



Electrifying a Sustainable Future

**High Voltage
Shore Connections (HVSC)
for
Commercial Shore Power Applications**

We will cover key topics including:

- Industry standards
- Subsystems of a shore power system
- IEEE 80005 shore power sockets and plugs
- Applications (cruise, Ro-Ro, and container vessel)
- Shore Power vault solutions – system overview, precast versus cast-in-place
- Lessons learned
- Resources



Purpose: to reduce at-berth emissions and associated health impacts from diesel auxiliary engines on-board vessels calling the ports.

IEC/IEEE 80005 Shore Power Standard

Requirements - Container Vessels

Requirements - Cruise Vessels

Requirements – Ro-Ro Vessels

Shore Power also known by its variety of trade names and acronyms:

Cold Ironing

Shore-to-Ship Power

Alternative Maritime Power (A.M.P.)

On-shore Power Supply (O.P.S.)



Shore Power Solutions



Commercial Shore Power Solutions

Where are At-Berth regulations currently enforced?

- USA – California ports – Required, other states – voluntary
- Canada – Voluntary (Currently installed in Port of Vancouver, BC, Prince Rupert, Montreal, etc.)
- European Union has similar regulation – mandatory by 2035
- Asia and other countries – Voluntary

California CARB At-Berth Regulations

Shore Power connection as a method to reduce emissions in CA ports has been mandatory in progressive vessel call frequency percentage since early 2000's.

The following is 100% connection effective date for various vessel categories:

Container & refrigerated cargo vessels	January 1, 2023
Cruise (passenger) vessels	January 1, 2023
Roll-on Roll-off vessels	January 1, 2025
Tanker vessels visiting (POLA & POLB)	January 1, 2025
All remaining tanker vessels	January 1, 2027



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Safety, Compliance, and Environment



Safety-Interlocked Connections

Prevents accidental energizing with a Kirk-lock and key system during plug-in or removal connections.



IEEE 8005 Shore Power Standard

Shore power connections follow international standards for cross compatibility.

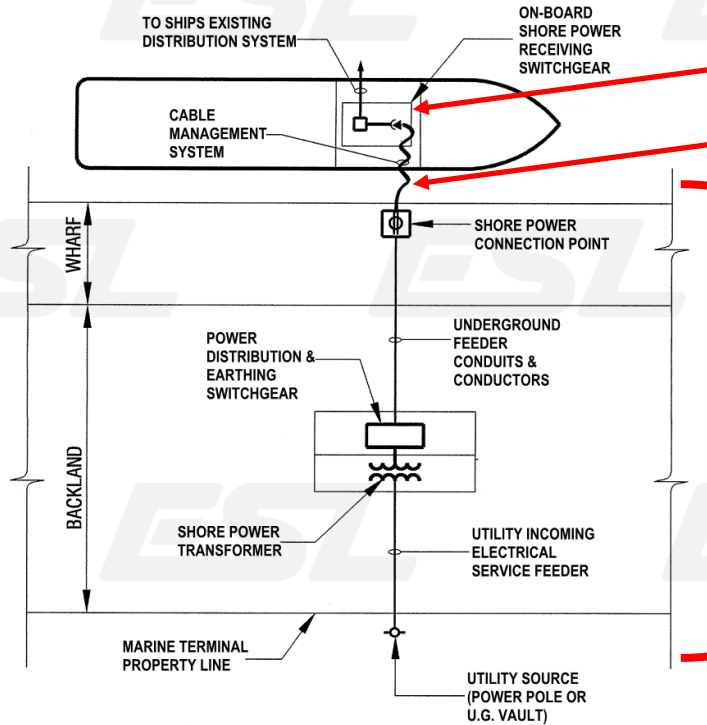


Reduced Environmental Impact

Reduces emissions and noise for cleaner air and a quieter port.



Commercial Shore Power Solutions



3 

Ship Side
Infrastructure

2 

Cable
Management

1 

Shore Side
Infrastructure

Shore Power is the electrical power distribution, delivery and connection system enabling a ship to connect to shore-based electrical source, while at moored at berth.

