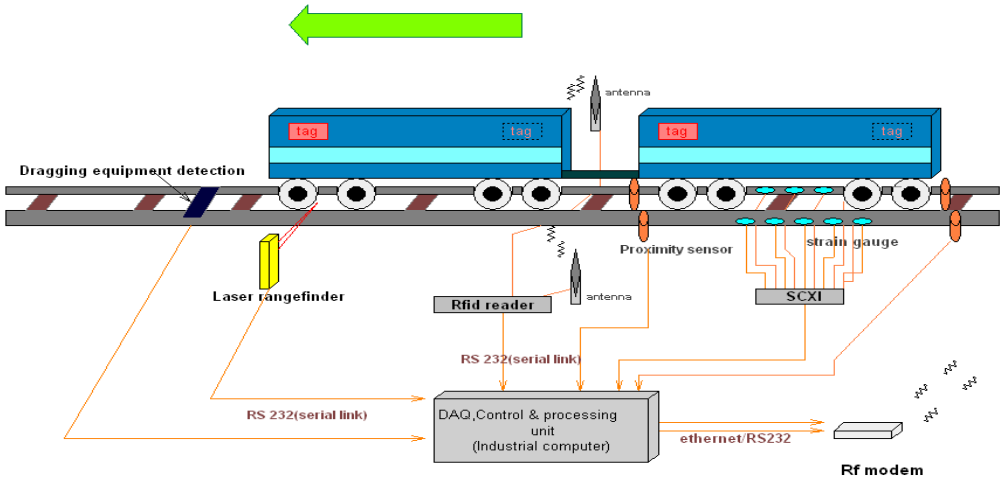
TRACK SIDE BOGIE MONITORING SYSTEM

Introduction: Indian Railways at present does not use any automated system for real-time online monitoring of the performance of bogies and wheel-sets. Bogies are checked only during TXR examination for loose or broken parts. Wheel sets are changed when they reach the condemning limit. Problems like skew ness in bogie or asymmetric wheel-wear are attended to during preventive maintenance schedule only. Geometric faults in alignment and tracking of wheel are known to cause premature were as well as abnormal stresses. Re-profiling and replacing worn wheel sets constitutes a significant portion of rolling stock maintenance costs. Misaligned wheel sets are also responsible for increased fuel consumption and accelerated track deterioration.

In developed countries state of the art on-line monitoring systems, such as the T/BOGI station, which measures angle of attack (AOA), and tracking position (TP) of each axle of a passing train. AOA and TP parameters combine to provide a planar description of the bogie, which is a distinct signature of a particular bogie that remains stable over time and distance traveled. Other parameters that characterize the performance of bogies, viz. inter-axle misalignment (IAM) and tracking error (TE) etc.

Objective: To develop an automated system which can be installed along the track for detecting faults in bogies of rolling stock, for measurement of lateral and vertical rail forces, for detection of components of the rolling stock which may cause derailment.



Present Status:

Laser Range Finder (LRF) based trackside bogie monitoring system on installed at Ajgain Railway station on the Kanpur-Lucknow main track for measuring AOA, TP, IAM and TE of passing trains. Analyzed data also being uploaded automatically to website for monitoring by RDSO. LRF located at trackside, but data acquisition etc in a nearby instrumentation room. cRIO based strain guage system for measuring V, L, forces and L/V ratios of passing trains. Data uploaded regularly for monitoring by RDSO.

Task Remaining:

Compact RIO (cRIO) based trackside rugged prototype, housing both LRF and data acquisition. Field trails and detailed studies for correlating the L/V ratio with AOA, in order to set thresholds for various types of coaches/wagons.

LRF away from the track

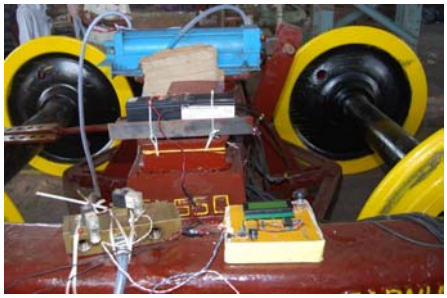
Vertical Load calibration(upto 20T)

Field Trial site(Ajgain Station)

DERAILMENT DETECTION DEVICES

Objective: The objective of the project is to develop an indigenous electronic derailment detection device for the coaching stock and a mechanical device for the freight stock.

