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Research Problems for DIA-CoEs

Directorate of Futuristic Technology Management


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DRDO

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Introduction

DRDO is funding multi-institutional and multi-disciplinary directed research projects to Academia and National Research Institutes to develop cutting edge defence technologies. The funding is focused on translational research for developing the crucial and futuristic technologies in defined research domains through a network of DRDO Industry Academia – Centre of Excellences (DIA-CoEs) at premier and capable academic institutes and universities in the country.

To foster the research in academia, DFTM invites project proposals on problem statements in multiple areas, that will be taken up through DIA-CoEs for directed research. Received proposals will be scrutinized by DFTM and forwarded to respective DIA-CoEs as per research verticals for further evaluation.

Forms for submission are provided at ***https://www.drdo.gov.in/drdo/en/offerings/schemes-and-services/dia-coes***

Fully furnished project proposals shall be submitted to DFTM through ***techforesight.drdo@gov.in***

Sensitivity / Survivability analysis of Stealth Unmanned Combat Aircraft under heavily contested airspace

ADE

Technology Area
Wargaming

Technology Category
Flight Simulation

Brief of the Research Problem
- Sensitivity / Survivability analysis of the High performance Unmanned Combat Aircraft is required to converge towards the missions which are survivable under different war gaming scenario. This analysis will also include the risk quantification and risk mitigation strategies with respect to change in scenarios.
- It is proposed that analysis to carried out through high fidelity mathematical modelling & simulation of adversaries' various assets like - Air defence radar network, Air defence Guns, Surface to Air missiles batteries etc.
- It is proposed to consider the stealth attributes of the Unmanned Combat Aircraft as per open literature data which will be refined with original inputs at appropriate stage of the study.
- A detailed analysis report along with the simulation model to be submitted.

Major Objectives
To refine the tactics of own ship operations in dynamics and contested airspace where probability of survival can be quantified

Expected Deliverables
Detailed technical report and developed software tool/s for analysis

Probable Applications
Futuristic Projects

Technologies for Low Observable High Temperature Radar Absorbing Structure

ADE

Research Vertical
Ultra- High Temperature Materials for Hypersonic Applications (UHTM)

Thrust Area
High Temperature Coatings

Brief of the Research Problem
Nozzle of aircraft is one of the critical component which contributes significantly to rear aspect RCS of an aircraft. There is a requirement of broadband RCS reduction of aircraft from rear aspect. Technologies are available on band specific RCS reduction as on today which works up to 200 degrees Centigrade. Aircraft nozzle experience ~600 degrees Centigrade temperature. In order to meet the RCS requirement at rear aspect, high temperature Radar Absorbing Material needs to be designed and developed. Further details on requirements will be provided by ADE.

Major Objectives
Design and development of high temperature radar absorbing structure for aircraft nozzle

Expected Deliverables
Nozzle with additional of high temperature radar absober on it

Probable Applications
Aircraft nozzle

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Figures of Merit

S No.	Parameter	Value
1	Foam Expansion	Minimum 7
2	Foam 25% drainage time	<3.5 min
3	Maximum Extinguishing time	60s
4	Minimum Burn back time	240s
5	PFAS	Free

Low Observable Optical and IR Window

ADE

Research Vertical
Advanced Electro Optic Technologies (EOT)

Thrust Area
Optronic Sensor Shield Next Generation EO Sensors

Brief of the Research Problem
IR and Optical windows works at different frequency bands. Few systems in aircraft consist of sensors which works on both IR and Optical frequencies. There are only a few materials available (like sapphire) which transmit on both IR and optical frequencies. These materials are radar transparent and hence, it impacts the RCS of the aircraft due to the internal reflection from the sensors and structural components. In order to reduce the RCS of IR and optical window, the window needs to be coated with special material which has optical and IR transparent and radar reflecting behaviour. However, any additional coating will impact the optical and IR performance. An optical/IR window (details will be provided by ADE) with low observable performance to be designed and developed. Also, the trade-off between optical/IR and RCS performance, if any, to be evaluated.

Major Objectives
RCS reduction of window working in IR and optical Band

Expected Deliverables
Panel of 300mmx300mm coated with special material for RCS reduction of window working in IR and optical Band

Probable Applications
EOTS windows

Low observable Radome

ADE

Research Vertical
Sensing, Stealth and Surface Protection Using Nano Materials and Meta Materials (SSSP)

Thrust Area
Multi-Spectral Stealth and Cloaking

Brief of the Research Problem
Radome are used to protect antennae on aircraft while it also takes aerodynamic/structural loads. These radome are radar transparent and hence, it impacts the RCS of the aircraft due to the internal reflection from the antenna and structural components. In order to reduce the RCS of antenna and structural components, the radome needs to designed with low observable technology. In this project, it is expected to design and develop a radome which is transparent to electromagnetic for in-band of frequencies and behave as absorber and/or reflector for the out of band frequencies. Specific frequency details will be provided by ADE.

Major Objectives
Transparent Radome as absorber in-band of frequencies (X-Band) and behave as reflector (S, C, and Ku) for the out of band frequencies.

Expected Deliverables
Radome with absorber in-band of frequencies (X-Band) and behave as reflector (S, C, and Ku) for the out of band frequencies

Probable Applications
Radome for X-Band SAR antenna

Low Observable Optical windows

ADE

Research Vertical
Advanced Electro Optic Technologies (EOT)

Thrust Area
Optronic Sensor Shield Next Generation EO Sensors

Brief of the Research Problem
Optical windows on aircraft (for example, Wing tip position lights, camera windows etc.) are radar transparent and hence, it impacts the RCS of the aircraft due to the internal reflection from the light and structural components. In order to reduce the RCS of optical window, the window needs to be coated with special material which has optical transparent and radar reflecting behaviour. However, any additional coating will impact the optical performance. An optical window (curved in shape, details will be provided by ADE) with low observable performance to be designed and developed. Also, the trade-off between optical and RCS performance, if any, to be evaluated.

Major Objectives
RCS reduction of curved optical window working in optical Band

Expected Deliverables
Curved optical window with RCS reduction solution

Probable Applications
light covers/ optical windows of UAVs

Low Observable Broadband (2 -18GHz) Air Intake duct

ADE

Research Vertical
Sensing, Stealth and Surface Protection Using Nano Materials and Meta Materials (SSSP)

Thrust Area
Multi-Spectral Stealth and Cloaking

Brief of the Research Problem
Air intake duct is one of the critical component which contributes significantly to frontal RCS of an aircraft. There is a requirement of broadband RCS reduction of aircraft. Technologies are available on band specific RCS reduction as on today. It has already been demonstrated. Also, multiband RCS reduction of air intake duct is demonstrated. The RCS reduction of air intake duct at lower frequencies are challenge in combination of RCS reductions at higher frequencies. In this work, optimal (minimum impact on weight due to RAS) air intake design to be carried out, followed by realization and RCS measurement of air intake duct. The CAD details of the air intake duct will be provided by ADE.

