ECMO Transport System

Description
&
Operation Manual

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ECMO Transport System, Description & Operation Manual

DISCLAIMER AND LIMITATION OF LIABILITY

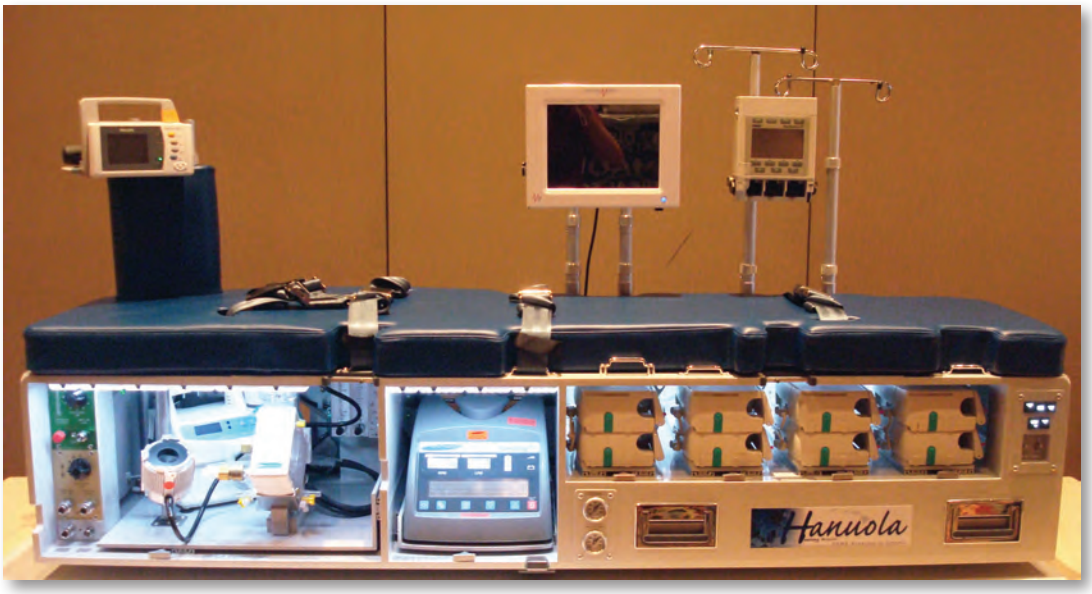
This *Description and Operation Manual* is intended to provide a general understanding of the ECMO Transport System's basic functions, manner of use, and component parts. It is not intended to nor does it replace the manufacturer's instructions manual. It should not be used or relied upon as a training manual. Kapiʻolani Medical Center for Women & Children and the other organizations that have participated in the Hanuola ECMO Program of Hawaiʻi expressly disclaim the accuracy or completeness of the information contained in this manual or that the information is warranted in any way, including merchantability or fitness for any particular purpose.

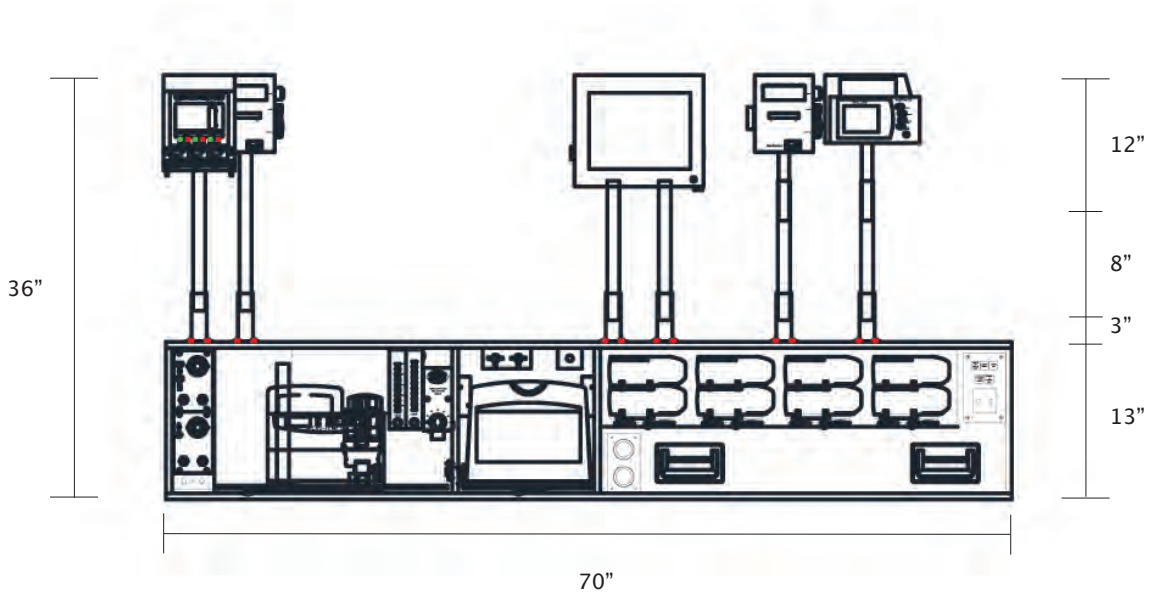
INTRODUCTION

This Description and Operation Manual describes the Hanuola Extracorporeal Membrane Oxygenation (ECMO) Transport System (ETS) and its basic operation in a ground ambulance, medical aircraft, and hospital environment. ("Hanuola" means "healing breath" in the Hawaiian language).