SHORE POWER SCHEMATIC DIAGRAM

PREPARED BY: H3 ENGINEERING SOLUTIONS, INC.
VAHIK HADDADIAN, P.E.

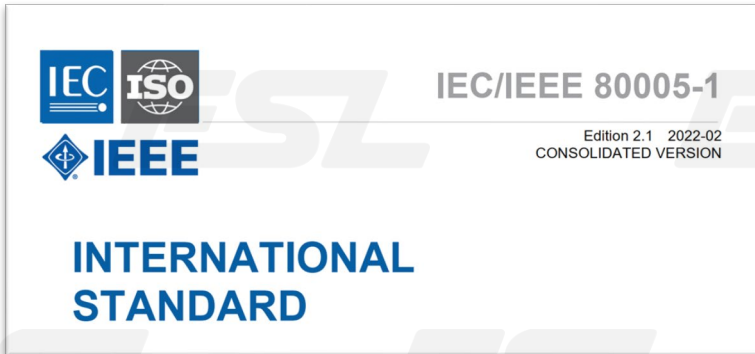


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Shore Power International Standards:

IEC/ISO/IEEE High Voltage Shore Connection (HVSC) Standard

80005-01 - High Voltage vessels 6.6 kV, 3-phase & 11 kV, 3-phase, larger than 1 MVA load
(Published by IEC, currently in use)




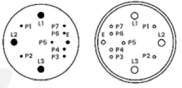
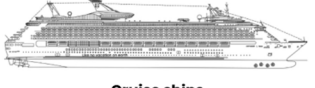
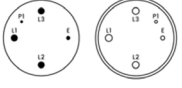


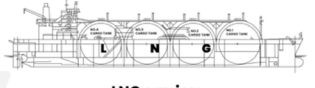
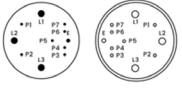
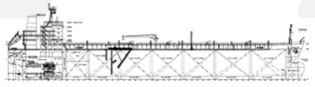
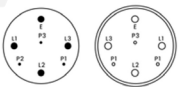
High Voltage > 1 MVA	Operability	Dimensions	Plug
 <p>Ro-Ro cargo and Ro-Ro passenger ships</p>	<p>80005-1 Annex B Normative</p>	<p>62613-2 Annex J</p>	
 <p>Cruise ships</p>	<p>80005-1 Annex C Normative</p>	<p>62613-2 Annex G/H</p>	
 <p>Container ships</p>	<p>80005-1 Annex D Normative</p>	<p>62613-2 Annex I</p>	
 <p>LNG carriers</p>	<p>80005-1 Annex E Informative</p>	<p>62613-2 Annex J</p>	
 <p>Tankers</p>	<p>80005-1 Annex F Informative</p>	<p>IEC 62613-2 Annex I</p>	
<p>Other</p>	<p>80005-1 Not defined</p>	<p>62613-2 As appropriate</p>	<p>Not defined</p>

Table from sustainable-ships.org

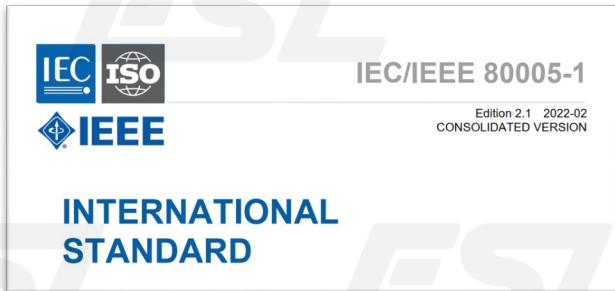


Commercial Shore Power Solutions

Shore Power International Standards:

80005-03 - Low Voltage vessels up to 690 V, 3-phase and 1 MVA load (standard under development)

Future standards under consideration:
 Electric vessel DC connection/charging
 Automatic and autonomous vessel connection



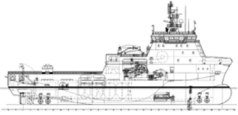
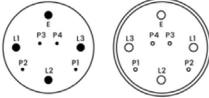

