also indicates the availability of space for Relays in Relay racks, provision of Relay racks and the TCAS station equipment in these Relay Huts.

NOTE 1: For the relays having no spare contact, the contacts wired for Data loggers shall be spared for TCAS working for opening repeater relays & the contact of repeater shall be proved in Data logger.

NOTE 2: It is preferred to take direct inputs from EI (at Data Level) instead of using relay interfacing for speedy execution as well as to enhance the reliability of the system.

3.5 SERVICE BUILDING: At number of locations the availability of Space in Relay Room / Relay Huts / LSCs for the TCAS equipment is not there, a separate additional Service Building of suitable size will be required to be constructed just besides the Existing service building. The tentative locations are indicated in the table below:

Table 3.4

S.NO	STATION NAME/Auto Huts	AVAILABILITY OF SPACE FOR (Yes/No)	
		RELAY RACK	STCAS / RIU
A	NDLS_CPYZ Section (Ex TKJ-GZB-CPYZ)		
1	TKJ-MWC AUTO Hut 1	No	No
2	TKJ-MWC AUTO Hut 2	No	No
3	TKJ-MWC AUTO Hut 3	No	No

4	Anand Vihar	Yes	Yes
5	B' PANEL	No	No
6	SBB	Yes	Yes
7	SBB-GZB Auto Hut 1	No	No
8	SBB-GZB Auto Hut 2	No	No
9	SBB-GZB Auto Hut 3	No	No
10	SBB-GZB Auto Hut 4	No	No
11	GZB	Yes	Yes
12	CYZ	No	No
B	**NDLS_PWL Section (NDLS-TKJ-HNZM-PWL)**		
1	NDLS	Yes	Yes
2	NDLS-TKJ Auto Hut	Yes	Yes
3	TKJ	Yes	Yes
4	HNZM-TKJ Auto Hut	Yes	Yes
5	**HNZM**	Yes	Yes
6	**OKA**	No	No
7	**TKD**	Yes	Yes
8	**JNC**	No	No
9	PH1	No	No
10	PH2	No	No
11	**FDB**	Yes	Yes
12	PH3	No	No
13	**FDN**	Yes	Yes
14	**BVH**	Yes	Yes
15	PH 4	No	No
16	PH 5	No	No
17	PYLA	Yes	Yes
18	PH 6	No	No
19	PH 7	No	No
20	**AST**	Yes	Yes
21	PH 8	No	No
22	PH 9	No	No
23	PH 10	No	No
24	PH 11	No	No
25	**PWL**	Yes	Yes
S.NO	**LC Gate(Block Section)**	**AVAILABILITY OF SPACE FOR (Yes/No)**	
		RELAY RACK	**STCAS / RIU**
A	**NDLS-CPYZ Section**		
1	4C (MLB)	Interlocked- **Controlled by SBB Stn**	

2	153C (MLB)	Interlocked- **Controlled by GZB Stn**	
3	152A (ELB)	Interlocked- **Controlled by CPYZ Stn**	
4	152B (ELB)	Interlocked- **Controlled by CPYZ Stn**	
B	**NDLS-PWL Section**		
1	579B (MLB)	YES	YES
2	579A (MLB)	YES	YES
3	576 SPL (ELB)	Interlocked- **Controlled by Station**	
4	571 SPL (ELB)	Interlocked- **Controlled by AH7**	
5	568 SPL (ELB)	Interlocked- **Controlled by AH10**	

*Note: Even though the Space availability is mentioned as "YES", the space may not be sufficient for new installations (which are OEM Specific), thus detailed survey is required to be carried out in the initial phase of project to assess the actual requirement and accordingly new S&T service building is to be contructed/built. The locations where Space availability is mentioned as "NO", new S&T Service building of adequate size is required to be constructed/built.

3.6 TELECOMMUNICATION DETAILS :

3.6.1 GSM-R based MTRC: For secure & reliable communication NDLS-TKJ-PWL section is equipped with GSM-R based Mobile Train Radio Communication with Optical fiber as back bone to MTRC and control communication. For the purpose Telecom Towers ranging from 30m to 100m are provided throughout the section. Some Microwave towers in NDLS-TKJ-PWL and Ex TKJ-CPYZ Section are also detailed in Table 3.5

3.6.2 Optical fiber Cable: The section NDLS-TKJ-PWL and NDLS-TKJ-CPYZ is equipped with 01 number of 24 fiber Optical fibre cable and the signalling circuits between Stations and Automatic Block Huts are working over these OFC for signalling, and MTRC communication.

3.6.3 Telephones and VHF Sets: All Block Stations on the route have been provided with Railway & BSNL Telephones along with 25W VHF sets. Also 5Watt hand held Walkie-Talkie sets have been provided to Loco Pilots and Guards of all Mail / Express and Goods Trains

3.6.4 Exchanges: Railway Telephone Network comprising Electronic Exchanges with ISDN and VOIP features are available for administrative communication requirements.

3.6.5 Communication Towers: The location of Existing Towers, the height of Existing towers and the type of antennas already existing on these towers are indicated in the table below:

Table 3.5

SN	Station	Tower Exists (Yes/No)	Height of Tower (m)	Co-ordinates of Existing Towers		No of Antennas at Tower	Height of Antenna -1	Height of Antenna -2	Height of Antenna -3	Height of Antenna -4
				Long	Lat					
NDLS-PWL Section										
1	HNZM	Yes	40	77°15'14.02'E	28°35'8.15'N	3	40m	40m	40m	
2	HZNM-NCC	Yes	21	77°15'03.6'E	28°36'32.9'N	2	20m	20m		
3	OKA	Yes	35	77°15'50.59'E	28°33'37.12'N	4	35m	35m	18m	16m
4	TKD	Yes	40	77°17'31.34'E	28°30'19.92'N	4	40m	40m	30m	25m
5	JNC	Yes	35	77°18'14.15"E	28°27'28.61"N	3	35m	35m	28m	
6	FDB (Microwave)	Yes	70	77°18'22.46'E	28°24'52.98'N	3	50m	50m	18m	
7	FDN	No	-							
8	BVH	Yes	50	77°18'47.05'E	28°20'24.73'N	4	50m	50m	35m	30m
9	PYLA	No								
10	AST	Yes	50	77°19'26.30'E	28°15'6.57'N	4	50m	50m	32m	28m
11	PWL	Yes	50	77°20'30.73'E	28° 9'21.06'N	3	50m	30m	30m	
NDLS-CYZ Section										
1	NDLS (Microwave)	Yes	100	77°13'19.69'E	28°38'22.27'N	4	60m	60m	60m	35m
2	TKJ	No	-	-	-	-	-	-	-	-
3	B' PANEL	No	-	-	-	-	-	-	-	-
4	SBB	No	-	-	-	-	-	-	-	-
5	GZB (Microwave)	Yes	35	77.427294E	28.655088N	2	30m	28m		
6	GZB Trng School (For Educ Purpose)	Yes	35	77°25'49.31'E	28°39'41.88'N	2	30m	30m		
7	CYZ	No								

3.6.6 Tunnels

Communication need not be mandatory in tunnels except for those which are on immediate approach (distance corresponding to 30 seconds at highest permissible speed of any TCAS equipped train at that spot) of a signal. Leaky feeder cable type communication arrangements are to be made available in such tunnel. The details of the tunnels in the section for the purpose are listed in table below:

Table 3.6

S.No	Block Section	Chainage		Length of Tunnel
		From	To	
1	NIL	-	-	-

3.7 **Power Supply Details:** KAVACH (TCAS) to be installed at Stations and in LSCs/AHs/LC Gates of Block Section, power supply (220vAC) will be there or may be required to be extended.. However it may be required to augment the Power supply. For locations with Conventional Power Supply, only 220vAC will be provided by railways and further provision of DC supply with adequate backup will be covered as a part of this project. For locations with IPS, Separate of SMR & battery Set may be required to enhance the capacity to support additional load alongwith provision of separate DC-DC Converters modules for TCAS. For 220 V AC supply it is planned to use existing AT available. The details of Power supply, Type of equipment, capacity and loading details are given in Table as Annexure C.

3.8 **Details of Bridges / ROBs / RUBs /LHS / ROR Bridge**

As already discussed in Chapter I, KAVACH project requires laying of OFC cable as well as tower erection. The cable will have to be laid across various Bridges, ROBs, RUBs and Rail Over Rail Bridges. The site has a number of these enroute and they are as listed below:

Table 3.7

Details of Bridges / ROBs / RUBs /LHS / ROR Bridge NDLS-CPYZ and NDLS-PWL Section			
S.NO	Item	Numbers	Details
1	Important Bridges		
2	Major Bridges	18	As in Annexurre D
3	Minor Bridges		As in Annexurre E
4	ROBs	22	As in Annexurre F
5	RUBs / LHS	19	As in Annexurre G
6	ROR Bridge	-	As in Annexurre H

3.9 The site also includes a no. of "**Transmission lines crossing"** the right of way. The details

of the same are given in the table as Annexure I and also it includes a no. of **"Underground power lines"** crossing the right of way. The details of the same are given in the table as Annexure J

3.10 Electrification Details: Presently the section under consideration is a 25 KV AC Traction system which has TSS, SP and SSP as detailed below:

Table 3.8

A. LOCATION OF TSS					
SN	Railway	STATE	Name of TSS	Section / Route	Chainage
1	NR	UTTAR PRADESH	SBB/TSS	NDLS-CPYZ	12.33
2	NR	HARYANA	BVH/TSS	NDLS-PWL	1499.67

Table 3.9

B. LOCATION OF SP					
SN	Railway	STATE	Name of SP	Section / Route	Chainage
1	NR	HARYANA	FDB/SP	NDLS-PWL	1512.69
2	NR	HARYANA	PWL/SP	NDLS-PWL	1479.6

Table 3.10

C. LOCATION OF SSP					
SN	Railway	STATE	Name of SSP	Section / Route	Chainage
1	NR	DELHI	NDLS/SSP	NDLS-CPYZ	1537.64
2	NR	DELHI	TKJ/SSP	NDLS-CPYZ	1535.4
3	NR	DELHI	ANVT/SSP	NDLS-CPYZ	7.38
4	NR	UTTAR PRADESH	GZB/SSP	NDLS-CPYZ	1430.82
5	NR	DELHI	HNZM/SSP	NDLS-PWL	1528.46
6	NR	DELHI	TKD/SSP	NDLS-PWL	1523.28
7	NR	HARYANA	FDN/SSP	NDLS-PWL	1507.26
8	NR	HARYANA	AST/SSP	NDLS-PWL	1486.93

However the work of 2 X 25 KV Electrification, in connection with the works of "MISSION RAFTAR to achieve 160 Kmph" the TSS, SP and SSP new locations are detailed below and are likely to be completed by xx.xx.2023

Table 3.11

LOCATION OF TSS for new 2 X25 KV(PROPOSED)					
S.No	Railway	STATE	Name of TSS	Section / Route	Chainage
1	NR	HARYANA	BVH/TSS	NDLS-PWL	1501.51

Table 3.12

LOCATION OF SP for new 2 X25 KV(PROPOSED)					
S.No	Railway	STATE	Name of SP	Section / Route	Chainage
1	NR	HARYANA	PWL/SP	NDLS-PWL	1479.6
2	NR	HARYANA	FDB/SP	NDLS-PWL	1512.69

Table 3.13

LOCATION OF SSP for new 2 X25 KV(PROPOSED)					
S.No	Railway	STATE	Name of SSP	Section / Route	Chainage
1	NR	HARYANA	AST/SP	NDLS-PWL	1489.42
2	NR	HARYANA	FDN/SP	NDLS-PWL	1504.92

3.11 Details of Permanent Speed Restrictions in CPYZ-CNB section:

A number of Permanent speed restrictions are prevailing on in NDLS-TKJ-CPYZ anfd NDLS-TKJ-PWL Section. The same will be monitored by the KAVACH. The details of these speed restrictions are given in table below:

3.11.1 Details for the NDLS-TKJ-CPYZ Section are as follows

Table 3.14

STATEMENT OF PERMANENT SPEED RESTRICTIONS (NDLS-CPYZ Section)								
S. No.	**Section**	**Line No**	**Location**		**S.R KM PH**	**Distance (Mtrs)**	**Time Loss (mts)**	**Reason for restriction**
			From	**To**				
A	**NDLS-CPYZ**	**UP LINE**						
1		4UPGAL	1534.14	1534.64	*PSR-70kmph already imposed in WTT	500	-	Not possible due to Infringement with Delhi Metro alignment & Shfiting of entire railway colony Shfting of religious
2		3UPGAL	1533.78	1534.041		263	-	

3		2UPGAL	1532.19	1533.412		1221	-	structures. Hence SR is imposed
4		1UPGAL	1532	1532.09	*PSR-50kmph already imposed in WTT	90	-	1. Diamond Xing of 1in 8.5 exist between the straight portion of the two curves no 1 & 2. Hence SE and TL is zero in curve no 1 (approach of bridge). There is no possibility of removing the diamond as it facilitates movement to NDLS and HNZM. Further Railway grade seprator is also not possible to remove diamond due to bridge no 31 and RUB of outer ring road. 2.As on GZB end of curve no. 2, there is Diamond obligatory point, so SR is imposed
5		Yamuna Bridge	0	0.55	*PSR-50 already imposed in WTT	550	-	
6		1A	12.293	12.423	*PSR-70kmph already imposed in WTT	130	-	Major Yard Remodelling at Sahibabad Yard. Land acquisition involved (commercial Land)
7		1B	12.67	12.74		70	-	
8		GZB Yd	18.196	21.375	*PSR-100kmph already imposed in WTT	3179	-	Major Yard Remodelling at Ghaziabad Yard. Land acquisition involved (Built up area and commercial Land)
B		**DN LINE**						
1		4DNGAL	1534.120	1534.620	*PSR-70kmph already imposed in WTT	500	-	Not possible due to Infringement with Delhi Metro alignment & Shfiting of entire railway colony Shfting of religious structures. Hence SR is imposed
2		3DNGAL	1533.807	1534.700		893	-	
3		2DNGAL	1532.196	1533.417		1221	-	
4		1DNGAL	1532.003	1532.093		90	-	
5		Yamuna Bridge	0	0.550	*PSR-50kmph already imposed in WTT	550	-	Not possible due High embankment of approaches of Iind Yamuna Bridge.
6		11DNGAL	10.990	11.496	*PSR-70kmph already imposed in WTT	506	-	Major Yard Remodelling at Sahibabad Yard. Land acquisition involved (commercial Land)
7		3B	12.351	12.451	*PSR-70kmph already imposed in WTT	100	-	

8		GZB Yd	18.196	21.375	*PSR-100kmph already imposed in WTT	3179	-	Major Yard Remodelling at Ghaziabad Yard.Land acquisition involved (Built up area and commercial Land)