Major Objectives
Broad band RCS reduction of air intake duct of unmanned aircraft

Expected Deliverables
Low observable air intake working in 2-18GHz of frequencies

Probable Applications
Air intake duct of UCAV

Algorithms for Integrated Vehicle Health Management (IVHM)

ADE

Research Vertical
Aerospace Systems Design and Characterization (ASDC)

Thrust Area
Integrated Vehicle Health Management

Brief of the Research Problem
IVHM is used to monitor, diagnose, and prognosticate the health of UAV, and it also estimates the Remaining Useful Life (RUL). It incorporates sensors, data analytics, and software tools to detect, predict, and manage vehicle performance, maintenance needs, and failure risks.

Major Objectives
Algorithm development, data set generation, model training and testing for diagnostic and prognostic analysis of UAV systems, that includes airframe, environment control system, hydraulic system, landing gear system, fuel systems, Li-Ion battery, electronic systems, actuators and electrical systems.

Expected Deliverables
- Trained and tested algorithms and models, source code that performs diagnostic and prognostic analysis of UAV systems.
- Test report, analysis report

Probable Applications
Future UAVs

Figures of Merit

S No.	Parameter	Value
1	Accuracy of the model	>85 %

Terrain Aided Navigation System

ADE

Research Vertical
Artificial Intelligence and Autonomous Systems (AIAS)

Thrust Area
Sensor Processing for Autonomous Systems

Brief of the Research Problem
Terrain Aided Navigation (TAN) can be defined as technique for determination of the position location of an airborne vehicle with respect to terrain over which the vehicle is flying. TAN uses Barometer, Radio Altimeter, and referenced terrain data stored onboard. Onboard sensors observes terrain features in the vicinity of the vehicle. By comparing these features with the one stored in memory, the TAN algorithm constructs an estimated position and altitude error. In the event of GPS jammed/spoofed, Terrain Aided Navigation based position is used for updating a mid -course guidance system.

Major Objectives
- Design and Development of TAN Algorithm for localization of vehicle using Terrain contour.
- Optimization of a mission plan for maximization of TAN system output availability.

Expected Deliverables
- Detail Design, Model, Source Code of TAN algorithm.
- Analysis reports, Test results of TAN algorithm for various type of natural terrain.

Probable Applications
Cruise missile navigation in GPS denied environment

Scene Aided Navigation system

ADE

Research Vertical
Artificial Intelligence and Autonomous Systems (AIAS)

Thrust Area
Sensor Processing for Autonomous Systems

Brief of the Research Problem
Scene Aided Navigation (SAN) can be defined as a technique for estimate the position location of an airborne vehicle with respect to the imaged scene by EO (Visible & IR) camera. SAN system is loaded with processed satellite MAPS before flight. During flight, SAN takes a sequence of short-exposure frames from low altitude, nominally along nadir, with a video camera. Each frame are matched with on-board stored MAP to estimate sensor position. SAN based position can be used for updating a INS based guidance system in the event of GPS denied/spoofed.

Major Objectives
Design and Development of SAN Algorithm for localization of vehicle. Modelling and simulation for sensor configuration for SAN system for various air vehicles

Expected Deliverables
- Detail Design, Model, Source Code of SAN algorithm.
- Analysis reports, Test results of SAN algorithm for various type of various scene. SAN Sensor configurations for cruise missile, UAVs

Probable Applications
Cruise missile, UAV navigation in GPS denied environment

Comprehensive software code solution for Machine Learning based Data-Driven Structural Digital Twin for UAV applications

ADE

Research Vertical

Artificial Intelligence for Missile and Missile Defence (AIMMD)

Thrust Area

AI for Performance Analysis, Verify Design and Operations of Missiles

Brief of the Research Problem

- Modern UAVs increasingly demand lightweight and optimized wing structures. These wings experience complex aerodynamic loads during flight, making accurate prediction of structural response (such as strain, deformation, and internal stresses) critical for ensuring structural safety, improving performance, and enabling predictive maintenance. ADE is involved in structural design and development of various UAV airframes. As a design house, we constantly face the following issues in different phases of airframe development and design validation :
- Finite Element (FE) simulations offer high-fidelity insights during the detailed design phase, but are computationally intensive, time consuming and impractical for real-time or onboard applications.
- Moreover, only limited instrumentation (sparse sensors) is possible during real flight or test conditions. This constrains detailed direct monitoring of full field structural health at un-instrumented locations.
- The FE simulation predictions and the test results often have variations, for which model updating is required manually. This manual correlation is highly iterative and tedious task. To address these gaps, this project aims to develop a comprehensive Data-Driven Structural Digital Twin of a semi-span UAV wing, that can:
- Emulate the FE Solver behavior, mapping input loads to strain outputs
- Predict strain and deformation fields across the wing using sparse sensor data.
- Enable Virtual sensing at un-instrumented critical locations.
- Estimate applied loads from observed structural response (inverse modeling).
- Calibrate model fidelity using design of experiments and experimental test data, enabling proper Model matching with obtained test results

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Major Objectives

- Surrogate Modeling of Load-Deformation Relationship.
- Generate a high-fidelity dataset from FE simulations (e.g., using Abaqus or NASTRAN) under diverse loading conditions.
- Finalize a semi span wing structure sufficiently capturing critical parameters like joint stiffness, material property variation, etc.
- Generation of sufficiently high numbers of Linear static load cases.
- Carrying out FE simulations for all load cases and obtaining Solver agnostic output data as per requirement.
- Construct a data-driven surrogate model (e.g., neural networks or Gaussian process regression) to emulate the FE solver behavior, mapping input loads to strain/deformation outputs.
- Compare and validate the surrogate model results against FE Solver results for unseen load cases to ensure generalization. Virtual Sensing and Spatial Extrapolation.
- Use strain data from a limited number of physical sensors to estimate full-field strain and stress at un-instrumented locations using the surrogate model.
- Employ modal superposition and interpolation techniques for efficient spatial reconstruction. Inverse Load Estimation.
- Develop an inverse modeling framework using latent force models and Kalman filters to estimate applied loads from measured or inferred strain fields.
- Enable post-event diagnostics and load reconstruction using observed structural responses. Calibration via Design of Experiments (DoE) and Model matching with hardware testing
- Identify critical structural parameters (e.g., material properties, joint stiffness) that influence model accuracy.
- Use DoE techniques to generate simulation data across different parameter combinations.
- Train a meta-model to learn the influence of these variables and calibrate against experimental strain data.
- Validate the calibrated model using known test loads.

