

NAVAL SCIENCE AND TECHNOLOGICAL LABORATORY



SYSTEMS, TECHNOLOGIES & SERVICES

TO ACHIEVE SELF RELIANCE IN CUTTING EDGE NAVAL TECHNOLOGIES



WEAPONS

HYDRODYNAMIC RESEARCH

WARSHIP TECHNOLOGIES



VISION

TO BE CENTRE OF EXCELLENCE IN

TORPEDOES, DECOYS AND UNDERWATER MINES WITH COMPETITIVE AND CUTTING EDGE TECHNOLOGIES

HYDRODYNAMICS WITH EXPERTISE FOR SUPPORTING INDIGENOUS DESIGN OF MARINE VEHICLES AND PROVIDE COMPREHENSIVE TEST FACILITIES

STEALTH TECHNOLOGY FOR NAVAL PLATFORMS

MISSION

DESIGN, DEVELOPMENT AND EVALUATION LEADING TO PRODUCTION OF TORPEDOES, MINES, TARGETS, DECOYS, FIRE CONTROL SYSTEMS AND INDUCTION INTO SERVICES AND ESTABLISH TEST FACILITIES FOR THE SAME

ESTABLISH WORLD CLASS HYDRODYNAMIC TEST FACILITIES FOR EVOLVING DESIGN CRITERIA THROUGH MODEL TESTS FOR SURFACE AND SUB-SURFACE VEHICLES AND TORPEDOES

DEVELOP STRUCTURAL DESIGN CAPABILITIES AND MATERIALS FOR MITIGATION OF RADAR, INFRARED, MAGNETIC, ACOUSTIC AND ELECTRIC SIGNATURES LEADING TO STEALTHIER PLATFORMS

CHARTER

DESIGN AND DEVELOPMENT OF ADVANCED UNDERWATER WEAPONS, COUNTERMEASURES AND FIRE CONTROL SYSTEMS.

DESIGN AND DEVELOPMENT OF ADVANCED AUTONOMOUS MARINE AND UNDERWATER VEHICLES.

RESEARCH & DEVELOPMENT IN SHIP DESIGN AND SHIP BUILDING TECHNOLOGIES, STEALTH, HYDRODYNAMICS AND MARINE PROPULSION TECHNOLOGIES



MARINE
PROPELLERS

COMPUTATIONAL
FLUID DYNAMICS

HULL FORM
DEVELOPMENT

PERFORMANCE
PREDICTION

NAVAL STEALTH
TECHNOLOGIES

ENVIRONMENTAL
TESTING



SHOCK, NOISE
AND VIBRATION

PROPULSION SYSTEM
INTEGRATION

“NSTL OFFERS DESIGN SUPPORT & EVALUATION SERVICES
FOR NAVAL SYSTEMS”

ABOUT NSTL – EXPERTISE AND CAPABILITIES

NSTL is a premier laboratory of DRDO under the cluster of Naval Systems & Materials. The laboratory is equipped with several world class facilities /infrastructures and also has expertise with immense domain knowledge in the areas of underwater systems design, development, critical studies, testing, evaluation and providing expert solutions in similar areas of technologies and applications.

The laboratory is equipped with facilities for evaluation of data required for sea surface and underwater platforms, viz. studies on hydrodynamic and hydro-ballistic and cavitation parameters for warship & submerged vehicles, hydrofoil boats and underwater missiles.

Further, over a period of time NSTL has also pioneered in Stealth systems and technologies. NSTL also extends it's technical consultancy on stealth technologies to Indian Industries apart from Indian Navy which includes Infrared Signature Suppression (IRSS) , underwater magnetic signature assessment and threat analysis, design and evaluation of degaussing systems and mitigation, underwater electric field measurement and threat assessment, simulation of electric signature for varying hull conditions, Radar cross section (RCS) evaluation and mitigation.



TEST FACILITIES OPEN TO DEFENCE INDUSTRY TO REAP BENEFIT
TO COUNTRY
IN NAVAL SHIP BUILDING AND WAR-FIGHTING CAPABILITY



INNOVATIVE DESIGN SUPPORT AND
EVALUATION SERVICES FOR SELF-
RELIANCE

Further more, NSTL has the expertise to support specific PSI activities. Propulsion System Integration (PSI) is a concept that is widely used by navies around the world. In most cases, the propulsion components (Main engine, Gearbox, shafting, propeller and control system) are picked up from different suppliers. Hence in order to optimize on costs, PSI becomes very significant. The main function of PSI is to understand needs of the client, look at OEM deliverables, identify gaps, verify data for integration and make sure that the final system is as envisaged by the client with active involvement of all stakeholders.