3.11.2 Details of PSR of NDLS-TKJ-PWL Section are listed below:

Table 3.15

STATEMENT OF PERMANENT SPEED RESTRICTIONS (NDLS-PWL Section)								
S. No.	**Section**	**Line No**	**Location**		**S.R KM PH**	**Distance (Mtrs)**	**Time Loss (mts)**	**Reason for restriction**
			From	**To**				
A	**NDLS-PWL**	**UP LINE**						
1		11UPM/L	1535.414	1535.524	**PSR-120kmph Already imposed	110	-	1. Infringement with Delhi Metro alignment Shfiting of entire railway colony Shfting of religious structures. 2. Land acqusition in heart of Delhi prime area (zoo area) & acquisition may be difficult
2		10UPM/L	1533.745	1534.565	*PSR-70kmph Already imposed	820	-	
3		9CUPM/L	1533.085	1533.283	**PSR-120kmph Already imposed	198	-	
4		9BUP	1532.48	1532.64	*PSR-70kmph Already imposed	160	-	
5		9AUP	1532.07	1532.21	*PSR-90kmph Already imposed	140	-	
6		8UP	1530.38	1530.7	*PSR-60kmph Already imposed	320	-	
7		7DUP	1530.03	1530.13		100	-	
8		7CUP	1529.87	1529.97		100	-	
1		7BUP	1529.68	1529.76		80	-	
2		5UP	1524.56	1524.92	*PSR-120kmph Already imposed	360	-	Not possible due to infringement with Delhi Metro
3		3UP	1520.71	1520.85	*PSR-120kmph Already imposed	140	-	
4		2UP	1520.43	1520.54		110	-	Not possible due to approaches of TKD yard

5		24up/FDB	1510.441	1510.651	*PSR of 120 Kmph already imposed	210	-	Not possible due major Yard re-modeling involve in BVH Yard.
6		23up/FDB	1510.216	1510.436		220	-	
7		14UP/BVH	1502.03	1502.320	*PSR of 120 Kmph already imposed	290	-	It is possible to remove PSR during yard remodeling. However it is not proposed to do the same due to large quantum of work which is not commensurate with saving in time.
8		13up/BVH	1501.740	1502.001		261	-	
B		**DN LINE**						
1		11R/CM/L	1535.18	1535.54	*PSR-70kmph Already imposed	360	-	1. Infringement with Delhi Metro alignment Shfiting of entire railway colony Shfting of religious structures. 2. Land acqusition in heart of Delhi prime area (zoo area) & acquisition may be difficult
2		8R/CM/L	1534.837	1535.057		220	-	
3		10DNM/L	1533.761	1534.587		826	-	
4		9CDNM/L	1533.095	1533.291	*PSR-120kmph Already imposed	196	-	
5		9BDN	1532.48	1532.64	*PSR-70kmph Already imposed	160	-	
6		9ADN	1532.07	1532.21	*PSR-90kmph Already imposed	140	-	
7		8DN	1530.38	1530.72	*PSR-60kmph Already imposed	340	-	
8		7DDN	1530.03	1530.13		100	-	
9		7CDN	1529.87	1529.97		100	-	
10		7BDN	1529.68	1529.76		80	-	
11		7ADN	1529.05	1529.11	*PSR-120kmph Already imposed	60	-	Not possible due to infringement with ROB
12		5DN	1524.56	1524.92	*PSR-120kmph Already imposed	360	-	Not possible due to infringement with Delhi Metro
13		3DN	1520.71	1520.73	*PSR-120kmph Already imposed	20	-	
14		2DN	1520.43	1520.54		110	-	Not possible due to approaches of TKD yard
15		20/dn/FDB	1510.441	1510.641	*PSR of 120 Kmph already imposed	200	-	Not possible due to infringement with ROB

16		13/dn/BVH	1501.744	1502.004	*PSR of 120 Kmph already imposed	260	-	It is possible to remove PSR during yard remodeling. However it is not proposed to do the same due to large quantum of work which is not commensurate with saving in time.

3.11.3 Details of PSRs: As in 3.11.1 and 3.11.2

Table 3.16

3.11.4 Details of PSRs: As in 3.11.1 and 3.11.2

Table 3.17

3.12 Details of The Locos on NR:

The On Board Loco TCAS Equipment shall be fitted on selected Locomotives in nominated Loco sheds of Indian Railway along with UHF radio system for communication between On Board TCAS equipment in Loco & Station TCAS equipment all along the route.

The tentative holding of Locomotives with NR proposed for onboard TCAS Equipments is appended here under:

Table 3.18

Type of Locomotive	**Loco suitable for 160 Kmph (In Kmph)**	**Loco Shed- ELS GZB**
WAP-5	160	106
TOTAL		106

The various type of Locos based on type of braking i.e Conventional (IRAB), E-70 and CCB will require to have different type of BIUs. The tentative percentages of Locos of different type of Locomotives on NR are also detailed below:

Table 3.19

Details of Braking System of Locos:

WAP5:

1. Computer Controlled Air Brake E-70 system supplied by M/S Fritil- 77 No
2. Computer Controlled Air Brake CCB system supplied by M/S KBIL-42

3.13 Plans and Drawings – SIPs, Gradient details etc.

Existing Signal Interlocking Plan (SIP) of all stations and Block sections in NDLS-TKJ-CPYZ AND NDLS-TKJ-PWL Section of DELHI Division of Northern Railway are attached in Annexure-M

The Existing Gradient details of the section in NDLS-TKJ-CPYZ AND NDLS-TKJ-PWL Section of DELHI Division of Northern Railway are attached as Annexure – L.

The Standard drawings of various Locos showing the location where Loco TCAS and DMI are to be installed are provided at RDSO web site.

4. Factors For Project Planning

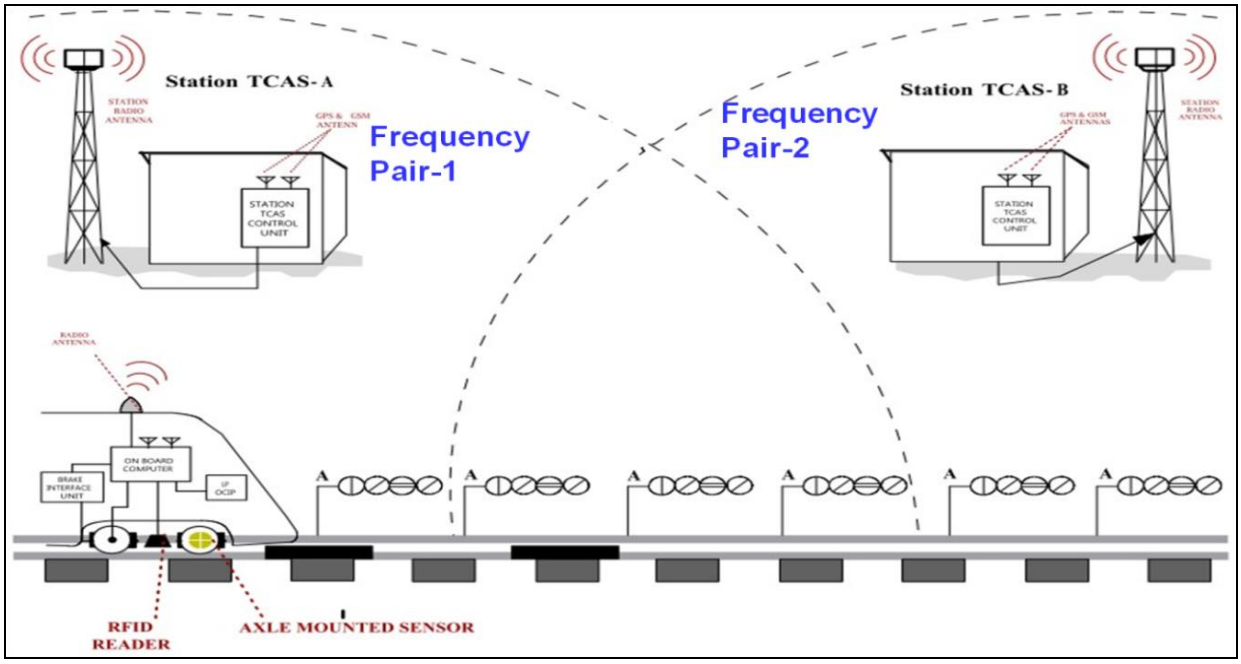
4.1 Specifications and future developments:

The Train Collision Avoidance System to be procured and installed shall conform to RDSO Specification No. RDSO/SPN/196/2012 version 3.2.

Draft Specifications RDSO/SPN/196/2020 Version 4.0 is under development stage and is likely to be finalized soon. The project envisages to commission finally based on Version 4.0 also.

4.2 RADIO TELECOMMUNICATION SUB - SYSTEM: The indigenous ATP system KAVACH (TCAS) is a system based on continuous updating of "MA" (Movement Authority), which requires continuous radio communication in "Communication Mandatory Zone".

For an Automatic Signaling territory the mandatory zone extends throughout the section. Presently the RDSO specification specifies use of UHF frequency based system and the section concerned is having GSM-R based MTRC system. In view of GSM-R being out dated, presently the section is being planned with the UHF frequency based system which can be at a later stage capable to migrate to LTE-R once it is implemented on IR.



4.3 TOWER PLANNING:

4.3.1 Additional REQUIREMENT OF TOWERS: Due to the requirement of continuous update of MA (Movement Authority) and the section having Automatic Signaling throughout, *proper Radio Signal Strength will play a very important role for success of the project.*

As such it is planned to have an initial software based simulation of Received signal strength (RSSI survey) so as to correctly judge the numbers, location and height of towers required for present UHF based communication. The initial survey report is also a part of this DPR as Annexure - K. It is planned to have a fade margin of 30dB.

Subsequently a detailed survey is proposed by the successful contractor on the project. These towers are also required to be planned in such a way so as to have a smooth transition to LTE based future KAVACH.

In order to economize on the cost of the project and make use of the existing facilities, the use of existing MW and MTRC towers is also suggested. However care needs to be taken for ensuring the effective tower height available for use of TCAS radio Equipment.

4.3.2 TOWER STRUCTURE: Based on experience of South Central Railway and North Central Railway ongoing projects, it is proposed to have site specific tower structure preferably Lattice type. The structure can be suitably designed by the contractor, duly approved by a 3rd party before being approved by IR. The norms followed by IR need to be taken care by the contractor. Certain standard designs of super-structure and sub-structure of the tower are available on RDSO site, the same can also be utilized.

4.3.3 LOCATION OF TOWERS: A detailed survey is required to be done in the initial phase of the project to assess the strength of Radio Communication in the nominated KAVACH section based on which the location and height of the additional Towers is required to be planned.

The towers at the Stations are already existing or are to be planned at the station where not existing. However in the Block section in order to have proper signal strength of UHF in the project initially and latter on of LTE – R additional towers will be required. All the additional towers in mid section will have to be planned adjacent to AH/LSC / LC gates following all the Railway norms and regulations. As such the survey will have to be done taking due care of this.

4.4 SIGNALING INTERFACE:

The ATP system "KAVACH" (TCAS) works on top of Existing Signaling system, taking Input from it and utilizing the same for Automatic Train Protection. Presently in the referred section we have PI/EI/RRI at stations in NDLS-TKJ-PWL and NDLS-TKJ-CPYZ.

There are two possibilities of taking the signaling input from the signaling system. Directly through EI using a SIL 4 protocol converter or by using relay contacts of the concerned relays which are ECRs, NWKRs / RWKRs & TPRs. Presently the OEMs have not developed protocol converters as such the provision of taking inputs from relays is being planned.

As such it is planned to initially use Relay contacts of the concerned relays and in due course migrate to protocol converters as and when they are developed.

4.5 Requirement for Building :

The Train Collision Avoidance system as discussed above will require Interfacing with the Existing Signaling system, wherein the Equipments will be required to be placed in The Existing Relay Rooms / LSCs of the Automatic section. However, at number of places the existing Relay Room/ LSCs may not have proper space for provision of Relay Racks, TCAS equipment, Power supply augmentation etc. Hence, a detailed survey will be requirement for this and the scope of work will also need to include the same.

As this can become a critical activity of the project, it is planned to use Pre-fab concrete structure for the same.

4.6 Communication backbone:

The ATP (Automatic Train Protection) System will also require a **Back – Bone of an Optical Fiber Network in redundancy** for the connectivity of the various Stationary Station TCAS with LC & IB TCAS and LSCs/AHs with the help of RIUs (Remote Interface Units) in the Automatic Signaling section as per requirement.

In order to achieve this, two numbers of minimum 24 core OFC cables are required to be laid, one on each side of the track for connecting the RIUs / LC TCAS to the Station TCAS as per requirement. On NR, a Telecom OFC-24 Core is running parallel to track on the whole

of the section.

For the section under consideration, it is decided that for Automatic Train Protection System only one 48 Fiber OFC cable will be laid throughout the section as a part of this project and the existing OFC cable will be used for "RING REDUNDANCY". This OFC cable will have to be terminated in the required LC/AHs/LSCs also as a part of the scope of work. Further a detailed survey will be required for ensuring spare Optical Fibers in the existing OFC. In case the same is not available in particular section, shifting these to new OFC will be required to be planned well in advance.

4.7 Loco TCAS planning:

The Locos running on the section are required to be equipped with Loco TCAS. As it is not possible to have all the Locos equipped with Loco TCAS simultaneously, under discussion with the Electrical Department following priority has been decided for prioritizing the Locos:

a. High Speed Locos.

b. Mail Express Locos.

c. All other passenger Locos.

d. Goods Locos.

However it will also depend on availability of these Locos, as such some the priority needs to be followed as far as possible.

4.8 Maintenance Strategy

KAVACH is a new technology on Indian Railways with only some experience with South Central Railways. Being a new technology a defect liability period of additional 2 years (Normal 2 years plus additional 2 years) is planned along with the life cycle maintenance contract.

In addition to this Training by OEMs and training centres over Indian Railways are also being planned.

5. SCOPE OF WORK

5.1 Introduction:

The KAVACH (TCAS) shall be provided to cover entire section in NDLS-TKJ-CPYZ and NDLS-TKJ-PWL Section of Northern Railway. This Project scope includes detailed survey of the geography, geology and topography of the section, detailed design for deliverables as listed in Chapter 6, design approvals, fitment of TCAS at stations, Auto LSCs, IBSs, LCGates as per requirement, fitment of Loco TCAS, Construction of towers including foundation, power, signaling and OFC cabling, quality check and inspection, independent safety assessment and introduction of system in service. Thereafter monitoring of performance through DRACAS (Defect Reporting and corrective Action System), corrective actions required if any to achievethe performance criteria and maintenance support.

Works to be done by all wings of the railways including approval, sanctions, Quality inspections and Acceptance tests:

a. Bridge Engineering: Substructure and Superstructure design of towers.

b. Traction (Electrical): Loco TCAS fitment in Electrical Locomotives.

c. Traction (Diesel): Loco TCAS fitment in Diesel Locomotives.

d. S&T: Radio Link design, STCAS design and installation and all associated activities as per deliverable listed in Chapter 6 of this document.

Works to be done by the contractor including arranging statutory approvals as per labour laws, local regulations etc, requirement of land on rent to enable the work execution in railway land or access to railway land shall be defined in the Contract Requirements, i.e., scope descript of the tender to be floated.

The Train Collision Avoidance System to be procured and installed through this tender shall conform to RDSO Specification No. RDSO/SPN/196/2012 version 3.2 or latest.

5.2 Survey:

5.2.1 RSSI Survey: Though a preliminary RSSI Signal strength survey report is attached at

Annexure - K. However as communication is one of the most important part for success of the project, a detailed RSSI survey is required to be done as a part of this project in the initial phase of the project to assess the strength of Radio Communication in the nominated TCAS section based on which the location and height of the additional Towers is required to be planned.

5.2.2 Arial Drone Survey: The project scope also includes the aerial drone survey for entire track profile so as to have the mapping of all signals enroute for provision of RFID tags.

5.2.3 Survey for cable route plan: Cable Route plan is to be prepared and approved before starting of cable trenching and laying as per the scope of works.