Present status: 6 Oscillograph Cars have been instrumented for collection of the base data on normal running trains in order the fix the threshold values. A derailment mechanism has been designed and developed by IIT Kanpur. Electronic device for derailment detection has been developed and trial has been done at the laboratory stage. Derailment tests were conducted with necessary instrumentation on the bogie at different speeds in collaboration with M/s Frontier Alloy Steels, Kanpur. The field trial for the functioning of the device is in progress. Analysis of Data collected from field trials for fixing threshold values for derailment detection device is also in progress.



Derailment trial of Bogie using Derailment mechanism and brake actuator unit

Task remaining:

A full scale derailment test of the entire bogie is to be conducted for the validation of the threshold values. The electronic device has to be ruggedized and transfer of technology is to be done to Indian Railways. A proper manual is to be prepared for working with this system. An additional time of about 6 months is required to accomplish the activities.

SENSORS FOR HOT BOXES AND HOT WHEELS

Objective: The project envisages development of detection system for identifying axle-boxes running hot due to bearing failure and wheels having abnormally high temperatures due to brake-binding. This includes use of sensors having fast response time so as to identify hot boxes and hot wheels on trains running up to 200 kmph besides development of appropriate instrumentation and signal processing.

The trial units have continued to be run frequently at RDSO and have been performing satisfactorily for the past two years using the pyrometer based instrumentation. M/s Centum Industries, Bangalore had designed and fabricated the housing for the pyrometer based system. Besides this, indigenous development of the preamplifier for the MCT sensors which will be used for 200kph operation has been made. The final unit for use in the production units is under development. It may be added that while the pyrometer base units are suitable for 70kph operation, replacement with the MCT sensors will increase the speed range to 200kph and beyond.

Present Status: A prototype unit for operational speeds up to 70kmph is in operation at RDSO since 6 months. The sensors for the high speed unit (200kmph) have been shipped from Germany and are expected very soon. Once received this unit is likely to be commissioned at Ajgain in a month's time. The housing etc. for this unit has been fabricated and installed. Other hardware, like cRIO units and modules, power supply, wireless link, etc. is available.

Task Remaining: Integration of the AIM TMS35 High Speed Sensors. These will replace the current Impac IPE140 units with minor modifications in the software developed. The former unit is already on extended trials, and the latter will be put on trials as and when it is ready. An expected time of about 6 months is required to accomplish the task remaining.

Classic & revised geometries

Proximity under test

MCT under bench test

In the field testing

ON BOARD DIAGNOSTICS ON DIESEL AND ELECTRIC LOCOMOTIVES

Objective: The objective of the project is to develop an On-Board Diagnostics panel for diesel and electric locos through microprocessor based controls. This will include development of appropriate instrumentation and signal processing strategy for various equipments which form part of the transmission and other auxiliary machines on board the locomotives. This enables real time monitoring of vital locomotive elements like prime mover, rotating machines, traction motor suspension bearings, axle bearings, radiator drive, compressor, transformer, tap changer, pantograph, etc.

The data acquisition is based on FPGA (Field Point Gate Array) state of art system which has been developed for appropriate signal processing strategy for various parameters. The system is designed and implemented to measure main reservoir, break pipe, lube oil, fuel oil, boost air pressures, traction motor current and voltage, loco speed, traction motor armature bearing vibration and temperature. The data acquired through sensors is being transmitted through mobile network to IIT Kanpur server.

Overall system integrated in Diesel Loco No.18774

Overall system integrated in Electric Loco No.27247

Software programs were developed using LabView platform for display of the parameters and the engine location. The other measurement positions (locations on the Locos) like axle bearing vibration and temperature, front traction motor blower vibration and current, compressor vibration, traction generator vibration, traction alternate current and voltage, auxiliary generator voltage, exciter voltage for both electric and diesel locos.

