Technical Note on Overrun-Type Deperming Facility for Indian Navy - NUWR, Goa

By: Geomarine Dynamics India Pvt. Ltd.

Executive Summary

This technical note presents the indigenous development feasibility proposal for an Overrun-Type Deperming Facility (ODMR) for the Indian Navy at Naval Underwater Ranges (NUWR), Goa. The facility represents a critical advancement in naval stealth technology, enabling rapid and efficient magnetic signature reduction for various classes of naval vessels without requiring docking or physical cable wrapping procedures.

Background

This document responds to the official communication received via fax from Naval Underwater Ranges (NUWR), Goa, regarding the indigenous development of an Overrun Type Deperming Facility (ODMR).
Geomarine Dynamics India Pvt. Ltd. is pleased to provide comprehensive technical inputs supporting this strategic initiative, which aligns with the Indian Navy's objectives of advancing self-reliant and mission-critical maritime infrastructure under the Atmanirbhar Bharat and Make-in-India initiatives.

Strategic Importance

The development of indigenous deperming capabilities is crucial for:

- **Operational Security**: Reducing magnetic signatures enhances stealth capabilities
- **Strategic Autonomy**: Reducing dependence on foreign technology for critical naval operations
- **Cost Effectiveness**: Long-term operational savings compared to traditional docking methods
- **Mission Readiness**: Faster turnaround times for naval vessels
- **Technology Transfer**: Building indigenous expertise in specialized naval technologies

Magnetic Signature and Naval Warfare Context

Understanding Magnetic Signatures

Naval vessels, particularly those with steel hulls, develop permanent magnetic signatures due to:

- **Construction Process**: Welding and fabrication in Earth's magnetic field
- **Operational History**: Repeated exposure to varying magnetic fields during operations
- **Environmental Factors**: Earth's magnetic field variations at different geographical locations
- **Material Properties**: Ferromagnetic materials in hull construction

Threat Assessment

Modern naval threats include:

- **Magnetic Mines**: Triggered by vessel magnetic signatures
- **Magnetic Anomaly Detection (MAD)**: Used by anti-submarine warfare systems
- **Underwater Sensors**: Capable of detecting magnetic field disturbances
- **Submarine Detection**: Surface vessels' magnetic signatures can compromise submarine operations

Working Principle of Overrun-Type Deperming Facility

An Overrun-Type Deperming Facility is designed to reduce or neutralize the permanent magnetism of steel-hulled naval vessels by allowing them to slowly traverse a specially designed seabed-laid electromagnetic coil array. This method eliminates the need for vessel mooring or physical cable wrapping.

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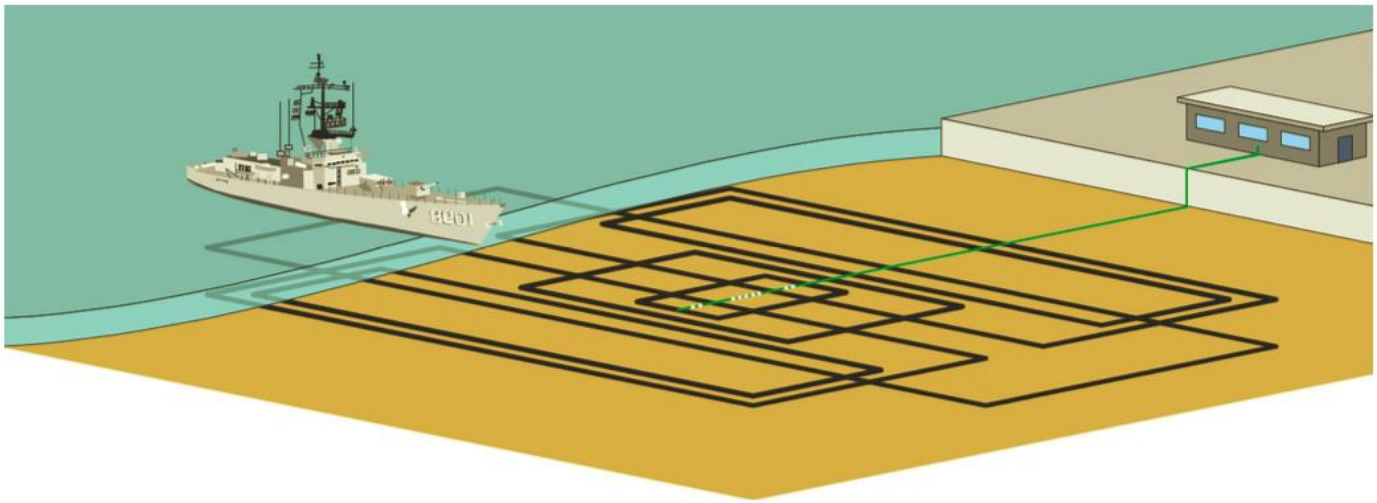