DESCRIPTION

The Hanuola ECMO ETS is a custom-designed, FAA-approved, medical platform. It is lightweight, portable and functional in many modes of transportation, including ambulance and fixed-wing aircraft. The ECMO equipment and circuitry are all contained within the footprint of the frame, with independent gas and electrical systems incorporated into the design. Space for eight syringe pumps, a circuit heater, lighting and an air/oxygen blender are also provided within the framework. Slide-out trays make the equipment and circuitry accessible, while multiple attachment points can accommodate the use of a variety of patient monitors and ventilator and intravenous pumps. The ETS five-point harness system provides safe restraint for patients ranging from infant to adult.





DESCRIPTION

1. Medical Equipment

The ETS was specifically designed, engineered and tested for use with the following medical equipment:

- Pulmonetics LTV 1200 Ventilator
- Cincinnati SubZero Heater
- Sechrist Air/Oxygen Blender
- Jostra Quadrox D or iD Oxygenator
- Maquet Rotaflow Centrifugal Pump
- Levitronix CentriMag Centrifugal Pump
- BBraun Space Perfusor Medication Infusion Pump (8)
- Phillips MP2 Patient Monitor
- Spectrum M3 Monitor
- Alaris Triple Channel IV Pumps(s)
- Aluminum E Cylinder Air
- Aluminum E Cylinder Oxygen

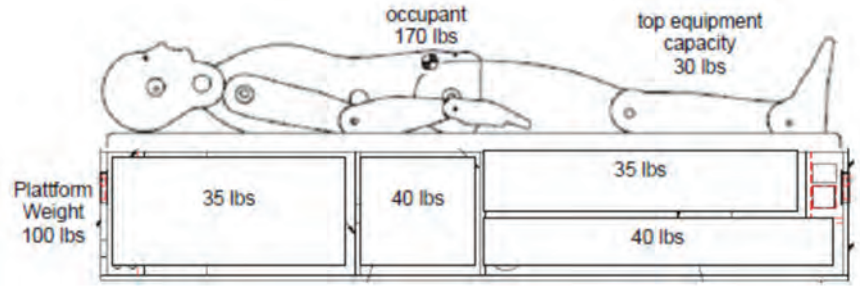
2. Basic ETS Construction Components

- Basic Bed, Honeycomb Panels (1/2" p/n NB610-10733-500B [Nordam])
- Medical Oxygen Cylinder (p/n ME [24] Hy-Maryk Cylinders)
- Oxygen Valve (p/n P870-3-4-3360)
- CGA-870 Medical O2 Regulator (p/n FMDO0 296HF)
- Industrial Cylinder (p/n N-24 Hy-Mark Cylinders. Inc)
- CGA-950 Medical Air Valve (P950-3-4-3360)
- CGA-950 Medical Air Regulator (p/n FMDA05117HF)
- (2) Min. Industrial Pressure Gauge (p/n PGI-50M-PG3000-CAQX)
- Time Delay Relay (p/n 24D F/F HDFA)
- 115VAC to 24VDC Converter (SWS100-24)
- (5) 15AMP 125V Receptacle (p/n 1374-1)
- 115 VAC to 12VDC Converter (p/n LS100-12)

For a complete list of all parts and equipment installed, see Section 5.b., ETS Power Matrix.

3. Maximum Design Weight

The ECMO Platform's capacity weight by compartment.