5.2.4 In case the spare Fibres are not available in the Existing OFC, a survey report needs to be prepared where in sections need to be identified where the circuits on these fibres need to be transferred to new OFC.

5.2.4 Survey for Civil works: A detailed site survey is required for firming up the locations of the additional Towers (preferably near LSCs and Level crossing for Block section), requirement of additional Building structures and any requirement of utility shifting.

5.3 Design of Station / LC TCAS and RIUs

The scope also incorporates design of station specific TCAS Table of controls, TCAS RFID TIN Layout, RFID Tag Data, Wiring diagrams for TCAS relay interface, Equipment Layout diagrams of STCAS, Radio and Loco TCAS Equipment. It also includes power supply arrangement design, Radio link design including the design of Towers with foundation if required. The Tower design if required need to be certified by a 3rd party. Standard Tower design available on RDSO site can also be used.

5.4 Provision of Additional Building and Towers:

The scope includes the provision of additional rooms of suitable size, wherever there is no space in the existing relay rooms. These specifications need to be specified. Further based on the RSSI survey there might be a requirement of additional Towers, the scope also

includes the provision of these additional Towers, preferably of 30 to 40 metres high keeping in view of future requirement of LTE – R.

Tower may also be required at a location where existing tower is available but is required to be replaced as per design. At these locations dismantling of existing tower, relocation of existing equipment of the tower and erecting new tower as per approved design will also be covered in the Scope of works.

5.5 Provision of Track side KAVACH (TCAS):

Stationary TCAS equipment to be installed in this project will NDLS-TKJ-CPYZ and NDLS-TKJ-PWL Section of Northern Railway. This includes 17 Stations with Block sections having 20 numbers of total AHs. The scope of project KAVACH on the section includes the supply, installation, testing and commissioning of

1. Station TCAS for interfacing with Station Signalling,
2. LC TCAS and RIUs for interfacing with Signalling in the Block section.
3. UHF communication arrangement at these locations so as to enable STCAS to talk to the Loco TCAS.
4. Provision of RIFD Tags on the track as per the design.
5. Provision of the SMOCIP at the stations for SOS functioning.
6. Enhancement of power supply as per requirement.

5.6 Installation of LOCO TCAS

5.6.1 The On Board Equipment (Loco TCAS) shall be fitted on selected Locomotives in nominated Loco sheds of Indian Railway along with UHF radio system for communication between On Board TCAS equipment in Loco & Station TCAS equipment all along the route.

Test bench is also to be provided in nominated Loco Sheds of IR. The scope of this project covers provision of Loco TCAS on 106 Locomotives.

5.6.2 BRAKE INTERFACE UNIT: The Brake Interface Unit (BIU) is an integral part of Loco TCAS. It shall be capable of giving following three levels of brake commands for train braking:

i. Normal Brake (NB) command (not applicable for EMUs and other self propelled vehicles)
ii. Full Service Brake (FSB) command
iii. Emergency Brake (EB) command.

The various type of Locos based on type of braking i.e Conventional (IRAB), E-70 and CCB will require to have different type of BIUs.

5.7 Provision of 48 Fibre OFC with path redundancy on Existing:

Remote Interface Units of the Block section are required to be connected in ring fashion so that they shall be able to connect to station TCAS even in case of failure of Main Path. For this purpose one new 48 Fiber OFC shall be laid out of these 48 fibers, 6 fibers shall be used for signalling purpose (4 working + 2 Spare). In addition to that 4 fibers in existing OFC cable shall also be used for ring protection. The circuits on these 4 fibers of existing OFC cable shall be transferred to new OFC cable. Separate OFC shall be laid from the nearest joint in existing OFC to extend it to RIU hut.

The scope also includes Supply, laying of HDPE pipe/duct of size 40/33 mm duct using Horizontal Directional Drilling at a depth of 3 mtr or more and blowing of 48 Fiber OFC cable, splicing of OFC cable in the entire section, dropping & termination of 06 fibre at each station / OFC Hut / Auto hut etc and balance 42 fibers at Major Junction / Important stations.

5.8 Provision of Network Management System:

The scope also includes provision of a Network management system at “New Delhi Control Room”. It includes extending the required E1 channel from the given place in the OFC room or connecting through Dark fibre with associated Hardware & Software of Modems, Optical Network Unit with interconnecting Cables/ Pig Tails & Wiring. It also includes OFC cable

laying & Termination / U/G Splicing as required up to nearby place for Dark Fibre / E1 channel as required. The EI channel will be provided by the Zonal Railways.

5.9 Certification by ISA:

The scope of the project incorporates a proper certification by an "Independent Safety Assessor" (ISA) after the testing and commissioning of the section i.e NDLS-TKJ-PWL and NDLS-TKJ-CPYZ or a workable part of the section.

5.10 Training of Railway Officers / Staff

5.11 Provision of STM-4 with associated equipments and accessories:

All the station have been provided with OFC rooms having STM1/STM4 as mentioned in table below catering to Station Railway Telecom requirements. 24F Telecom OFC has been provided in NDLS-TKJ-PWL and NDLS-TKJ-CPYZ sections, NDLS to Control Office. At NDLS Station, there is no OFC Room as the Station Telecom requirement is being met with directly from DRM Control Office OFC room. Details of STM and Mux in the section are as follows:

S.NO	STATION NAME of Stn/AH	STM-1/STM-4	Mux	No of E1 Channels used
1	**NDLS_CPYZ Section**			
1	**TKJ**	**STM-1(Fibcom)**	**Puncom V-100**	**All E1 are occupied**
2	AH1-Akshardham Hut	-	-	-
3	AH2-Mandavli Halt	-	-	-
4	AH3-Anand Vihar Halt	-	-	-
5	**Anand Vihar**	**STM-4(Tejas)**	**Puncom V-100**	**All E1 are occupied**
6	**B' PANEL**	**STM-1(Fibcom)**	**Puncom V-100**	**All E1 are occupied**
7	**SBB**	**STM-4(Tejas) & STM-1(Fibcom)**	**Puncom V-100**	**All E1 are occupied**
8	SBB-GZB Auto Hut 1	-	-	-
9	SBB-GZB Auto Hut 2	-	-	-
10	SBB-GZB Auto Hut 3	-	-	-
11	SBB-GZB Auto Hut 4	-	-	-
12	**GZB**	**STM-1(Fibcom)**	**Puncom V-100**	**All E1 are occupied**
13	**CYZ**	**STM-1(Fibcom)**	**Puncom V-100**	**All E1 are occupied**

B	NDLS_PWL Section			
1	**NDLS at DRM office**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
2	NDLS-TKJ Auto Hut	-	-	-
3	**TKJ**	-	-	-
4	HNZM-TKJ Auto Hut	-	-	-
5	**HNZM**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
6	**OKA**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
7	**TKD**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
8	**JNC**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
9	PH1	-	-	-
10	PH2	-	-	-
11	**FDB**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
12	PH3	-	-	-
13	**FDN**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
14	**BVH**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
15	PH 4	-	-	-
16	PH 5	-	-	-
17	**PYLA**	-	-	-
18	PH 6	-	-	-
19	PH 7	-	-	-
20	**AST**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**
21	PH 8	-	-	-
22	PH 9	-	-	-
23	PH 10	-	-	-
24	PH 11	-	-	-
25	**PWL**	**STM-1(Tejas)**	**Puncom V-100**	**All E1 are occupied**

The Scope of Work under this project Covers Provision of STM4 (Supply, Installation Testing and commissioning of Managed expandable rack type STM-4 add/Drop multiplexer upgradable to STM 16 as per TEC spec. no. GR/Tx/SDH-10/03 Jan 11 or latest equipped with 4x5TM-4, 2x5TM-1 53E1 with 1.2 protection at E1 level, Minimum 8 Nos pf 10/100 T Ethernet port with 1.2 switching functionality, redundant power supply cross connect and synchronization, including all Software support for working of above STM4s through the existing NMS/s. (offered equipment should match with existing system) alongwith 19 inch 42 U rack for STM equipments, maintenance free valve Regulated lead acid battery 48V-200 AH, 48V/ 50 Amp SMPS based power plant in (2+1) configuration using 3 Nos. of 48v/ 25A modules to charge the VRLA battery bank of 48V/ 200 AH with

lightning & surge protection for each set of STM. (Stns Covered- NDLS, TKJ, Bpanel, GZB, CYZ, HNZM, OKA, TKD, JNC, FBD, FDN, BVH, PYLA, AST, PWL)

6. DELIVERABLES:

6.1 Detailed design necessary for justifying the chosen sub systems like Radio, towers, Transmission media other than Radio, Remote Interface units (RIU), Brake interface units and construction to take place.

6.2 RAM Plan showing how the reliability, Availability and Maintainability is addressed on this project.

6.3 System RAMS Assessment to support the RAM Plan.

6.4 Programme on DRACAS (Defect Reporting and Corrective Action System) to report failures and track the corrective actions.

6.5 Survey & Mapping Report to confirm the location and features details already furnished and its fitness for detailed design.

6.6 General and Detailed Design:

6.6.1 Buried Service Records (Pipes and Cables)

6.6.2 Cable Routing strategy and Route Plan detailing routing strategy for all cables and to demonstrate the method of achieving full diversity.

6.6.3 Cable schedule showing cables across all sub systems including termination and jumpering details.

6.6.4 TCAS Table of Control.

6.6.5 TCAS RIFD Tin Layout.

6.6.6 RFID Tag Data.

6.6.7 Wiring Diagram (TCAS Relay Interface)

6.6.8 Equipment layout Diagram (STCAS and Radio)

6.6.9 Locomotive TCAS Equipment Layout Diagram including Locomotive Desk.

6.6.10 Radio link Design.

6.6.11 Power Supply Scheme.

6.6.12 Redundant Communication Scheme.

6.6.13 Earthing Diagram showing earthing across all sub systems.

6.7 Engineering Assurances:

6.7.1 Design Risk Log: Records of identified risks and assumptions and interdependencies identified during the design process and approval.

6.7.2 Design Compliance Certificate: Confirmation that the design complies with the requirements and later in the project lifecycle that the installation complies with the design.

6.7.3 Inter Disciplinary Review Records.

6.7.4 Inter Disciplinary Check Cetificate.

6.7.5 Master Records Register: Register of Master Records that are signed copies of the working installation.

6.7.6 Entry into Service Strategy showing how entry into service will be carried out with a checklist of deliverables.

6.7.7 Testing Plan and Commissioning Strategies including Pre-Commissioning Checklists.

6.7.8 QA Certification including all inspection and test records of all sub systems and integrated system.

6.7.9 Test Certificates: Records who has tested to which specification and the results. Should not use general terms.

6.8 Functional Train Collision Avoidance System as per RDSO Specification No. RDSO/SPN/196/2020, version 4.0 at all Stations, Intermediate Block Signals, Automatic Signals, LC Gates and Locomotives with all subsystems including communication.

6.9 ISA certification and approved Application Safety Case for the project before introduction of services.

6.10 As Built Designs (Tower including foundation, STCAS, IBS, LC Gate, LTCAS) that describes the assets that has been installed.

6.11 Maintenance

6.11.1 Report on future maintenance requirements due to proposed solutions.

6.11.2 Maintainability Study: It shall determine suitable options for access to the Relay Room, Radio Towers, IBS and LC Gate Relay rooms and Locomotives and requirement of competent resources along with their deployment matrix.

7. ROLES AND RESPONSIBILITY OF EMPLOYER AND EXECUTIVE

7.1 Table below describes the Role and responsibility for Stations, NMS and Loco.

S.N	Item	Responsibility	Remarks
A. For each station			
1	Station number allocation	Railway & OEM	Follow RDSO TAN
3	Central location in Kilometer	Railway	Stations / LC / AH
4	Communication Mandatary Zone	Railway	For Continuous Radio Coverage
5	Stationary TCAS wise Frequency pair allocation (Pair1 and Pair2 shall be alternative)	Railway	**F_0**- 441.8 MHz, Pair 1: F1/F2-456.8MHz and 416.8 MHz, Pair 2: F3/F4-466.8MHz and 426.8 MHz
6	TIN number allocation (Track Identification Numbers)	Railway & OEM	As per RDSO TAN no STS/E/ TAN/ 5001 dated; 20.02.2019
7	RFID Tag number allocation	Railway & OEM	-do-
8	SIP (Including Stations, LC gates and IBS etc.,)	Railway	Existing SIPs are at Annexure M.
9	Table Of Control (TOC) or Selection Table	OEM	To be prepared by Successful bidder for approval by Railways.
10	Gradient Data	Railway	As per details at Annexure L.
11	Turnout Speed Restriction Details	Railway	Can be derived from SIPs.
12	PSR information	Railway	As per Chapter 3 Para 3.10
13	Latest Working Timetable	Railway	
14	Whether LC Gate warning Tags to be provided (Yes/No)	Railway	Yes
15	Whether Auto Whistling feature is to be provided (Yes/No)	Railway	
16	Whistling pattern	Railway	As per extant guidelines
17	Frequency slot allocation	Railway	WPC clearance also required.

S.N	Item	Responsibility	Remarks
18	RSSI Survey	OEM	Draft provided at Annexure K
18	Drone Survey data	OEM	To be arranged by the bidder.
19	GSM SIM Card1 Details	Railway	Reliance Jio
20	GSM SIM Card2 Details	Railway	BSNL or as decided by authority
21	Relay Contact Analysis data	Railway	As per Annexure B
22	Relay Rack Charts	Railway & OEM	Existing shall be made available by Railway. New Relay rack chart to be prepared by OEM.
23	Whether new Relay Rack is to be erected or not	OEM	Yes, Repeater relay, if any is to be opened in new relay rack.
24	Whether Circuit to be submitted as per British/Siemens Practice	Railway	As per the existing Interlocking. Detailed in table 3.2
25	Cable Route Plan	OEM & Railway	To be prepared by OEM and approved by Railway.
26	Floor plan of S&T Equipment Room.	OEM & Railway	To be prepared by OEM and approved by Railway.
27	Location of RIUs	Railway	As per Table 3.2
28	Floor plan of Relay huts, if RIU is to be installed in huts	OEM	To be prepared by OEM and approved by Railway.
29	Number of RIUs for which Location boxes are to be supplied	OEM	RIUs to be installed in Brick Rooms/ building
30	Number of RIUs for which Power supply 230V AC is provided	OEM & Railway	Power Supply of 230 V AC will be made available, but if required to be extended
31	Proposed Location of Tower (Latitude and Longitude)	OEM & Railway	After RF/RSS survey, the tower location and tower height to be determined.
32	Design of Stationary TCAS tower	OEM & Railway	As per Standard design or non standard

S.N	Item	Responsibility	Remarks
	and foundation		design approved by 3rd party to be submitted for approval.
33	WPC or/and SACFA Clearance Procedure	OEM & Railway	Clearance will be taken by Railways.
34	Location of Stationary TCAS Test Benches	Railway	One for each Division
B	**For each NMS (To be provided at NDLS)**		
1	No of Stn TCAS unit in one E-1 Ring	Railway	It shall be limited to 5-7
2	Proposed connectivity of stationary TCAS at mid-section where E-1 is not available	Railway	
3	PC Configuration	Bidder	For connecting 150 number of 4-Line stations following PC configuration is recommended 1. 12 CPU CORES 2. 12 GB RAM 3. 1 TB storage for 90 days Data 4. Windows 10 or higher version
4	Static IP address of NMS	Railway	Will be provided
5	Internet bandwidth of 25 MBPS	Railway	Assuming 4 live consoles & 2 report generators working in parallel
6	Whether furniture for NMS is to be provided(Yes/No)	Bidder	Yes
7	Floor plan for S&T Control office for NMS	OEM & Railway	To be prepared by bidder and to be approved by Railway
8	VDU Quantity , Size & Resolution	Railway	55" (Min 4k resolution) at each station