Expected Deliverables

- A trained and validated machine learning model that predicts strain/deformation for a range of loads. A real-time virtual sensing module that reconstructs full-field stress and strain from sparse sensors. An inverse load estimation algorithm for flight event reconstruction. Software tools with documentation and test case demonstrations.
- Hardware level Test plans and reports
- Detailed compiled Reports

Probable Applications

- Structural Health Monitoring with greater real-time insights like stress, fatigue, remaining useful life, etc.
- Development of virtual sensors and in turn facilitation of virtual testing.
- AI based matching of FE Model-Test model, leading to reduction of design iteration time and cost.

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- AI based novel design of airframe structures.
- AI based matching of FE Model-Test model, leading to reduction of design iteration time and cost.
- AI based novel design of airframe structures.

Figures of Merit

S No.	Parameter	Value
1	Weight class of the UAV, which the AI model can cater	Min 100Kg
2	Minimum number of sensors needed per unit surface area, to obtain full accurate field stress-strain data	Max 4/m^2
3	AI model-Test data-FE data max variation after final model matching	Within 5%

Advanced Fluid Structure Interaction Modelling, Simulation and Experimental Characterization of Internal Bay and Door for EUAV Airframe

ADE

Research Vertical
Aerospace Systems Design and Characterization (ASDC)

Thrust Area
Aero-Elastic, Aero-Thermo Elastics, Aero-Servo Elastic, Aero-Acoustic Studies

Brief of the Research Problem
The structural response of the internal store bay and the bay door coupled with fluid interaction needs to be established. Thus, a two-way Fluid Structure Interaction (FSI) study shall be performed to characterize the aerodynamic / aero-acoustic loading, coupled structural response, dynamic aeroelastic instabilities and acoustic noise levels of the store bay and its door. Suitable design modifications, as necessary, shall also be implemented based on the results of this study.

Major Objectives
- Estimation of the aerodynamic / aero-acoustic pressure distribution and the structural dynamic response for different store bay door conditions and load cases through FSI simulation.
- Experimental characterization of the internal bay and door through wind tunnel testing.
- Comparison of the FSI simulation results with rigid condition and with wind tunnel testing data.
- Recommendation & implementation of structural improvements and comparison / quantification of the improvements achieved.
- Recommendation & implementation of flow control devices, as required, and comparison / quantification of the improvements achieved.

Expected Deliverables
- Comprehensive Technical Documentation
- FSI Simulation Files: Pre-processing Files (Models), Workflow Scripts (for Coupling) and Analysis Result Files
- CAD Models / Files of the improved design (with structural improvements and flow control devices, if any)
- Wind Tunnel Models and Wind Tunnel Test Reports

Probable Applications
For Acoustic and Structural Design of Internal Cavities in Aircraft (Manned and Unmanned)

Figures of Merit

S No.	Parameter	Value
1	Simulation Accuracy Band	<= 5%

Composite Bulkhead for EUAV Airframe

ADE

Research Vertical
Advanced Aircraft Structure (AAS)

Thrust Area
Reconfigurable Aero Structures

Brief of the Research Problem
ADE is working on the design and development of an experimental UAV (EUAV). In order to reduce weight and maximize structural efficiency, it is necessary to design components made using composite material to replace their metallic counterparts. Thus, the aim of this proposal is to design and develop a composite bulkhead using carbon-fibre based composites (CFC). The designed composite bulkhead shall also be manufactured and validated through structural testing.

Major Objectives
- Design and Analysis of Composite Bulkhead
- Manufacturing and Non-Destructive Evaluation of Composite Bulkhead
- Validation of Composite Bulkhead through Structural testing

Expected Deliverables
- Comprehensive Technical Documentation
- CAD Models and Engineering Drawings of the Composite Bulkhead
- FE Simulation Files: Pre-processing (Meshing) Files and Analysis Result Files
- Structural Test Plan and Test Result & Validation Reports
- 3 Nos. of Composite Bulkhead

Probable Applications
Replacement of metallic bulkheads in airframe of Aircraft (Manned/Unmanned) for Weight Reduction and to meet Weight Target.

Figures of Merit

S No.	Parameter	Value
1	Weight Reduction	>= 15%

Disposal of Discarded High-Performance Fibers

CFEES

Research Vertical
Defence Waste Management (DWM)

Thrust Area
Bio Remediation / Chemical Treatment of Defence Waste

Brief of the Research Problem
High-performance fibers (HPFs) such as aramid (p-aramid, m-aramid), ultra-high molecular weight polyethylene (UHMWPE), and carbon fibers - are extensively used in aerospace, defense, automotive, and protective textiles due to their exceptional strength-to-weight ratios, chemical resistance, and thermal stability. However, end-of-life management of HPF-based composites and textiles poses a significant environmental challenge. These materials are difficult to degrade, thermally stable, and incompatible with conventional recycling or landfill disposal methods, leading to resource wastage and ecological burden. Current disposal practices - such as incineration or landfilling - are energy-intensive and environmentally unsustainable. There is an urgent need to develop sustainable, economically viable, and scalable disposal or recycling methods for HPFs to enable circular economy practices.

Major Objectives
To develop and evaluate eco-efficient and technically feasible strategies for the disposal, recycling, and recovery of discarded high-performance fibers, aimed at minimizing environmental impact while maximizing material value recovery.

Expected Deliverables
- Comprehensive database of degradation and recyclability characteristics of major HPFs.
- Optimized disposal/recycling protocols for each fiber type (e.g., solvent-based recovery, pyrolysis parameters).
- Comparative environmental and economic performance metrics versus existing disposal routes.
- Prototype demonstration of recycled HPF-based materials or composites.
- Technical guidelines for sustainable HPF waste management.

Probable Applications
- Defense and aerospace sectors for recycling obsolete composites and protective gear.
- Automotive industry for recovery of fibers from end-of-life components.
- Protective textiles for closed-loop recycling systems.