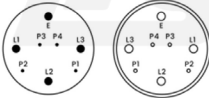
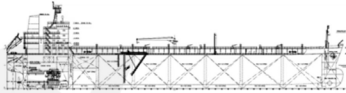
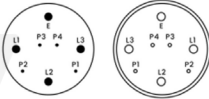
Low Voltage < 1 MVA	Operability	Dimensions	Plug
 Offshore supply, service, working ships	80005-3 Annex B Normative	IEC 60309-5	
 Container Ships	80005-3 Annex C Normative	IEC 60309-5	
 Tankers	80005-3 Annex D Informative	IEC 60309-5	
Other	80005-3 Not defined	IEC 60309-5 As appropriate	Not defined

Table from sustainable-ships.org



Cruise Vessel Shore Power



Typical cruise vessel

- Four power receptacles per vessel connection
- Up to 24 MVA per berth, per vessel capacity
- System voltage of 6.6 or 11 kV, 3-phase
- On-shore vessel cable management system



Shore based mobile cable management system



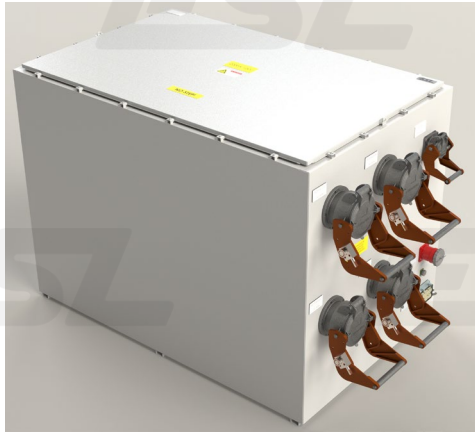
Cruise vessel connection point on-board vessel



High Voltage Shore Connection (HVSC)



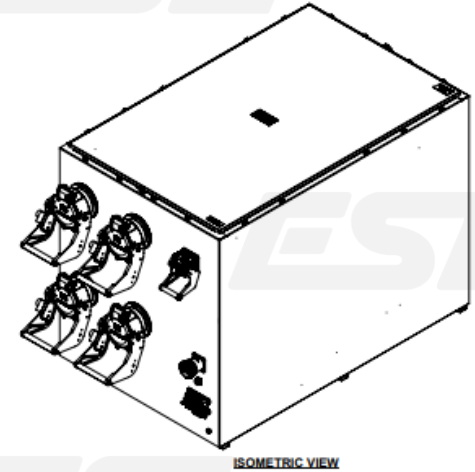
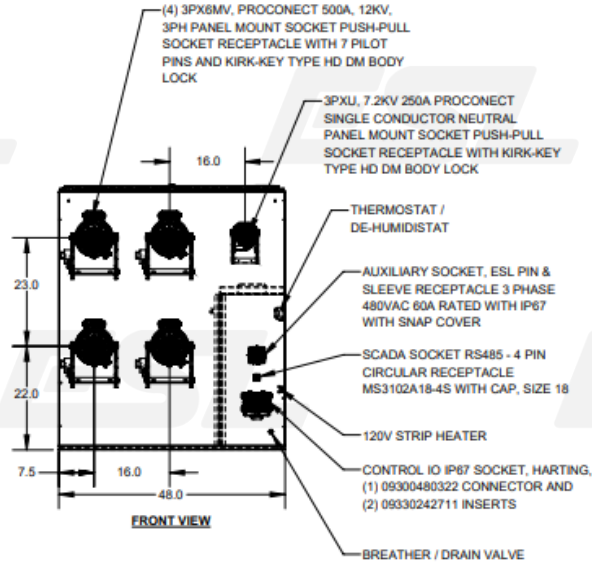
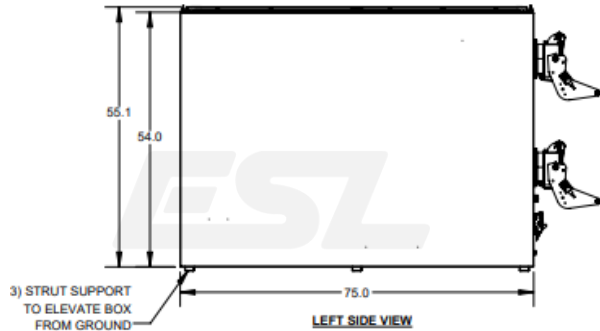
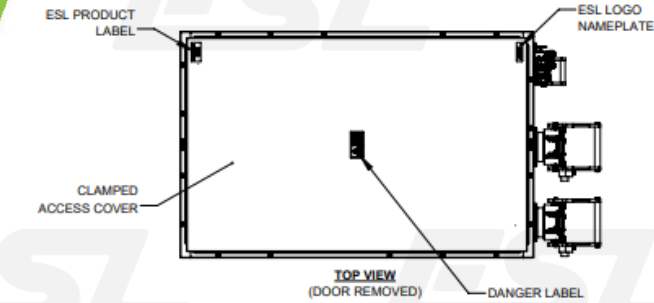
Cruise Vessel Shore Power