S.N	Item	Responsibility	Remarks
			and control office each with furniture and 01 executive chair
9	UPS backup for NMS	Railway	2-3 Hrs
C	**For each Loco**		
1	Loco Type	Railway	Tentative as per Table 3.18 & 3.19
2	Loco ID	Railway	
3	Loco Shed	Railway	
4	Type of Brake System	Railway	As per item no. 1 above.
5	Loco Wheel dia	Railway	As per item no. 1 above.
6	GSM SIM Card1 Details	Railway	Reliance Jio
7	GSM SIM Card2 Details	Railway	BSNL or as decided by CA
8	Axes for providing pulse generators	Railway	As per RDSO's fitment diagram.
9	Fitment diagrams	Railway	Fitment drawing for Onboard Eqpts in Loco are available at http://10.100.2.19/Signal/Policy
10	Interface details for auto-whistling	Railway	As per RDSO's drawings
11	Interface for Traction cut-off	Railway	As per RDSO's drawings
12	Responsible Authorities in Shed	Railway	Sr DEE/TRS or any other authority nominated by Rly
13	Location of Loco TCAS Test Benches	Railway	

7.2 The table below gives the Roles and Responsibility for Various Factors for Design Outputs:

S.N	For each station	Responsibility	Relevant Inputs
1	RFID Tag Layout	OEM	SIP, TOC, Drone data, Tag & TIN Ids
2	RFID Tag data	OEM	RFID Tag Layout

S.N	For each station	Responsibility	Relevant Inputs
3	Interface circuits	OEM	SIP, Contact analysis
4	TCAS Table of Control (TOC)	OEM	SIP, Tag layout, TOC
5	Station Application Data	OEM	TOC(TCAS), Tag Layout
6	Floor Plans	OEM	Drone Survey
7	Drone Data	OEM	Drone Survey
8	Stationary and Loco TCAS timeslots and frequency channel pairs	OEM	Maximum trains, Frequency allocation
9	Cable route plan, Cable core plan, Power supply diagram, Location / CTR details, Relay Contact Chart, Interface and Logic Circuits in Case of EI alteration, Circuit diagram in case of PI alteration, LC Gate Circuits, Testing reports, SWRD, SWR, GWR, VDU/ Panel Diagrams, 1W/2W/ bell test details/ Quality Audit documents/ completion plans (laminated) etc as per NR practice	OEM	SIP

8. COST ESTIMATION:

8.1 INTRODUCTION:

The Cost Estimation for the project have been done by including the **cost of Station TCAS** including the cost of interfacing with the existing signaling & cost of Radio Equipment for that station, **Cost of Civil engineering** works including the Tower cost & that of Building and other structure, **Cost of Equipment provided on the track** which includes the RIFD Tags cost along with equipment utilized for programming these RFID, **Cost of the Loco TCAS** including radio Equipment cost and interface equipment with the track side RFID and the interface with the Loco Pilots, Cost of RIUs/ LC TCAS, Power Supply equipments, Earthing, SPDs, Surveys, Drawings, NMS, KMS, ISA Certification, Installation, commissioning, etc

The cost has also a **component of the Telecommunication OFC** based back bone, STM-4, the cost of WPC and SCAFA License fee and Xx years of AMC as a part of the project.

The costing is based on SC Railway LOA of Nov 2019 and the rates of the Northern Railways.

The Overall Cost of the project is as mentioned in RFP. However this cost does not include the cost of change over to LTE – R from UHF communication in a later stage. Separate works for provision of LTE – R over IR are being sanctioned.

8.2 CIVIL EINGINEERING COST:

As envisaged for the project there is no need of land procurement for the project. The two

basic components of civil Engineering costing will be provision of Towers and the provision of Building structure where there is a space constraint in the Existing Relay Room.

It is envisaged that in addition to the Existing towers of MTRC and MW, additional Towers are required to be built in Block sections/ Stations where the length of block section is more than 8 Km and as envisaged in the preliminary RSSI survey report (As per Annexure Xx). Also provision of shifting to LTE – R in future needs to be taken care.

For the Building works as per survey the same is required to be provided at locations as specified in Table-3.4

8.3 LINE SIDE & STATION TCAS COST:

This cost includes the cost of Supply, Installation, Testing and Commissioning of Station TCAS equipment along with associated Radio Equipment, Cost of LC TCAS equipment along with Radio Equipment required for additional Tower sites in the Block section at LSCs, Cost of the RIUs at balance LSCs of the Automatic Signaling section, cost of SM operation panel, cost of Relays and other accessories for interfacing with the existing signaling and cost of equipment required to program the STCAS / LC TCAS and the Test benches required for testing the TCAS.

This cost is also inclusive of RFID tags (required for knowing the position and direction of the locomotive movement) which are to be provided in duplicate at all the signals, 200 mtrs before each signal and in station Yards for demarcating the point zone and the berthing track circuits.

The cost of this has been based mainly on Nov' 2019 LOA of the SC Railway and rates of NR

8.4 LOCO TCAS COSTING:

The cost of Loco TCAS is the cost of Supplying, installation, testing and commissioning of all the equipments to be provided on board the Locos to be used on the System.

This includes the costing of OBC (On Board Computer), DMI (Driver Machine Interface), on board radio equipments for UHF communication, GPS and GPRS communication, RFID readers, BIU (Brake Interface units) and the other accessories.

This cost will also include the test bench to be provided in the Loco Sheds and has been

worked out per Loco basis and planned for 139 locos.

8.5 COST OF COMMUNICATION BACKBONE:

For efficient working of TCAS a telecom backbone of 48 Fiber OFC is required to be laid throughout the section. This cost is also an important element of the project and includes the cost of mostly trenchless trenching along with supply and laying of HDPE pipe and a 48 fiber OFC and using this OFC for ring redundancy along with existing OFC.

8.6 OTHER CHARGES:

The capital cost of the project also includes the WPC & SCAFA license fee for the period of the project, which latter on will be paid from the revenue.

8.7 Summary Table:

Scheme Elements	**Cost Estimate (%)**
Civil Engg cost (Towers, Buildings etc)	As mentioned in EPC Tender document-CA
STCAS	
LTCAS	
Telecommunication Back Bone	
Others including WPC license fee	
TOTAL	100 %

9. PROJECT RISK AND ASSUMPTIONS

9.1 Qualitative Cost Risk Analysis (QCRA) with the objective of identifying the projects risks for the KAVACH project with all stakeholder is to be done post contract award and risk owners identified to:

- Identify significant risks to the achievement of the project objectives
- Establish a project risk register
- Conduct an assumption analysis and identify any constraints

9.2 Each risk shall be analysed to understand the probability of occurrence and impact of the risks on the project outcome ranging from very high likelihood of occurrence / impact to very low likelihood of occurrence / impact. Few examples but not limited to these can be:

- Tower Sites near the water bodies, drains etc.
- Soil with abnormally low bearing capacity or encountering of unexpected rocks, underground water streams etc.
- Non-availability or delayed availability of a particular type of locomotive.
- WPC AND SACFA CLEARANCES: The frequency of the operation for TCAS has been defined by RDSO. The application for WPC & SACFA shall be prepared by contractor in the name of Railways and filed by the Railway so that the license remains with Railways. The WPC and SACFA clearance are required for the use of towers and radios. As this factor is dependent on external agency any delay in getting these clearances becomes a potential Risk.
- Interoperability between various new and Existing KAVACH OEMs.

10. IMPACT ON EXISTING INTERNAL CUSTOMER

10.1 Train working by LOCO Pilot:

TCAS equipped locos are provided with Brake Interface Unit (BIU), Driver Machine Interface (DMI), RFID reader and LTCAS. In general, Loco pilot checks driving console position, load meter response, Main reservoir pressure,Brake pressure, Feed pressure and air continuity. In TCAS equipped loco, in addition to the mandatory checks mentioned above, Loco Pilot has to bring theLTACS system into functioning at the time of starting the train. Procedure of activating LTCAS involves switching on of all MCBs, booting of DMI, operation of Isolation switch to Normal position, operation of leading/non leading switch, selection of train type and Staff Responsible Mode/ Shunt Mode depending upon the intended movement of train. This entire procedure takes 2 to 3 minutes in addition to the time required for energization of Loco. Further depending on the aspects of signals in DMI proper mode selection to be done by Loco Pilot.

10.2 Train Working by Station Master:

In TCAS equipped territories Station Master Operation cum Indication Panel (SMOCIP) is installed in SM rooms to generate and cancel SOS (Save Our Soul) messages during emergency situations. SMOCIP displays TCAS related information like number of locos in the Station's vicinity, their absolute positions and TCAS health condition such as status of Battery voltage through LED indications etc. Station Master on duty is responsible for operation of SMOCIP (Station Master Operation cum Indication Panel) and custody of keys to prevent unauthorized operation. on receiving any message that endangers through traffic and requires stoppage of train, station master shall generate SOS and the same is to be recorded in the register. Apart from generation and acknowledgement of SOS, failure of STCAS and its restoration shall be reported to all concerned and accordingly records are to be updated.

10.3 Signalling System Maintenance

As TCAS system makes use of existing signaling relays for computing movement authority, all the maintenance requirement for existing signaling system are applicable to TCAS maintenance. In addition to maintenance of additional relays picked up for TCAS working, maintenance and monitoring of RFID tags and RIU's installed in remote locations is a vital activity. Round the clock monitoring of real time events through NMS is another crucial maintenance activity. Apart from maintenance of TCAS gears any signaling alteration work on account of shifting of points, extension of track circuits, shifting of signals, provision of additional points/track circuits/signals need to be incorporated in TCAS.

Man power requirement need to be worked out for the maintenance activities mentioned above. This can be done through assigning maintenance units to TCAS sub systems and use existing yard sticks as done in computation of man power requirement for any signal installation. Till creation of manpower maintenance of TCAS can be outsourced.

10.4 Locomotive Periodical Maintenance

Periodical maintenance of the locomotives is carried out by trip sheds and main sheds once in 45 days and 90 days respectively. The condition of the brake blocks, brake power and the pantograph are checked and cleaning of the filters is carried out at Trip sheds in general. The wheel profile, Bogie inspection & topping up of lubricants will be carried out at main sheds. The chances of interference & damage of TCAS equipment are minimal as the duration between two consecutive maintenance schedule is not very high however, TCAS maintenance team/OEM engineers should test the system thoroughly and attend all the failures if any before putting the system in to service. Coordination between shed officials and the maintenance team of OEM is very crucial for maintenance of LTCAS.

10.5 Locomotive Periodical Overhauling

Overhauling of the locomotives is carried out approximately once in 09 years and 18 years for passenger locos and goods locos respectively. During the overhauling all the equipment & bearings except the cables are stripped out and new items will be installed. Proper care should be taken to safe guard the fitted TCAS equipment in the locomotives. Maintenance of LOCO and LTCAS has to be synchronized otherwise improper removal/handling of

wiring and LTCAS sub systems during overhauling of LOCO will result into permanent damage of LTCAS. After completion of the Periodical overhauling of thelocomotives, TCAS OEM engineers should test the system thoroughly and attend all the failures if any before putting the system in to service.

10.6 Track Maintenance

Functioning of TCAS involves fixing of RFID tags on tracks that determines the absolute location of loco and the track ID on which the loco is running. These RFID tags are required to be removed during PQRS and other track machine working. Hence the working of track machine in TCAS territory needs a close coordination between Civil and S&T engineers. Other than increased extent of co-ordination there is no major impact on the track maintenance as such with the introduction of TCAS

10.7 Towers Maintenance

Periodic maintenance is essential to keep the tower structures in good fettle. Technical competency is required to maintain the tower structures. Hence, Bridge inspectors need to be deployed for proper maintenance and supervision of the towers. Outsourcing of this activity can also be an option however, supervision of maintenance, proposed to be carried out through outsourced agency, still need to be done by Bridge inspectors.

11. ENVIRONMENTAL APPRAISAL

As no major Civil works are invoved, the project has no major Environmental Impact. However the execution of TCAS project involves the excavation of earth and erection of high steel structure for radio towers and hence requires consideration about following environmental factors. These factors shall be identified for each worksite during the post contract survey and mitigation measures shall find place in the concept design.

(i) The worksite within a floodplain and/or subject to flooding from rivers, sea, surface water or groundwater.

(ii) The worksite in or over a watercourse or drainage channel or near the bank of a watercourse or near marine waters, on coastal areas below mean high tide or

affecting navigation.

(iii) Any river bank, ditch or a pond bank physically impacted by excavation works.

(iv) Draining down or diversion of any water body as a result of the works.

(v) Any geotechnical stability problems for example erosion, subsidence orlandslides associated with the site.

(vi) The project may require to clear few trees, vegetation or hedgerows on the work site or its compounds, access routes or staging areas.

(vii) The project affecting agricultural land or impact any agricultural holding.

(viii) Ponds within 500 metres.

(ix) Residences, businesses, schools, medical facilities etc that could be affected by noise/ vibration and or dust/ poor air quality during construction?

(x) Any footpath or road closures/ diversions required during project delivery.

12. STANDARDS

Following standards, codes and manuals shall be followed in the proposed work of deployment of TCAS in the section under the consideration.

(i) General Rules for Indian Railways (Open Line) 1976

(ii) Indian Railway Signal Engineering Manual – July 2021

(iii) Indian Railway Telecommunication Manual – September 2021

(iv) RDSO Specification for TCAS – RDSO/SPN/96/2012, Ver. 3.2 or latest

(v) Indian Railway – Standard Code of Practice for the Design of Microwave Towers of Self-Supporting Type – 1982

(vi) Indian Railway – Standard Code of Practice for Fabrication and Erection of Steel Works on Microwave Towers: Self Supporting Type – 1979

(vii) Policy on Design Basis Report / Checklist for Design of Superstructure of TCAS Tower by RDSO B&S Directorate issued vide letter No. CVS/R/DRT/ TCAS, dated

11.1.2021

(viii) EN50126: Specification and demonstration of RAMS for all railway applications

(ix) EN50128: Railway applications - Communication, signalling and processing systems - Software for railway control and protection systems.

(x) EN50129: Railway applications - Communication, signalling and processing systems - Safety related electronic systems for signalling.

(xi) EN50159: Railway applications - Communication, signalling and processing systems - Safety-related communication in transmission systems.

(xii) For other activity corresponding IS Codes shall be referred.

13. CONTRACTING STRATEGY

Following system of contracting shall be adopted.

I. Pre – Bid survey contract for identification of most critical radio tower location, height, space and desktop survey for Received Signal Strength at various heights of antenna.

II. Engineering, Procurement and Construction contract (EPC) for detailed survey, concept design, detailed design, installation, testing and commissioning of various subsystems, Independent Safety Assessment of the project, training, As Made designs, introduction of system into service and subsequent defect reporting and corrective action and maintenance support.