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Probable Applications

- Defense and aerospace sectors for recycling obsolete composites and protective gear.
- Automotive industry for recovery of fibers from end-of-life components.
- Protective textiles for closed-loop recycling systems.
- Sustainable materials engineering for upcycling HPF residues into high-value products.
- Policy and regulatory frameworks for waste management of high-performance materials.

Figures of Merit

S No.	Parameter	Value
1	Recycling efficiency	>80%
2	Energy consumption	< 5 MJ/kg
3	Carbon footprint reduction	> 50%
4	Recovered material strength retention	>70%
5	Cost effectiveness	>70%
6	Waste reduction	>90%

Fluorine free firefighting foam

CFEES

Research Vertical
Advanced Ballistics and Protection Technologies (ABSSP)

Thrust Area
Nanotechnology for Armour Material.

Brief of the Research Problem
To combat class B liquid fuel fires, aqueous film forming foams (AFFF) have been employed. These foams find use in the defence, i.e., army, navy and air force, and civil sectors. Conventionally, AFFFs contain fluorinated surfactants, i.e., per and poly-fluoroalkyl substances (PFAS) as the key ingredient responsible for the excellent firefighting performance of the fire fighting foams. However, since the last decade, the persistent, toxic and bio accumulative nature of the PFAS has been under the keen eye of the environmental researchers. Consequently, the government bodies across the world have imposed regulations on the use and production of these substances, restricting their use. The development of fluorine free fighting foam having fire extinguishing performance equivalent to the traditional AFFFs is need of the hour. The recent fluorine free foam available in the market are incompetent to match the firefighting efficacy of the AFFFs. They have poorer burn back resistance and drainage time. The critical technology/factors required for Fluorine Free Firefighting Foam is the development of suitable substitute of fluor surfactant having capability to reduce surface tension of water from 72 dyne/cm to ? 20 dyne/cm and fire extinguishing performance equivalent to AFFFs. The demand for the environmentally relevant fluorine free firefighting foams complying with the international standard US MIL-PRF-24385F (2023) having performance at par with the fluorinated AFFFs needs to be met as this is the necessity of the defence and civil sectors.

Major Objectives
To develop fluorine free firefighting foam complying with the international standard US MIL-PRF-24385F (2023).

Expected Deliverables
Know-how for formulations of Fluorine Free Foam

Probable Applications
Firefighting agent for Flammable liquid Fuel (Class B) Fire for defence application (Army, Navy & Air force).

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FPGA IP Core for Eigen Vector Decomposition and Singular Value Decomposition

DLRL

Technology Area
Electronic Warfare

Technology Category
Single Processing

Brief of the Research Problem
Super resolution algorithms for DOA Estimation like MUSIC , ESPRIT or their variants require Eigen Vector and Singular Value Decomposition of Data Covariance Matrix estimated using signal samples acquired from multiple antennas. In EW, each channel has to be processed in parallel and therefore there is a need for efficient FPGA IP Core for EVD and SVD. Number of Antennas could be 2, 5, 6 or 7. It is also expected that number of sources to be estimated in the IP Core using the computed Eigen Values making use of Information Theoretic Criteria like AIC and MDL.

Major Objectives
Development of FPGA IP Core for Eigen Vector Decomposition and Singular Value Decomposition capable of Real Time Performance.

Expected Deliverables
FPGA IP Core along with Profiling Results, Test Results, Technical Report and Computational Requirements for Xilinx Kintex Ultra scale, Intel Stratix 10 or Xilinx Versal Computation Engines.

Figures of Merit
Parameter: Time taken for Eigen Value Eigen Vector Decomposition.

Single Station Location Algorithm for HF DF using Azimuth Bearing, Elevation Bearing and Ionospheric Model Software

DLRL

Technology Area
Electronic Warfare

Technology Category
COMINT

Brief of the Research Problem
In High Frequency Direction Finding (HF DF) Stations, geolocation of distant HF transmitters need to be carried out using estimated Azimuth and Elevation bearings. The mode of propagation assumed is Ionospheric or Sky Wave. The Virtual Height of Ionospheric Layer that caused total internal reflection of Sky Wave signal is dependent on Location, Time of the Day, Season of the Year, Sun Spot Number, Frequency of Signal etc. Scope of Work is to identify and procure Ionospheric Model Software. Further use information like Frequency of Signal, Azimuth Bearing, Elevation Bearing and Virtual Height obtained using Ionospheric Model Software for estimating the geolocation of HF Transmitter.

Major Objectives
Development of Single Station Location Algorithm for HF DF using Azimuth Bearing, Elevation Bearing and Ionospheric Model Software.

Expected Deliverables
Ionospheric Model Software, Simulation Results with Profiling of Execution Time, Tool for test signal generation, Technical Report and Geolocation Algorithm Description along with Computational Requirements and Code.

Figures of Merit
Parameter: Accuracy of Single Station Location of HF Emitter.

Geolocation of Terrestrial Radio Emitters from RF Payloads on LEO Satellites

DLRL

Technology Area
Space Technologies

Technology Category
Electronic Warfare

Brief of the Research Problem
3D Hawk Eye from USA, is a "Data as a Service" Product, that is made recently available to subscribers for Situational Awareness through Space Based EW. It consists of constellations of satellites in Formation Flying in LEO & it is projected that with multiple constellations in multiple orbits, revisit time for surveillance of a given area of interest would be close to 15 minutes in the foreseeable future. Targets include AIS, ADS-B, Military Radio/Radars. Performance data with respect to geo location accuracies is not publically available in the open domain. Similar systems (Kleos etc.) are being commissioned by some other countries in Europe. Difference is number and geometry of satellites in Formation Flying. Some use three Satellites in Triangular Geometry whereas, others use four satellites in Rectangular Geometry. These systems work on the principle of Joint TDOA and FDOA and require precise Time/Frequency Synchronization across multiple satellites and multiple constellations. The spacecraft move at a speed of approximately 50 Kms/s. Knowledge of precise location of spacecraft's that carries these payloads with respect to a common frame of reference is mandatory apart from synchronization requirements listed above. The digitized IQ data of the signals received would have to be recorded when spacecraft is moving with area of interest in the field of view. The recorded data would have to be relayed back to Ground Control Station (GCS) when it is in field of view of the spacecraft's. All the signal detection and parameter estimation would have to be done on the ground to perform geolocation of the potential emitters. DLRL seeks solutions with Academic Institutions to develop and implement the Algorithms.

