NAVAL HANDLING SYSTEMS

CURTISS-WRIGHT

CW-EMS.COM/INDAL

+ Products + Capabilities + Solutions

AIRCRAFT HANDLING SYSTEMS

AVIATION SUPPORT EQUIPMENT

UNDERSEA SENSOR HANDLING

INDAL NAVAL HANDLING SYSTEMS

AIRCRAFT HANDLING SYSTEMS

- ASIST (Aircraft Ship Integrated Securing & Traversing)
- RAST (Recovery Assist Securing & Traversing)
- TC-ASIST (Twin Claw Aircraft Ship Integrated Securing & Traversing)
- MANTIS Aircraft Tug
- Modelling and Simulation

AVIATION SUPPORT EQUIPMENT

- Horizon Reference System (HRS)
- Tracks and Tie-Downs

UNDERSEA SENSOR HANDLING SYSTEMS

- Active/Variable Depth Sonar Handling Systems
- Towed Array Handling Systems: Surface Ships
- Towed Array Handling Systems: Submarines
- Modelling and Simulation

DELIVERING SUPERIOR SOLUTIONS TO THE WORLD'S NAVIES

Curtiss-Wright's INDAL facility combines a high level of engineering and manufacturing capability with expertise in the management of large and complex defense programs to produce specific solutions for the world's navies. With over 50 years of experience, we lead in the design and development of shipborne helicopter handling systems, undersea sensor handling systems and aviation support equipment.

Customers see specific value in:

- Enhanced safety for both personnel and equipment
- Superior performance at a competitive price
- Reliable, long term support and services

All INDAL products are designed to relevant MIL-STD's, tailored to each customer's specifications, and backed by a comprehensive training, documentation, and field support network. Extensive use of computer simulation, modelling and manufacturing resource planning aids in developing and producing high quality, custom products efficiently and economically.

AIRCRAFT HANDLING SYSTEMS

INDAL brings unmatched experience and expertise to ship/helicopter integration and the design and fielding of integrated shipboard helicopter handling systems. INDAL systems and solutions are capable of supporting all critical phases of the shipboard helicopter handling evolution, including initial helicopter recovery support, on-deck securing, maneuvering and traversing operations. They are the preferred choice for today's sophisticated navies.

Our innovative engineers, using stringent manufacturing and test practices, deliver systems that meet the most demanding requirements and provide superior value to our customers.

To support our main helicopter handling system products, we have developed sophisticated computer simulations to evaluate the on-deck performance of manned maritime helicopters and unmanned rotary UAVs for various ship platforms.

Our integrated RAST (Recovery Assist, Securing & Traversing) and ASIST (Aircraft Ship Integrated Securing & Traversing) helicopter handling systems are established as the capability of choice with many navies. These fully integrated systems are unique in that they enable helicopter pilots to safely land and take-off in severe weather conditions and at night from the decks of relatively small ships. Then, after landing, the helicopter can then, be securely traversed into and out of the hangar. TC–ASIST (Twin Claw Aircraft Ship Integrated Securing & Traversing) and MAST (Manual Aircraft Securing & Traversing), a newly developed system, provide many similar features to RAST and ASIST but are compatible with the grid landing system and secure the helicopter using its main landing gear eliminating the requirement for an integrated probe.

The above systems employ an integrated lightweight track system to provide absolute security to the on-deck helicopter and precise repeatable traversing to and from the confined hangar parking position. The track benefits from the use of extruded stainless steel shapes to minimize welding detail and provide the interfaces necessary for welding the modules into the ship structure during installation.

INDAL's product offering also includes the specialized battery powered free-deck MANTIS aircraft handlers. The MANTIS provides the capability to maneuver helicopters and fixed wing aircraft within the physical and operational restrictions of a flight deck or shipboard hangar space.

ASIST SYSTEM

Designed for ease of installation on new ship builds and retrofit to existing ships, the ASIST (Aircraft Ship Integrated Securing & Traversing) System delivers all the benefits of INDAL's advanced handling technology in a lightweight, fully integrated 'wireless' system with unrestricted operations in up to sea state 5-6 conditions dependent on platform and helicopter characteristics.

Using ASIST, helicopter landings are performed solely by the pilot during a quiescent period in ship motion. During landing the system's precision Helicopter Position Sensing System (HPSS) continuously tracks and monitors the exact position of the aircraft relative to the designated landing area, and displays it to the pilot through a series of visual cues.