In addition, NSTL has also equipped with unique ENTEST(Environmental Test) Facility meeting world class standards/specifications for testing and qualification of systems/subsystems suitable to be used for defence applications or any other applications which are complex and critical in nature. NSTL ENTEST facility has Shock test with varying capacities, vibration test, climatic chambers for thermal cycling and EMI/EMC chambers.

NSTL has Anechoic chamber which is designed to simulate free field environment where there are no reflecting boundaries. It is designed to create very low noise environment and free from excessive variation of temperature and humidity. It is equipped with low noise high sensitive microphones, intensity probe, five degrees of freedom robotic sensor positioning system and analyzer loaded with advanced noise analysis software. This facility is used for measurement of sound power level, Intensity mapping, directivity of sound sources & receivers.

NSTL has also established Reverberation room which is designed to create a highly diffused sound field environment. The chamber is used to characterize acoustic machines, transmission loss of partitions, Random incidence absorption coefficient of materials, Sound power output of noise sources.

HULL FORM DEVELOPMENT & MARINE PROPELLERS

Hull forms



Planing Hull



Hydrofoil Craft



EPH



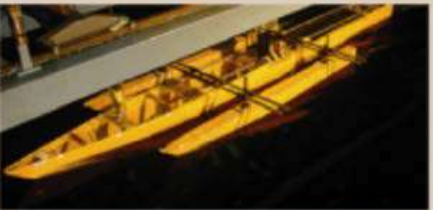
Planing Catamaran



SEACAT



FOILCAT



Trimaran corvette with waterjet propulsion



Delta hull form with podded propulsion



NSTL has capabilities for studies and tests underwater for space capsules, aeroplane structures, parachutes, underwater escape suits, sonars, pumps, pipes and lot more. It has tested more than 400 models since its inception for Navy and other major Government and Private agencies. The Lab is actively involved in Design & Development of hull forms and propellers catering to various functional and operative requirements of Navy and Shipyards. Various advanced hull forms, propellers and other performance enhancing devices have been developed by NSTL by utilising advanced Research, Test & Evaluation facilities

Propellers



Contrarotating Propeller



Surface Piercing Propeller



Super Cavitating Propeller



Pump Jet Propulsor



Water Jet Propulsor

“NSTL offers Consultancy to Shipyards in designing Advanced Hull Forms and Propellers”

COMPUTATIONAL FLUID DYNAMICS

"A State-of-the art Computational Fluid Dynamic simulation facility and capability exists with NSTL to undertake Quality product development and augment the solution oriented experimental approach.

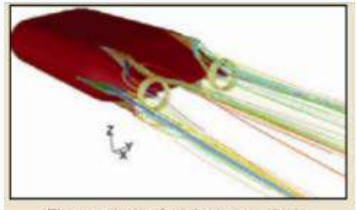
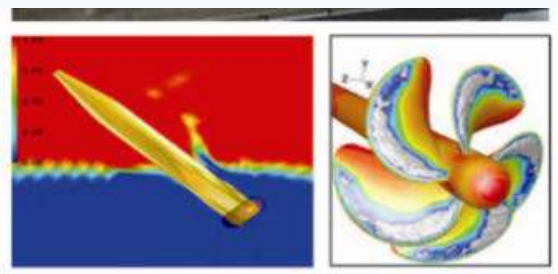


Seakeeping Analysis of a Frigate



CHARACTERISTICS

- Drag & Forces Estimation
- Propulsion Characteristic Estimation
- Seakeeping and Manoeuvring Studies
- Cavitation Studies
- Study of the effect of Environmental Factors on vehicle performance
- Flow Visualization Studies

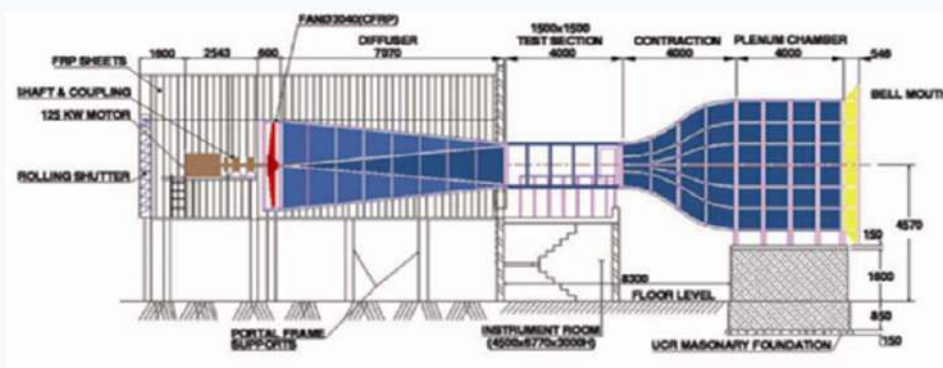


Flow analysis of underwater vehicle

LOW SPEED OPEN CIRCUIT WIND TUNNEL

Wind Tunnel Facility equipped with advanced Data Acquisition and velocity probes is utilized to estimate drag and vehicle-propulsor interaction thereby aiding NSTL to predict and optimize the performance of high speed marine crafts