Major Objectives
Development of Practically Implementable Algorithms for Geolocation of Terrestrial Radio Emitters from RF Payloads on LEO Satellites that will be enabling technology for future Projects

Expected Deliverables
System Design Document specifying Satellite Geometry, Trajectory, Data Link Throughput, RF Payload Capabilities, Signal Processing Algorithms for Payload, Ground Station for Geolocation Computation along with Profiling of Execution Time, Simulation Results for Statistical Performance Evaluation, Tool for signal generation, Technical Report, Algorithm Description and Computational Requirements.

Figures of Merit
Parameter: Accuracy of Geolocation, Minimum number of Satellites.

Conduction cooled light weight electronics chassis for Man portable mountaineering

DLRL

Technology Area
Electronic Warfare

Technology Category
Thermal Management

Brief of the Research Problem
Four PC Boards (6U) each dissipating of 75W is placed vertically in 4 slot conduction cooled chassis for Man portable mountaineering. All the PCBs are plugged in to the horizontal mother board. The heat of the components will be transferred from PCB to chassis edge through wedge locks. Chassis edge temperature should be maintained at 71Deg C in the ambient of 55 DegC. The chassis may be designed with suitable innovative and advanced concepts in materials/cooling techniques. Constraints: i. Operational condition: -20 DegC to 55 DegC ii. Mechanical Weight of the chassis including cooling solution: ≤ 4 Kg iii. Noise level of the system at 1m distance: ≤ 50dB. iv. Size of the chassis with cooling system: 300 (W) X 300 (D) X 240 (H) mm. (Max.) v. Man portable for mountaineering Test details: Sl No. Test Specification Remarks 1 Physical inspection : Dimensional test 2 High temperature test: High Temperature test at 55 Deg C to be carried out with dummy heater loads and edge temperature to be measured. Duration: 4 hours 3 Random Vibration Frequency 20 Hz to 2000 Hz , PSD 0.02g²/Hz, Test Duration: 15 min in X & Y axes. Heaters will be ON during test

Major Objectives
To develop conduction cooled light weight electronics chassis which dissipate 300W and to maintain 71 Deg C at chassis edge temperature

Expected Deliverables
- Conduction cooled light weight electronics chassis (Hardware)
- Classical Design and simulation reports
- Functional test reports
- ESS reports (Test conditions are given at brief of the research problem) 1) a) Physical inspection report b) Random vibration test report c) High temperature test report

Figures of Merit

S no	Parameter	Value
1	Chassis edge temperature	<71Deg C
2	Chassis weight	≤ 4 Kg

Thermal management of microwave electronics module housed in Titanium Shell for underwater application

DLRL

Technology Area
Electronic Warfare

Technology Category
Thermal Management

Brief of the Research Problem
- Aim: To carryout thermal management of microwave electronics stack, packaged as conduction cooled chassis housed in the Titanium shell which dissipates 400W (PCB based modules). Card edge temperature of the modules to be maintained at 70 Deg C when the shell is exposed to 45 bar external hydrostatic pressure & 55 Deg C ambient temperature.
- Description: Antennas are mounted all around the Titanium shell. Structurally, Titanium shell should withstand 45 bar external hydrostatic pressure. There are 4 modules each dissipates 100W packaged in a enclosure and placed centrally in the Titanium shell. The Module edge temperature to be maintained at 70 Deg C in the ambient of 55 Deg C. This shell will be mounted on a submarine Mast for underwater application. Innovative cooling methods to be planned to maintain the inside electronic modules well within the safe temperature limits as the titanium shell is having low thermal conductivity. External effective conductive surface area of shell is limited due to placement of antennas and radomes.
- Constraints:

  i. System should work in -20 Deg C to 55 Deg C environmental conditions. ii. Noise level of the system should not cross 40 dB. iii. The maximum size of the Titanium shell is Ø 620 X 600 (H) mm X 10 (t) mm. iv. Shell is a sealed unit against 45 bar hydrostatic pressure.

Major Objectives
Development of ESS qualified Titanium shell hardware with cooling mechanism to transfer heat from the central core to the outer walls of the Titanium shell, maintaining required temperature at Card edges.

Expected Deliverables
- ESS qualified Titanium shell hardware with cooling mechanism
- Design & analysis report
- ESS reports

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Probable Applications

Underwater applications

Figures of Merit

S no	Parameter	Value
1	The Module edge temperature to be maintained in the ambient of 55 Deg C	70 Deg C

Solid State Batteries for portable systems

DLRL

Research Vertical
Energy Storage Device (ESD)

Thrust Area
Novel Battery Technologies

Brief of the Research Problem
Solid state batteries are emerging as better solution for energy storage as compared to lithium ion batteries presently available for portable systems. The solid state batteries are envisioned for light weight, higher power density and hence are suitable replaceable choice for presently available Li ion batteries.

Major Objectives
Realization of portable solid state batteries.

Expected Deliverables
Light weight hand held batteries.

Probable Applications
For portable EW systems.

Figures of Merit

S No.	Parameter	Value
1	Energy Density	500 Wh/

Broadband Blade Monopole antenna covering from 20 MHz to 2500 MHz

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
The antenna is to be housed inside a low loss Aerodynamically shaped Radome. Its envisage applications are in airborne platform where the metallic body of the aircraft will act as the ground plane of the Monopole Antenna.

Major Objectives
Design and Development of a Broadband Blade Monopole antenna covering from 20 MHz to 2500 MHz.

Expected Deliverables
7 Nos. of Broadband Blade Monopole antenna covering from 20 MHz to 2500 MHz. This must include Electrical and Environmental Stress Screening (ESS) test results.

Probable Applications
This antenna can be useful for Direction Finding and Monitoring applications of Airborne Electronic Warfare (EW) system.

Figures of Merit
Details will be shared with concerned PIs.

Log Periodic Monopole Array Antenna (LPMA), covering from 30 MHz to 512 MHz

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
LPMA covering 30-512 MHz can be used for Trans-Receive purpose in EW system. LPMA is to be mounted on a conductive ground plane of platform. The platform can be a vehicle roof / army tank / aircraft. Design approach to be carried out considering the trade-off between miniaturization and optimum antenna performance mounted on platforms.

Major Objectives
Design and Development of a Log Periodic Monopole Array Antenna (LPMA), covering from 30 MHz to 512 MHz.

Expected Deliverables
1 No. of Log Periodic Monopole Array Antenna (LPMA), covering from 30 MHz to 512 MHz. This must include Electrical and Environmental Stress Screening (ESS) test results.