Position data is simultaneously relayed to the computer-controlled Rapid Securing Device (RSD), which automatically moves fore and aft along the flight deck track to maintain its position directly beneath the probe installed on the underside of the helicopter.

Within two seconds of touchdown, the probe is secured by the RSD and the aircraft is ready to be aligned and traversed into the hangar.

ASIST's aligning and traversing capability is a critical feature, as a single operator in the hangar can perform the entire operation in a safe environment. No other personnel are required on the flight deck for any operations and the ship is cleared to maneuver with no restrictions once the helicopter has been secured. After initial securing, maneuvering and traversing to the hangar can be accomplished by an experienced operator in less than 5 minutes, even in the worst conditions.

Function	Description
General	Provides positive, uninterrupted securing at all times
Recovery Assist	Landing dispersion controlled through use of automated Helicopter Position Sensing System and pilot visual cues 100% free-deck landing
Capture Area	4~6 m^2 [typical]
Maneuvering and Traversing	Achieved through single operator controlled movement of Rapid Securing Device along deck track Constant helicopter lateral positioning maintained during traversing

Performance/ Specifications	Description
Capture Time	2 seconds
Traverse Speed	Variable 0 ~ 0.3 m/sec
Operational Envelope	Sea state 5/6 (up to 30° apparent roll & 10° apparent pitch, dependent on ship and helicopter)
Manpower Requirements	No on-deck personnel required for handling system related operations

Physical Characteristics	Description
System Configurations	Single and Dual configurations available All equipment typically mounted at flight deck or mezzanine level
Power Requirements	440V, 3 phase, 60 Hz 440V, 3 phase, 400 Hz 115V, 1 phase, 60 Hz

TC-ASIST

While ASIST is a popular system for those navies that have probe-equipped helicopters, probe installation is not always possible. To support non-probe installed aircraft, INDAL offers the TC-ASIST (Twin Claw Aircraft Ship Integrated Securing & Traversing) System, a derivative of our already proven and successful ASIST System. Designed for operation with either harpoon deck lock and landing grids or as a standalone system, the TC-ASIST offers safe and effective deck securing and traversing capabilities especially for heavier maritime helicopters. It incorporates mature subsystem and component equipment designs from INDAL's ASIST System and represents a low risk solution for navies operating helicopters such as the AW101 or NH90.

The TC-ASIST System provides full security after landing and through all on-deck operations up to sea state 5-6 dependent on platform and helicopter characteristics. When initiated the Rapid Securing Device (RSD) moves from the standby position to align itself with the aircraft's position. The RSD is fitted with a pair of spring-loaded claw arms to capture and secure the wheel spurs installed on the aircraft main landing gear. The arms are brought in until sensors located on each arm detect the tires, at that time each claw arm rotates upwards to capture the wheel spur. The arms act independently, but with a mechanical interlock to ensure simultaneous operation.

Once the aircraft has been secured, it is ready to be aligned for traversing to the hangar or any intermediate location. All deck handling operations can be accomplished without the need for personnel on the flight deck. TC-ASIST provides a secure and rapid straightening and traversing function with no personnel or cables on the deck.

With additional optional equipment the TC-ASIST can operate more like ASIST and provide a fully automated capture upon landing, thus removing the need for a harpoon deck lock and grid.

Function	Description
General	Provides positive, uninterrupted securing at all times when connected
Recovery Assist	Optional ASIST style helicopter tracking system available to supplement standard deck cues and line-up lines 100% free-deck landing
Capture Area	3~4 m^2 [typical]; Compatible with harpoon deck-lock grid
Maneuvering and Traversing	Achieved through single operator controlled movement of Rapid Securing Device along deck track Constant helicopter lateral positioning maintained during traversing

Performance/ Specifications	Description
Capture Time	4 seconds
Traverse Speed	Variable 0 ~ 0.3 m/sec
Operational Envelope	Sea state 5/6 (up to 30° apparent roll & 10° apparent pitch dependent on ship and helicopter)
Manpower Requirements	No on-deck personnel required for handling system related operations

Physical Characteristics	Description
System Configurations	Single and Dual configurations available All equipment typically mounted at flight deck or mezzanine level
Power Requirements	440V, 3 phase, 60 Hz 440V, 3 phase, 400 Hz 115V, 1 phase, 60 Hz