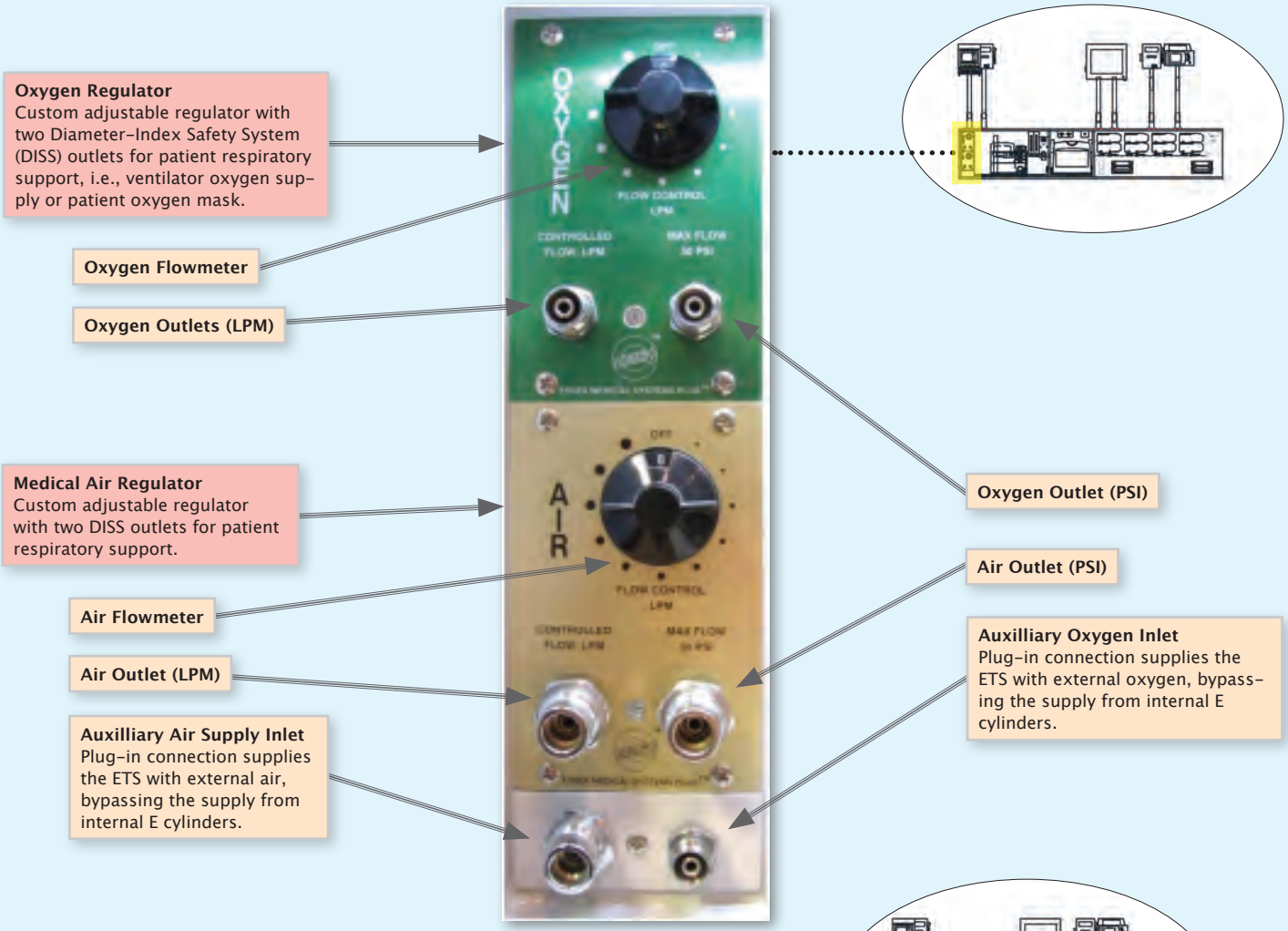


Description	Weight/Capacity
Occupant	170 lbs
Top Equipment	30 lbs
ECMO Platform Assy	100 lbs
Forward Compartment	35 lbs
Middle Compartment	40 lbs
Aft Lower Compartment	40 lbs
Aft Upper Compartment	35 lbs
Total Weight	**450 lbs**

NORMAL OPERATION SYSTEMS

1. Medical Gas Supply Systems – Description

1.a. Outlets for Oxygen and Medical Air



Oxygen Regulator
Custom adjustable regulator with two Diameter-Index Safety System (DISS) outlets for patient respiratory support, i.e., ventilator oxygen supply or patient oxygen mask.

Oxygen Flowmeter

Oxygen Outlets (LPM)

Medical Air Regulator
Custom adjustable regulator with two DISS outlets for patient respiratory support.

Air Flowmeter

Air Outlet (LPM)

Auxilliary Air Supply Inlet
Plug-in connection supplies the ETS with external air, bypassing the supply from internal E cylinders.

Oxygen Outlet (PSI)

Air Outlet (PSI)

Auxilliary Oxygen Inlet
Plug-in connection supplies the ETS with external oxygen, bypassing the supply from internal E cylinders.

1.b. Pressure Gauges and E Cylinders for Medical Air and Oxygen

Top Pressure Gauge
Displays the amount of oxygen in the internal E cylinder.

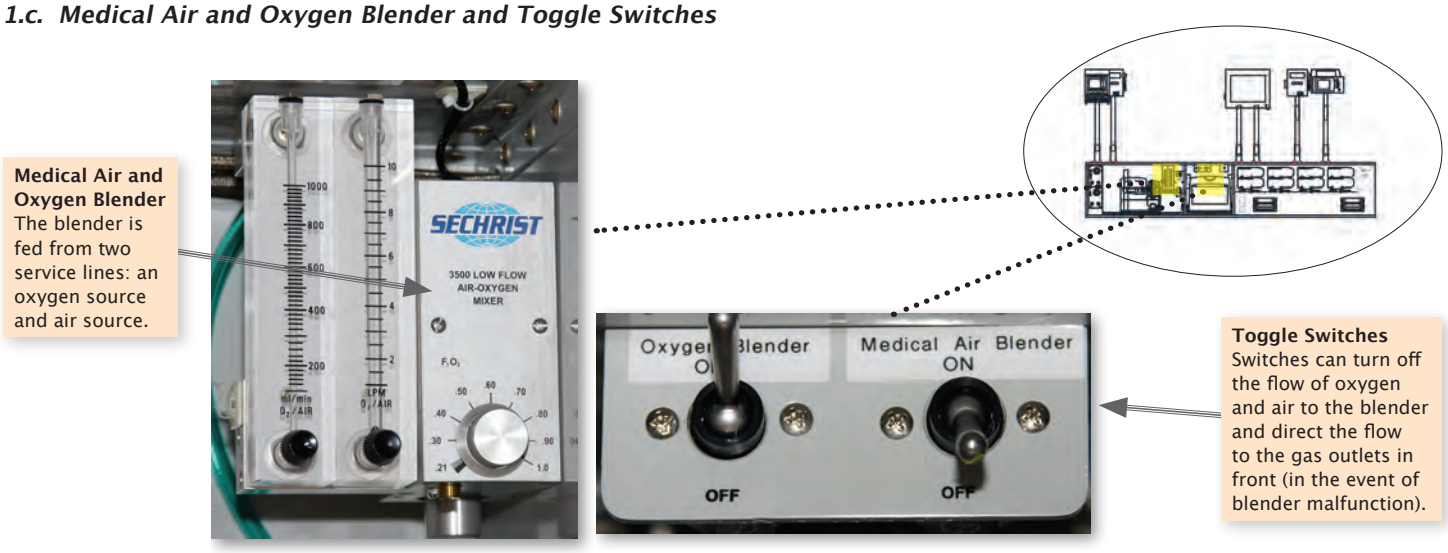
Bottom Pressure Gauge
Displays the amount of air in the internal E cylinder.

