AIRCRAFT HANDLER TYPE

MANTIS SHH

TECHNICAL SPECIFICATION

ISSUE 4

INDAL Technologies

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CURTISS WRIGHT Flow Control Company
INDAL Technologies

GENERAL INFORMATION
LEADING PARTICULARS

Aircraft Handler Type MANTIS SHH

Dimensions:

Length overall	10.5 ft. / 3196 mm
Width	6.75 ft/ 2058 mm
Height (over drive wheels)	1.5 ft/ 450 mm
Height (over central portion)	1 ft / 307.5 mm
Drive Wheel Track	7.4 ft / 2266 mm
Steer Wheel Track	7.25 ft / 2210 mm
Wheelbase	4.6 ft / 1416 mm
Ground clearance	2 ¾ in / 70 mm
Weight:	5,324 lbs / 2415 kg
Weight (less batteries)	4,685 lbs / 2125 kg

Performance:

Tractive effort	30,000 N max
Speed Variable from	0 to 3.5 mph / 5.5 km per hour
Turning circle	0 in / 0 m
Duration of Batteries	Moving an aircraft of 55,000 lbs / 25,000 kg at least 11,500 ft / 3,500 meters including nose wheel pick-ups and set- downs OR 3.5 hours continuous movement with a 39,700 lbs / 18,000 kg aircraft
Traction motors:	2 off 3kw A.C. Controlled Synchronous Motor
Batteries	2 off 24V Sealed Valve Regulated Lead Acid GEL (SLA/VRLA) Full Traction battery packs giving total 180Ah (C_5)
Battery type:	6 EPzB or approved equivalent
Battery size:	Each 2 V Cell
Battery Weight	27 lbs / 12 kg

Hydraulic System

Tank capacity	10.5 qts /10 liters
Hydraulic pump displacement	4.75 qts / 4.5 liters/min
Pump/motor unit	Bosch 0541 300 032
Hydraulic Pressure (Main system and lift pressure)	175 Bar
Pin Clamp pressure: Normal	125 Bar
Clamp Release Pressure	100 Bar
Aircraft to Handler Interface	**M**ulti **A**ircraft **M**atrix **A**cquisition **S**ystem MAMAS (patents pending)

Wheels:

Driving	Solid Polyurethane – Special high traction 'deck friendly' – 'designed for purpose' low shore hardness compound – 13 in / 333 mm x 5 in /127mm Wide
Steering	Solid Polyurethane – Special high traction 'deck friendly' – 'designed for purpose' low shore hardness compound – 9 in / 225 mm x 2.5 in / 60mm Wide

Theoretical Tractive Effort Calculations
(see also sea state stability and traction calculations)

- Handler MANTIS SHH
- Phase 1 (weight over drive wheels 1280 lb / 581kg each)
    - No Lift of Aircraft. Max tractive effort delivered from MANTIS SHH = 581+581 at 0.6 Mu = 1540 lb / 700kg
    - Therefore Aircraft AUM = 700/0.07 = 22,000 lb / 10,000kg
- Phase 2 (weight over drive wheels 5,300 lb / 2400kg each)
    - Maximum Lift of Aircraft. = 581+581+3629 at 0.6 Mu = 6,338 lb / 2875kg
    - Therefore Aircraft AUM = 2875/0.07 = 90,600 lb / 41,100kg

AIRCRAFT HANDLER TYPE MANTIS SHH

INTRODUCTION

INDAL Technologies combines a high level of engineering and manufacturing capability with expertise in the management of large and complex defense programs to produce unmatched solutions to the world's navies.

Since incorporation in 1951 under the name Dominion Aluminum Fabricating Ltd., the company has developed its engineering design and manufacturing capabilities and today is heavily involved in systems integration and testing. This blend of engineering design and manufacturing has enabled the company to become a world leader in the design and development of ship borne helicopter handling systems and other sophisticated systems for international navies and commercial aviation industries. In November of 1989, INDAL Technologies Inc. (ITI) acquired Fathom Oceanology Limited, to further strengthen and enhance its overall capabilities in sonar handling systems.

In March 2005, ITI was acquired by the **Curtiss-Wright Corporation**. The company now operates as a business unit within **Curtiss-Wright Flow Control**. Products designed, produced and supported meet the many industry and customer standards in equipment specifications, manufacturing practices, quality assurance procedures, and program management and control systems.