- (4) 11kV, 320A (24 MW) Proconect push-pull receptacles
- (1) 7.2kV Neutral single conductor Proconect push-pull receptacle
- 12GA, 304 stainless-steel enclosure, type 4X, powder coated texture gray (RAL 7038)
- External Ground
- feeder cables terminated (crimped) to receptacle lugs
- Clamped, grounded, removable top
- Available options:
 - Earthing switch
 - External fiber optic box
 - Kirk locks/keys on receptacles
 - Kirk key transfer box
 - Heater
 - Thermostat
 - De-humidistat



Cruise Vessel Shore Power



ESL

2000A 12KV 50/60Hz 3 ϕ 4W
CRUISE VESSEL SHORE POWER

ESL CAT# S200-177-US

SERIAL # _____

MFG DATE: _____

TYPE: 4E

SHORT CIRCUIT CURRENT RATING: 19,000 RMS SYMMETRICAL AMPS
Corona, CA ☎ (855)923-4188 ☎ (561)739-7000 ☎ info@eslpen.com

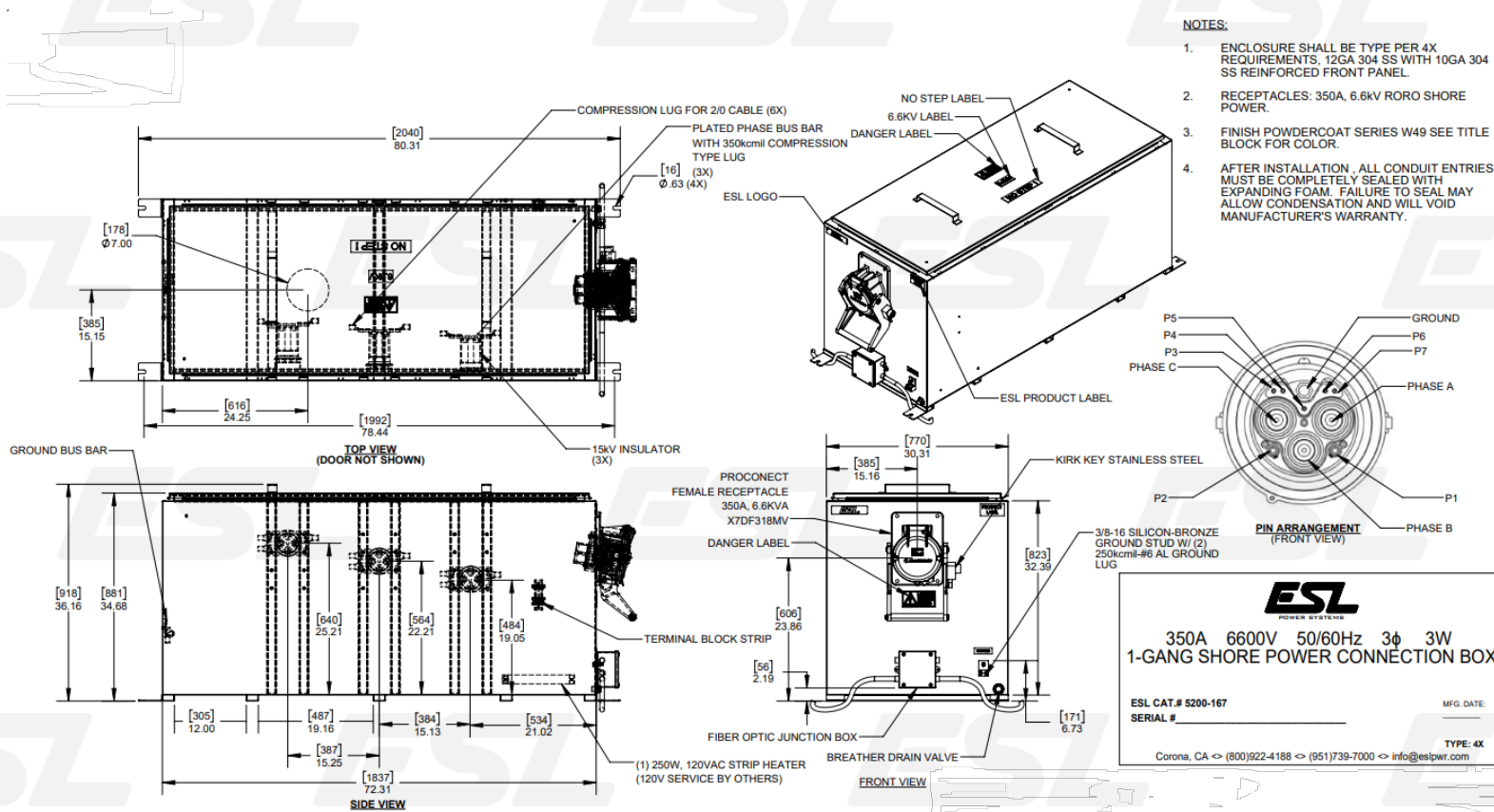


Ro-Ro Vessel Shore Power



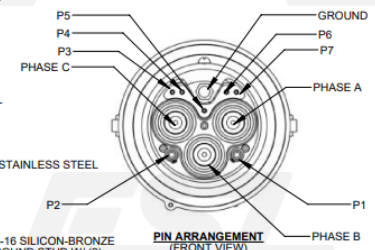
- One power receptacle per vessel connection
- Min of 3 MVA per berth, per vessel capacity
- System voltages up to 11 kV
- On-shore or on vessel cable management system