Probable Applications
This antenna can be useful for Jamming applications of COMINT Electronic Warfare (EW) system.

Figures of Merit
Details will be shared with concerned PIs.

Broadband Blade Dipole Antenna covering from 20 MHz to 1500 MHz

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
The antenna is to be housed inside a low loss Radome. It is well suited for UAV based platform where the platform surface is made of non metal. It can also find applications in Ground based, Shipborne, Airborne and Submarine platforms where very broadband coverage is required. It provides stable radiation pattern over the entire band. The Antenna is sleek and compact as it does not require ground plane.

Major Objectives
Design and Development of Broadband Blade Dipole Antenna, 20-1500 MHz.

Expected Deliverables
7 Nos. of Broadband Blade Dipole antenna covering from 20 MHz to 2500 MHz. This must include Electrical and Environmental Stress Screening (ESS) test results.

Probable Applications
This antenna can be useful for Direction Finding and Monitoring applications of COMINT Electronic Warfare (EW) system.

Figures of Merit
Details will be shared with concerned PIs.

Miniature COMINT Active Antenna covering 20 MHz to 1000 MHz

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
The typical size of half wave dipole antenna to cover 20 MHz frequency is in the order of 7.5m (lambda/2) but the available space constraints on the Electronic Warfare platforms such as Airborne and Shipborne restrict it to mount on Platform. Miniaturizing of antenna without comprising its efficiency is the need for active antenna technology. Active Antenna is broadband electrically small antenna with small form factor, designed to meet the requirements of DF and Monitoring applications of a COMINT EW System.

Major Objectives
Design and Development of Miniature COMINT Active Antenna covering 20MHz to 1000 MHz.

Expected Deliverables
5 Nos. of Miniature COMINT Active Antenna covering 20MHz to 1000 MHz. This must include Electrical and Environmental Stress Screening (ESS) test results.

Probable Applications
This antenna can be useful for Direction Finding applications of Electronic Warfare (EW) system.

Figures of Merit
Details will be shared with concerned PIs.

Conformal Antenna DF Array (1-18 GHz)

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
i. To carry out design & Development of 1-18 GHz Conformal Antenna DF Array (consisting of eight elements)
ii. Antenna Array has to be conformed on missile radome (nose cone) to enhance the performance of Missile borne passive seeker.

Major Objectives
Design & Development of Conformal Antenna DF Array (1-18 GHz).

Expected Deliverables
1 No. of Electrical & ESS qualified Conformal Antenna DF Array (consisting of eight elements).

Probable Applications
For Missile borne passive seeker

Figures of Merit
Details will be shared with concerned PIs.

HF DF Loop Array Active Antenna covering from 1 to 30 MHz

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
The HF DF Loop Array Active Antenna covering 1-30MHz consists of two Loop antennas placed at an angular spacing of 90° with respect to their planes. These two Loops provide Sine and Cosine radiation patterns required for DF in Watson - Watt technique. Two crossed loops and a Monopole antenna are used to get omnidirectional radiation patterns for ambiguity resolution. The antenna with integrated LNA (Low Noise Amplifier) will provide better gain and will improve the DF system sensitivity. There will be an option to use the antenna system with or without LNA, based on available signal strength in the environment by provision of a RF switch. Both these antennas, loops and monopole are required to be designed in small form factors as conventional size of these antennas will be more owing to low frequency of operation.

Major Objectives
Design and Development of HF DF Loop Array Active Antenna covering from 1 to 30 MHz.

Expected Deliverables
6 Nos. of HF DF Loop Array Active Antenna covering from 1 to 30 MHz.

Probable Applications
This antenna can be useful for high accuracy HF Direction Finding applications of Electronic Warfare (EW) system.

Figures of Merit
Details will be shared with concerned PIs.

Integrated Stacked Biconical Antenna (0.5-40 GHz)

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
Design and development of Integrated Stacked Biconical Antenna (0.5-40 GHz). It is compact, ultra- broadband Antenna. It provides Omni coverage and Slant Linear Polarization which is most essential requirement of monitoring antenna..

Major Objectives
Design and development of Integrated Stacked Biconical Antenna (0.5-40 GHz). To be realized in two antenna configuration (0.5-2 & 2-40 or 0.5-18 & 18-40 GHz).

Expected Deliverables
5 Nos. (ESS Qualified)

Probable Applications
For monitoring of RF Signals.

Figures of Merit
Details will be shared with concerned PIs.

Polarisation Agile Sinuous antenna (0.5-2 GHz)

DLRL

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Advanced RF Antenna System

Brief of the Research Problem
The research problem is to design a Dual Polarized Sinuous Antenna working in the band of 0.5-2 GHz.

Major Objectives
The mentioned Antenna must be designed to receive all types of polarizations and meet the given specifications.

Expected Deliverables
ESS Qualified antennas

Probable Applications
Direction Finding

Figures of Merit
Details will be shared with concerned PIs.

Sectoral Horn BLI Array 18 - 40 GHz

DLRL

Research Vertical
Space Systems for Defence (SSD)

Thrust Area
Adoption of Technologies for Space Applications

Brief of the Research Problem
To Design and Develop Sectoral Horn BLI Array Antenna in 18 - 40 GHz frequency band using H-plane Sectoral Horn Antenna elements with polarizer embedded Radome arranged in a pre-defined inter-element spacings. The Array is to be covered with an overall thin wall radome.

Major Objectives
To Design and Develop Sectoral Horn BLI Array Antenna in 18 - 40 GHz frequency band using H-plane Sectoral Horn Antenna elements with polarizer embedded individual Radomes.

Expected Deliverables
Sectoral Horn BLI Array Antenna in 18 - 40 GHz frequency band, Qty: 02 nos.

Probable Applications
Direction Finding

Figures of Merit
Details will be shared with concerned PIs.

In-Channel Full Duplex Radio

DEAL

Technology Area
Communication

Technology Category
Wireless

Brief of the Research Problem
Design, development and testing of In-Band Full Duplex (IBFD) Radio in the frequency band, 225-400MHz, for technology demonstration. The IBFD radio will cater for self interference cancellation component at hardware as well as in software/waveform. One of the most challenging technologies, Self interference cancellation will be handled at three domains of the radio, namely:
a. Antenna Feed Network b. Analog Domain c. Digital Domain

Major Objectives
To design and develop Self Interference Cancellation (SIC) techniques for voice and data communication in the frequency band of 225-400MHz.