Present status: Two prototype units for recording parameters on the engine with limited sensors have been designed and implemented on Diesel locomotive and Electric locomotive. The data transfer to remote location has been implemented and the software to show the location and data parameters has been developed on standard maps. The trials are going on with out any loss of data. The next phase software and hardware design was developed about eight months back. Laboratory calibration of all the sensors has also been completed.

Tasks remaining: The rest of the sensors (respective parameters to be measured) are available. The hardware like IP67 junction boxes to minimize the running of wire is designed and is yet to be implemented on the locos. The availability of the engines has become a difficult task and RDSO is completing the formalities. IIT Kanpur is ready with software and hardware.

WHEELS AND AXLES OF IMPROVED METALLURGY

Objective: The project envisages for the development of new chemical composition of wheels, axles both for forging and casting without altering the design parameters. At present the Wheel fails through radial fractures, shattered rim and shelling to a large extent. This can be avoided by improvement in the metallurgy by enhancing the values of critical parameters. Similarly, cold breakage of axles can be avoided to a large extent by having axles made of materials with improved metallurgy. Besides, improved metallurgy of wheels and axles can impart characteristics to wheels and axles of present design that can withstand higher axle loads without sacrificing safety online.

Present Status:

Forged Wheel: RDSO is coordinating the dispatch of wheels from the "Wheel and Axle Plant" of Durgapur Steel Plant to the Northern Railway Workshop at Jagadhari for subsequent assembly with the axle (pressing-in) and field trials.

Cast Wheel: RDSO is coordinating the completion of the heat treatment of all the manufactured wheels at RWF Bangalore. RDSO will also co-ordinate dispatch and assembly of these wheels as a wheelset and monitor the trials.

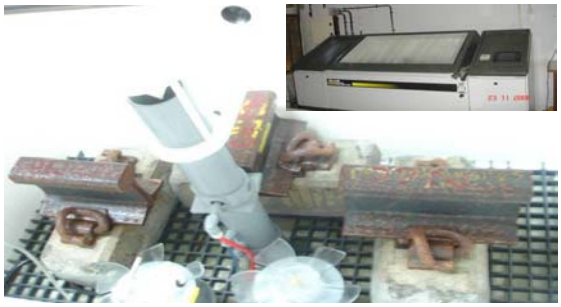
Axle: Currently, the project team is pursuing with Durgapur Steel Plant for the manufacture of steel ingots for producing axles. Durgapur management has agreed to produce these heats in principle. Some pricing issues have been raised by DSP and the team is trying to persuade for manufacture of these heats as done in the case of forged wheels. In the meantime, RDSO is also trying to place a formal order for manufacture of axles.

Remaining Tasks: Manufacture of Axles heat at Durgapur Steel Plant, which may take 2-3 months time from now. Testing and Mechanical Properties evaluation of manufactured Axles. Wear testing of cast wheels. Assembly of forged as well as cast wheels for facilitating field trials.

CORROSION PREVENTION OF RAILS

The project envisages development corrosion prevention methods of the existing rails and the liner location. The objective includes alloy development of rail steel composition for corrosion prevention. Based on the observations and various studies and field studies, it was found that cold zinc spray coating is the best option suggested. Four new rail steels, containing microalloying elements Cu, Cr, Ni and Si, were tested by a variety of experimental methods at IIT Kanpur. A variety of experiments were conducted in order to achieve the final composition. Some of the experiments were duplicated in Chemical Analysis and Corrosion Engineering Laboratory of RDCIS, Ranchi and RDSO, Lucknow. Based detailed analysis of the laboratory results obtained, the most promising rail steel composition containing Cr-Cu-Ni was recommended in April 2007. Final composition was suggested to Railways against which 120 Tons of NCC rails were rolled at Bhilai Steel Plant in the year 2007, 50 Tons of rail is welded and laid down at Vijayawada division for the field trails. In continuation to the above orders by the Railway Board, it was decided to roll 500 Tons of NCC rails and will be laid in East Coastal Railways. At present NCC rail composition was incorporated in the Railway Standards. The behaviour of these new rails will be monitored in the field, while at the same time laboratory simulation experiments are being conducted. Based on the comprehension of the results in the field and the laboratory experiments a bulk order of about 10,000 Tons is being contemplated by the Railway Board.