Test Section	: 1.5 m x 1.5 m x 4.0 m
Plenum chamber	: 4.3 m x 4.3 m x 4.0 m
Contraction	: Section varying from 4.3m x 4.3 m to 1.5m x 1.5m
Diffuser	: Section varying from 1.5 m x 1.5 m Square to Ø 3.048 m
DC motor	: 125 Kw, 750 rpm max
Tunnel Fan	: 12 bladed with Maximum speed at Test section: 55 m/sec



"PERFORMANCE PREDICTION & SOLUTION ORIENTED APPROACH FOR NOVEL HYDRODYNAMIC PROBLEMS CARRIED OUT BY NSTL"

PERFORMANCE PREDICTION – CAVITATION TUNNEL

“A Closed Circuit Variable Speed Variable Pressure Cavitation Tunnel to predict cavitation and hydro-acoustic performance characteristics of submerged bodies and propellers exists with NSTL to cater for all needs of Naval weapons and platforms”



Facility Constructed in Vertical Plane

Closed Circulating



SPECIFICATIONS:

- Closed Circuit Tunnel
- Test Section: 1 m x 1m x 6m long
- Flow Speed: 15 M/s
- Pressure Range: 0.1-3.0 Kg/cm²
- Cavitation number: 0.08-37
- Turbulence Level: <0.5%
- Background Noise: <90 db
- Tunnel Material : SS

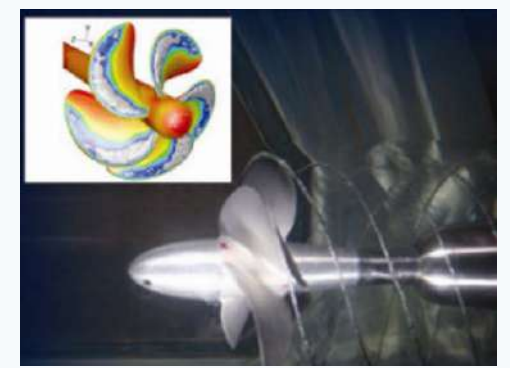
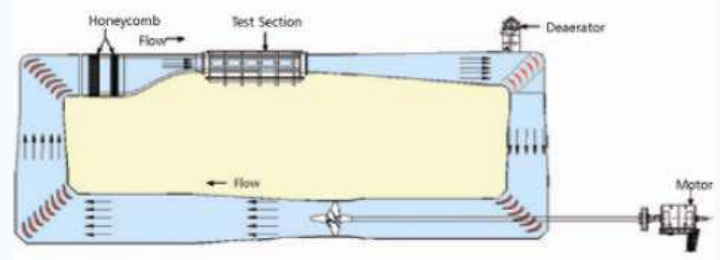
OTHER FEATURES:

- Acoustic Trough : 5.2 m length
- Aeration and De-aeration
- Fine Filtering
- Stroboscopy and Videography
- Models/Dynamometers mounted on removable test section cover

Variable Speed/Variable Pressure Type with Automatic Control System

Data Acquisition and Analysis System(DAAS) for operation, control and conduct of tests

Acoustic measurement system for Acoustic data acquisition, analysis and extrapolation



PERFORMANCE PREDICTION – HIGH SPEED TOWING TANK

NSTL has setup High Speed Towing Tank(HSTT), the longest hydrodynamic facility in India to undertake model testing of various submerged bodies and predict the performance parameters in a controlled conditions. With in-house model manufacturing facilities and state-of-the-art instrumentation and motion mechanism facilities fitted, HSTT has contributed to hydrodynamic designs for development of various Naval weapon and platform hydrodynamic designs.