Expected Deliverables
- Self Interference Cancellation (SIC) techniques-

a. At antenna feed network, b. In analog domain, c. In digital domain
- Prototype hardware in 19 inch rack and 3U form factor with above SIC techniques.

Probable Applications
- Simultaneous transmission and reception at the same frequency to enhance the spectral efficiency.
- Support relaying at same frequency.
- To provide protection from interception while receiving mission critical commands.
- To intercept adversary communication while transmitting mission critical commands.

Figures of Merit

S no	Parameter	Value
1	Self Interference Cancellation at antenna feed network	45 dB
2	Self Interference Cancellation at analog domain	55 dB
3	Self Interference Cancellation at digital domain	40 dB

On-Chip Analog To Information Converter (AIC) for minimum 2GHz Bandwidth

DYSL CT

Research Vertical
Emerging RF Technologies for Application in Defence Communications (RFT)

Thrust Area
Development of On-Chip Analog To Information Converter (AIC) for minimum 2GHz Bandwidth

Brief of the Research Problem
Future radar/EW systems must handle multi-GHz bandwidth to detect small, fast, and low RCS targets. Conventional High Speed ADC's become power-prohibitive and data-heavy at this bandwidths, limiting true potential. Analog-to-Information Converter could provide sub-Nyquist sampling by exploiting sparsity in radar returns, dramatically reducing data rate and power without any compromise on system performance.

Major Objectives
- Develop on-chip Analog to Information Converter (AIC) capable of handling >= 2GHz signal bandwidth.
- Achieve sub-Nyquist sampling by leveraging sparsity in radar echoes, thereby reducing data rate, power requirement, and ADC speed.
- Demonstrate accurate signal reconstruction and target detection performance.

Expected Deliverables
- Circuit level simulation models
- On-Chip AIC Prototype design including schematics, timing constraints, and interface specification for CMOS implementation.
- Digital Reconstruction and Signal Processing pipeline
- Performance comparison reports

Probable Applications
- Compact Radars - low power, high resolution
- EW / Spectrum Monitoring Receivers - Wideband sensing and rapid signal classification
- UAV payload synthetic aperture radar

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Figures of Merit

S No.	Parameter	Value
1	Effective Input Bandwidth	>= 2GHz
2	Compression Ratio - Nyquist Sampling to Actual AIC sampling rate	> 25x
3	Reconstructed SNR	> 20 dB
4	Clock Jitter Tolerance (RMS Jitter)	<80-100 fs
5	Power Consumption (Frontend + ADC + DSP)	<10x
6	Latency of Reconstruction Pipeline	< few ms

Ultrahigh temperature ceramic matrix composites (UHTCMCs)

DMRL

Research Vertical
Ultra- High Temperature Materials for Hypersonic Applications (UHTM)

Thrust Area
UHTCMC (Carbon Fibre - Ceramic Matrix Composites)

Brief of the Research Problem
Ultra-high temperature ceramic matrix composites such as Cf-ZrB2, Cf-HfB2, Cf-TaB2, Cf-ZrC, Cf-HfC, Cf-TaC etc are next generation materials which are expected to withstand the temperatures above 1600°C. Very limited literature is available to develop these materials through CVI process. Even the thermodynamic data required to study reaction feasibility for formation of ZrB2, ZrC, HfB2, HfC, TaC and TaB2 are not available or available only up to limited temperature range. It is therefore required to fill the theoretical and technological gaps required to realize these advanced composites.

Major Objectives
- Determine thermodynamic properties of ZrCl4, HfCln (n: 1 to 4), TaCl5 by experimental methods or by theoretical calculations or by using both.
- Reaction feasibility studies for formation of ZrB2, ZrC, HfB2, HfC, TaC and TaB2 with varying temperatures and pressures (below atmospheric). Also study the effect of excess Hydrogen gas in the reaction.
- Study gaseous ZrCl4, HfCln (n: 1 to 4) and TaCl5 flow controllers at temperature above their respective boiling or sublimation points.

Expected Deliverables
- Thermodynamic properties ZrCl4, HfCln (n: 1 to 4) and TaCl5
- Reaction feasibility parameters
- Inputs for high temperature flow controllers

Probable Applications
This information is useful in design and development of CVI reactor for development of UHTCMCs.

Quality Function Deployment (QFD) Model for the Small Turbojet Engine for the Missile Application

GTRE

Technology Area
Aero Structures

Technology Category
Processing/Fabrication

Brief of the Research Problem
Develop a QFD model for the design and development of a turbojet engine for the missile application.

Major Objectives
- Develop a QFD matrix
- Prepare a full House of Quality
- Carry out competitive analysis
- Prepare a correlation matrix

Expected Deliverables
A full QFD report and Chart with House of Quality.

Radar Waveforms for Low Probability of Intercept (LPI) Radar

LRDE

Technology Area
Radar

Technology Category
LPI Radar

Brief of the Research Problem
Design, Development and Simulation of the waveforms for Pulse Doppler Radars, which are: 1. Difficult to detect/identify by Radar Warning Receiver (RWR) 2. Difficult to regenerate (by Jammer) in the battlefield i.e. random in nature (Ex: Noise or pseudorandom signals etc.) 3. Doppler tolerant in nature for detection and tracking of targets like Fighter Aircrafts, UAVs, Drones etc. (Max target speed up to 1000 m/s (> 03 Mach) 4. Waveform bandwidth can be up to 5/10 MHz 5. Minimum deterioration in radar's performance in comparison to conventional radar waveforms such as Frequency (LFM) / Phase (P4 codes) Modulation.

Major Objectives
- Identification and Simulation of LPI waveforms
- Simulation and Analysis of the identified LPI waveforms on the radar's performance with respect to the existing waveforms such as LFM and P4 codes
- Comparison of Receiver Operation Characteristics (ROCs) for various target characteristics and velocity

Expected Deliverables
Software programs (Example: MATLAB/ Octave/ any Open Source S/w codes) for generation, simulation and analysis of LPI waveform's coefficients

Figures of Merit

S no	Parameter	Value
1	Receiver Operating Characteristic (RoC) for various target characteristics (such as Swerling models) including target velocity	NA
2	Range Doppler Characteristics in comparison with existing waveforms	NA

Reception and analysis of IP traffic from VSAT and traffic from mobile satellite network

SAG

Research Vertical

Military Communication Technologies

Brief of the Research Problem

Under the scenario of multiple-band signals emanating from VSAT network and mobile satellite network, it is proposed to develop a platform which will cater L, S, C, X, Ku and Ka band satellite interception of existing and evolving protocols. After carrying identification; demodulation, decoding/ demultiplexing of TDM, SCPC, DVB etc would be done to get baseband signal in pcap format. Carrier-in-carrier protocol will also be included to be identified and demodulated in the scope of the project.