Remaining Task: Field trials of rails with the specified compositions are underway. They have to be inspected for progress. Simulation experiments in the corrosion chamber at IIT Kanpur complete. Analysis of corrosion product and corrosion nature to be evaluated. Time expected for completion of these tasks is about 6 months



Experimental setup of various samples collected

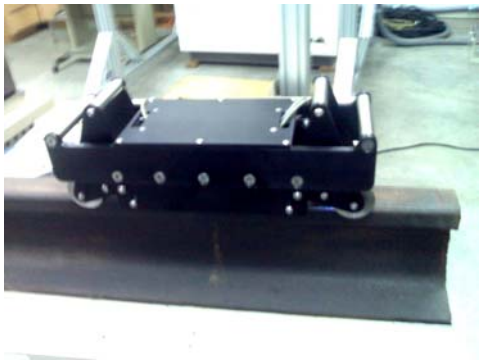
MEASURING WHEEL TECHNOLOGY

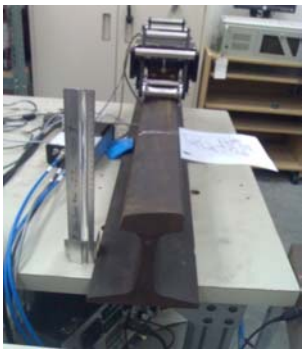
The objective of the project is to design and development of an Instrumented wheel set for wagon, carriage and locomotive etc. This measuring wheel is used to obtain the lateral and vertical forces running at about 80kmph. The instrumented wagon wheel set has been fabricated and installed along with hydraulic load actuators, sensors etc and RDSO Lucknow. Testing at various loading conditions and force calibration for static dynamic conditions were done on the test rig. The wheel set is instrumented with a telemetry system for data transmission wireless on running conditions. The wheel set is ready for field testing for about 3 months.

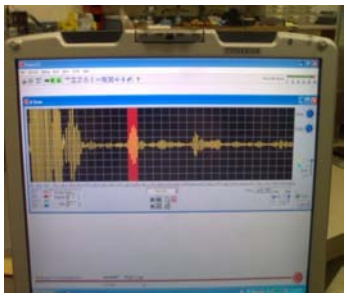
Present Status: The project is at the completions stage. All the laboratory trials on the test rig fabricated at RDSO are completed. Now the instrumented wheel-set is to be installed on a running train for field trials which will take about 3-4 months of time.

RAIL FLAW DETECTION INSTRUMENTATION

The projects expedites for development of indigenous flaw detection and testing equipment for rails and rail weld joints at a speed of about 40-50 kmph. The equipment design and development is completed. The required equipment along with road cum rail vehicle was obtained with the necessary instrumentation. Software has been developed at IIT Kanpur for analysis of the signals obtained by the electro magnetic transducer technique. Laboratory experiments and tests were conducted with EMAT system on standard test blocks having known defects. A universal probe has been designed to detect the flaw in the rail. Optimization of the system parameters for various samples with defects in the rail is in process.







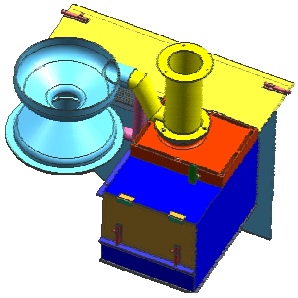
Present Status: EMAT guided wave probes have been procured. Laboratory tests on guided wave probes are in progress. Development of software / Matlab code to identify various defects is also under progress.