- Towing tank Dimensions: 500 m long, 8 m wide and 8 m deep
- Maximum Towing Speed is 20 m/s in forward motion and 4 m/s in astern condition with an accuracy of 0.1% of the set speed between 2-20 m/s

“COMPLETE HYDRODYNAMIC PERFORMANCE EVALUATION SERVICES ALONG WITH VALIDATION BY FULL SCALE TRIALS CAN BE UNDERTAKEN BY NSTL”

TESTING CAPABILITIES

CALM WATER POWERING TESTS

Resistance tests : To Predict bare and appended hull resistance

Flow Visualisation Tests: to visualize the flow ad streamline on hull surface and check the alignment of appendages to flow(neutral angle orientation)

Propeller Open Water tests: to validate propeller characteristics in the absence of hull form and for prediction of thrust, torque and efficiency

Self-propulsion tests: Fully Appended ship model is fitted with propulsion machinery to predict delivered power and number of revolutions required.

Wave survey: To measure the inflow to propeller, prediction of 3D velocity components and estimation of nominal wake

CAPTIVE MANOEUVRING TESTS

- Manoeuvring and Control Characteristics of Hull form : for assessing dynamic stability and controllability and for simulating the trajectory

- Towed body tests to assess the towing and mooring dynamics, estimation of catenary behavior and cable loads of towed body systems

- Foil system tests to assess the lift drag and torque performance of variety of foil systems.



PERFORMANCE PREDICTION- SEAKEEPING AND MANOEUVRING BASIN

“A State-of-the-art facility equipped with wave pattern simulators and advanced instrumentation setup to carry out model testing of submerged bodies to validate the efficacy of hydrodynamic and control surface design”

Model Testing Capabilities

- Motion measurements in regular waves
- Seakeeping experiments in irregular and random seas for head, following and oblique seas at various speeds and sea-states
- Loss of speed in waves
- Rolling characteristics at various speeds and headings
- Turning circle trials with propulsion
- Free running manoeuvring trials
- Broaching of ship in following and quartering seas
- Dynamics of towed and moored vessels under the action of waves
- Studies on dynamically positioned vehicles under the action of waves



Model Tracking Systems (MTS)

MTS is an optical tracking system to track the ship model in free sailing mode. The optical tracking system cameras are mounted above the ship model attached to a rigid frame mounted on the sway carriage. The positional output signal of the optical system will be used for data logging purposes in conjunction with the carriage position to determine the position of the model with reference to the tank fixed co-ordinate system.

Wave Generation System



A multi-segmented wave generation system with 256 independently controlled paddles. The system can generate 'Regular Waves' of 0.5 m(max) height and 'Irregular Waves' with significant wave height of 0.35 m for peak of 2-3 sec

Wave Absorption System



Consists of a perforate d parabolic slope mounted on to a stainless steel horizontal framework. At the long side beaches, this framework can be lowered from the surface of the tank, thus creating a larger space for free sailing model tests

FULL SCALE SEA TRIALS

Dedicated expertise exists with NSTL to participate in Full scale sea trials evaluate and validate speed-power and other hydrodynamic characteristics obtained from numerical and experimental performance predictions

Instrumentation

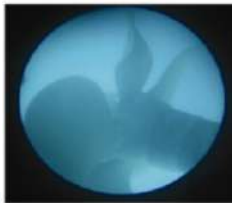
- Twin DGPS for position, course and heading
- Motion Reference Unit
- Rudder Angle Sensor
- Power Measurement system for two shafts
- CTD meter for water temperature and salinity
- Anemometer for wind speed measurement
- Wave Radar for sea state estimation
- Cavitation Observation System (CAVOBS)
- Data Acquisition System



Power Measurement System



Rudder Angle Measurement



Ship Propeller observed from CAVOBS

NAVAL STEALTH TECHNOLOGIES

Stealth technology, also known as Low Observable Technology is the assimilation of a range techniques for air, marine and land platforms that makes them less vulnerable to detection. The act of deceiving the enemy by a reduced giveaway signature or by appearing differently is core of the philosophy of stealth technology. Stealth technology involves management of above water viz. IR, Radar and underwater signatures viz. Magnetic, Acoustic, ELFE of Naval platforms. Management of these signatures is a challenging task as they are quite conflicting and a change in one leads to an unforeseen change in the others.



NAVAL STEALTH RANGES



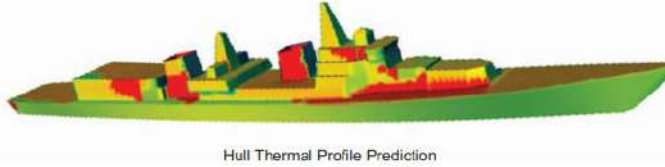
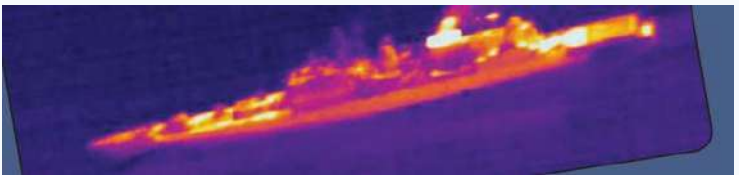
Today, it is well recognized that all warships are required to be designed for stealth. Stealth design enables the ship to avert threats from above water or underwater while enhancing its own first strike capability. With the advent of advanced computational techniques, the prediction and assessment of these signatures during design phase itself is possible thereby enabling the designer to adopt an integrated design and build approach to manage stealth within acceptable limits.