The pcap data will be analysed to extract IP packets in speech, text, webpage, e-mail for traffic reconstruction including SMS, geo-information, text from mobile satellite traffic. The inhouse developed tools for IP analysis and metadata analysis of encrypted traffic would also be utilized.

Further to stitch the in-bound and out-bound channels, analysing newer user data formats/ frames, an AI based solution is proposed which will integrate entire tools and help in enriching the analysis results into useful and actionable intelligence from the plain/ encrypted traffic.

Major Objectives

- Development of satellite communication signal reception system in L, S, C, X, Ku and Ka band form VSAT network as well as from mobile satellite network to get the baseband signal, subsequent to demodulation, decoding and demultiplexing.
- Development of AI based tools and techniques for reconstruction of voice, webpage, email from IP packets of VSAT; and voice SMS, geo-location information from mobile satellite traffic, including the metadata of encrypted signal.

Expected Deliverables

- Antenas covering L, S, C, X, Ku and Ka band and outdoor electronics units.
- RF swith-matrix, RF recorder, L-band tuner, RF signal digitizer, computer server, and software for demodulation and decoding.
- AI- driven tools and techniques for speech, text, webpage, email, reconstruction from IP traffic; and speech, text, SMS decoding from mobile satellite traffic. Tools for metadata analysis of encrypted traffic.

Probable Applications

Satellite communication signal analysis for user.

Figures of Merit

Reception of intelligence using protocol/ spectrum agnostic. Hardware/ Software tool and techniques.

Proximity Sensing Technology For Fuzes

TBRL

Brief of the Research Problem

The efficacy of the warhead/ ammunition would be greatly enhanced by detonating them at an optimum distance from the target wherein most of the energy generated will do useful destruction. The fuze is one of the critical parts of the ammunition which not only provide the initial safeties but detonates the ammunition at right time thereby enhancing its effectiveness against the intended target. An ideal fuze would detonate the ammunition at the most favorable position to inflict maximum damage to the target. In such cases the fuze senses its distance from the target and initiates the ammunition at an optimum distance set using proximity sensing technique. In such application the proximity sensor continuously senses its altitude from the ground and generates the firing command.

Requirement

The development of technologies for futuristic Electronic Safe & Arm fuzes for service ordinance and warheads. For the same, proximity module having specifications as given below needs to be developed.

Objective

The aim is to design and develop a proximity fuze to determine altitude. The system should effectively work in a fast moving platform.

The system should works on short ranges and low power since very limited power is available during flight and it should be as miniaturized as possible due to its application in space constrained environment.

Expected Deliverables

modular and easily integrated with the fuze

1. comply with mechanical/thermal constraints related to the gun firing environment and to the ballistic flight of projectile.
2. The module should have advance signal processing capabilities for exact height of burst measurement.
3. The developed module should be immune to jamming.
4. **Preparation of Test jig**: Portable and rugged field operable test jig to test the system on ground during environmental testing.

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Application

Proximity sensing technology is widely used in fuzes to improve the effectiveness of the ammunition.

The Challenge

1. Miniature and rugged/ hardened RF electronic circuits
2. Miniature patch antenna
3. Signal processing circuitry with high accuracy and fast processing capability
4. Radome (Fuze Nose cone)

Radome

the outstanding electrical mechanical and thermal characteristics.

Figure of Merit

S No.	Parameter	Value
1	Range (Height of Burst)	2m to 20m
	Accuracy	± 1m
2	Height of burst programmability	Required
3	Angle coverage	Upto 60° from vertical
4	Interference	Immune to Jamming
5	Operating time	≥ 25 secs
6	Shelf life	15 years
7	Output	TTL pulse on reaching HOB
8	Size	As per drawings provided below
9	Power requirement	6V/9V, 300mA max.
10	Target	Ground

Power sources for fuzing application

TBRL

Brief of the Research Problem

One of the critical technologies for the development of futuristic fuzing technologies for service ordnance and warheads is the power source. The minimum shelf life requirement of fuze is 15 years. Hence the power source to be developed should have at least 15 years shelf life and can withstand the environmental conditions the fuze has to undergo.

Major Objectives

Development two different type of power sources (Batteries) depending upon the end use.

Expected Deliverables

1. **Launch activated ampoule battery for artillery fuze**

   In case of fuze for artillery shells a passive/inert power source which can get activated only by launch environment is required. Artillery fuzes world over use launch activated ampoule battery for powering the fuze electronics. The broad specifications of the battery required is as given below;

Specification

S.No	Parameter	Requirement
1	Output voltage Open circuit voltage	 6V±1V @ 80mA load
2	Output current	Continuous 80mA Pulse current of 900mA for 2s at 80s,150s, 190s
3	Operational life	200s
4	Activation method Activation threshold Activation time	Gun launch 1500g or higher ≤ 0.5s
5	Operating temperature	-40°C to +71°C
6	Storage temperature	-55°C to +71°C
7	Shelf life	15 years or more
8	Maximum Size	Diameter : 35mm Height : 32mm
9	Electrochemistry	Li/SOCl2/ equivalent

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Long shelf life primary battery

Development of Long shelf life primary battery with following specifications:

Specification 1

S.No.	Parameter	Requirement
1	Open circuit voltage (OCV)	4.0V ± 0.5V
2	Close circuit voltage @ 0.25A load	3.7V ± 0.2V
3	Capacity	≥75mAh
4	Output current	Continuous 40mA Pulse current of 500mA for 50ms
5	Cell Impedance	≤ 300mΩ
6	Operating temperature	-40°C to +71°C
7	Shelf life	15 years or better
8	Maximum Size	Diameter : 15mm Length : 20mm
9	Electrochemistry	Lithium based

Specification 2

S.No.	Parameter	Requirement
1	Open circuit voltage (OCV)	7.8V ± 0.3V (May be 2 cells in series in a single pack)
2	Close circuit voltage @ 0.25A load	≥7.0V
3	Capacity	≥ 200mAh
4	Output current	Continuous 100mA Pulse current of 1 A for 3s
5	Cell Impedance	≤ 300mΩ
6	Operating temperature	-40°C to +70°C
7	Shelf life	15 years or better
8	Maximum Size	Diameter : 15mm Length : 35mm
9	Electrochemistry	Lithium based

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