Remaining Tasks: Integrate the EMAT equipment in Hyrail. Arrive at the specifications for integrated probe tailored to the Indian rail section. Run trials on actual rail tracks

ENVIRONMENTAL FRIENDLY RAILWAY COACH TOILET SYSTEM

Objective: The objective of the project is to design and develop an environmental friendly railway coach toilet system for Indian Railways. The system being developed at IIT Kanpur is able to prevent damage to the railway track and coache, maintain hygienic/sanitary conditions, particularly on the railway stations, compliance with the environmental regulations/standard/practices, enable Indian Railways to obtain appropriate ISO certification for passenger coach toilets and toilet waste management.

System under test at IIT Kanpur



First version of the design approved and released by RDSO as the prototype

First prototype fabricated by the Industry Partner

Present Status: The trials on the first two prototypes fitted on a Coach No SR 8224 started on February 3, 2009. This coach is a part of the rake which runs as Train No 6093/6094: Gomti Sagar Express (Chennai-Lucknow-Chennai; Journey Time: 4 days and 6hrs) and Train No 6031/6032: Andaman Express (Chennai-Jammu-Chennai; Journey Time: 5 days and 6hrs) in a cyclic manner.

The results based on passenger reaction survey, feed-back from Southern Railway and RDSO officials, and testing carried out by us suggest that the performance is satisfactory and better than that estimated from static trials. The system has been in operation un-interruptedly for more than 41 days.

Member, Mechanical, Railway Board was briefed on February 24, 2009 about the Environment-Friendly Passenger Coach Toilet System being developed under TMRS. Our efforts have been fully appreciated and assurance has been given to extend for full support.

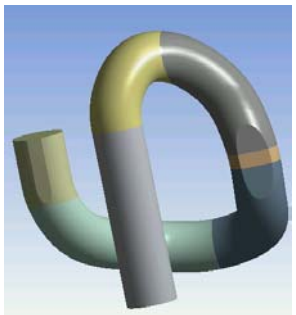
A letter from the ED, Carriage, RDSO, has been received informing IR's intention to go for extended trials on a full rake of 24 coaches. CME, Southern Railway has been asked to identify the train route for the extended trials and we were requested to give a proposal for the full rake of 24 coaches including installations to be done at BBQ Yard, Chennai for evacuation and processing of residues at the yard.

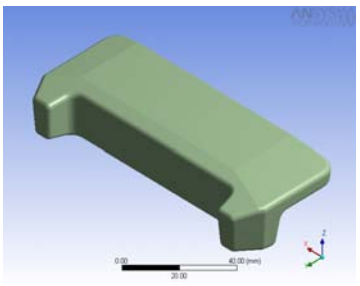
On the request of the DG, RDSO, a proposal has been submitted for installing Zero Discharge Toilet System at Charbagh Station.

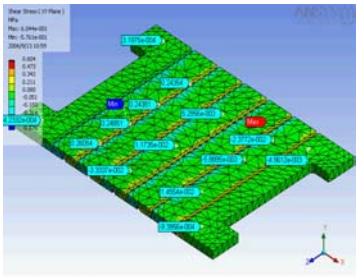
Remaining Tasks: Trials on prototypes fitted on the coach. Design, installation and testing of prototype system for evacuation, transfer and processing of residues. Detailed design/drawing/specifications for residue management system for railway yards/ stations. Indian Railway Manual for Environment-Friendly Toilets in Passenger Coaches.

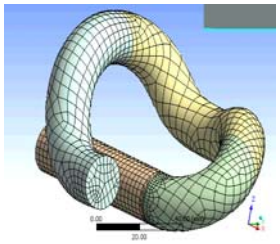
IMPROVED RAIL FASTENINGS

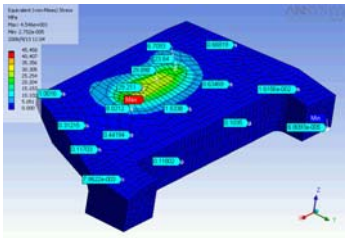
In the existing railway track structure, elastic fastenings are used to hold the rails with sleepers elastically, as elastic rail clips (ERCs), liners and rubber pads. After a period of time, it was found that the loss of toe load takes place due to fatigue of ERC, crushing/damage/shifting of grooved rubber pads and corrosion/breakage of liners. The present design is also not having anti seizure properties due to which jamming of leg of ERC inside the insert takes place. In addition to these fastenings, rail free fastenings are used on switch expansion joints (SEJs) and bridges. The fastenings being used on channel sleepers get loosened frequently. Hence, to overcome these problems, this project is proposed to develop suitable fastening system including its components with improved features. The status of the project is that the design and analysis of all the three fastenings is completed. Prototypes are underway for testing in the laboratory. Once the prototypes are tested in the lab and get validated, the components will be kept on trail on the track.