INDAL Technologies employs a staff of professional engineers to enhance the company's product offerings and to accommodate customer requests for custom design. Trained technicians proficient in a variety of related fields and assisted by state-of-the-art computer aided engineering systems support these professionals. In support of the main helicopter handling market, the company has developed computer simulation programs for evaluating launch and recovery procedures of handling systems in various sea states and for conducting analysis of helicopter securing and landing gear loads.

These analyses are proving invaluable to navies in the selection and evaluation of systems tailored to their particular needs. The proprietary photogrammetric position sensing system used in helicopter recovery has been integrated into a system for automating the movement of aircraft passenger bridges at busy airports.

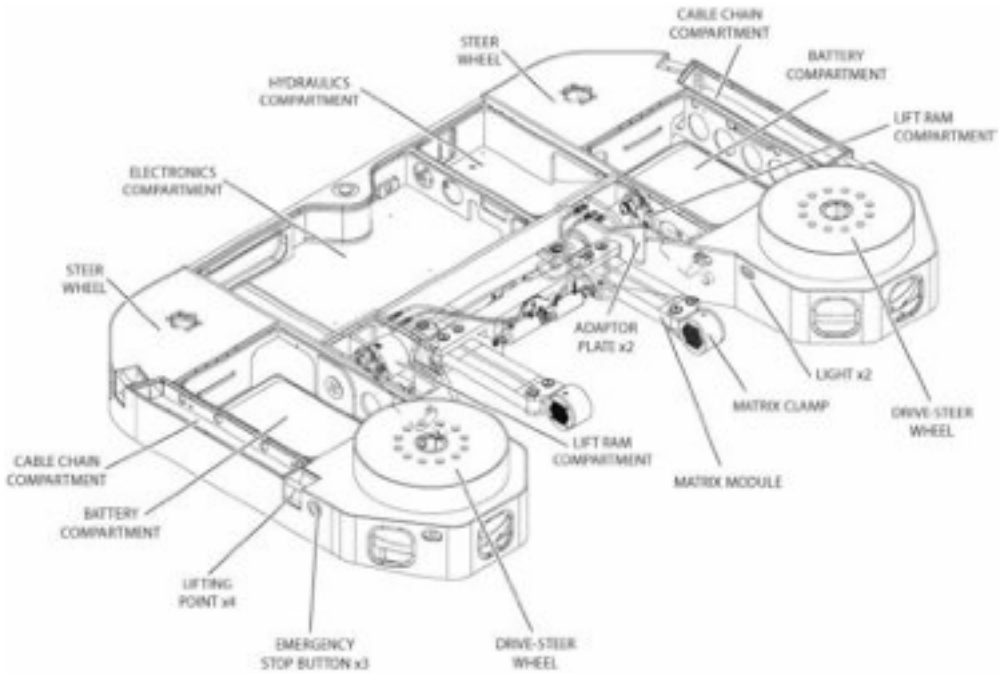
DESIGN PHILOSOPHY

The underlying philosophy to the design of all our equipment is that it utilizes the latest technology applicable to its sphere of operation and is (relatively) lightweight and portable in nature. This has become particularly important in the design thinking for equipment to be utilised on decks above the water line in modern Naval vessels where equipment mass has become an increasingly significant consideration. Equally essential is the advantage gained when the equipment is air transported.

Although the equipment is lightweight it is also specifically designed to be extremely tough and with a wide envelope of survivability in the harsh maritime condition in which it is to operate.

The SHH Handler utilizes a range of proven technology brought together in an innovative (patent pending) combination to achieve a genuine tri-force - multi-role Aircraft Handler for today's multi-platform vessels.

GENERAL DESCRIPTION ~ MECHANICAL HANDLER MANTIS SSH



This is a battery powered pedestrian controlled vehicle capable of moving a wide range of aircraft types, extending from lightweight very low ground clearance helicopters such as the Apache right through to the new JSF and other aircraft proposals with AUM in excess of 66,140 lb / 30,000 kg.