MANTIS AIRCRAFT TUG

The MANTIS aircraft tug is an off-the-shelf product designed specifically for ship's deck and ground handling of military helicopters and fighter aircraft. It provides the capability to maneuver helicopters and fixed wing aircraft within the confines of a flight deck or shipboard hangar space or a ground apron to support shore-based maintenance activities. Offering fast, precise control from an umbilical-connected operator chest pack, the MANTIS fits wholly within the aircraft footprint to permit high precision, high parking densities and make the best use of valuable parking space. The operator has full visibility of all points of the aircraft and surrounding area while carrying out the maneuvering operation.

The MANTIS interfaces directly with the aircraft, using our unique matrix head, and with no requirement for tow bars or airframe modifications. The low-profile design and resultant under-fuselage clearance allows the handling of a wide range of helicopters and fixed wing aircraft in both land-based and marine operations. The unit will operate with aircraft that have deflated tires or collapsed oleos, and with nose installed radomes.

The electrically operated MANTIS tug provides significant continuous operating time with high payload aircraft from a single charge of its purpose-designed batteries. Traction management, regenerative braking and charging are all computer-managed and require no operator intervention. Digital speed 'ramping' during acceleration and deceleration operations maintains aircraft loadings within design limits. Careful material selection ensures long life and reliability in both land-based and marine embarked operations.

The MANTIS has the ability to drive in four directions and spin on the spot around the tow point. This maneuverability and electric operation does not emit fumes and also makes it suitable for use in land based maintenance facilities.

Function	Description
Recovery Assist	Standard deck cues and line up; lines 100% free-deck landing
Capture Area	Maneuvers to aircraft landing spot
Maneuvering	Achieved via operator control of MANTIS Turning circle of 0 metres
Traversing	Self-propelled; relies on frictional force between MANTIS unit and deck surface

Performance/ Specifications	Description
Capture Time	11 seconds
Traverse Speed	Variable 0 to 1.2 m/sec [4.2 km/hr]
Operational Envelope	Ship and helicopter specific
Manpower Requirements	One MANTIS unit system operator using umbilical chest pack control module

Physical Characteristics	Description
System Configurations	Standalone unit no connection to ship
Power Requirements	96 to 260 VAC input for charging 3.5 hours continuous operation on a single charge with 18,000 kg a/c
Steering	2 steer wheels in base unit MANTIS-RAM-1 4 wheel steer with MANTIS-ELP-1

RAST SYSTEM

Navies around the world rely on INDAL's RAST (Recovery Assist, Securing & Traversing) System to support shipborne helicopter operations.

RAST is a fully integrated shipboard system able to accommodate a wide range of helicopters, even in the most demanding marine environments. More than two hundred shipsets have been delivered to the navies of Australia, Canada, Japan, Spain, Taiwan, and the United States.

Throughout its long and successful history, INDAL's RAST System has been continuously improved. The latest versions employ advanced, solid-state electronic subsystems and ultra-lightweight components and tracks. More recently, the RAST has been modified to the hybrid 'RAST Mark 6 System' configuration to incorporate the additional functionality offered by the ASIST Rapid Securing Device.

In operation for over 40 years, RAST has been the system of choice for many navies. Fully mature, the system has performed flawlessly in the most demanding of seaway conditions. The first of INDAL's integrated shipboard helicopter handling system suite of products, it has fully demonstrated its extensive functionality and capability.

Function	Description
General	Provides positive, uninterrupted securing at all times
Recovery Assist	Landing dispersion controlled via mechanical Recovery Assist cable connection from ship to helicopter
Capture Area	1 m^2
Maneuvering	Achieved via external auxiliary wheel winch cables
Traversing	Achieved through controlled movement of Rapid Securing Device along deck track Constant helicopter securing and lateral positioning maintained

Performance/ Specifications	Description
Capture Time	2 seconds
Traverse Speed	Variable 0 ~ 0.3 m/sec
Operational Envelope	Sea state 5/6 (up to 30° apparent roll & 10° apparent pitch dependent on ship and helicopter)
Manpower Requirements	On-deck personnel required for: (i) attachment of RA cable; and (ii) attachment of auxiliary wheel winch cables