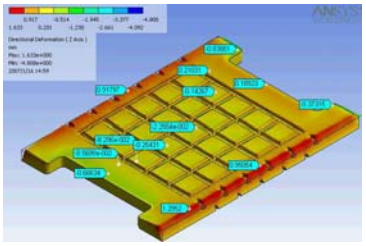












Elastic Rail Clip | Liner | Rubber Pad

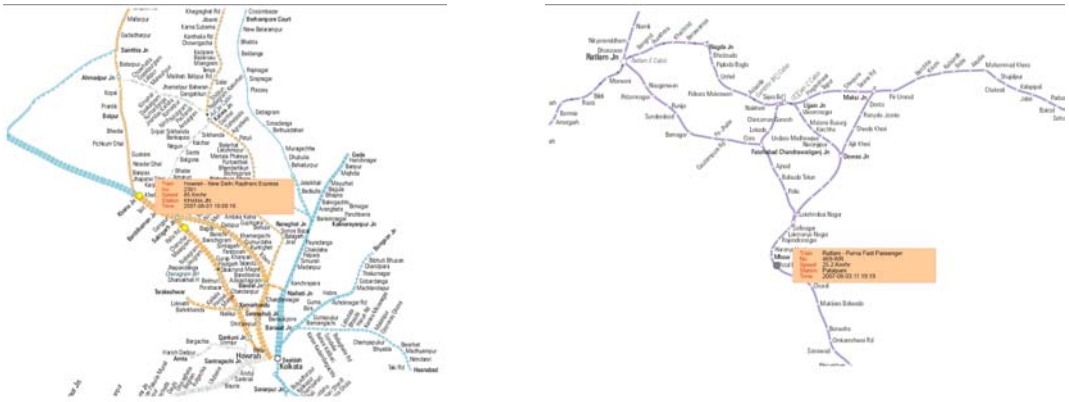
<u>Remaining Tasks</u>: Receipt of manufactured components- Not yet. Delivery promised in March 2009. Lab evaluation of components and design modifications if needed any. Estimated time six months after receipt of manufactured components

SATELLITE IMAGING FOR RAIL NAVIGATION (SIMRAN)

SIMRAN is a Real Time Train Tracking System for Indian Railways. A digital map of Indian railways has been prepared as a core development under SIMRAN. Daily train running operations and collecting nation vide GPS coordinates for all the Railway Stations is also being done. Hardware and software for SIMRAN operations was done indigenously at IIT Kanpur. Positional tracking data is logged automatically by all the train and station devices at central server with the help of GSM. Data validation is being performed on a real time basis. Currently SIMRAN Train Device has been deployed over 75 trains including Rajdhanis, Shatabdis and MEMUs with an average of 30-40 trains are being tracked continuously.

Main Features of the device:

1. Web based Real time train information www.simran.in
2. SMS query Service for Train Arrival.
3. LCD Screens at platforms for the real time train information.
4. Wireless coach display system, Train indication boards at railway stations. Track detection device is an addition to the SIMRAN Train device. It also involves Incab signalling with the help of RF repeaters.



Real Time Tracking System on the Railway Map

Present Status: SIMRAN Train Device Version 5 (V5) has been developed but trials are pending. Currently SIMRAN V2 & V3 Devices are running successfully over 75 trains. Currently Data Logging, SMS Service & Web Service are running on a single server. It leads to a single point failure. Remote control feature in train device is under test. LED Coach Display trial for has been performed in “Gomti Express”. But more trials are required for design stabilization. LCD Coach Display trial for has been performed in “Patna Rajdhani” Express. But more trials are required for design stabilization.