E Cylinders
Internal cylinders for medical air and oxygen are contained on the end of the ETS. The compartment is accessed through a latched door and is lined with Teflon for fire resistance and skid protection.

NORMAL OPERATION SYSTEMS

1. Medical Gas Supply Systems – Description

1.c. Medical Air and Oxygen Blender and Toggle Switches



2. Medical Gas Supply Systems – Operation

2.a. Internal Medical Air and Oxygen E Cylinders – Operation

• Using a tank key (not provided), the air and oxygen E cylinders can be turned on to verify the pressures on the gauges in the center front panel. (See Section 1.b., Pressure Gauges).
• The tank key can turn off the oxygen and air E cylinders when not in use to prevent inadvertent use of gas supply.
• The E cylinders must be removed from the ETS to be refilled.
• Only one air and one oxygen E cylinder will fit into the compartment.

2.b. External Medical Air and Oxygen Supply – Operation

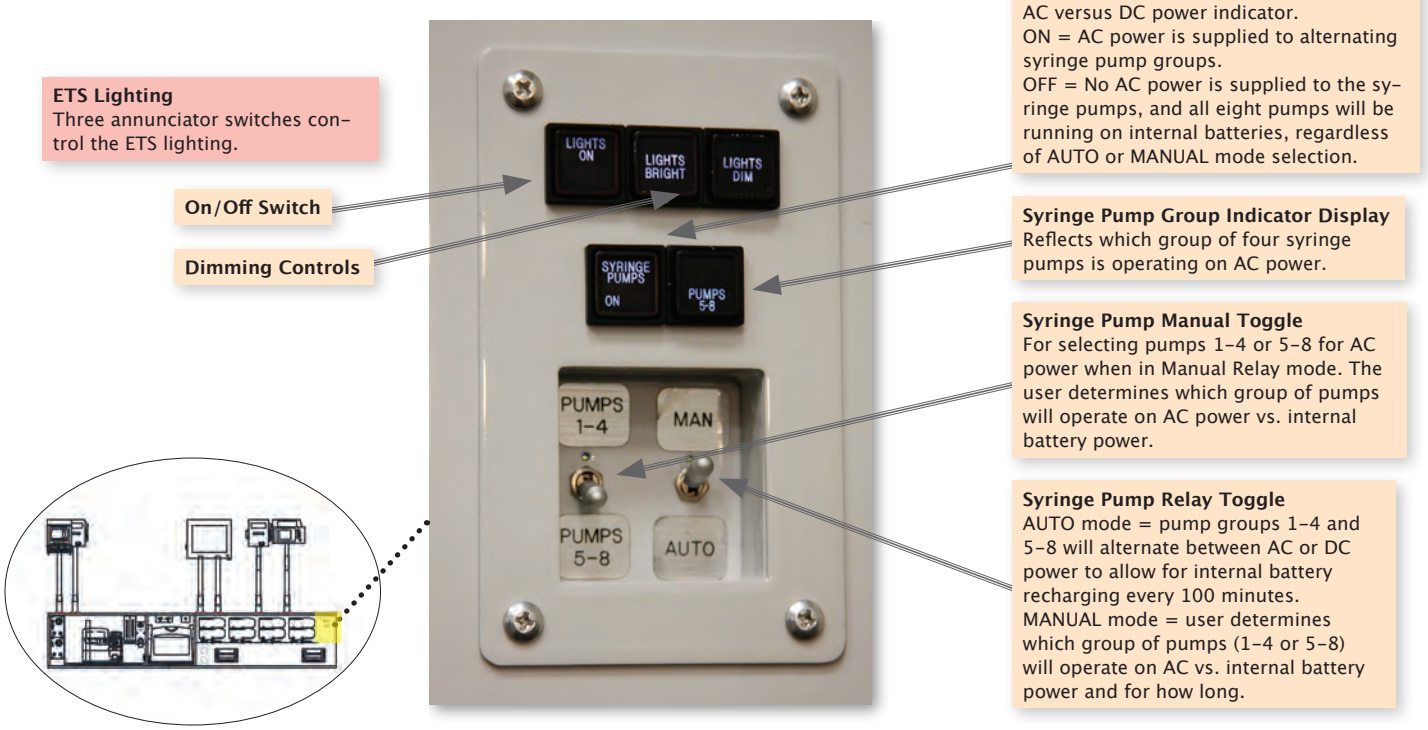
• For use in hospitals, ambulances, aircraft.
• Auxiliary air and oxygen supply inlets are located on the lower front panel, underneath the air and oxygen outlets, at the head of the ETS. (See Section 1.a., Auxiliary Air/Oxygen Inlets).
• These connections supply the platform with external air and oxygen and bypass the supply offered by the ETS internal cylinders.
• Air and oxygen gas hoses, at least 15 feet long, should be permanently connected to these inlets and mounted on the front end of the ETS for quick access.
• The compatibility of all air and oxygen inlet/outlet "quick connect" adapters/couplers should be verified in all medical transport vehicles and hospital facilities.
• Once the ETS is operating under external gas supply, the internal air/oxygen E cylinders should be turned off.
• When transitioning back to an internal gas supply, the E cylinders should be turned on before disconnecting from the external gas supply.