14. ON GOING WORKS IN THE SECTION

On the section discussed, a number of works are ongoing. These works are likely to be completed in various months in 2022/2023. A list of these works is as given below:

i. The work of Bidirectional Automatic Signalling is sanctioned and planned in NDLS-SBB Section, targeted to be completed by 2023

ii. The work of Provision of Electronic Interlocking at Ghaziabad Station is planned and targeted to be completed by 2023/2024.

iii. The work of Sahibabad-Ghaziabad - Repl. of automatic section is planned and targeted to be completed by 2022/2023.

iv. The work of provision of Thick Web Switches and 2 x 25 KV traction system for 160 kmph will be ongoing simultaneously.

v. The work of Provision of Electronic Interlocking at Hazrat Nizamuddin Station is planned and targeted to be completed by 2023/2024.

vi. The Work of Anand Vihar-Tilak Bridge - 3rd & 4th line (9.77 km) is sanctioned and planned in the Section.

vii. The Work of Anand Vihar - Development of new coaching terminal (Phase-II), COMMISSING OF 3RD 4TH line work & alteration at ANVR/BPNL is sanctioned and planned in the section, targeted to be completed by 2022/23

viii. Addition and alteration in Chipyana-Buzurg and Ghaziabad Railway stations in connection with 4th Line of CPYZ-Dadri

ix. Addition and alteration in Tughlakabad Railway station in connection with 4th Line.

x. Addition and alteration in Palwal Railway station in connection with DFCCIL Work of PWL-New Prithla and Yard remodelling in connection with 4th Line work of NCR

ANNEXURES

Annexure A

KAVACH Technology:

1 Concept:

KAVACH (TCAS) is an indigenously developed Automatic Train Protection (ATP) System meant to provide protection to trains against Signal Passing at Danger (SPAD), excessive speed and collisions. It provides continuous update of Movement Authority (distance upto which the train is permitted to travel without danger). Hence during unsafe situations when brake application is necessitated, and the Crew has either failed to do so, or is not in position to do so, automatic brake application shall take place. TCAS has additional features to display information like speed, location, distance to signal ahead, Signal aspects etc. in Loc Pilot's cab and generation of Auto and Manual SOS messages (Distress messages) from Loco as well as Station unit in case of emergency situation.

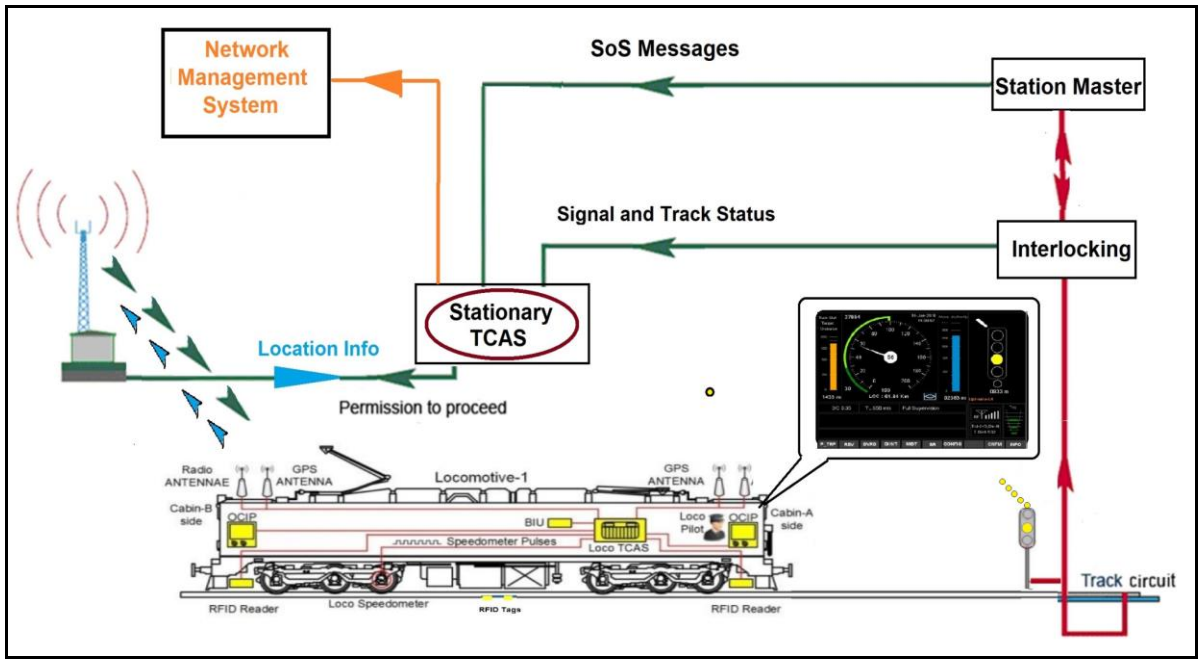
2 Working of KAVACH:

The trackside sub-system of TCAS consists of RFID tags fitted on track in station section and block section for giving Trackside information to Loco TCAS unit installed in the locomotive. Portions of track including berthing tracks, point and block sections are assigned unique IDs called Track Identification Number (TIN). TIN along with RFID Tags are used to determine the direction of train.

The system also consists of Stationary TCAS unit installed at Station with radio tower to communicate with locomotives in station area. Stationary TCAS is interfaced with station interlocking to acquire real-time dynamic information related with signalling such as various signal aspects. Route information of all the signals monitored by a specific stationary TCAS unit is configured on the basis of TCAS Control Table (excluding shunt signals and overlaps). Stationary TCAS unit gets real-time information regarding Locations, Speed etc of various trains in its jurisdiction through UHF Radio Communication.

Separate Stationary TCAS unit is provided at Mid –Section interlocked Level Crossing Gate and Intermediate Block Signalling (IBS) locations if they do not come within the coverage

of station radio tower. Remote Interface Unit (RIU) shall be used where remote signalling functions are required to be fetched to a nearby Stationary TCAS unit for example from end cabins /distributed interlockings or LC gate/IB coming within the radio coverage of station tower.



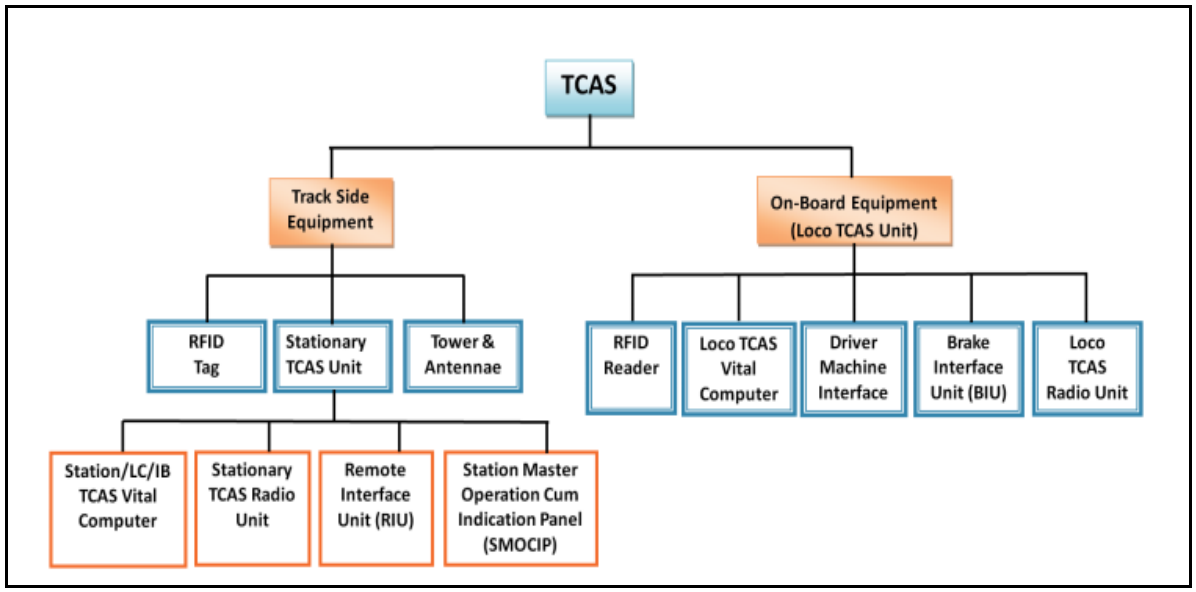
The onboard Loco TCAS unit installed in the locomotive determines the location of train by reading pre-programmed RFID Tag data with the help of RFID reader. Loco TCAS unit sets its absolute location (Approaching signal distance from the train position) and TIN as undefined (zero) before determining the direction. The direction of movement of train shall be determined, when Loco/Train has passed two RFID tags sequentially with Absolute location. Loco TCAS unit calculates the location of the train between two RFID tags dynamically based on the distance travelled from last RFID tag through speed sensing arrangement provided on Locomotive. On passing through the RFID Tag, Loco TCAS unit transmits the location and direction of the train to the Stationary TCAS unit through UHF radio antenna provided in locomotive.

The Stationary TCAS unit shall use the direction of movement of Loco/Train, to find approaching signal of the Loco/Train. Stationary TCAS unit shall then calculate the movement authority based on the signal aspect or/and track circuit status or/and route

locking status, point position and the status of the berthing track circuit. Stationary TCAS unit shall then transmit the Movement Authority to the Loco TCAS in its jurisdiction in station area. The length of the movement authority is decided based on the signal aspect of the approaching Stop Signal. The Loco unit shall make speed profile/ brake curve for different situations based on movement authority, speed restriction and other information as received from Trackside sub-system. The Loco TCAS unit shall display the train speed, the permitted speed, the target distance and the target speed to the loco pilot through a Driver Machine Interface (DMI).

4.3 Components of KAVACH:

The Train Collision Avoidance system broadly comprises of following components: (i). Trackside equipment including Stationary TCAS Unit and (ii). On-board equipment.



4.3.1 Trackside Sub-system:

(A) RFID Tag

RFID Tags provide site specific static information to Locomotive. Apart from acting as Location references, these relieve the Radio Channels and provide immediate information such as crossing the signal etc. to Loco Unit. RFID tags shall be fitted on track in station

section, point zones, near Signals & track in block section for giving Trackside information to Loco TCAS unit.

The RFID tags shall be fitted on the sleepers between the rails as per guidelines given for Indian Railways. RFID tag shall be as per following specifications:

- Suitable for reliable working at train speed upto 200 KMPH (minimum).
- Frequency of operation: 865-867 MHz.
- Can be programmable with minimum 128 bits (including CRC) of user data.
- Shall be able to work even when submerged in water up to rail level.
- Under field operating conditions RFID reader antenna shall be able to read RFID tag from a vertical distance of 700 mm from bottom of RFID reader antenna to top of the rail level.

(B) Stationary TCAS Unit

Stationary TCAS Unit shall be universally suitable for various types of signalling of Indian Railways with provision of colour light signalling. By default, it shall be suitable for interfacing with Panel Interlocking and Electronic / Solid State Interlocking. Normally Stationary TCAS Unit shall be provided at Stations to cover all the trackside signals. It shall also be provided at Intermediate Block Locations (IBS) and midsection interlocked Level Crossing Gates where the radio signal coverage of station TCAS tower is not adequate.

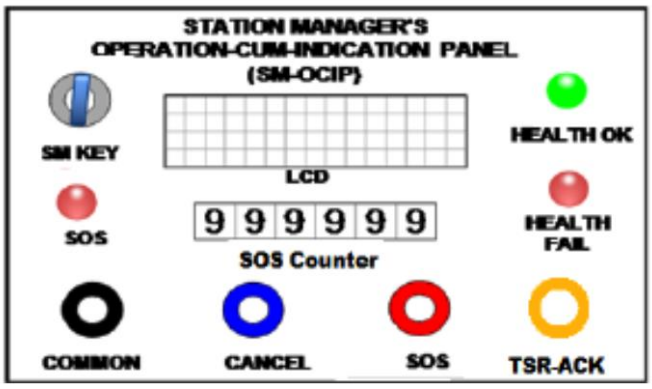
This shall be interfaced with interlocking equipment to acquire real-time dynamic information related with signalling such as various signal aspects. It has database of static signalling related information such as location & details of RFID tags and Speed Restrictions. It gets real-time information regarding Locations, Speed etc of various trains in its jurisdiction through UHF Radio Communication. On the basis of this information, it detects any emergency situation and can direct the command to Loco to take action to stop. Stationary TCAS Unit shall comprise of:

(a). Station/LC/IB TCAS Vital Computer: The Vital Computer of Station/LC/IBS TCAS Unit is a computer-based system that generates messages to be sent to the train on basis of information received from interlocking inputs and on basis of information exchanged with the Loco TCAS units.

(b). Stationary TCAS Radio Unit: Radio communication network shall be used for the bi-directional exchange of messages between Loco TCAS unit and Stationary TCAS units. Stationary TCAS Radio Unit shall have two UHF full duplex Radio modems with separate cable and antennae in hot standby mode to communicate with Loco TCAS unit.

(c). Remote Interface Unit: Remote Interface Unit (RIU) is a miniature version of STAS without radio communication unit, which captures (multiplexing) the relay information wired to it and exchanges the data with master STCAS directly without any relay interfaces. Remote Interface Unit (RIU) shall be used where remote signalling functions are required

to be fetched to a nearby Stationary TCAS unit, for example from end cabin, distributed interlocking, a nearby LC Gate, Intermediate Block or Automatic Signalling section. RIU at such end cabins /distributed interlockings or LC gate/IB shall be installed if they are coming within the radio coverage of station tower. RIU is used to communicate remote signalling inputs to STCAS over OFC media.



(d). Station Master Operation cum Indication Panel (SMOCIP):

SMOCIP consists of following:

- LED Indications
- Switches
- LCD Panel
- Buzzer
- 6 digits counter which are updated on pressing of manual SOS switch
- Station Master's key.

It has the following LED Indications on the Console:

Sr. No.	LED Name	Colour	Description
1	HEALTH OK	GREEN	Indicates Station TCAS Healthy
2	HEALTH FAIL	RED	Indicates Station TCAS Un Healthy
3	SOS	RED	When SOS generated from Station

It has the following switches on the Console:

Sr. No.	LED Name	Colour	Description
1	COMMON	BLACK	Common switch to press along with SOS switch
2	CANCEL	BLUE	To cancel the SOS from station
3	SOS	RED	To generate SOS from Station

No functionality of switches is allowed without SM-KEY insertion into SM-OCIP.

(C) Tower and Antenna:

The antennae for stationary communication system at station/ IBS/ midsection interlocked Gate unit shall be combination of vertically polarized omni and/ or directional antennae.

4.3.2 On-board Sub-system (Loco TCAS Unit):

(A) Loco TCAS Vital Computer

The Loco TCAS vital computer is a system that supervises the movement of the train to which it belongs, on basis of information exchanged with Stationary TCAS units and other Loco TCAS units.