Figure: Typical Layout of an Overrun-Type Deperming Facility

Operating Mechanism

Phase 1: Approach and Positioning

- Vessel approaches the facility at predetermined speed (typically 2-4 knots)
- DGPS guidance system provides precise navigation coordinates
- Pre-deperming magnetic signature measurement using seabed magnetometer arrays

Phase 2: Compensation Field Application

- Vertical and horizontal compensation coils activate to cancel local geomagnetic field
- Real-time field strength monitoring ensures optimal cancellation
- Ship's magnetic field is temporarily isolated from Earth's magnetic influence

Phase 3: Working Field Application

- High-intensity alternating electromagnetic field applied via working coils
- Frequency typically ranges from 0.1 to 10 Hz (Extremely Low Frequency - ELF)
- Field strength gradually increases as vessel approaches coil center

Phase 4: Deperming Process

- Strong alternating field randomizes magnetic domains in ship's hull
- Controlled field gradient ensures uniform treatment across vessel length
- Process duration depends on vessel size and speed (typically 10-15 minutes)

Phase 5: Field Attenuation and Stabilization

- As vessel moves away from field center, field strength gradually decreases
- Magnetic domains stabilize in randomized state
- Post-deperming signature measurement confirms effectiveness

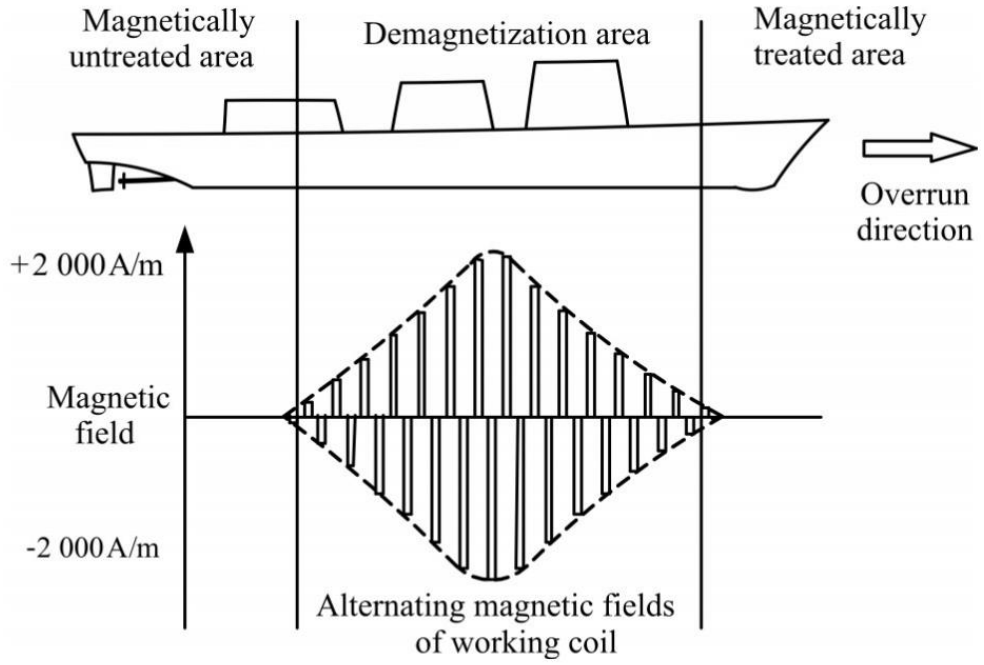

Figure: Distribution of the magnetic fields from the working coils

Figure: Typical deperming process

Technical Advantages

- **Continuous Operation**: No need to stop or dock the vessel
- **Uniform Treatment**: Entire hull receives consistent magnetic treatment
- **Scalability**: Effective for various vessel classes from patrol boats to aircraft carriers
- **Weather Independence**: Underwater installation unaffected by surface conditions