The design incorporates clearance and lifting capacity for all current and envisaged aircraft within its payload range including EFA and JSF. The listing shown on page 15 indicates the total compatibility of the SHH Handler system with widely differing aircraft types from a wide range of manufacturers in a wide range of countries from lightweight fixed wing trainers and helicopters to the new generation heavy fighter aircraft. Page 5 of 18 DATE: August 2009 ISSUE NO: 4 Typical Overview The Handler is steered by a remote console connected to the Handler via a coiled steel wired armored cable of 6 meters length (extended). This enables the operator to view the aircraft and handler from the safest position whilst giving the best visibility. The Handler can be positioned, engaged and disengaged from the aircraft by the operator remotely.

Operating Procedures

1.0 The operator identifies the aircraft type to be moved, and selects the aircraft type on the remote chest pack console. (This sets the maximum tractive effort within strict parameters laid down by the aircraft manufacturer for the particular aircraft)

2.0 Select an appropriate set of tow pins from their stowage location on the Handler and insert into the towing attachment points on the aircraft.

3.0 With the lift arms fully lowered move the Handler to approximately encompass the aircraft nose wheel or tail wheel. Then using the chest pack controls, close the arms until they come into contact with the towing pins.

4.0 Continue to lift and as the lift pressure increases, a locking mechanism automatically engages the tow pin extensions and secures them in place.

The aircraft is now secured to the Handler and can be moved as required

Please note it is a design feature of the SHH unit to utilize the aircraft mass to maximize the tractive effort available. Up to a maximum 8,000 lb / 3629 kg strut download.

During normal procedures the aircraft wheel of lighter aircraft (AUM <40,800 lb /18,500kg) will be lifted clear of the deck.

Where aircraft AUM 41,000 lb / 18,500 kg – > 66,000 lb / 30,000 kg the undercarriage strut will not be lifted clear of the deck, but is limited by the SHH's internal relief valve control system to simulate a lift equivalent to 8,000 lb / 3629 kg. During these conditions the undercarriage wheel WILL NOT LEAVE THE DECK and the aircraft will be moved with the wheel in rolling contact with the deck as it would with a conventional tow bar.

NB: All tractive effort and deck stability/slide calculations have utilized 0.6 Mu for the deck coefficient of friction – this is considered to be a conservative figure, and therefore inherently safe.

The INDAL Technologies SHH Handler has many other advantages making it especially suitable for maneuvering aircraft in confined spaces such as aircraft hangars, onboard ship and aircraft parking aprons.

The SHH Handler is extremely maneuverable, utilizing its power steer computers Page 6 of 18 DATE: August 2009 ISSUE NO: 4 (patents pending) linked to the speed and traction controller; to carefully control the torque on each of the drive wheels proportionally to the steering angle required by the operator. This results in a turning circle almost within the outline shape of the Handler.

The MANTIS SHH's intuitive controls ensure that each step of the process is logical and ergonomic via the chest pack console. Computerized inter-actions and internal protocols ensure that operators carry out action in logical progression, and most importantly safely.

Aircraft types and consequently traction/airframe loadings are all pre predefined and require only operator selection. Consequently, very limited operator training is required.

Logical, finger tip, joystick steering allows the aircraft to be moved with absolute precision even under the most arduous deck condition and ships motions in confined spaces and to the extremities of hangars or deck edges. With most current and proposed fleet aircraft designs the SHH Handler will actually be within the footprint of the aircraft which when couple to it 'turn on the spot' capability means that aircraft can be parked at very high densities and very close to bulkheads.

Since the SHH has been designed for marine embarked operation it has no emissions, which makes it particularly suitable for indoor and below deck use.

Hangars and equipment are kept cleaner and the relatively silent operation means that reflected noise in enclosed metallic hangars is virtually eliminated.

The Sealed Valve Regulated Lead Acid GEL (SLA/VRLA) battery pack eliminates hazardous hydrogen charging emissions to zero and also eliminates the need for daily checks on electrolyte fluid. This will give a great saving in manpower and eliminate the need for special Zone 0 environment for battery charging and storage on board ship.

MANTIS SHH utilizes the latest technology and sophisticated digitally controlled computerized battery management computers to ensure the shortest charge times and maximum on deck endurance whilst maximizing battery life in a completely maintenance free environment.

The in built battery charging and management system automatically controls charge and battery condition, whilst the traction system provides digitally controlled regenerative braking feeding the over-run power back into the batteries further increasing on deck endurance.