Physical Characteristics	Description
System Configurations	Single and double configurations available Requires below deck machinery room space
Power Requirements	440V, 3 phase, 60 Hz 440V, 1 phase, 6- Hz 208V, 3 phase, 400 Hz

INDAL: THE PREFERRED CHOICE FOR NAVIES AROUND THE WORLD

Anzac-class, Hobart-class,
Hunter-class

RAST, MANTIS, ASIST

Halifax-class, Protecteur-class,
Canadian Surface Combatant (CSC)

RAST, ASIST

Duke-class

ASIST

Bergamini-class, Thaon di Revel-class

TC-ASIST/RAM

Maya-class, Mogami-class

RAST MK IV

Formidable-class, Endurance-class,
Multi-Role Combat Vessels (MRCV)

ASIST, MANTIS

Álvaro de Bazán-class, Bonifaz-class

RAST, ASIST

Barbaros-class, Istanbul-class

ASIST

Arleigh Burke-class, Constellation-class,
Freedom-class, Independence-class

RAST, ASIST, MANTIS

The above shows a selection of navies that use INDAL systems and is not meant to represent an endorsement of the navies listed therin, and is not a complete listing of navies that use INDAL systems.

MODELING & SIMULATION OF NAVAL HELICOPTER HANDLING SYSTEMS

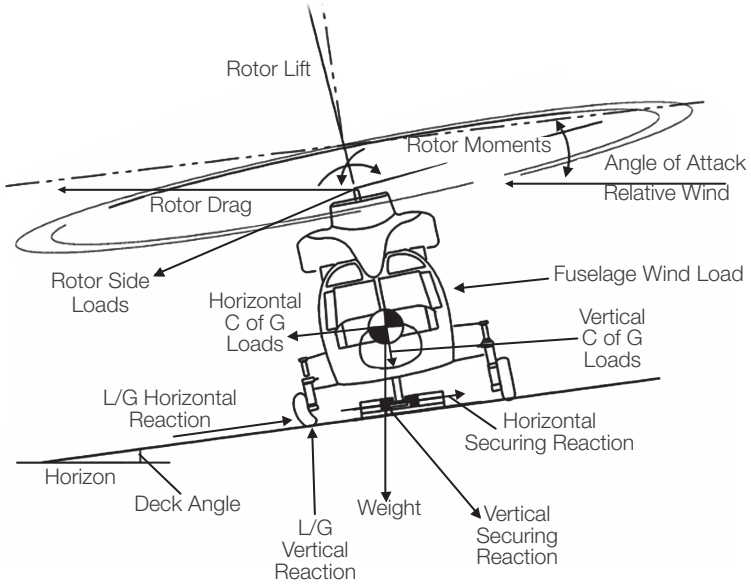
Sophisticated dynamic interface analysis methodology and computational tools provide INDAL with a unique insight and capability for the design, manufacture, and operation of naval helicopter handling systems.

Aircraft on ships experience complex loading as the result of ship motion, wind, and inertial effects. This loading, combined with the highly nonlinear aircraft response characteristics, creates a complex dynamic interface between the secured aircraft and the ship. By actively applying mathematical modeling and computer simulation, INDAL is able to ensure the efficiency and safety of our engineered products and solutions.

Central to our analysis capability is Dynaface™, which solves the nonlinear dynamic equations governing the response of a secured helicopter to ship accelerations and environmental influences. The results provide insights into peak securing forces, operational envelopes, deck clearances, and fatigue spectra for an embarked aircraft.

As the dominant excitation acting on embarked aircraft is ship motion, INDAL has also developed simulation tools for accurately generating representative flight deck motions for the complete range of conditions in which helicopters must be secured. ShipSim evaluates time histories of flight deck motions as well as a number of additional parameters that are used to indicate the potential severity of securing conditions when the amplitudes of ship motions are small to moderate.