2.c. Air/Oxygen Blender and Controls

• The Air/Oxygen Blender has two service lines, one from an oxygen source and one from an air source.
• Under normal operation oxygen and air will flow from the gas sources to both the Air/Oxygen Blender and to the oxygen and air OUTLETS on the front panel at the head of the ETS.
• In the event of an Air/Oxygen Blender malfunction, two toggle controls have been installed to turn off the oxygen and air gas flow to the Blender and direct gas flow to the front panel gas outlets. (See Section 1.c., Toggle Switches).

3. Lighting Systems

4. Syringe Pumps



4. Syringe Pumps

4.a. Power Distribution

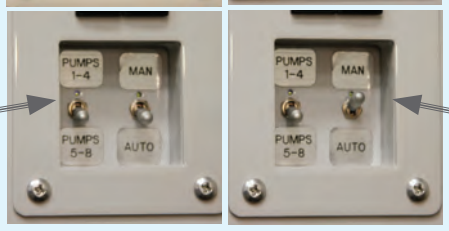
A timed relay alternates AC power between pumps 1-4 and pumps 5-8. This allows for one group of pumps to be charged while the others rely on their internal batteries. Both sets of pumps are fully operational. In the auto mode, the relay switch between power sources occurs automatically every 100 minutes. The manual mode allows you to immediately switch power from one group of pumps to the other (overriding the timed relay).

4.b. Operation Modes

AUTO Mode #1
In this configuration, pumps 1-4 are operating on AC power while pumps 5-8 operate on internal batteries. Automatic relay timing switches the power supply every 100 minutes to recharge the internal batteries.

MANUAL Mode #1
Pumps 1-4 are operating on AC power while pumps 5-8 operate on internal batteries. Switching the power source is done by toggling between the pump groups. Caution: be aware of the internal battery status of each pump.

AUTO Mode #2
Pumps 5-8 are operating on AC power while pumps 1-4 operate on internal batteries. Automatic relay timing switches the power supply every 100 minutes to recharge the internal batteries.



MANUAL Mode #2
Pumps 5-8 are operating on AC power while pumps 1-4 operate on internal batteries. Switching the power source is done by toggling between the pump groups. Caution: be aware of the internal battery status of each pump.

Caution: To prevent overload of the electrical system, all eight syringe pumps cannot run on AC power at the same time. (See Section 5.f., Electrical System).

NORMAL OPERATION SYSTEMS

4. Syringe Pumps

Syringe Pump Power Cords
Cords are hardwired into the platform and cannot be removed. Individual syringe pumps can be removed from the platform for access to auxiliary power sources or to change internal batteries by disconnecting the power cord from the back of the pump.

5. Electrical System

Most medical transport vehicles, whether air or ground, possess electrical inverts capable of converting DC power to AC power. Operators must verify the power capacity and limitations in each vehicle and verify that the total ETS power draw will not exceed the specified limits. The ETS has been designed not to exceed a total of 10.5 amps of power draw if the equipment is operated under normal conditions and as outlined in this manual. Power surges may occur in extreme environments or clinical situations. Anticipation of these events and control over the total amount of power draw to the various electrical components of the ETS may be required.

5.a. Access

The electrical system consists of an electrical circuit for equipment that is hardwired into the ETS and an electrical outlet strip for specific plug-in equipment.

5.b. ETS Power Matrix

Equipment	Weight (lb)	Weight (kg)	Current Draw (amps)	Battery Time (min)
Maquet Rotaflow System	31	14.4	2	90
Maquet Rotaflow Drive unit	7	3.2	n/a	n/a
Maquet Rotaflow hand crank	4.8	2.2	n/a	n/a
Phillips MP2 Monitor	3.3	1.5	1.3	180 (3 hrs)
CSZ Heater	11.4	5.2	1.75	n/a
Spectrum Medical M3 monitor	7.7	3.5	1.35	20
Hardwired Equipment				
Braun Space Perfusor syringe pump	3	1.4	0.55	480 (8 hrs)
Optional Equipment				
Levitronix Centrimag primary console	11	5	1.2	60 (1 hr)
Levitronix Centrimag backup console	8.7	4	1.5	120 (2 hrs)
Pulmonetic LTV 1200 Ventilator	14.5	6.3	5.5 powerup, 4 run	60 (1 hr)
Pulmonetic Srint Battery Pack LTV	4.5	2	n/a	300 (5 hrs)
Alaris MedSystem III triple pump	5.1	2.3	0.05	360 (6 hrs)

NORMAL OPERATION SYSTEMS

5. Electrical System

5.c. Power Sources

Power to the ETS comes from three sources:

1. Direct AC power – i.e., a wall outlet
2. Medical transport vehicle DC to AC inverter – i.e., ambulance or aircraft
3. Portable battery pack

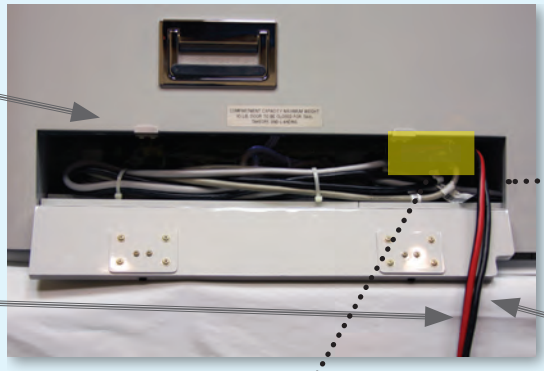
5.d. AC/DC Cords

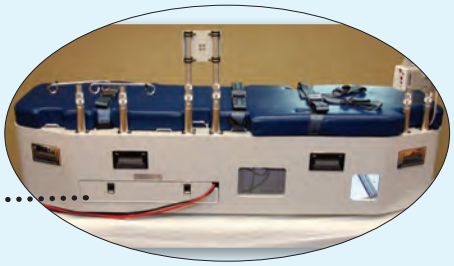
Two power cords are hardwired into the ETS and provide access to AC power and/or DC power.
Caution: The medical equipment shown is the ONLY equipment that should be plugged into the electrical outlets on the power strip in order to prevent system overload.