The Stealth technologies developed by NSTL are on par with the international standards and many of these technologies have been inducted into service by Indian navy. The developments include many shore based and at sea facilities for assessment and management of naval platform signatures. Considerable expertise exists with NSTL for prediction, assessment and management of both Acoustic and Electromagnetic Signatures of Naval platforms.

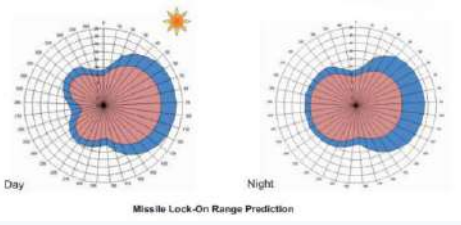
NAVAL STEALTH TECHNOLOGIES

INFRARED SIGNATURE SUPPRESSION SYSTEMS

360 degree appraisal of whole ship IR signature through Hemo based IR imaging to assess thermal hotspots and estimate Missile Lock-on Range



Hull Thermal Profile Prediction



Missile Lock-On Range Prediction

Designed to Mitigate Detection by IR Seekers

- State of the Art Indigenous Design with 100% "Make in India"
- Proven IRSS Systems for Gas Turbines, Diesel Engines and Diesel Alternators
- Designed Eductor-Diffuser based passive & Water Injection based active systems for varying exhaust flow rates upto 98 kg/s
- Reduction in IR signature due to exhaust ducts

IR Prediction Capability for Frontline Naval platforms

- Prediction of Thermal profile for new ship designs
- Evaluation of alternative designs on stealth matrix
- Prediction of Radiant intensity and Missile Lock-on ranges
- Analysis & Design changes for reduced IR stealth

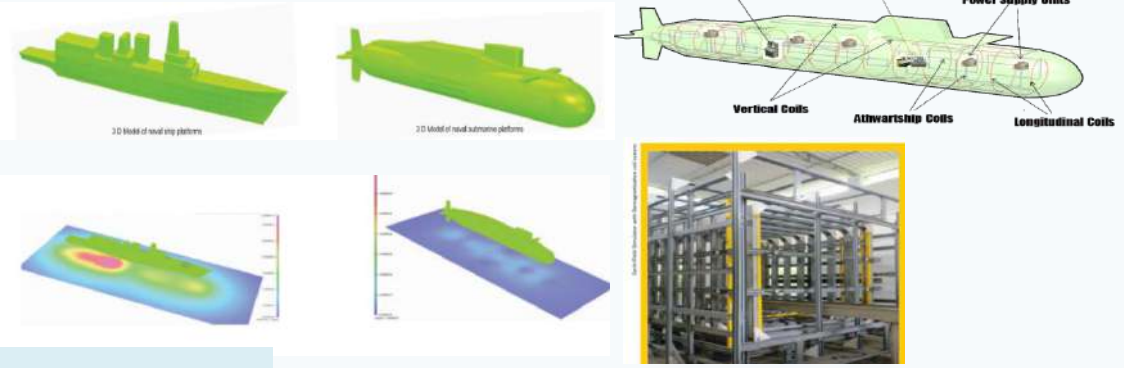
Large number of IR Signature Mitigation systems inducted on frontline naval ships

"HOLISTIC INFRARED SIGNATURE MANAGEMENT CAPABILITIES EXIST WITH NSTL"

NAVAL STEALTH TECHNOLOGIES

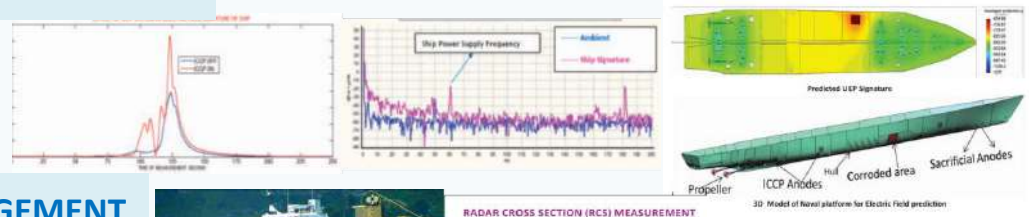
MAGNETIC SIGNATURE MANAGEMENT

- Magnetic signature estimation capability on par with international expertise.
- Ability to design advanced Degaussing and Magnetic signature compensation systems for Naval vessels
- State of the art facility setup for design validation and scaled model testing
- Ability to provide end-to-end magnetic signature management solution