The Handler is charged by local mains power supply, which can be between 96 to 264V AC.

Typical Clamping of Undercarriage Wheel

SAFETY FEATURES

The Handler incorporates many integrated and automated safety features, designed to safeguard both personnel and aircraft and prevent misuse as follows:

Static Conditions

The Handler cannot be moved if:

- The battery isolating switch is in either the OFF or Battery Charge position, (Can be pad locked OFF)
- The charging lead is connected.
- The 'Dead-Mans' grip is not activated correctly.
- The remote chest pack is not connected in the correct manner.
- The Emergency Stop system is activated.

Operating Conditions

The fail-safe electromagnetic brakes are applied automatically when the power is OFF. The brakes can only be released when forward or reverse motion is requested via the remote console. An emergency system is incorporated to release the brakes for servicing or manual movement of the Handler.

The Handler will electronically 'stall' if the draw bar pull (or equivalent) exceeds the design parameters for the aircraft being handled (theoretical max ultimate pull >28,200N @ 0.6 Mu with 8,000 lb / 3629 kg Load)

Lift 'Arms' cannot be opened until the weight of the aircraft is released. This ensures that the aircraft cannot be released with the undercarriage wheel still raised from the deck or ground. The Green lights show that load is present on the lift arms, these will extinguish when the load is removed.

KEY FEATURES

Listed below are a few advantages in using the MANTIS SHH Aircraft Handler as opposed to a conventional aircraft tractor for aircraft movement.
'Cost'- cheaper running costs, no fuel bills - long life expectancy, minimal maintenance expenditure - self contained, no ancillary equipment required - saving in manpower, only one pedestrian operator required.

'Operational Advantage' - superior maneuverability plus ultra low chassis enables the aircraft to be stowed more compactly - precise steering and stopping capability minimize risk of accidental damage to aircraft - time saving achieved by accurate aircraft "spotting" - simplicity of control renders the Handler 'foolproof', minimizing the level of operator skill required.

Aircraft can be parked right up to bulkheads or other aircraft without the need to leave maneuvering space to remove the handling system or tractor

'Lightweight' - the Handler utilizes the weight of the aircraft over the driving wheels to give tractive grip - its weight, compared with conventional tractors, renders it particularly suitable for embarked aviation operations by minimizing above waterline equipment mass.

As a rule of thumb a ‘dead mass’ deck tractor with an equivalent pull to the SHH unit would have a mass of 13,325 lb / 6,044 kg against the SHH unit at 2415 Kg.
On a typical ten unit deck fleet this would add over 77,000 lb / 35,000 kg to the ‘above water line mass.

'Environmental Advantages' - pollution from exhaust fumes with attendant health hazards are avoided - can be used safely within enclosed areas - quiet operation enables commands to be heard distinctly and avoids distraction of operators engaged in other work in the vicinity, thereby reducing annoyance which may lead to fatigue errors. With the addition of the Sealed Valve Regulated Lead Acid GEL (SLA/VRLA) batteries charging emissions are completely eliminated.

'General Advantages' - Up to 1,000 kg of stores can be carried on the Handler’s robust flat top deck; making it a fast and stable transit platform. The Handler can also be used to haul cables or heavy wheeled ground support equipment. The Handler is fitted with low intensity night vision enhanced load area lighting.

CONSTRUCTION DETAILS

Chassis

The chassis is a computer designed welded carbon steel-plate box monocoque structure. Strengthening steel plates welded inside the box structure and preformed structural shaping form an equipment bay with separate compartments into which the batteries, hydraulic pump/motor, fluid tank, and the electrical control unit are housed. Each compartment is designed to contribute to the chassis strength and rigidity by virtue of shape rather than thickness. Extreme attention to anti-corrosion processes adds to the overall ‘design for application’ approach.

Lifting and Lashing Points

Lugs are fitted into each of four strong points. Two are located at the front of the Handler and one each to the outside of the two drive wheels. The points are for use with a four-legged sling or deck/floor lashing when the Handler is being hoisted or air transported.