Access Panel
The electrical system is accessed through a hinged door panel on the back of the ETS.

The Red Cord
Provides power to the vital equipment:
• Maquet Rotaflow/Levitronix Centrimag centrifugal pump
• Spectrum M3 monitor

The Red Power Strip
1. The power strip has two designated outlets, identified by red tape, reserved for the centrifugal pump and Spectrum monitor.
2. The power cords for these pieces of equipment must be plugged into these designated outlets.





The BLACK Cord
Provides power to the ancillary equipment:
• CSZ Heater
• Phillips MP2 patient monitor
• BBraun syringe pumps
• LED lights

The BLACK Power Strip
1. The power strip has three designated outlets, identified by black tape, that are reserved for the heater and patient monitor.
2. The power cords for this equipment must be plugged into these designated outlets.
3. The syringe pumps and LED lights are hardwired into the ETS.

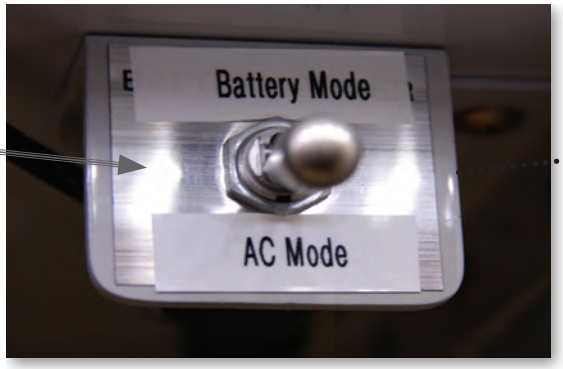
5.e. Battery Selector Control

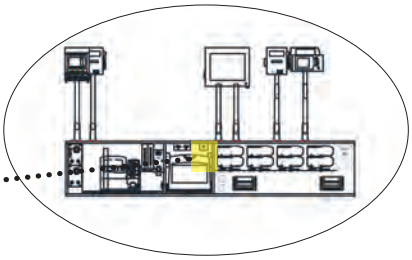
For normal ETS operation under AC power, the Battery Selector Switch should be in the AC mode. For ETS operation with a portable battery pack, the Battery Selector Switch should be in the Battery mode.

5.f. Battery Mode

The **Black** power cord will supply battery power ONLY to the heater. The **Red** power cord will supply battery power *only* to the centrifugal pump and the Spectrum monitor. All other equipment will operate on internal batteries. The LED lights will not function in Battery Mode.

Battery Selector Switch





NORMAL OPERATION SYSTEMS

5. Electrical System

5.g. Electrical Operating Modes

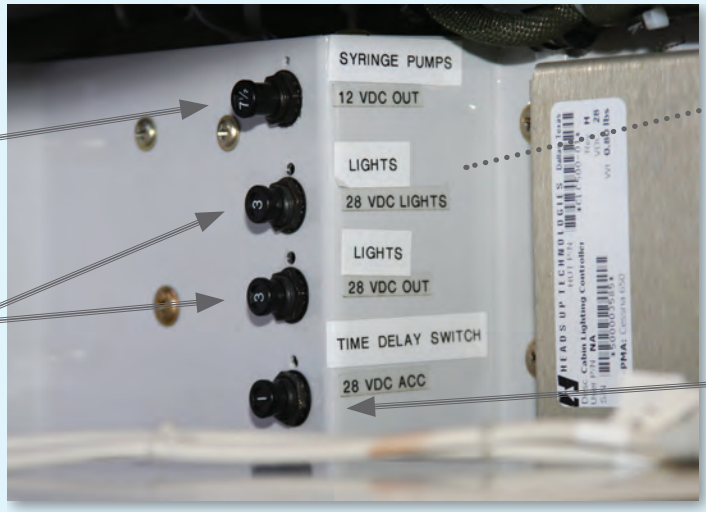
DIRECT AC POWER – I.E., HOSPITAL WALL OUTLET
Both the **Red** and the **Black** power cords are plugged into wall AC outlets.
All equipment is running on AC power and charging internal batteries.
Syringe pump groups (1–4 and 5–8) autocycle between AC power and internal battery power.
Syringe pump batteries charge when in the AC mode of the cycle.

AMBULANCE/AIRCRAFT INVERTER
Both the **Red** and **Black** power cords are plugged into the vehicle inverter.
All equipment is running on AC power through the inverter and charging internal batteries. Inverter power capacity should be verified.
Syringe pump groups (1–4 and 5–8) are auto cycling between AC power and internal batteries. Syringe pump batteries charge in the AC mode of the cycle.
The system as configured will draw 10.5 amps of power.
Caution: Do NOT add equipment to ETS power strip inverter without verifying the inverter capacity.

PORTABLE BATTERY PACK (GEODATA SYSTEMS YARD DOG TRANSPORT BATTERY)
Red power cord plugged into the Portable Battery Pack outlet.
The centrifugal pump and Spectrum monitor will run on the Portable Battery Pack (DC) power.
The power draw is limited to 3 amps for this battery pack.
The **Red** power cord supplying the vital equipment requires its own designated Portable Battery Pack.
Use a second Portable Battery Pack to supply battery power to the heater or alternate equipment using the **Black** power cord.