ELFE SIGNATURE MANAGEMENT

- Electric field signature estimation and ICCP optimization capability for effective corrosion protection and electric field mitigations



RADAR CROSS SECTION SIGNATURE MANAGEMENT

- High resolution wide-band RCS measurement facility setup at Dolphin hills, Visakhapatnam for RCS measurement of Naval platforms and aerial weapons.
- Immense experience in RCS estimation of various naval and air platforms and optimization techniques to achieve low RCS
- Experience in design of Battle practice targets for various aerial weapon systems

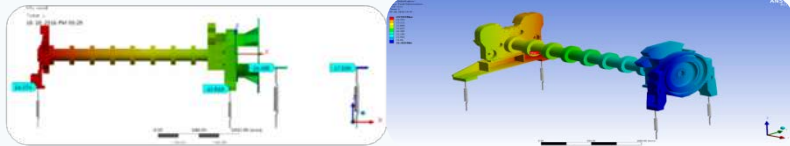


“COMPLETE RCS, ELFE AND MAGNETIC STEALTH DESIGN AND EVALUATION CAPABILITIES IN PLATFORM DESIGN EXISTS WITH NSTL”

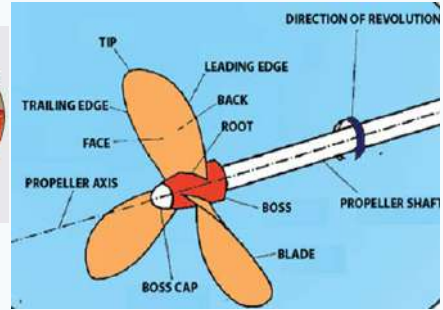
ACOUSTIC & PSI STUDIES



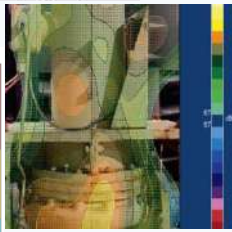
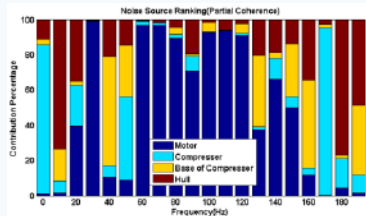
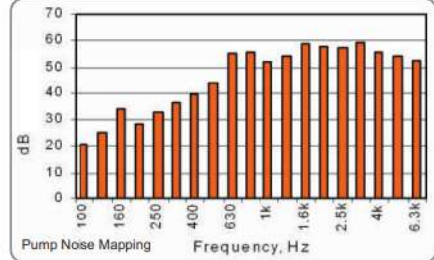
- Preparation of baseline design report for propulsion system
- Feasibility and concept study for selection of suitable propulsion system
- Development of propulsion system design including the arrangement and positioning
- Shaft line arrangement
- Prime mover and propeller matching
- Power speed curves for various loading calculations
- Analysis and verification of shock calculations and shock test report
- Propeller design and model testing
- Torsional, longitudinal and transverse vibration calculations based on equipment supplier



“NSTL CAN UNDERTAKE PSI , NOISE & VIBRO-ACOUSTIC STUDIES, MEASUREMENTS AND VALIDATIONS WITH IN-HOUSE FACILITIES AND EXPERTISE SO AS TO PROVIDE A HOLISTIC SOLUTION ”



- Fuel consumption
- Power to weight ratio
- Space
- Cost & Maintainability
- Availability & reliability
- Vulnerability
- Risk



ENVIRONMENTAL TESTING

VIBRATION TEST FACILITY (VTF)

A Unique Vibration Test facility has been setup to undertake various vibration studies and tests for qualification and acceptance of equipment.

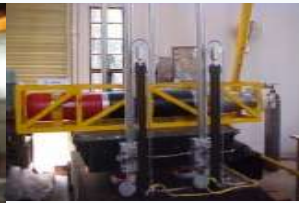
Standards : JSS55555, MIL-167-1A & MIL T 18404

Types of Tests : SINE, RANDOM, SOR, ROR , Resonance & Endurance in X,Y and Z axes

- Max. Payload : Up to 3000kg
- Max. Acceleration : Up to 100g
- Frequency Range : 5 Hz to 2500 Hz
- Max. Displacement : 38 mm
- Types of Cooling : Air & Water Cooling



“NSTL OFFERS ITS STATE-OF-THE-ART ENTEST FACILITIES TO INDUSTRY AND NAVAL SHIP BUILDING AGENCIES FOR EXPERT EVALUATION“



SHOCK TESTING

Double-walled Shock Tank (15 x 12 x 10 m) along with bench test facilities are available at NSTL to carry out shock studies on structures, materials in free field Floating Shock Platform (FSP) for testing of equipment upto 15 tonne Facilities such as Shock tube facility to simulate crash conditions and generate upto 3500 g / 65 msec half-sine pulse along with High speed data loggers and data acquisition systems along with Advanced analysis tools for damage potential estimation are also available.