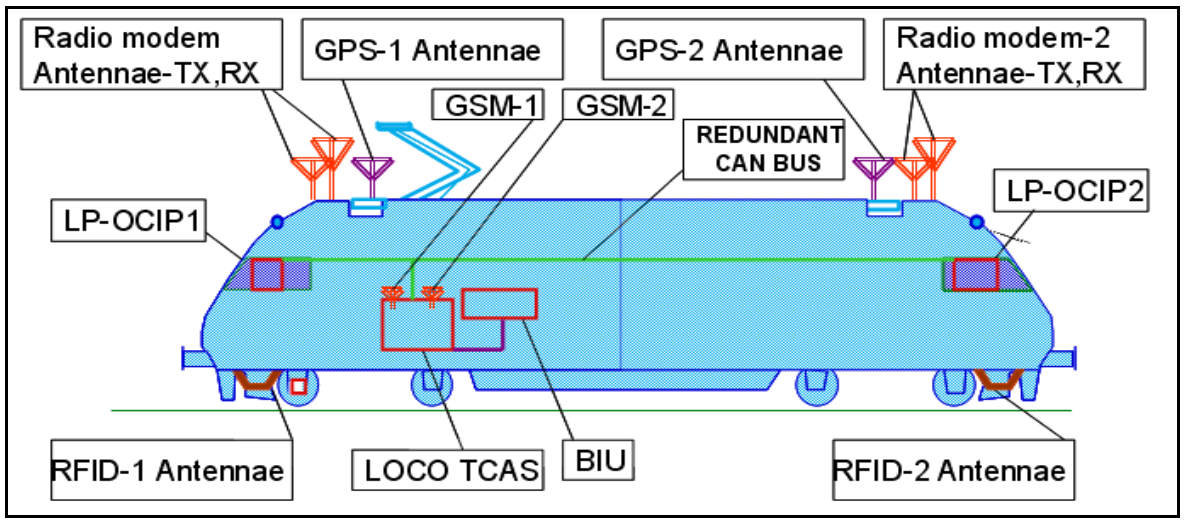
Loco TCAS vital computer shall have provision for the following:

- To interface with train interface unit & brake interface unit.
- Two Direction sensing type Speed Sensor interface for distance and speed measurement.
- To interface with RFID reader to read RFID tags fitted on the track.
- To interface with BTM reader to read Balise fitted on the track in TPWS sections.
- To interface with Driver Machine Interface (DMI) consisting of display arrangement buttons/ switches for operation.
- Two GSM interfaces for connectivity with centralized Network monitoring System (NMS) and Key Management System (KMS). It shall be also to be operable with LTE where LTE is proved.

• USB interface for downloading of log & other data for diagnostic purposes.

(B) Loco TCAS Radio Unit

Loco TCAS Radio Unit specifications shall be similar to Stationary TCAS Radio unit. Loco TCAS Radio Unit shall have two UHF full duplex Radio modems with separate cable and antennae in hot standby mode to communicate with Stationary TCAS unit. Loco unit Antenna shall be Omni-directional & shall have vertical polarization.



(C) RFID Reader

Each Loco TCAS unit shall have two RFID readers for getting the information from RFID tags fitted on the trackside in hot standby manner.

(D) Loco Pilot Machine Interface (DMI)

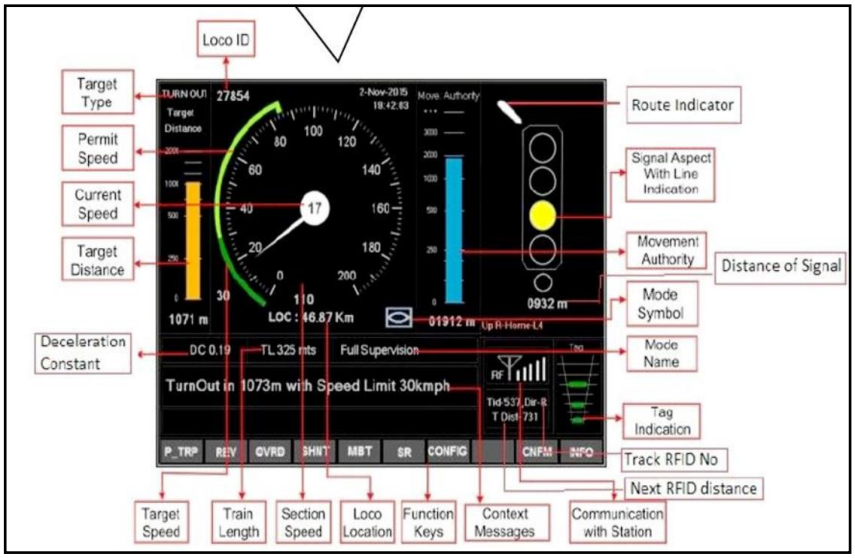
Most of the information displayed is in form of Analog Displays in form of Circular Gauges (Arcs) and bars keeping ergonomics and convenience of Loco Pilots. Digital values have also been additionally displayed. Audio prompts and warnings also are implemented.

(E) Brake Interface Unit (BIU)

BIU shall apply normal, service & emergency brakes of locomotives respectively based on the type of brake command received from Loco TCAS unit. In addition to these brakes, it shall also apply Loco brake, if Loco Brake command is generated by Loco TCAS.

BIU consists of two modules:

1. Electronic Module: It consists of a Control Card having built-in air brake control logic. Control Card interfaces with Analog Input Module, Digital Input Module & Digital Output Module to monitor and control air brake application/release.



2. Pneumatic Panel: It consists of different valves, pressure transducers and manual cocks-Interfaced with IRAB system & Electronic Module for brake control purpose.

Working of BIU:

- TCAS identifies the braking requirement.
- TCAS communicates braking signal(s) to BIU.
- BIU communicates signals to existing brake system of locomotive
- BIU communicates signal for cutting off traction of locomotive
- BIU generates audio-visual indication for Loco Pilot
- BIU gives status of execution of braking command to TCAS

Annexure B: SPARE RELAY CONTACTS

No Spare relay contacts will be provided for TCAS at any Station/Auto Huts/ LC Gates in NDLS-TKJ-PWL and NDLS-TKJ-CPYZ Section. TCAS inputs will be taken by opening repeater relay in a separate relay rack for the concerned relays which are ECRs, NWKRs / RWKRs & TPRs, etc

NOTE 1: For the relays having no spare contact, the contacts wired for Data loggers shall be spared for TCAS working for opening repeater relays & the contact of repeater shall be proved in Data logger.

Annexure C: POWER SUPPLY DETAILS

POWER SUPPLY DETAILS										ANNEXURE - C
S.No	**Stations**	**AT Availability**				**MAKE of IPS**	**DOI**	**Capacity IPS 220V**	**LOAD at 220V (Amp)**	**Spare DC-DC converter slots of IPS**
		AT1	**AT2**	**AT3**	**AT4**					
A	**NDLS_CPYZ Section**									
1	TKJ-MWC AUTO Hut 1 (Akshardham Hut)	10KVa	10KVa	-	-	Conventional Power Supply, 220v AC available			18A	N/A
2	TKJ-MWC AUTO Hut 2 (Mandavli Halt)	10KVa	10KVa	-	-	Conventional Power Supply, 220v AC available			18A	N/A
3	TKJ-MWC AUTO Hut 3 (Anand Vihar Halt)	10KVa	10KVa	-	-	Conventional Power Supply, 220v AC available			15A	N/A
4	Anand Vihar	10KVa	10KVa	10KVa	-	STATCON- 2 Nos	2009	Battery-300AH	40A	NIL
5	B' PANEL	10KVa	10KVa	-	-	AMAR RAJA- 1 No STATCON- 1 Nos	2014, 2017	Battery-200AH Battery-120AH	36A	NIL
6	SBB	10KVa	10KVa	10KVa	25KVa	Conventional Power Supply, 220v AC available			117A	N/A
7	SBB-GZB Auto Hut 1	10KVa	10KVa	-	-	STATCON	2021	Battery-200AH	15A	NIL
8	SBB-GZB Auto Hut 2	NIL	-	-	-	STATCON	2021	Battery-200AH	9A	NIL
9	SBB-GZB Auto Hut 3	NIL	-	-	-	Conventional Power Supply			10A	NIL
10	SBB-GZB Auto Hut 4	10KVa	10KVa	-	-	Conventional Power Supply, 220v AC available			8A	NIL
11	GZB	25Kva	25Kva	10KVa	10KVa	Conventional Power Supply, 220v AC available			110A	NIL
12	CYZ	10KVa	10KVa	-	-	STATCON	2016	Battery-300AH	18A	NIL

S.No	Stations	AT Availability				MAKE of IPS	DOI	Capacity IPS 220V	LOAD at 220V (Amp)	Spare DC-DC converter slots of IPS
		AT1	AT2	AT3	AT4					
B	**NDLS_PWL Section**									
1	NDLS	25KVa	25KVa	25KVa	-	Conventional Power Supply, 220v AC available			160A	N/A
2	NDLS-TKJ Auto Hut	10KVa	-	-	-	STATCON	2019	Battery-200AH	10A	NIL
3	TKJ	50KVa	50KVa	-	-	Conventional Power Supply, 220v AC available			65A	N/A
4	HNZM-TKJ Auto Hut	-	-	-	-	STATCON	2021	Battery-200AH	-	NIL
5	**HNZM**	25KVa	25KVa	10KVa	-	Conventional Power Supply, 220v AC available			100A	N/A
6	**OKA**	10KVa	10KVa	-	-	STATCON	2007	Battery-300AH	32A	NIL
7	**TKD**	25KVa	25KVa	25KVa	-	Conventional Power Supply, 220v AC available			37A	N/A
8	**JNC**	25KVa	25KVa	-	-	STATCON	2012	Battery-300AH	20A	NIL
9	PH1	10KVa	10KVa	-	-	STATCON	2017	Battery-200AH	10A	NIL
10	PH2	10KVa	10KVa	-	-	STATCON	2017	Battery-200AH	12A	NIL
11	**FDB**	50KVa	50KVa	-	-	HBL, HBL	2020	Battery-300AH	45A	NIL
12	PH3	10KVa	10KVa	-	-	STATCON	2016	Battery-200AH	10A	NIL
13	**FDN**	50KVa	50KVa	-	-	HBL, HBL	2019	Battery-200AH	20A	NIL
14	**BVH**	50KVa	50KVa	-	-	STATCON	2019	Battery-300AH	24A	NIL
15	PH 4	10KVa	10KVa	-	-	STATCON	2010	Battery-200AH	10A	NIL
16	PH 5	10KVa	10KVa	-	-	STATCON	2017	Battery-200AH	9A	NIL
17	**PYLA**	25KVa	25KVa	-	-	HBL	2018	Battery-200AH	13A	NIL
18	PH 6	10KVa	10KVa	-	-	STATCON	2008	Battery-200AH	9A	NIL
19	PH 7	10KVa	10KVa	-	-	STATCON	2016	Battery-200AH	15A	NIL
20	**AST**	50KVa	50KVa	-	-	HBL, AMAR RAJA	2021, 2018	Battery-300AH, 200AH	34A	NIL
21	PH 8	10KVa	10KVa	-	-	STATCON	2008	Battery-200AH	15A	NIL
22	PH 9	10KVa	10KVa	-	-	STATCON	2008	Battery-200AH	12A	NIL
23	PH 10	10KVa	10KVa	-	-	STATCON	2008	Battery-200AH	22.7A	NIL
24	PH 11	10KVa	10KVa	-	-	STATCON	2008	Battery-200AH	18A	NIL
25	**PWL**	50KVa	50KVa	-	-	STATCON, AMAR RAJA	2019	Battery-300AH,200AH	50A	NIL

POWER SUPPLY DETAILS										
S.No	**LC Gates**	**AT Availability**				**MAKE of IPS**	**DOI**	**Capacity IPS 220V (Amp)**	**LOAD at 220V (Amp)**	**Spare DC- DC converter slots**
A	**NDLS-CPYZ Section**									
1	4C (MLB)	Interlocked- Controlled by SBB Stn								
2	153C (MLB)	Interlocked- Controlled by GZB Stn								
3	152A (ELB)	Interlocked- Controlled by CPYZ Stn								
4	152B (ELB)	Interlocked- Controlled by CPYZ Stn								
B	**NDLS-PWL Section**									
1	579B (MLB)	10KVa	10KVa			STATCON	2018	Battery-200AH	11A	NIL
2	579A (MLB)	10KVa	10KVa			STATCON	2017	Battery-200AH	11A	NIL
3	576 SPL (ELB)	Interlocked- Controlled by Stn								
4	571 SPL (ELB)	Interlocked- Controlled by AH7								
5	568 SPL (ELB)	Interlocked- Controlled by AH10								

Annexure D: MAJOR BRIDGES

DETAILS OF MAJOR BRIDGES					
S.No	**Block section**	**Br. No**	**Location/ Chainage**	**No. of span with span length (m)**	
				SPAN	**Total Length**
1	NDLS-CSB	RUB 7	1536/38-42	3X26.80	80.4
2	NDLS-CSB	RUB 7	1536/38-42	3X26.80	80.4
3	TKJ-SBB	31	1532/1G-25G	12x47.85	574.20
4	TKJ-SBB	31	1532/1G-25G	12x47.86	575.20
5	BPNL-SBB	8	9/28-30	3x13.30	39.90
6	BPNL-SBB	8	9/28-30	3x13.30	39.9
7	HNZM-OKA	17	1529/14-15	4x19.65	78.60
8	HNZM-OKA	17	1529/14-15	4x19.65	78.60
9	HNZM-OKA	17	1529/14-15	3x19.65	58.95
10	HNZM-OKA	17	1529/14-15	4x19.65	78.6
11	HNZM-OKA	17	1529/14-15	4x19.65	78.6
12	HNZM-OKA	17	1529/14-15	1x19.65	19.65
13	OKA-TKD	29- A	1520/1-2	2x25.89	51.78
14	OKA-TKD	13	BTPS siding TKD	2x13.30	26.60
15	OKA-TKD	14	BTPS Siding TKD	1x32.460	32.46
16	OKA-TKD	17	BTPS Siding TKD	1x32.460	32.46
17	FBD-BVH	2	1502/14-16	1x13.30	13.30
18	FBD-BVH	2	1502/14-16	1x13.30	13.30

Annexure E: MINOR BRIDGES

Sr.	Block Section	Bridge No.	Location				Bridge Category	No. of Spans	Span Configuration in Metres
			Location						
			From		To				
			km	m	km	m			
1	HNZM-TKJ	16 UP ML	1530	507	1530	563	Minor	1	3.05
2	HNZM-TKJ	16 DN ML	1530	560	1530	563	Minor	1	3.05
3	HNZM-TKJ	15 UP ML	1531	846	1531	855	Minor	3	3.05
4	HNZM-TKJ	15 DN ML	1531	846	1531	855	Minor	3	3.05
5	HNZM-TKJ	15 EMU	1531	846	1531	855	Minor	1	9
9	HNZM-TKJ	14III Line	1532	899	1532	909	Minor	1	9.15
10	HNZM-TKJ	14 DN ML	1532	899	1532	909	Minor	1	9.15
11	HNZM-TKJ	14 UP ML	1532	899	1532	909	Minor	1	9.15
12	HNZM-TKJ	14 EMU	1532	899	1532	909	Minor	1	9.15
20	HNZM-TKJ	11	1534	840	1534	845	Minor	1	3.05
28	TKJ-NDLS	8 ML	1536	840	1536	900	Minor	1	3.66
29	TKJ-NDLS	8 UP GAL	1536	868	1536	872	Minor	1	3.66
30	TKJ-NDLS	8 DN GAL	1536	868	1536	872	Minor	1	3.66
31	TKJ-NDLS	8 UP ML	1536	868	1536	872	Minor	1	3.66
32	TKJ-NDLS	8 DN ML	1536	868	1536	872	Minor	1	3.66
41	PWL-AST	1479_3	1479	540	1479	542	Minor	1	1
42	PWL-AST	1479/3	1479	540	1479	542	Minor	1	0.32
44	PWL-AST	1479_4	1479	934	1479	939	Minor	1	0.61
45	PWL-AST	1479/4	1479	934	1479	939	Minor	1	0.61
46	PWL-AST	1480_1	1480	190	1480	192	Minor	1	0.61
47	PWL-AST	1480/1	1480	190	1480	192	Minor	1	0.61
48	PWL-AST	1480_2	1480	800	1480	810	Minor	1	0.61
49	PWL-AST	1480/2	1480	800	1480	810	Minor	1	0.61
51	PWL-AST	1481/1DN	1481	175	1481	190	Minor	1	1
52	PWL-AST	1481/1UP	1481	175	1481	191	Minor	1	1
53	PWL-AST	1481/1	1481	185	1481	192	Minor	1	1
54	PWL-AST	1481/2III	1481	461	1481	466	Minor	1	1
55	PWL-AST	1481/2	1481	461	1481	466	Minor	1	1
56	PWL-AST	1483_1	1483	944	1483	951	Minor	1	1
57	PWL-AST	1483/1_III	1483	944	1483	951	Minor	1	1
58	PWL-AST	1483/1	1483	944	1483	951	Minor	1	1
59	PWL-AST	1483_1 V	1483	945	1483	950	Minor	4	1.00
60	PWL-AST	1483_1 IV	1483	945	1483	951	Minor	4	1.00
61	PWL-AST	1485_1	1485	83	1485	85	Minor	1	0.61

