ABSTRACT

The automotive electrical system for a tracked vehicle for defence is very complex as the several systems have to function in close proximity. The electromagnetic interference (EMI) is the phenomena of coupling of electromagnetic energy intentionally or unintentionally by one system to a neighbouring system leading to either malfunction, degradation of performance or catastrophic failure. The Electromagnetic compatibility (EMC) is the ability of a system to give the intended performance in the presence of EMI.

The tracked fighting vehicle has to meet the stringent EMI-EMC requirement conforming to the various military standards such as MIL STD 461 C, MIL STD 220A, MIL STD 5087 etc, during their normal performance. The subsystems are required to perform without loss of signal, degradation of performance or equipment failure. The entire study is mainly concentrated on power supply modules and control elements of the vehicle.

The simulation studies were carried out using Ansoft 2D modeler which is based on Maxwell's equation by simulating various sources of interference such as lightning and its coupling of EMI with the tracked
vehicle. The 2D modeling simulation study was carried out due to resource limitations of the computers. A case study was made on the effects of extra high voltage transmission line on the tracked vehicle in close proximity during deployment. The various field patterns were generated and were utilised to compute the associated matrices, inductance, and capacitance parameters. This would enable us to compute the safe distance at which one can deploy any other critical equipment. The predicted levels of EMI also helped us to specify the equipments that have to work in conjunction with the tracked vehicle. The Finite element method (FEM) based field modeling studies both at system and subsystem level were carried out on a desktop computer using ‘ANSOFT’.

The tracked vehicle is required to survive external disturbances such as a lightning, NEMP threat in field condition. A case study in Ansoft was made on a model developed for the tracked vehicles along with simulated lightning waveform to study the coupling coefficients, field pattern generated during the occurrence of such EMI interferences in a system. The levels of energy that is encountered by the system during lighting may cause irreversible damage to the equipment. The external threats cause malfunction of subsystems of vehicle due to coupling of electromagnetic energy through open ports or antenna. The antenna being always on the highest point in vehicle the lightning is most likely to strike
at this unit. A working model of the arrestor fitted on the antenna was
designed for a tracked vehicle application. A gas insulated lightning
arrestor was deployed after evaluation for its performance using impulse
generator. The live testing was carried out to validate the performance,
before fitment of the same in the vehicle.

Ansoft based model analysis were extended to onboard
subsystems like slipring assembly, harness assembly, etc. The FEM
analysis also enabled us to derive the electrical equivalent circuit diagram
based on the geometrical, mechanical data in the presence of known
electrical energy source. This enabled user to generate the complete
electrical system equivalent for further theoretical analysis. The impulse
energy levels is known, adoption of staggered multilevel protection system
becomes ideal solution to bring down the threat levels to safe limits.

The tracked vehicles are to be made compact to ensure fast
transportability by air, rail, ships etc. The system modules are required to
packed in small space envelop that invariably results in EMI problems.

The choice of components has to be made to meet higher levels
of shock, vibration, dust, exposure to harsh environment as indicated by
Joint service specification for the defence vehicles (JSS 55555 or MIL
STD 810 E).

The power supply is seen as the one of the primary source
through which EMI gets into vital system. Therefore the power line
interference studies were made onboard the vehicle to conform MIL STD 1275A standards. This study mainly is intended to enlighten us more the bus voltages during various load conditions encountered in the tracked vehicles. The grounding aspects play a predominant role that gets addressed during course of this study. The measurement of grounding resistance was carried out on various power supply elements for the tracked vehicle such as connectors, main relays, slipring assemblies etc. EMI transient’s levels were investigated during normal functioning of automotive vehicle load dump, starter motor currents, dust ejector motor transients etc. The actual recordings were carried out before and after necessary EMI hardening. EMC engineer has to ensure compliance of EMI-EMC specifications to MIL STD 461C/462 for the vehicle.

EMI-EMC levels viz. radiated emission (RE) and conducted emission (CE) spectrum levels were measured practically and the external threat levels of EMI computed by Ansoft software. The vehicle as a whole along with its subsystems was found to meet stipulated EMI-EMC specifications. The advent of desktop fast machines it will be possible to do 3D simulation in near future. Similarly the compact packaging of power and control modules in the vehicle may lead to severe near field interferences that need to be tackled by adopting new methodology & hardening techniques in this field. EMI-EMC would continue to be an exciting field for the system designers.