Steering

Four powered steered wheels are mounted at the corners of the Handler. A signal input from the remote console powers the wheels to the required steering angle. The same signal input also varies the power output to the main drive wheels located at the rear of the Handler giving differential steering effect. On full lock the outer drive wheel will travel in the forward direction whilst the inner drive wheel would remain almost stationary. The powered steer wheels will align to the correct Ackerman geometry to enable each tire to contact the ground without any tire scrub to ensure maximum traction at all times. This results in a very maneuverable and stable Aircraft Handler. Three steer modes are available, this ensures the SHH can be maneuvered through and around a limitless number of obstacles normally preventing the use of an aircraft tow vehicle.

Capture Mode: Steering only available on the non-driven wheels.
Solo Mode: All wheel steer, enabling sideways driving.
Centre point steer Mode: the SHH will 'pivot' on the spot to enable tighter turns.

Traction Drive System

The main drive is from the two ‘in wheel hub motors’ located at the rear of the Handler each fitted with a unique integrated 3.5 KW A.C. Synchronous Motor. The motors are mounted directly in side the steel wheel section which in turn carries a 333 mm diameter x 127 mm wide purpose designed ‘deck friendly’ polyurethane tire. Each wheel is fitted with an Electromagnetic brake with a rating of 60 Nm torque on the drive wheels and 8Nm torque on the steer wheels, to act as an ultimate ‘Fail Safe’.

Brakes are only released under computer control when forward or reverse motion is selected. Under fully loaded conditions and travelling at top speed these brakes will stop the Handler within 600 mm.

Controls and Indicators

All controls and indicators associated with the control and operation of the Handler are located on the remote console. The console is connected to the Handler by a coiled Steel Wired Amour cable of 6 meters length (extended). The console houses the following functions:

Horn Button: Used for warning purposes

Night Loading Area Lights: Used to illuminate the lift area in low-level ambient lighting conditions

Forward/Reverse Joystick (Fitted with integrated 'Dead Man' switch): Steering Joystick. - Speed variable, centre bias

Hydraulic - Raise Button: Operation of this button will raise the Arms and automatically clamp the towing pins

Hydraulic - Lower Button: Operation of this button will lower the arms and automatically unclamp the towing pins

Hydraulic - Open Button: Operation of this button will open the arms.

> **Note:** for safety reasons the open/close functions will not work when the arms have been lifted. This is to prevent accidental opening of the arms when an aircraft has been lifted

Hydraulic - Close Button: Operation of this button will close the arms.

> **Note:** for safety reasons the open/close functions will not work when the arms have been lifted. This is to prevent accidental opening of the arms when an aircraft has been lifted

LED Warning Display: One indicator displays battery status and the other shows the alarm status

Emergency Isolating Pushbutton: This isolates the main battery voltage from the system and can be used in emergencies. Actuating this push button will immediately remove the power to the drive circuit and apply the electromagnetic brakes. This button is located on the remote chest pack.

> **Note:** There are three Emergency Isolating Pushbuttons located on the vehicle itself

Battery Isolating Switch: The battery isolating, ON-OFF- CHARGE-EBR switch is mounted on the chassis to the front side. It is used when operating the handler or charging the batteries, and in the OFF position isolates all circuits from the batteries. In an emergency situation, if the SHH cannot be moved by using the chest-pack, the EBR (Emergency Brake Release) mode may be engaged to release the brakes.

OPERATION OF THE HYDRAULIC SYSTEM

Closing the Arms

Pressing the CLOSE button on the remote console closes the solenoid-operated valve.

Current through the solenoid causes a relay to be energized, which routes the 48V D.C. supply to the pump motor. The motor runs and hydraulic fluid flows through the control valve and relief valve where it is regulated to a pressure of 100 Bar to the 'annulus' side of the hydraulic ram piston. The piston rod is retracted and the arms close around the nose or tail wheel. Pressure within the system is shown on the gauge.

Releasing the CLOSE button, switches off the pump. Pressure is retained within the system by the Pilot Operated Check Valve, which forms an integral part of the control valve.

Opening the Arms

Pressing the OPEN button on the remote console opens the solenoid valve and the internal ports in the valve route the hydraulic fluid to the output port then through a pressure relief valve to the 'full bore' side of the hydraulic jack piston. The piston extends and opens the jaw mechanism. Pressure in the system is regulated at 125 Bar by a pressure relief valve separate from that in the 'Close' hydraulic circuit.