Typical input parameters used in the modeling process



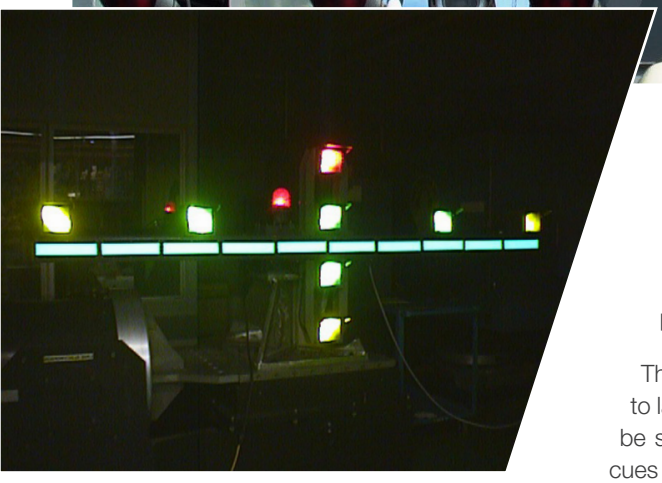
AVIATION SUPPORT EQUIPMENT

INDAL provides a number of products to support aviation facilities onboard naval ships, these include: Horizon Reference Systems (HRS), deck tracks, and tie-downs.

INDAL has broad experience in overcoming the challenges of operating helicopters and UAV's from small ships and provides design service and support to navies around the world. Our services range from engineering feasibility studies to providing complete turn-key ship aviation.

HORIZON REFERENCE SYSTEM

INDAL's portfolio of aviation facility support equipment includes a Horizon Reference System (HRS) that extends shipborne helicopter operations during periods of reduced visibility, high sea states and at night. The HRS provides a steady artificial horizon reference while the ship rolls during heavy seas or maneuvering.



The HRS position, when compared to the fixed lights on the ship's hangar or deck, provides the pilot with the degree and periodicity of the ship's roll. The system incorporates two fixed panels and a foot lighted panel that are mounted at the end of and parallel to the roll bar. The HRS can also be installed as part of a more comprehensive lighting or landing aid package to further enhance the visual cues to the pilot, thus reducing workload and enhancing safety.

The HRS remains the key element in providing the pilot the "true horizon" when preparing to land. The HRS System is in use with almost every INDAL RAST System worldwide. It can be supplied as a standalone product and is modified to incorporate additional pilot visual cues when sold with the INDAL ASIST.

HELICOPTER TIE-DOWNS

INDAL has used its innovative skills and extensive knowledge of the sea environment, high-grade materials, and welding techniques to develop and design a range of helicopter tie-downs. The tie-downs offer superior corrosion resistance and greater security for shipboard helicopters. These characteristics, combined with a simple construction and ease of installation, result in a cost-effective solution for shipboard helicopter securing.

SHACKLE TYPE

The Shackle is designed to interface with deck thickness ranging from 10 to 17 mm, and comprises of a flip up shackle that interfaces with the hook end of a helicopter lashing to assist with securing helicopters to the flight deck. This configuration is Lloyds Approved and is currently installed on board the United Kingdom's HMS Ark Royal, HMS Invincible, and all Type 45 Frigates.

CRUCIFORM TYPE

The Cruciform is designed to interface with deck thickness ranging from 14.5 to 36mm and comprises of a stainless cruciform that interfaces with the hook end of a helicopter's MC2 Storm Lashing to assist with securing helicopters to the flight deck. This configuration is installed on board the United Kingdom's Queen Elizabeth Class Aircraft Carriers.

UNDERSEA SENSOR HANDLING SYSTEMS

INDAL specializes in customized undersea sensor handling systems designed to operate safely in high sea states and at high speeds, meeting the specialized requirements for surface ship, submarine, helicopter, and unmanned vessel host platform applications.

The INDAL product line is recognized as offering innovative, lightweight, and automated solutions to meet the complex naval mission demands of undersea sensor handling and towing systems for anti-submarine warfare, mine and torpedo countermeasures and USV/AUV operations. Each system is customized to meet the diverse weight, space and operational challenges presented by individual vessel configurations.

ACTIVE / VARIABLE DEPTH SONAR HANDLING SYSTEMS

Navies from around the globe utilize INDAL's Variable Depth Sonar (VDS) cable handling systems, towed sonar bodies, and faired tow cable systems.