62	PWL-AST	1485/1_III	1485	83	1485	85	Minor	1	0.61
63	PWL-AST	1485/1	1485	83	1485	85	Minor	1	0.61
64	PWL-AST	1485_1iv	1485	84	1485	84	Minor	1	0.60
65	PWL-AST	1485_2	1485	254	1485	269	Minor	3	0.91
66	PWL-AST	1485/2_III	1485	254	1485	269	Minor	3	0.91
67	PWL-AST	1485/2	1485	254	1485	269	Minor	3	0.91
68	PWL-AST	1485_2 IV	1485	262	1485	268	Minor	1	3.66
69	PWL-AST	1485_3 iv	1485	523	1485	523	Minor	1	0.61
70	PWL-AST	1485_3	1485	523	1485	525	Minor	1	0.61
71	PWL-AST	1485/3_III	1485	523	1485	525	Minor	1	0.61
72	PWL-AST	1485/3	1485	523	1485	525	Minor	1	0.61
73	PWL-AST	1485_4	1485	901	1485	903	Minor	1	0.61
74	PWL-AST	1485/4_III	1485	901	1485	903	Minor	1	0.61
75	PWL-AST	1485/4	1485	901	1485	903	Minor	1	0.61
76	PWL-AST	1485_4 iv	1485	903	1485	903	Minor	1	0.61
77	PWL-AST	1486_1	1486	48	1486	486	Minor	1	0.46
78	PWL-AST	1486_1 iv	1486	300	1486	300	Minor	1	0.61
79	PWL-AST	1486/1_III	1486	302	1486	304	Minor	1	0.61
80	PWL-AST	1486/1	1486	302	1486	304	Minor	1	0.61
81	PWL-AST	1486_2	1486	556	1486	558	Minor	1	0.61
82	PWL-AST	1486/2	1486	556	1486	558	Minor	1	0.61
83	PWL-AST	1486_2 iv	1486	566	1486	566	Minor	1	0.61
84	PWL-AST	1486/2_III	1486	566	1486	575	Minor	1	0.61
85	PWL-AST	1487_1	1487	227	1487	236	Minor	1	4.00
86	PWL-AST	1487/1_III	1487	227	1487	236	Minor	1	4.00
87	PWL-AST	1487/1	1487	227	1487	236	Minor	1	4.00
88	PWL-AST	1487_1 IV	1487	240	1487	246	Minor	1	4.00
89	PWL-AST	1488_1	1488	427	1488	429	Minor	1	0.61
90	PWL-AST	1488/1_III	1488	427	1488	429	Minor	1	0.61
91	PWL-AST	1488/1	1488	427	1488	429	Minor	1	0.61
92	PWL-AST	1488_1 IV	1488	428	1488	428	Minor	1	0.61
93	PWL-AST	1488_2	1488	690	1488	697	Minor	2	0.90
94	PWL-AST	1488/2	1488	690	1488	697	Minor	2	0.90
95	PWL-AST	1488_2 IV	1488	693	1488	697	Minor	2	0.90
96	PWL-AST	1488/2_III	1488	693	1488	697	Minor	2	0.90
97	PWL-AST	1490/1up	1490	600	1490	608	Minor	4	0.92
98	PWL-AST	1490/1_III	1490	600	1490	608	Minor	4	0.92
99	PWL-AST	1490/1	1490	600	1490	608	Minor	4	0.92
100	PWL-AST	1490_1 IV	1490	602	1490	610	Minor	4	0.92
101	AST-PYLA	1492_1 IV	1492	122	1492	127	Minor	1	0.60
102	AST-PYLA	1492/1_III	1492	920	1492	922	Minor	1	0.46
103	AST-PYLA	1492/1	1492	920	1492	922	Minor	1	0.46
104	AST-PYLA	1492_1	1492	920	1492	930	Minor	1	0.46
105	AST-PYLA	1493_1	1493	439	1493	442	Minor	1	0.60
106	AST-PYLA	1493/1_III	1493	439	1493	442	Minor	1	0.60
107	AST-PYLA	1493/1	1493	439	1493	442	Minor	1	0.60

108	AST-PYLA	1493_1 IV	1493	440	1493	445	Minor	1	0.60
109	AST-PYLA	1493_2 IV	1493	820	1493	825	Minor	1	0.60
110	AST-PYLA	1493_2	1493	823	1493	825	Minor	1	0.46
111	AST-PYLA	1493/2_III	1493	823	1493	825	Minor	1	0.46
112	AST-PYLA	1493/2	1493	823	1493	825	Minor	1	0.46
113	PYLA-BVH	1495_1	1495	858	1495	860	Minor	1	0.46
114	PYLA-BVH	1495/1_III	1495	858	1495	860	Minor	1	0.46
115	PYLA-BVH	1495/1	1495	858	1495	860	Minor	1	0.46
116	PYLA-BVH	1495_1 IV	1495	859	1495	865	Minor	1	0.60
117	PYLA-BVH	1496_1	1496	178	1496	180	Minor	1	0.46
118	PYLA-BVH	1496/1_III	1496	178	1496	180	Minor		0.46
119	PYLA-BVH	1496/1	1496	178	1496	180	Minor	1	0.46
120	PYLA-BVH	1496_1 IV	1496	179	1496	185	Minor	1	0.60
123	PYLA-BVH	1501_1	1501	8	1501	13	Minor	8	0.91
124	PYLA-BVH	1501/1_III	1501	8	1501	13	Minor	8	0.91
125	PYLA-BVH	1501/1	1501	8	1501	13	Minor	8	0.91
126	PYLA-BVH	1501_2	1501	140	1501	150	Minor	1	0.46
127	PYLA-BVH	1501/2_III	1501	140	1501	150	Minor	1	0.46
128	PYLA-BVH	1501/2	1501	140	1501	150	Minor	1	0.46
130	BVH-FDN	1502_1	1502	81	1502	88	Minor	1	6.10
131	BVH-FDN	1502/1_III	1502	81	1502	88	Minor	4	0.91
132	BVH-FDN	1502/1	1502	81	1502	88	Minor	4	0.91
134	BVH-FDN	1502_2	1502	248	1502	260	Minor	4	3.50
136	BVH-FDN	1502/2	1502	248	1502	260	Minor	4	3.50
137	BVH-FDN	1505_1 IV	1505	0	1505	12	Minor	1	6.40
138	BVH-FDN	1505_1 V	1505	0	1505	12	Minor	2	3.05
139	BVH-FDN	1505/1UP	1505	7	1505	13	Minor	4	0.91
140	BVH-FDN	1505/1_III	1505	7	1505	13	Minor	1	6.20
141	BVH-FDN	1505/1	1505	7	1505	13	Minor	4	0.91
142	FDN-FDB	1505_2	1505	649	1505	653	Minor	1	0.91
143	FDN-FDB	1505/2_III	1505	649	1505	653	Minor	1	0.91
144	FDN-FDB	1505/2	1505	649	1505	653	Minor	1	0.91
151	FDB-JNC	1511_1 IV	1511	142	1511	148	Minor	1	3.60
152	FDB-JNC	1511_1	1511	144	1511	159	Minor	1	3.60
153	FDB-JNC	1511/1_III	1511	144	1511	159	Minor	1	3.60
154	FDB-JNC	1511/1	1511	144	1511	159	Minor	1	3.60
156	FDB-JNC	1511/2	1511	530	1511	535	Minor	1	0.46
157	FDB-JNC	1511_2 IV	1511	628	1511	634	Minor	1	0.60
158	FDB-JNC	1511_2	1511	663	1511	665	Minor	1	0.46
159	FDB-JNC	1511/2_III	1511	663	1511	665	Minor	1	0.46
160	FDB-JNC	1511_3	1511	903	1511	905	Minor	1	0.46
161	FDB-JNC	1511/3_III	1511	903	1511	905	Minor	1	0.46
162	FDB-JNC	1511/3	1511	903	1511	905	Minor	1	0.46
163	FDB-JNC	1511_3 IV	1511	904	1511	910	Minor	1	0.90
164	FDB-JNC	1512_1 IV	1512	115	1512	122	Minor	1	1.84
165	FDB-JNC	1512_1	1512	116	1512	121	Minor	1	1.84

166	FDB-JNC	1512/1_III	1512	116	1512	121	Minor	1	1.84
167	FDB-JNC	1512/1	1512	116	1512	121	Minor	1	1.84
168	FDB-JNC	1512_2 IV	1512	370	1512	375	Minor	1	1.00
169	FDB-JNC	1512_2	1512	390	1512	392	Minor	1	0.46
170	FDB-JNC	1512/2_III	1512	390	1512	392	Minor	1	0.46
171	FDB-JNC	1512/2	1512	390	1512	392	Minor	1	0.46
180	JNC-TKD	37 UP ML	1515	705	1515	710	Minor	1	4.57
181	JNC-TKD	37 DN ML	1515	705	1515	710	Minor	1	4.57
182	JNC-TKD	37 3RDLINE	1515	705	1515	710	Minor	1	4.57
183	JNC-TKD	37 4THLINE	1515	705	1515	710	Minor	1	4.57
184	JNC-TKD	36 UP ML	1516	349.85	1516	359	Minor	1	0.9
185	JNC-TKD	36 DN ML	1516	349.85	1516	359	Minor	1	0.9
186	JNC-TKD	36 3RDLINE	1516	349.85	1516	359	Minor	1	0.9
187	JNC-TKD	36 4THLINE	1516	349.85	1516	359	Minor	1	0.9
192	JNC-TKD	34 UP ML	1517	105	1517	107	Minor	1	1.8
193	JNC-TKD	34 DN ML	1517	105	1517	107	Minor	1	1.8
194	JNC-TKD	34 UP GAL	1517	105	1517	107	Minor	1	1.80
195	JNC-TKD	34 DN GAL	1517	105	1517	107	Minor	1	1.8
196	JNC-TKD	33 UP ML	1517	715	1517	718.05	Minor	1	3.05
197	JNC-TKD	33 DN ML	1517	715	1517	718.05	Minor	1	3.05
198	JNC-TKD	33 UP GAL	1517	715	1517	718.05	Minor	1	3.05
199	JNC-TKD	33 DN GAL	1517	715	1517	718.05	Minor	1	3.05
200	JNC-TKD	32 3RDLINE	1519	11	1519	30	Minor	3	6.1
201	JNC-TKD	32 UP ML	1519	11	1519	30	Minor	3	6.1
202	JNC-TKD	32 DN ML	1519	11	1519	30	Minor	3	6.1
206	TKD-OKA	30 UP ML	1520	235	1520	247.74	Minor	2	4.57
207	TKD-OKA	30 DN ML	1520	235	1520	247.74	Minor	2	4.57
208	TKD-OKA	30 TKDYARD	1520	235	1520	247.74	Minor	2	4.57
212	TKD-OKA	29 UP ML	1521	192.4	1521	195.45	Minor	1	3.05
213	TKD-OKA	29 DN ML	1521	192.4	1521	195.45	Minor	1	3.05
214	TKD-OKA	29 UP GAL	1521	192.4	1521	195.45	Minor	1	3.05
215	TKD-OKA	29 DN GAL	1521	192.4	1521	195.45	Minor	1	3.05
216	TKD-OKA	28 LINE 24	1521	867	1521	868	Minor	1	0.76
217	TKD-OKA	28 UP ML	1521	867.7	1521	868.46	Minor	1	0.76
218	TKD-OKA	28 DN ML	1521	867.7	1521	868.46	Minor	1	0.76
219	TKD-OKA	28 BTPS	1521	867.7	1521	868.46	Minor	1	0.76
220	TKD-OKA	27 UP ML	1522	299.5	1522	305.6	Minor	1	6.1
221	TKD-OKA	27 DN ML	1522	299.5	1522	305.6	Minor	1	6.1
222	TKD-OKA	27 UPDNGAL	1522	299.5	1522	305.6	Minor	2	6.1
223	TKD-OKA	27 BTPS	1522	299.5	1522	305.6	Minor	1	6.1
225	TKD-OKA	26 UP ML	1523	750.5	1523	752.33	Minor	1	1.83
226	TKD-OKA	26 DN ML	1523	750.5	1523	752.33	Minor	1	1.83
227	TKD-OKA	25 UP ML	1524	288	1524	289.22	Minor	1	0.91
228	TKD-OKA	25 DN ML	1524	288	1524	289.22	Minor	1	0.91

229	TKD-OKA	24 UP ML	1524	353	1524	354.83	Minor	2	1.83
230	TKD-OKA	24 DN ML	1524	353	1524	354.83	Minor	1	1.83
231	TKD-OKA	23 UP ML	1524	550	1524	553.05	Minor	1	3.05
232	TKD-OKA	23 DN ML	1524	550	1524	553.05	Minor	1	3.05
233	TKD-OKA	22 UP ML	1525	273.4	1525	279.5	Minor	1	6.1
234	TKD-OKA	22 DN ML	1525	273.4	1525	279.5	Minor	1	6.1
235	TKD-OKA	21 UP ML	1525	497	1525	503.1	Minor	1	3.60
236	TKD-OKA	21 DN ML	1525	497	1525	503.1	Minor	1	3.60
237	TKD-OKA	20 DN ML	1525	711.95	1525	721.1	Minor	1	3.05
238	TKD-OKA	20 UP ML	1525	711.95	1525	721.1	Minor	1	3.05
240	OKA-HNZM	19 UP ML	1527	378	1527	381.66	Minor	1	3.66
241	OKA-HNZM	19 DN MN	1527	378	1527	381.66	Minor	1	3.66
242	OKA-HNZM	18 UP ML	1528	32.45	1528	39	Minor	2	3.05
243	OKA-HNZM	18 DN ML	1528	32.45	1528	39	Minor	2	3.05
244	OKA-HNZM	17D UP ML	1528	238.1	1528	246	Minor	1	6.1
245	OKA-HNZM	17D DN ML	1528	238.1	1528	246	Minor	1	6.1
248	OKA-HNZM	17B UP ML	1528	294.7	1528	300.8	Minor	1	6.15
249	OKA-HNZM	17B DN ML	1528	294.7	1528	300.8	Minor	1	6.15

New Delhi-Chipiyana Section:

Sr. No	Bridge No.	Bridge Name	Section/Station	From		To		No. of Lines	Bridge Category	No. of Spans	Span Configuration
				km	m	km	m				
1	239/UP		SBB-GZB	13	242	13	244	1	Minor	1	1.83m
2	239/DN	239D	SBB-GZB	13	242	13	244	1	Minor	1	1.83
3	239/LL	minor	SBB-GZB	13	242	13	244	1	Minor	1	1.83m
4	239/LG	239	SBB-GZB	13	242	13	244	1	Minor	1	1.83
5	237/IIL	237 IIL	SBB-GZB	14	537	14	539	1	Minor	1	1.83
6	237/IL	237	SBB-GZB	14	537	14	539	1	Minor	1	1.83
7	237/IIIL	minor	SBB-GZB	14	537	14	539	1	Minor	1	1.83
8	237/IVL		SBB-GZB	14	537	14	539	1	Minor	1	1.83
9	236/IIL	MOHAN MEAKINS	SBB-GZB	15	3	15	5	1	Minor	1	1.83
10	236/IIIL	MOHAN MEAKINS	SBB-GZB	15	3	15	5	1	Minor	1	1.83
11	236/IL	MOHAN MEAKINS	SBB-GZB	15	3	15	5	1	Minor	1	1.83
13	236/IVL	MOHAN MEAKINS	SBB-GZB	15	3	15	5	1	Minor	3	1.83
15	235/IL	235	SBB-GZB	15	832	15	837	1	Minor	2	2.23
16	235/IIL	minor	SBB-GZB	15	832	15	837	1	Minor	4	2.23

17	235/IIIL	235	SBB-GZB	15	832	15	839	1	Minor	2	3.15
18	235/IVL	235	SBB-GZB	15	832	15	839	1	Minor	2	3.15
25	233B/IL	MINOR	SBB-GZB	16	815	16	821	2	Minor	2	1.2
26	233B	233B	SBB-GZB	16	815	16	821	4	Minor	2	1.2
28	233A/IL	Nagar Nigam	SBB-GZB	17	660	17	680	1	Minor	1	3.05
29	233A/IIL	Nagar Nagam	SBB-GZB	17	660	17	680	1	Minor	1	3.05
30	233A/IIIL	Nagar Nagam	SBB-GZB	17	660	17	680	1	Minor	1	3.05
31	233A/IVL	Nagar Nagam	SBB-GZB	17	660	17	680	1	Minor	1	3.05
32	233/IIIL	minor	SBB-GZB	18	1	18	7	1	Minor	5	1.2
33	233/IVL	minor	SBB-GZB	18	1	18	7	1	Minor	5	1.2
34	233/IIL	minor	SBB-GZB	18	1	18	7	1	Minor	5	1.2
35	233/IL	minor	SBB-GZB	18	1	18	7	1	Minor	5	1.2
36	232/IL	sadiq ki puliya	SSB-GZB	18	300	18	307	1	Minor	1	3.10 mtr
37	232/IIL	sadiq ki puliya	SSB-GZB	18	300	18	307	1	Minor	1	3.10 mtr
38	232/IIIL	sadiq ki puliya	SSB-GZB	18	300	18	307	1	Minor	1	3.10 mtr
39	232/IVL	sadiq ki puliya	SSB-GZB	18	300	18	307	1	Minor	1	3.10 mtr
40	232A/IL		SSB-GZB	18	900	18	910	1	Minor	1	6.1
41	232A/IIL	232A	SSB-GZB	18	900	18	910	1	Minor	1	6.1
42	232A/IIIL	232A	SSB-GZB	18	900	18	910	1	Minor	1	6.1
43	232A/IVL	232A	SSB-GZB	18	900	18	910	1	Minor	1	6.1
44	231/DN		SSB-GZB	19	300	19	301	1	Minor	1	0.305
45	231/UP		SSB-GZB	19	300	19	301	1	Minor	1	0.305
47	30A	30A	NDLS-SBB	2	254	2	260	2	Minor	1	6.1
50	30 DN GAL	30 DN GAL	NDLS-SBB	2	500	2	540	1	Minor	2	9.15
51	30 UP GAL	30	NDLS-SBB	2	500	2	540	2	Minor	2	9.15
55	28DNGAL	28 DN GAL	NDLS-SBB	3	290	3	291	1	Minor	1	0.46
56	28 UP GAL	28 UP GAL	NDLS-SBB	3	360	3	361	1	Minor	1	0.46
58	27 DNGAL	27 DN GAL	NDLS-SBB	4	163	4	164	1	Minor	1	0.46

59	26 DN GAL	26 DN GAL	NDLS-SBB	4	352	4	353	2	Minor	1	0.46
60	26 UP GAL	26 UP GAL	NDLS-SBB	4	352	4	353	1	Minor	1	0.46
61	27 UP GAL	27 UP GAL	NDLS-SBB	4	418	4	419	1	Minor	1	1X0.46
67	24 DN GAL	24 DN GAL	NDLS-SBB	5	720	5	780	2	Minor	1	9.5
68	20 DNGAL	20 DNGAL	NDLS-SBB	6	21	6	23	2	Minor	2	0.4
69	22 UP GAL	22 UP GAL	NDLS-SBB	6	50	6	83	1	Minor	1	3.048
70	22 DNGAL	22 DN GAL	NDLS-SBB	6	50	7	83	2	Minor	1	3.048
71	21 DN GAL	21 DN GAL	NDLS-SBB	6	423	6	433	1	Minor	1	9.15
72	21 UP GAL	21 UP GAL	NDLS-SBB	6	423	6	433	1	Minor	1	9.15
73	20 UP GAL	20 UP GAL	NDLS-SBB	6	640	6	641	1	Minor	1	0.457
74	19 DNGAL	19 DN GAL	NDLS-SBB	6	766	6	767	1	Minor	1	0.46
75	19 UP GAL	19 UP GAL	NDLS-SBB	6	766	6	767	1	Minor	1	0.46
78	18 DN GAL		NDLS-SBB	7	18	7	19	1	Minor	1	0.46
79	18 UP GAL	18 UP GAL	NDLS-SBB	7	18	7	19	1	Minor	1	0.457
80	17 UP GAL	17 UP GAL	NDLS-SBB	7	825	7	826	2	Minor	1	0.61
84	14	14	NDLS-SBB	7	996	8	50	2	Minor	1	9.15
85	13 DN GAL	13 DN GAL	NDLS-SBB	8	899	8	900	1	Minor	1	0.61
86	13 UP GAL	13 UP GAL	NDLS-SBB	8	900	8	901	2	Minor	1	1X0.61
87	11 DN GAL	11 DN GAL	NDLS-SBB	9	310	9	311	1	Minor	1	0.914
88	11 UP GAL	11 UP GAL	NDLS-SBB	9	310	9	311	1	Minor	1	0.914
89	12	12	NDLS-SBB	9	330	9	331	2	Minor	1	0.91
90	10 DNGAL	10 DN GAL	NDLS-SBB	9	650	9	651	1	Minor	1	0.61
94	7 DN GAL	7 DN GAL	NDLS-SBB	10	380	10	381	1	Minor	1	0.914

95	7 UP GAL	7 UP GAL	NDLS-SBB	10	380	10	381	1	Minor	1	0.914
96	6 DNGAL	6 DN GAL	NDLS-SBB	10	398	10	399	1	Minor	1	0.61
98	4 DN GAL	4 DN GAL	NDLS-SBB	10	806	10	807	1	Minor	1	0.914
99	3 DN GAL	3 DN GAL	NDLS-SBB	10	942	11	950	1	Minor	1	7.38
100	2 DNGAL	2 DN GAL	NDLS-SBB	11	124	11	125	1	Minor	1	0.914
101	1 UPGAL	1 UP GAL	NDLS-SBB	11	754	11	756	1	Minor	1	1.5
102	240	240	NDLS-SBB	11	818	11	881	1	Minor	1	1.829
103	31A	31A	NDLS-SBB	1532	168	1532	210	2	Minor	1	2.745
106	12 UP ML	12 UP ML	NDLS-SBB	1532	966	1532	970	1	Minor	1	2.44
107	12 DN ML	12 DN ML	NDLS-SBB	1532	966	1532	970	1	Minor	1	2.44
108	12 UPDNGAL	12 UP DN GAL	NDLS-SBB	1533	966	1533	970	2	Minor	1	2.44
112	10 UP GAL	10 UP GAL	NDLS-SBB	1534	672	1534	714	1	Minor	4	2x17.4+2x7.60
113	11 DN GAL	11 DN GAL	NDLS-SBB	1534	840	1534	845	1	Minor	1	3.05
115	11 DN ML	11 DN ML	NDLS-SBB	1534	840	1534	845	1	Minor	1	3.06
116	11 UP GAL	11 UP GAL	NDLS-SBB	1534	840	1534	845	1	Minor	1	3.06
117	9	9	NDLS-SBB	1536	760	1536	766	2	Minor	1	1.83

Annexure F: ROBs

DETAILS OF ROBs BRIDGES					
S.No	**Block section**	**Br. No**	**Location/ Chainage**	**No. of span with span length (m)**	
				SPAN	**Total Length**
1	OKA-HNZM	ROB-17A	1528/9-12	3x20.53(8 Girder in each row = total 24)	492.72
2	OKA-HNZM	ROB 17-C Ashram	1528/9-12	3x10.95(15 Girder in each row = total 45)	492.75
3	SBB-GZB	ROB GZB	17/24-26	1X52.41+2X37.84	128.09
4	TKJ-CSB	ROB 9A School-lane	1536/3-4	1x51.35	102.7
5	BPNL-SBB	ROB 9 Brij Vihar	9/25-27	1x14.17	14.17
6	TKJ-MWC	ROB 30A Akshrar Dham	2/16G-18G	1x14.00+ 1x16.54+ 1x14.06	89.2
7	TKD-OKA	ROB 19A OKA	1526/10-12	1x25.035+ 1x24.97+1x23.10	146.21
8	FDB-TKD	ROB 1511/2-A	1511/7-9	1x27.39	27.39
9	FDN-FDB	ROB-1507/1	1507/11-13	1x26.00	52
10	BVH-FDN	ROB-1505/3	1505/25.27	1x18.05 +1x30.79	48.84
11	BVH-FDN	ROB-1502/1	1502/3-7	1x13.70+1x35.15+1x13.70	62.55
12	OKA-HNZM	ROB-17A	1528/9-12	3x20.53(8 Girder in each row = total 24)	492.72
13	OKA-HNZM	ROB 17-C Ashram	1528/9-12	3x10.95(15 Girder in each row = total 45)	492.75
14	SBB-GZB	ROB GZB	17/24-26	1X52.41+2X37.84	128.09
15	TKJ-CSB	ROB 9A School-lane	1536/3-4	1x51.35	102.7
16	BPNL-SBB	ROB 9 Brij Vihar	9/25-27	1x14.17	14.17
17	TKJ-MWC	ROB 30A Akshrar Dham	2/16G-18G	1x14.00+ 1x16.54+ 1x14.06	89.2
18	TKD-OKA	ROB 19A OKA	1526/10-12	1x25.035+ 1x24.97+1x23.10	146.21

19	FDB-TKD	ROB 1511/2-A	1511/7-9	1x27.39	27.39
20	FDN-FDB	ROB-1507/1	1507/11-13	1x26.00	52
21	BVH-FDN	ROB-1505/3	1505/25.27	1x18.05 +1x30.79	48.84
22	BVH-FDN	ROB-1502/1	1502/3-7	1x13.70+1x35.15+1x13.70	62.55

Annexure G: RUBs and LHS

DETAILS OF RUBs BRIDGES					
S.No	**Block section**	**Br. No**	**Location/ Chainage**	**No. of span with span length (m)**	
				SPAN	**Total Length**
1	PRMG-TKJ	Tilak Bridge (No.10)	1534/10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	80.99
2	PRMG-TKJ	Tilak Bridge (No.10)	1534/10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	50.64
3	PRMG-TKJ	Tilak Bridge (No.10)	1534/ 10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	50.64
4	MWC-TKJ	Tilak Bridge (No.10)	1534/10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	50.64
5	MWC-TKJ	Tilak Bridge (No.10)	1534/10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	50.64
6	MWC-TKJ	Tilak Bridge (No.10)	1534/10-11	(1x8.02+1x17.30+1x17.30+1x8.02)	50.48
7	HNZM-PGMD	RUB 13 PGMD	1532/40-42	1x16.52+1x15.20+1x15.21+1x16.36	63.29
8	TKJ-HNZM	RUB 13 PGMD	1532/40-42	1x16.52+1x15.20+1x15.21+1x16.36	63.29
9	TKJ-HNZM	RUB 13 PGMD	1532/40-42	1x16.52+1x15.20+1x15.21+1x16.36	63.29
10	TKJ-HNZM	RUB 13 PGMD	1532/40-42	1x16.52+1x15.20+1x15.21+1x16.36	63.29
11	FDB-TKD	RUB 38 TKD	1515/3-5	1X13.30	13.3
12	FDB-TKD	RUB 38 TKD	1515/3-5	1X13.30	13.3
13	FDB-TKD	RUB 38 TKD	1515/3-5	1X13.30	13.3
14	FDB-TKD	RUB 38 TKD	1515/3-5	1X13.30	13.3
15	TKJ-MWC	RUB 32A PGMD	1532/22-26	(1x16.08+1x21.40+1x21.95+1x16.50)	75.93
16	TKJ-MWC	RUB 32A PGMD	1532/22-26	(1x16.08+1x21.40+1x21.95+1x16.50)	75.93
17	HNZM-MWC	32 (PGMD)	GAL/ 5-7	(1x15.57 + 2x19.86 +1x14.91)	70.2

18	HNZM-MWC	32 (PGMD)	GAL/ 5-7	(1x15.57+2x19.86+1x14.91)	70.2
19	Originate from in between OKA & TKD	RUB 29B Mathura Road	PH-2/8-10	(1x14.71+1x16.41+1x16.41+1x14.74)	62.27

Annexure G: RORs-

Sr.	Block Section	Bridge No.	Location				Bridge Category	No. of Spans	Span Configuration in Metres
			Location						
			From		To				
			km	m	km	m			
1	HNZM-TKJ	14A/34 III	1532	290	1532	310	ROR	1	
2	HNZM-TKJ	14A/34 DN	1532	290	1532	310	ROR	1	8.1X1,9.75X1
3	HNZM-TKJ	14A/34 UP	1532	290	1532	310	ROR	1	9.75
4	TKD-OKA	29A BTPSDN	1521	8.81	1521	22.81	ROR	2	24.75
5	TKD-OKA	29A BTPSUP	1521	8.81	1521	22.81	ROR	2	24.75

Annexure H: Transmission Lines Crossing The Right of Way

ANNEXURE - H					
SN	Station Between	Between Location	kV	OH/UG	Height
1	PWL-AST	1487/25-27	440kV	OH	17m
2	PWL-AST	1489/12-14	440kV	OH	17.2m
3	AST-BVH	1495/12-14	400 KV	OH	16.9m
4	AST-BVH	1494/24-26	220 KV	OH	15m
5	AST-BVH	1499/16-18	66KV	OH	14.1 m
6	AST-BVH	1499/18-20	220KV	OH	14.09 m
7	AST-BVH	1500/26-28	220 KV	OH	15m
8	AST-BVH	1500/30-32	66KV	OH	14m
9	BVH-FDB	1504/32-34	66KV	OH	14.1m
10	FDB-TKD	1514/28-30	220 KV	OH	15.1 m
11	FDB-TKD	1514/34-36	66 KV	OH	14m
12	FDB-TKD	1518/28-30	220 KV	OH	15 m
13	TKD-OKA	1523/17-15	220 KV	OH	15.1 m
14	SBB-GZB	17.2-17.4 &17/5-17/3	400KV	OH	22.6m

<u>Annexure I:</u> Transmission Lines Crossing The Site

As per Annexure-H above