Close/Open Valve Safety Interlock

The 'Close/Open' control valve cannot be operated when there is pressure present in the lift jack hydraulic line controlled by the Arms Raise/Lower valve. Pressure in the line locks the Arms Open/Closed valve in the closed position throughout the Arms Raise/Lower sequence until the pressure in the line is released. The interlock ensures that the jaws can only be opened when there is no additional load on the lift arms.

Raising the Arms

Pressing the RAISE button on the remote console opens the solenoid valve.

Current through the solenoid causes a relay to be energized which routes the 48V D.C. supply to the pump motor.

The motor runs and hydraulic fluid flows through the control valve and relief valve where it is regulated to a pressure of 180 Bar.

Lowering the Arms

Pressing the LOWER button on the remote console opens the solenoid valve. Current through the solenoid causes a relay to be energized which routes the 48V D.C. supply to the pump motor. The internal ports in the valve route the hydraulic fluid to the output port then through a pressure relief valve to the ‘annulus’ side of the hydraulic jack piston. The piston retracts and lowers the arm mechanism.

ELECTRICAL SYSTEM

General

Electrical power is derived from two banks of 12 x 2 volt Valve Regulated Lead Acid batteries connected in series.

Seven electric motors are fitted; two supply the traction power and four are the steering axle control motors, the last is the hydraulic pump motor. The control system of the traction and steer motors are composite in nature in that they utilizes the dominant features of both electro-mechanical and solid state devices using MOSFET technology and CANBUS communications. Control of the pump motor is through a switched relay and contactor.

Ten High Intensity LED work lights are fitted. These permit the Handler to be attached to the aircraft and used without recourse to auxiliary lighting in situations of low light intensity. While in 'Capture' steer mode the four Red lights are switched on to illuminate the capture area. During 'Solo' steer mode the four white lights are switched on to illuminate the area around the vehicle. The last two lights are the 'Loaded' green lights, which are switched on when the matrix system is loaded.

Provision is made to re-charge the batteries from a suitably rated AC supply through a built-in charging unit. A battery discharging indicator unit is provided on the vehicle. This gives visual indication when the batteries need to be recharged and serves as a continuous state-of-charge indicating device.

Speed Controller

The speed control unit is housed on an aluminum base plate that is bolted to the chassis main frame.

The main features are:

- High frequency MOSFET switching technology.
- Real-time control over the internal and external factors that influence the behavior and performance characteristics of the Handler with self-diagnosis of the checking circuits themselves.

Stored program machine configuration (SPC) where the hardware is completely separate from the configuration functions. The program is parametric and can be modified by the end

user.

Various chopper configurations can be selected by the user, without the need for hardware modifications.

Future technology and software updates are easily made easy for the user.

Logic and power units are fitted in sealed enclosures (IP54).

Battery Isolating Switch

The battery-isolating switch is the main current carrying switch. It is a heavy-duty, four position rotary switch. Each position is identified in accordance with its particular functions as follows:

- In the 'ON' position the battery's 48 V DC positive output terminal is connected through the 425 amp fuse - F100 - to the speed control unit.
- The 'OFF' position disconnects the battery from all the motors, control, indicator and lighting circuits.
- In the 'CHG' position the battery is connected to the battery charger output.
- In the EBR position, the electromagnetic brakes are released if required in an emergency situation.

CURRENT LIST OF COMPATIBLE AIRCRAFT

Aircraft
Buccaneer
Lightening
Jaguar
Sea-King
Wessex
Mirage 111S
Mirage 111C
Kaman HH2
Hunter
Puma
F5E Northrop
A109
F15
AMX (Italy)
NH 90 NFH
F104 (Grumman)
JCA
Merlin
Harrier GR7/9
Sea King Mk7
MASC *
Apache
JSF (STOVL) *
SCMR (Future Lynx) *
NH90
SH60 Seahawk
CH53
V22 Osprey *
EH101 (and EH101 variants)
Sikorsky MH60-R
Sikorsky MH60-S
Sikorsky MH60-M and variants
Denel Oryx
F18
F16
F22
Shorts Highlander
MRH90
*Simulations from current data availability

Note: this list is by no means exhaustive, this list refers to the most popular current uses; contact INDAL Technologies if the aircraft you require is not listed.