Remaining Tasks:

- SIMRAN Train Device Version 5 (V5) will be tested over various routes and trains. For example “Patna Rajdhani”, “Mumbai Rajdhani”, Kanpur – Lucknow MEMU etc. V5 design is Linux based.
- LED/LCD Coach Display trial. This LCD display is Linux based.
- GPS Track Data Collection for Rajdhani & Shtabdi Routes. This data is required to test SIMRAN V5 Train device.
- Wireless cum internet network setup for a Station. Station set will consist of Station Server (Internet ready), various Station, Enquiry and Platform Displays. Station server will also feed Platform Coach Displays.
- Driver Smart card setup at Driver lobby. Driver will register at driver lobby using one smart card. This card will be used with SIMRAN V5 Train device for correlating driver with Loco and Train.
- 24x7 Cluster (Redundant) setup for Train/Station Data Logging, Web Server, SMS Service
- Incorporation of Remote Controlling feature in devices.

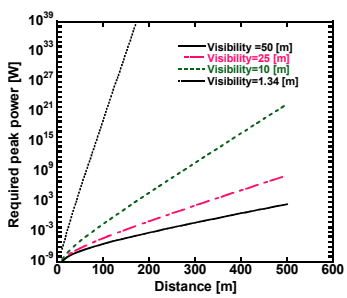
FOG VISION INSTRUMENTATION

Objective: The project envisages development of instrumentation for improving the visibility in foggy conditions by developing a proper fog vision system. This project envisages the characterization of the fog at various temperatures and particle concentration. Laser based reflection and scattering measurements to be developed by a detection system for the scattered laser light and its corroboration with the scanning sequence. A 25 mrad divergent CO_2 laser at 400m distance of required power 10 MW (peak) at a safe pulse width of 25ns with an image Sensitivity of 100mK and a safe power density of 0.4 MW/cm^2. Repetition rate of ~few kHz is desired for better image, where no scanning would be required.

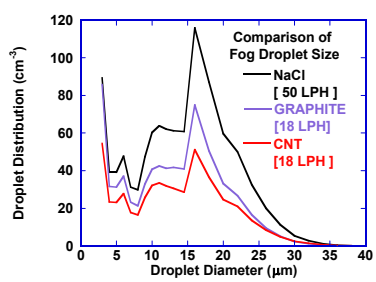
Present Status: BEL the chosen industrial partner had not played their role and their partnership has been dissolved. Measurements undertaken of optical and physical characteristics of fog in a controlled environment fog chamber, developed at IIT Kanpur. Completed theoretical feasibility study for an Infrared (IR) laser radar approach for fog vision. Conducted trials with a night vision camera system manufactured by Bharat Electronics Ltd under passive IR conditions. Completed theoretical considerations of 1.55□m (near-IR) and 10.6□m (mid-IR) for laser radar type applications in Fog Vision. Completed wavelength dependence of Fog Attenuation and Track Elements Scattering around 1.55□m IR using a TUNABLE LASER and at 10.6□m IR using a 1kHz pulsed CO2 Laser. Completed Imaging by Track Elements Scattering at 10.6□m IR and High Speed IR detector by a indigenously developed scanner. Hardware design for fog vision instrument has been completed.

Tunable laser along with the Fog chamber

Zn-Se Window at the laser and detector ends of the fog chamber



Power requirement at various visibility conditions



Characterisation of the fog developed in the fog chamber

Remaining Tasks: Install the x-y Optical scanner (which has just arrived) and develop the drive circuit for the scanner in conjunction with a data acquisition system (is expected to arrive shortly) through a laptop (is expected to arrive shortly). Extract imaging data through on-line signal processing for enhanced clarity. Install Optics for focusing the laser at a distance of 400m (on-order). Supply of prototype for lab model with complete instrumentation for fog vision. Search for a replacement CO2 laser with narrower (□s-ns) pulse widths and repetition rates better than 100Hz for better (image clarity)/ (distance of vision).