5.h. Circuit Breaker Panel

The panel is located in the aft inner platform to provide protection for the ETS hardwired equipment and connections. In the event that a circuit breaker is tripped, the circuit can be re-set by flipping the switch back on (if the breaker trips a second time, Do NOT re-set it. Evaluate the total power draw and assess for overload or equipment failure). See Section 5.b., ETS Power Matrix, for a list of hardwired equipment.



Syringe Pumps
Power comes from a 12-volt DC converter protected by a 7.5-amp circuit breaker.

LED Lights
Power comes from a 28-volt DC converter protected by a 3-amp circuit breaker. [2 dotted lines to knobs 2, 3]

Time Delay Switch for Syringe Pumps
Power comes from a 28-volt DC converter ACC.

NORMAL OPERATION SYSTEMS

6. ETS Loading and Unloading

6.a. ETS Lifting

Caution: Use only the recessed handles to lift the ETS. Do NOT lift by grasping the frame or footman loops.

Handles
Seven recessed, side-mounted lifting handles are provided around the ETS. To ensure stability, enough personnel should lift the ETS from all four sides.

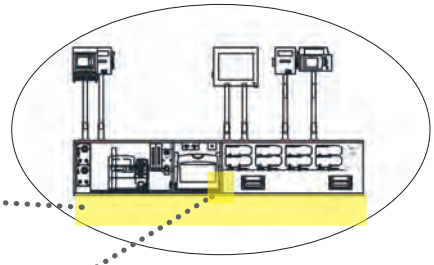
6.b. Medical Base

The ETS is a Lifeport compatible platform that allows for direct interface with a standard medical base unit in an aircraft or ambulance. Two base mounts with side locking pins under the ETS allow for sliding into the base tracking system. The ETS features automatic locking and single-hand release mechanism for securing onto the medical base.

6.c. Aircraft Loading

The ETS interfaces directly with the Lifeport medical base system in an aircraft.

- **Base Mounts.** Lift the ETS using the recessed, side-mounted handles to position the base mounts and pins over the medical base. Retract by pulling the release latch located near the ETS center. Once the ETS is resting on the medical base, release the latch and slide the ETS into a locked position to engage the four pins.
- **Securing the Mount.** To ensure the ETC is firmly secured to the medical base, grasp one end and attempt to slide forward or aft. Reposition if necessary until the ETS is firmly secured.
- **Removal.** To remove the ETS from the medical base, pull the release latch and lift with the side-mounted handles.



Base Mount

Release Latch

NORMAL OPERATION SYSTEMS

6. ETS Loading and Unloading

6.d. Gurney Loading

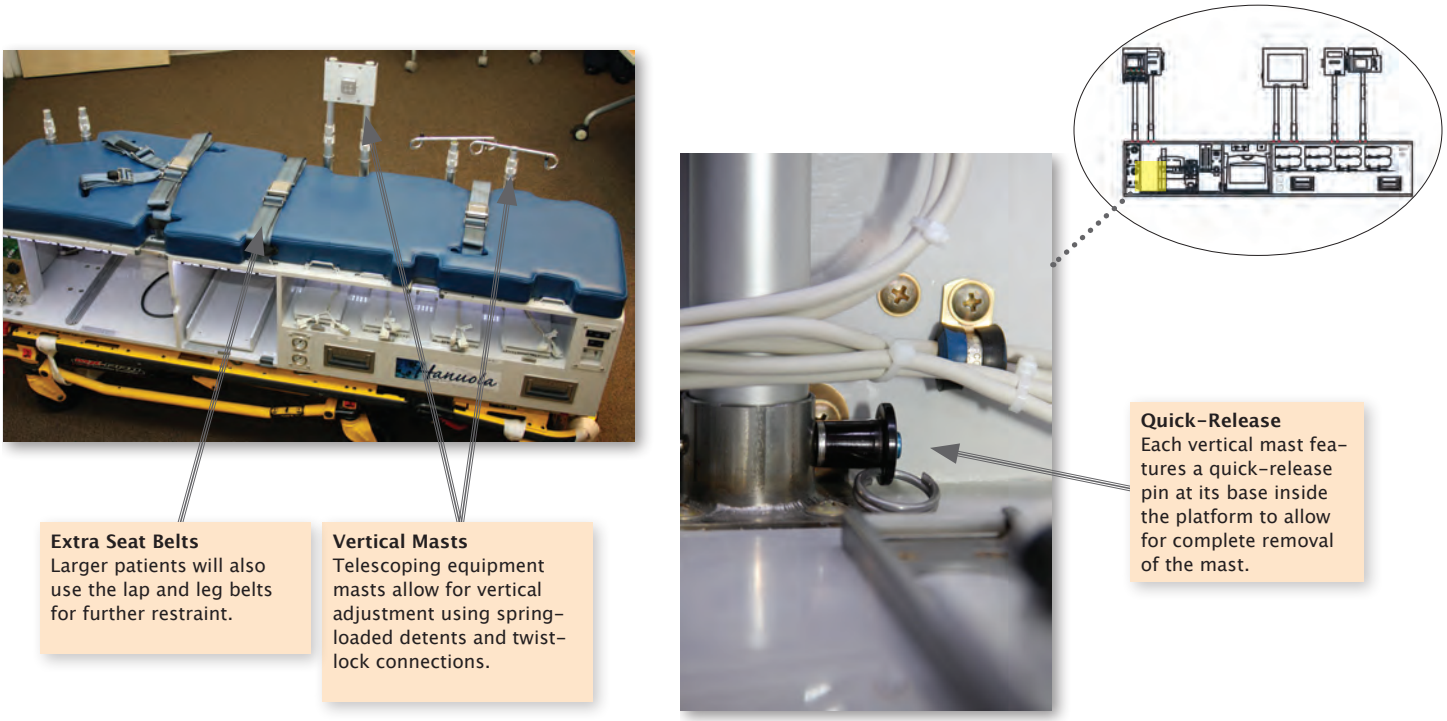
- Secure a Lifeport clip deck onto an acceptable medical gurney.
- Lower the gurney into its lowest position for stability and ease of transfer.
- Lift the ETS using the recessed, side-mounted handles to position the base mounts and pins over the clip deck
- Retract by pulling the release latch located near the ETS center.
- Once the ETS is resting on the clip deck, release the latch and slide the ETS into locked position to engage the four pins.
- Grasp one end of the ETS and attempt to slide forward or aft to ensure it is firmly secured to the clip deck and gurney. Reposition if necessary until the ETS is firmly locked into the clip deck.
- To remove the ETS from the clip deck, pull the release latch and lift with the side-mounted handles.