Technology Involved

1. Underwater Coil System (Seabed-Laid)

The underwater coil system represents the core technology component:

Coil Type	Function	Typical Field Strength	Power Requirements
Vertical Compensation Coils	Cancel Earth's vertical geomagnetic component	~80 A/m (DC)	500-800 kW
Horizontal Compensation Coils	Cancel horizontal geomagnetic field	~40 A/m (DC)	300-500 kW
Working Coil	Produces alternating deperming field	>2000 A/m (ELF AC)	2-5 MW

**Note: The values are subjected to changed based on the requirements, site conditions, etc.*

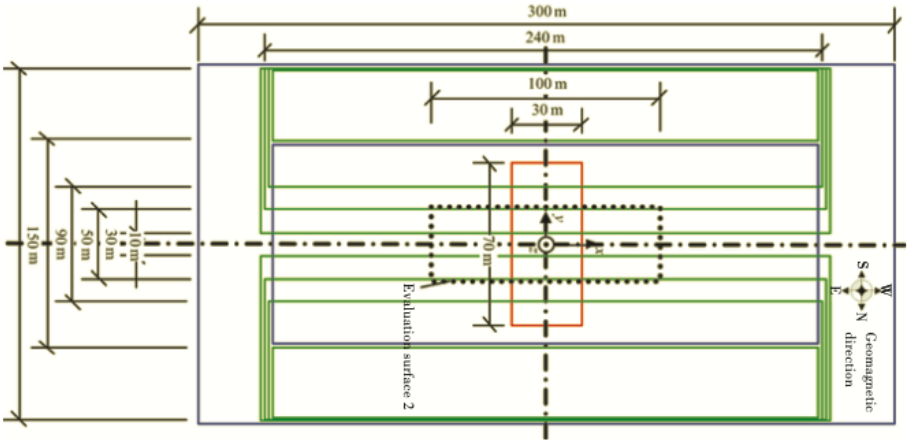

Figure: Coil Types and Layout

Coil Construction Specifications

- **Conductor Material**: Marine-grade with specialized insulation
- **Coil Diameter**: Suitable for optimal current carrying capacity
- **Insulation Rating**: Minimum 11 kV, suitable for submarine environment
- **Corrosion Protection**: Sacrificial anodes and cathodic protection systems
- **Installation Method**: Trenched burial or weighted placement with concrete mattresses

2. Shore-Based Power and Control Systems

Power Generation and Distribution

- **Primary Power**: 11 kV grid connection with redundant supply
- **Power Conditioning**: Variable frequency drives for AC systems
- **DC Power Systems**: Programmable DC power supply systems
- **Harmonic Filtering**: Power quality management systems
- **Emergency Backup**: Diesel generators for critical systems

Control Systems Architecture

- **Distributed Control System (DCS)**: Real-time process control
- **DAQ Server:** Central control for acquisition, synchronization, and relay
- **Custom Software:** For magnetic signature measurement, analysis and predictions along with control software for determining of the deperming treatment currents and controlling of power supplies
- **Database Server:** To store vessel ID, signature logs, pre/post deperming values, etc.

- **Human-Machine Interface (HMI)**: Operator workstations with graphical displays
- **Safety Interlocks**: Multiple redundant safety systems
- **Remote Monitoring**: Satellite/cellular communication for off-site monitoring

3. Magnetic Measurement Systems
Seabed Magnetometer Arrays

- **Sensor Type**: Fluxgate magnetometers with 0.1 nT resolution
- **Sampling Rate**: 100 Hz for dynamic signature capture
- **Data Transmission**: Underwater hybrid cable

Other Sensors

- **Current Sensors:** Onshore & inline current sensors for real-time monitoring
- **Environmental Sensors:** In-water & onshore to monitor temp, salinity, current, tidal variation for correctional factors

Ship Positioning and Navigation

- **DGPS Accuracy**: ±1 meter horizontal, ±2 meter vertical
- **Heading Control**: Gyrocompass integration for precise alignment
- **Speed Monitoring**: Doppler log or GPS-based velocity measurement
- **Communication**: VHF radio link between vessel and control station