SAILENT FEATURES

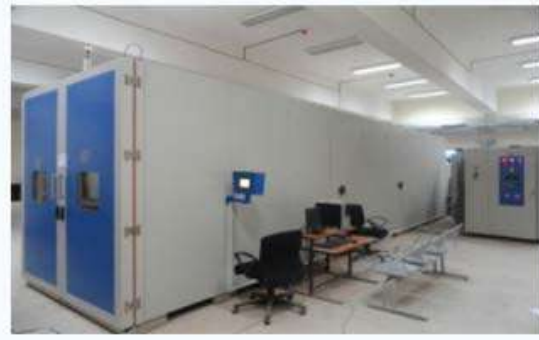
- Payload : 50 kg to 15000kg
- Max. Acceleration : 600g
- Shock Pulse Shape : Half sine, Saw tooth, Square wave
- Pulse Duration : 2 to 40 ms
- Types of simulation : Free-fall, Underwater explosion

BUMP TEST MACHINE

- Payload Capacity : 500kg
- Acceleration(peak) : 40g, 6ms & 25g, 11ms
- Bump rate : 1 to 2 Bumps per sec

ENVIRONMENTAL TESTING

TEMPERATURE TESTING



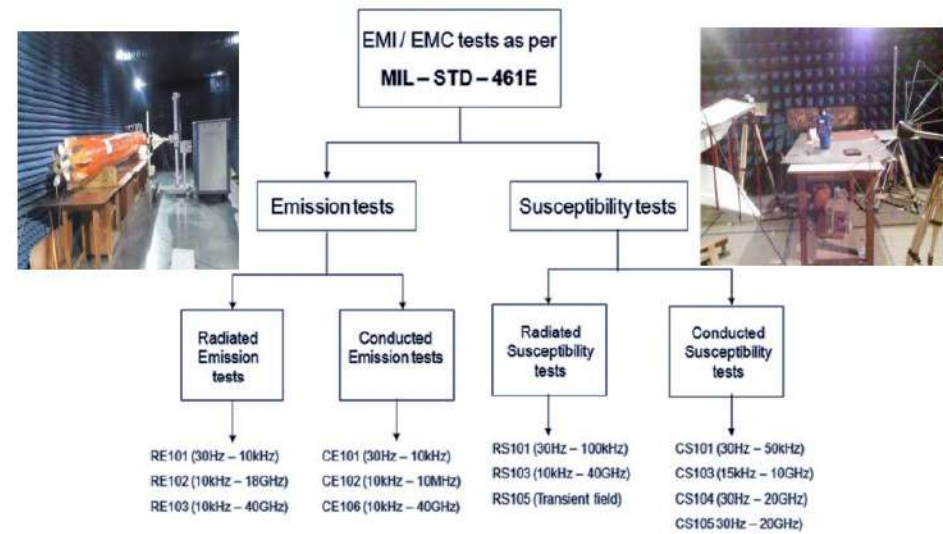
A Walk-in cooling and heating chamber along with a rapid heating and cooling chamber are setup to carry out rigorous testing of equipment by simulating the temperature conditions the equipment would be exposed to during its operation

RAPID CHAMBER
 Range : 180°C to -70°C, RH 95%
 Dimensions: 0.7 M x 0.5 M x 0.6 M
 Temp Rate: 15°C/Min

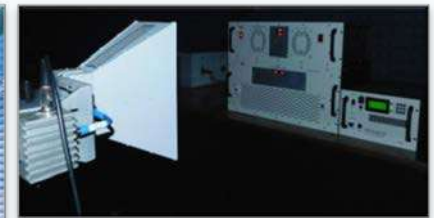
WALK-in CHAMBER
 Range: 100°C to -40°C, RH 95%
 Dimensions: 9 M x 2 M x 2 M
 Temp Rate: 1°C/Min

EMI/EMC TESTING

EMI/EMC facility catering for all Naval EMC requirements as per MIL-STD-461E/F is setup at NSTL and expert evaluation being rendered to Defence industry for EMI/EMC compliance