Caution: The protruding base mounts may result in the ETS being unstable on hard, flat surfaces not designed to accommodate the interface. Use caution when placing or storing the ETS on any surface not specifically designed to accommodate it in order to protect equipment and personnel.

7. ETS Patient Deck

7.a. Vertical Masts

The twist-lock connections can be released by turning counter-clockwise, then secured with a clockwise rotation once positioned. Removable IV adapters can be added to the top of any mast.



7.b. Seat Belts

The four-point harness and seatbelt system is made with washable, waterproof nylon and must be used for all patients in transport. Infants may require additional nesting to provide patient comfort.

7.c. Mattress

The four-inch patient mattress is fire-retardant, stain-resistant, and fluid-repellent. It should be cleaned between patients with a hospital-approved anti-bacterial product.

NORMAL OPERATION SYSTEMS

7. ETS Patient Deck

7.d. Footman Loops

Eight footman loops around the deck provide extra anchors for additional equipment straps. Two loops can be used to mount a patient ventilator to the front of the ETS.

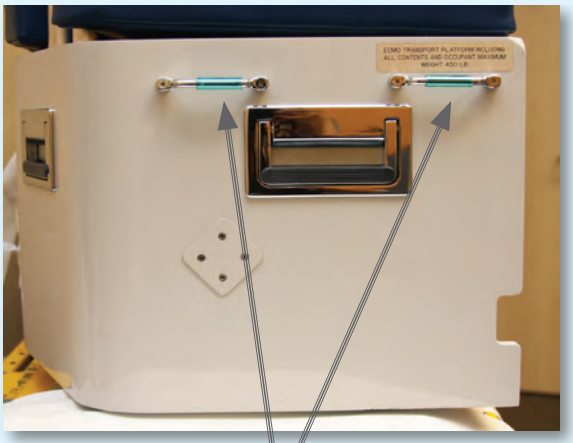
7.e. Slide Covers

Spring-loaded slides provide protection for the ECMO circuit tubing and syringe pump tubing. Two slides cover two cut-outs in the mattress, fore and aft.

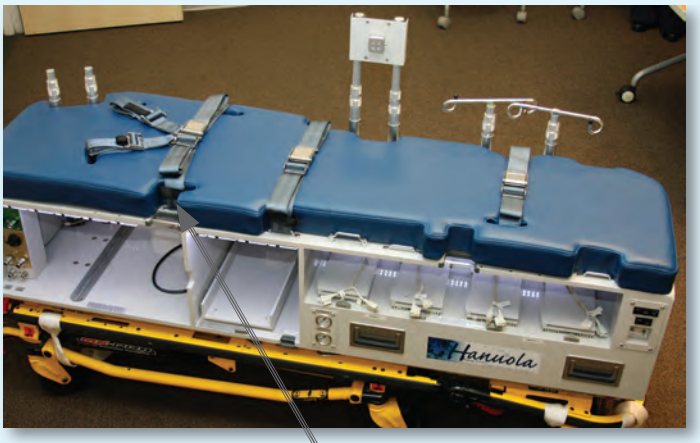
7.f. Access Trays

Three compartments in the ETS each contain various-sized removable, slide out trays to provide access to equipment.

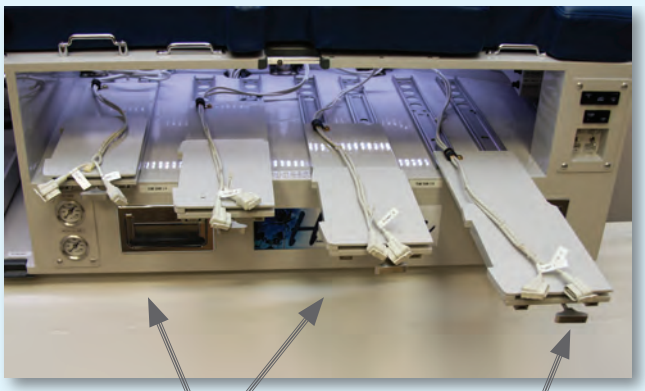
- To slide out the tray, grasp the tray handle located on the center/front edge of each tray and pull. To return the tray to its locked position, push the handle back and ensure that it "clicks" into place.
- To completely remove the tray, locate the track underneath the tray and depress the release tab in the indentation. Slide the tray forward and out. Ensure the compartment equipment does not hamper the movement of the tray or track.



Footman Loops



Slide Covers



Access Trays

Release Handle

Slide Cover Release Tab

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