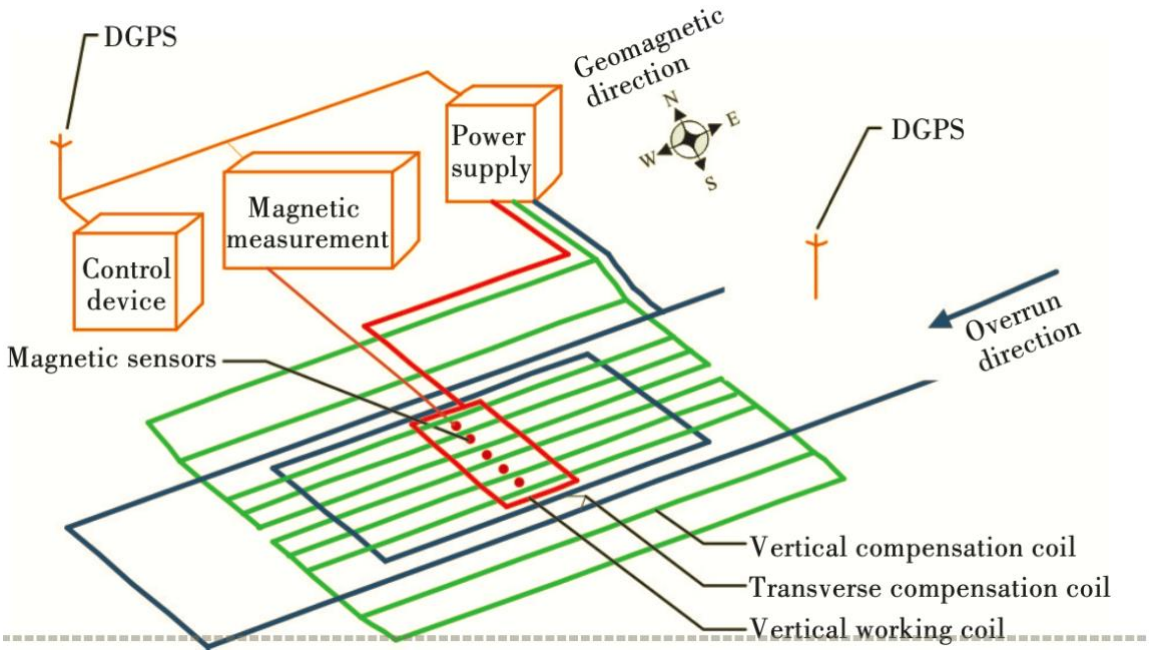

Figure: Overall system architecture

Site Selection and Environmental Considerations

Required Site Conditions
1. Seabed Conditions

- **Topography**: Flat or gently sloping seabed with maximum 2% gradient
- **Depth**: Optimal range 15-25 meters (compromise between accessibility and effectiveness)
- **Sediment Type**: Stable sandy or muddy bottom suitable for coil installation
- **Geological Stability**: Absence of active seismic zones or erosion patterns

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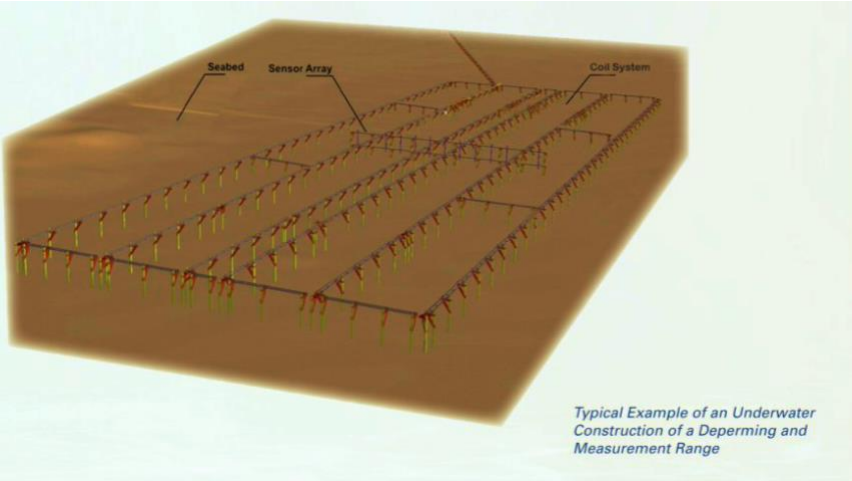