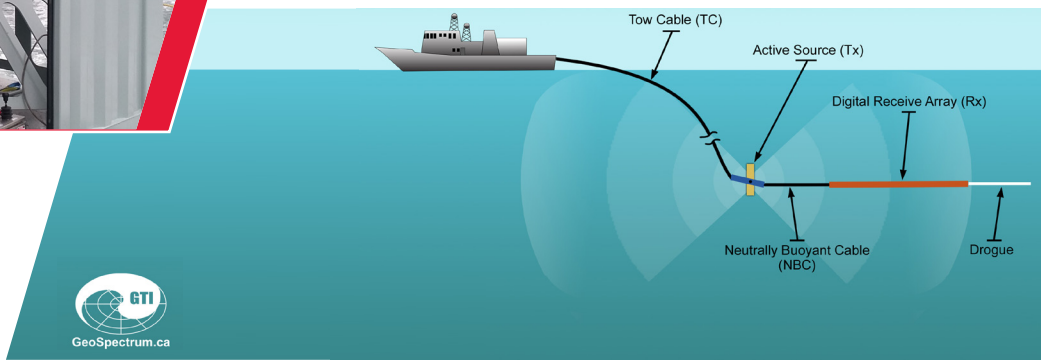
INDAL has a variety of VDS handling system models designed to meet a wide range of sonar frequencies, depth requirements and vessel sizes—from fast patrol craft to destroyers. Systems are designed as modular, self-contained units.

INDAL employs an extensive database of real-world towing performance information during the design of each system. We also utilize sophisticated dynamic analysis based computational tools. INDAL's proprietary 6DOFTOW modeling tool simulates the response of towed systems to ship/submarine motions and is used to optimize the design of underwater towed bodies and associated handling systems and tow cabling. By examining factors such as towed body depth and trail, cable tensions and system drag, INDAL ensures that ship speed and sea state operating windows are maximized.

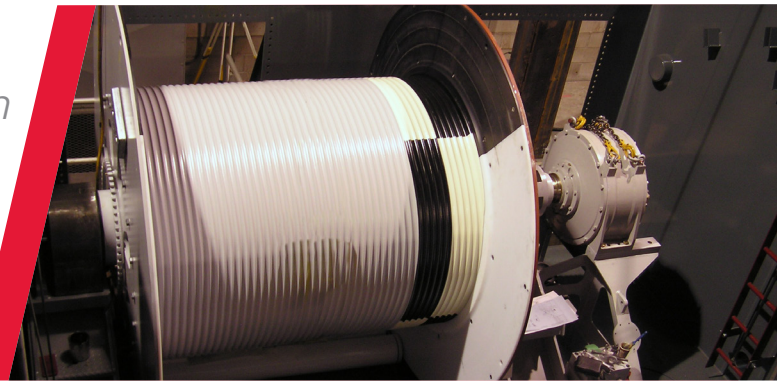
Many VDS handling systems employ a winch/hoist assembly, INDAL's Flexnose® faired tow cable system and an acoustically transparent, hydrodynamically stable towed body.

INDAL also offers innovative single-tow active/passive handling systems, where the towed receive array is attached to an active source body. This includes the exciting new TRAPS (Towed Reelable Active Passive Sonar) System. TRAPS is a compact, low-cost active passive variable depth ASW sonar. TRAPS meets the compact footprint required for small combatants and the performance required to detect submarines, torpedoes, and surface ships. The modular design of TRAPS, and its compact, lightweight winch, provides a variety of installation options, including containerization on multi-mission vessels and standard deck-mounting.

INDAL produces innovative towed array and VDS winch systems to meet demanding weight and size targets



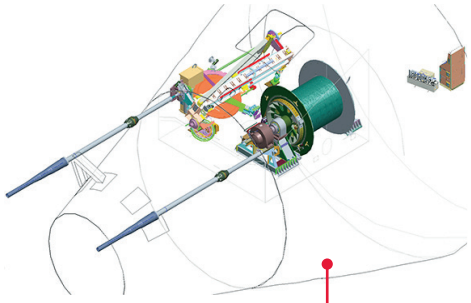
INDAL produces towed array winch systems designed to deploy and retrieve the array with high reliability and no array damage



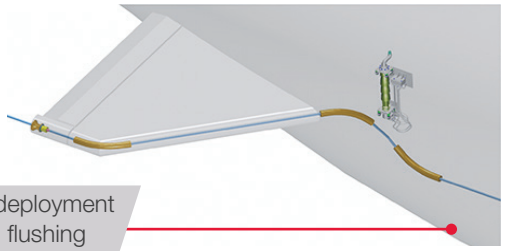
TOWED ARRAY HANDLING SYSTEMS: SUBMARINES

INDAL designs and manufactures towed array handling systems for submarines for handling of both “Fat Line” and “Thin Line” arrays. These systems allow the towed array to be smoothly and quietly deployed, positioned and retrieved to maximize operational efficiency. INDAL’s innovative and proven flushing deployment system guarantees extended array life by eliminating the need for mechanical capstans, cable traction or linear transfer mechanisms that can damage expensive towed arrays.