“EXPERT EVALUATION SERVICES WITH TEMPERATURE CYCLING AND EMI/EMC TESTING ALSO PROVIDED BY NSTL”



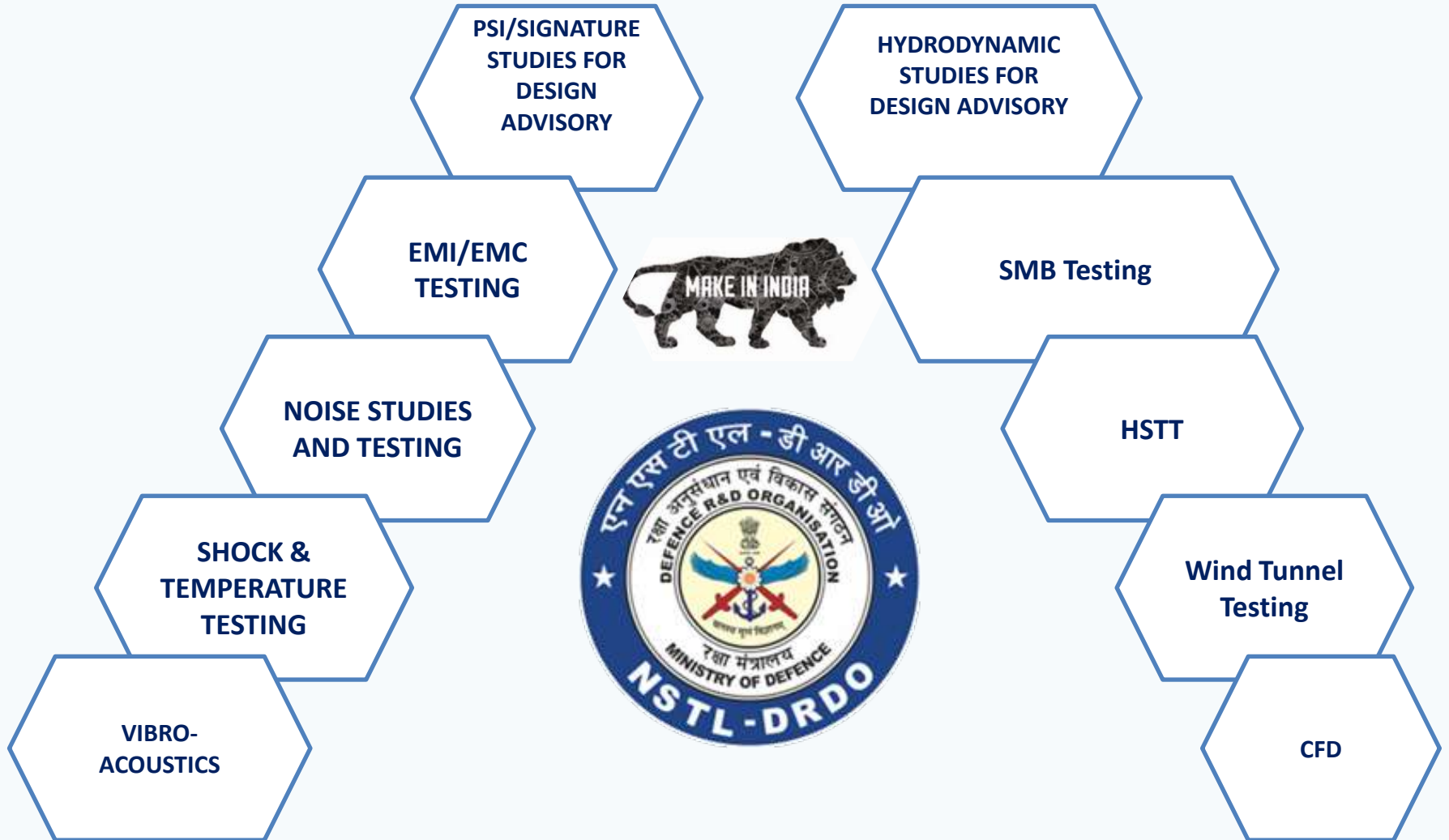
HANDING OVER OF NSTL SYSTEMS



TRANSFER OF NSTL TECHNOLOGIES



“TECHNOLOGIES DEVELOPED BY NSTL ARE TRANSFERRED TO INDUSTRY TO ACHIEVE SELF RELIANCE IN NAVAL SYSTEMS”



THE PURSUIT TO ACHIEVE SELF RELIANCE IN NAVAL SHIP BUILDING



COMMITTED TO EXCELLENCE IN INDIGENOUS NAVAL SYSTEMS



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