Figure: Typical seabed conditions and layout

2. Channel Dimensions and Layout

- **Coil Array Dimensions**: 300m (E-W) × 150m (N-S) minimum
- **Navigation Channel**: 50m width with 10m safety margins
- **Approach/Departure Zones**: 500m straight sections for vessel alignment
- **Turning Circles**: Adequate space for largest anticipated vessels

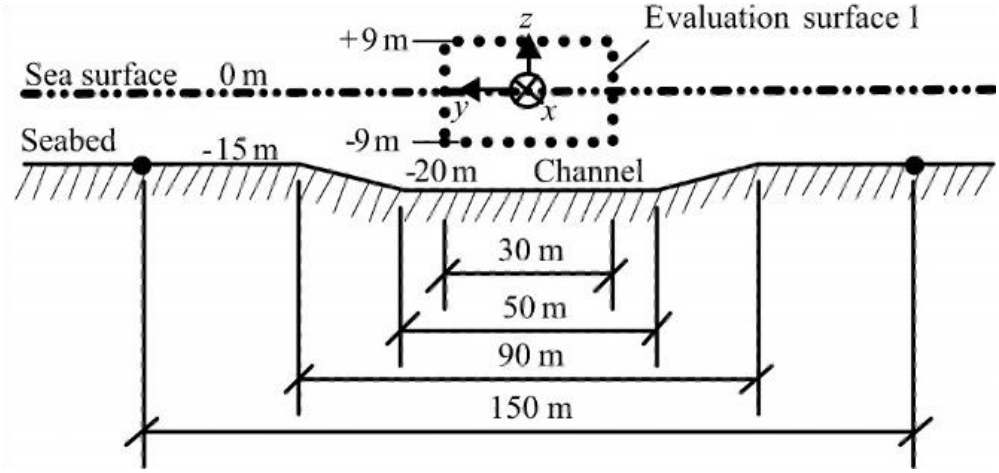

Figure: Channel dimensions and layout

3. Magnetic Environment

- **Geomagnetic Orientation**: Alignment with magnetic east-west direction
- **Magnetic Declination**: Account for local variation from true north
- **Magnetic Anomalies**: Avoid areas with natural magnetic disturbances
- **Baseline Measurements**: Comprehensive magnetic survey before installation

4. Environmental Factors

- **Tidal Range**: Consider impact on coil depth and vessel clearance
- **Current Patterns**: Evaluate effects on vessel control and coil stability
- **Wave Climate**: Assess impact on surface operations and underwater infrastructure
- **Seasonal Variations**: Account for monsoon and cyclonic weather patterns

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Site Assessment Methodology

Phase 1: Desktop Study

- Historical oceanographic data analysis
- Geological and geophysical survey review
- Environmental impact preliminary assessment
- Shipping traffic pattern analysis

Phase 2: Field Survey

- Multibeam bathymetric survey
- Side-scan sonar mapping
- Sub-bottom profiling for geological assessment
- Magnetic gradiometry survey
- Oceanographic measurements (currents, tides, waves)

Infrastructure Requirements

A. Underwater Coil Array

Design Specifications

- **Coil Configuration**: Multi-loop concentric design
- **Material Standards**: Marine-grade conductor standards
- **Installation Method**: Remotely operated vehicle (ROV) and USBL assisted placement
- **Protection Systems**: Concrete mattresses, rock berms, or trench burial
- **Monitoring Systems**: Continuous structural health monitoring

Design tools

Use a Field Modeling Software for:

- **Finite Element Analysis**: 3D electromagnetic field simulation
- **Coil Optimization**: Iterative design refinement algorithms
- **Vessel Modeling**: Different ship class magnetic signature databases
- **Environmental Modeling**: Geomagnetic field variation effects

Installation Challenges and Solutions

- **Precision Placement**: GPS-guided and USBL-guided installation vessels
- **Cable Management**: Specialized cable laying equipment
- **Coil Calibration**: Individual coil response characterization
- **System Integration Testing**: End-to-end performance validation
- **Quality Assurance**: Underwater inspection and testing protocols

B. Shore-Based Power Station

Facility Design

- **Building Footprint**: 1000 m² control building plus 500 m² transformer yard
- **Electromagnetic Shielding**: Faraday cage construction for sensitive equipment
- **Environmental Controls**: HVAC systems for equipment cooling
- **Security Systems**: Perimeter protection and access control