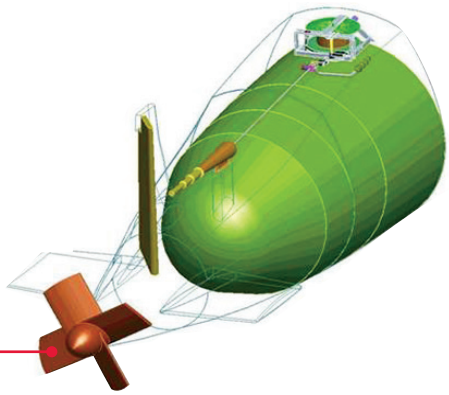
INDAL offers both electric and hydraulically driven submarine towed array winches with fail-safe, redundant systems, video monitoring, automatic and back-up controls to ensure submarine safety and maneuverability.



Reelable Towed Array Handling Systems supplied to BAE SYSTEMS for the Royal Navy’s Astute-class submarine



Complex deployment paths using flushing



Compact electric winches for thin-line submarine towed array handling

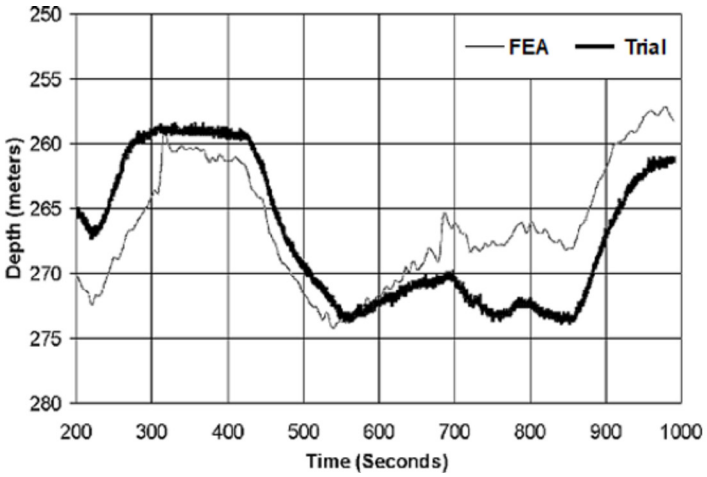
TOWED ARRAY HANDLING SYSTEMS: SURFACE SHIPS

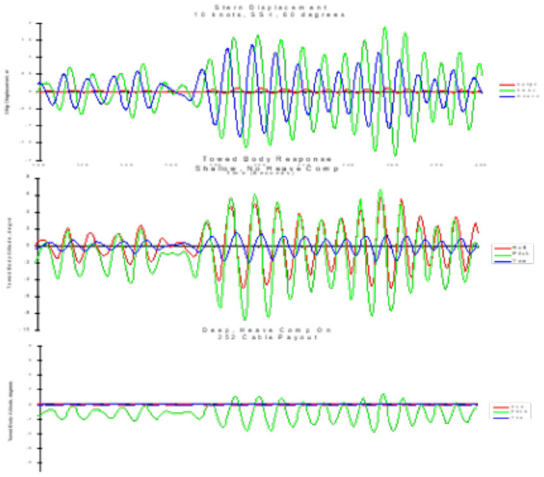
Lightweight automated towed array handling and stowage systems produced by INDAL are in operation with multiple navies. For surface ships, these systems enable deployment and retrieval of the array at high speeds without impeding ship operations. Systems are designed for either open weather deck or closed compartment operations as specified by the customer.

INDAL towed array winch systems are designed to deploy and retrieve with 100% reliability. The systems feature software controlled “smart levelwind” technology to automatically spool multi-diameter and multilayer tow cables and arrays efficiently onto a winch drum without over-stressing the array elements.

MODELING OF UNDERWATER TOWING

An INDAL designed program performs 6-degree of freedom FEA Analysis. It simulates the actions of towed cables or towed bodies being towed behind surface ships or submarines. It can determine the effects of ship motion sea state on the stability, depth, and trajectory of the tow. It can also be used to determine the tow loads during launch, recovery, or steady state deployment under different ship speeds or conditions.





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