Power Systems

- **Grid Connection**: 11 kV substation with redundant feeders
- **Power Conditioning**: Harmonic filters and power factor correction
- **Control Systems**: Distributed control architecture with redundancy
- **Emergency Systems**: UPS and backup generator systems

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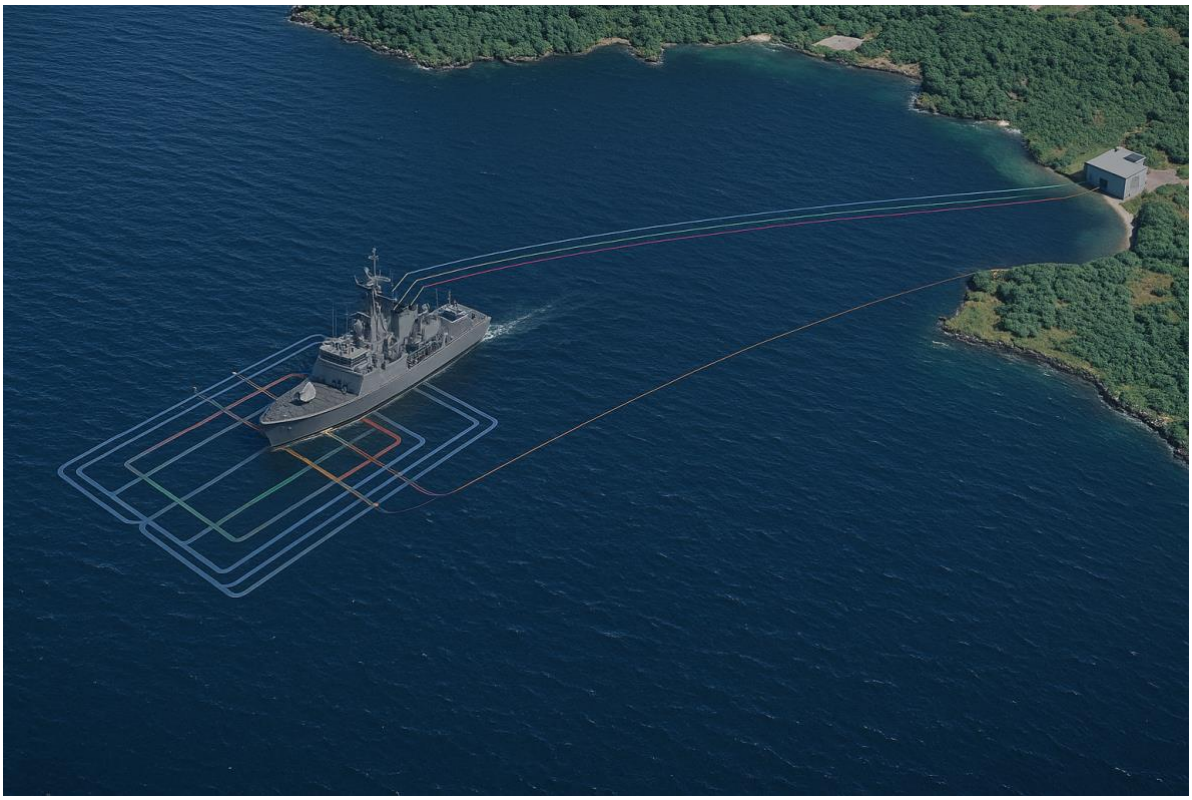
Conclusion

The development of an indigenous Overrun-Type Deperming Facility represents a strategic investment in India's naval capabilities and technological sovereignty. This facility will provide the Indian Navy with:

- **Enhanced Operational Capability**: Reduced magnetic signatures improve stealth and survivability
- **Strategic Independence**: Reduced dependence on foreign technology for critical naval operations
- **Operational Efficiency**: Faster processing times and reduced vessel downtime
- **Technological Advancement**: Indigenous capability development in specialized naval technologies
- **Economic Benefits**: Long-term cost savings and potential export opportunities



Mock-up Image: Overrun Deperming Station

The successful implementation of this project will establish India as a leader in naval electromagnetic systems technology while supporting the broader objectives of Atmanirbhar Bharat and Make-in-India initiatives.

NOTE: This technical note represents the preliminary assessment and recommendations of Geomarine Dynamics India Pvt. Ltd. for the indigenous development of an Overrun-Type Deperming Facility. Further detailed studies and consultations by the Indian Navy will be required to finalize the specific requirements and implementation approach.

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