Ro-Ro Vessel Shore Power



NOTES:

1. ENCLOSURE SHALL BE TYPE PER 4X REQUIREMENTS. 12GA 304 SS WITH 10GA 304 SS REINFORCED FRONT PANEL.
2. RECEPTACLES: 350A, 6.6KV RORO SHORE POWER.
3. FINISH POWDERCOAT SERIES W49 SEE TITLE BLOCK FOR COLOR.
4. AFTER INSTALLATION, ALL CONDUIT ENTRIES MUST BE COMPLETELY SEALED WITH EXPANDING FOAM. FAILURE TO SEAL MAY ALLOW CONDENSATION AND WILL VOID MANUFACTURER'S WARRANTY.



ESL
POWER SYSTEMS

**350A 6600V 50/60Hz 3φ 3W
1-GANG SHORE POWER CONNECTION BOX**

ESL CAT.# 5200-167 MFG. DATE: _____

SERIAL # _____ TYPE: 4X

Corona, CA ⇄ (800)922-4188 ⇄ (951)739-7000 ⇄ info@eslpsr.com



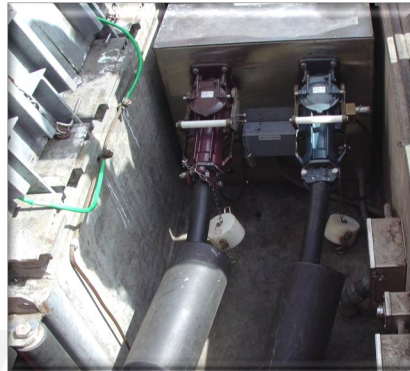
Container Vessel Shore Power

Container Vessels

- Two receptacles per vessel connection
- Up to 7.5 MVA per berth capacity
- System voltage of 6.6 kV 3-phase
- On-board vessel cable management system



Cable management system on board container vessel



High Voltage Shore Connection (HVSC)



Container vessel connection point on-board



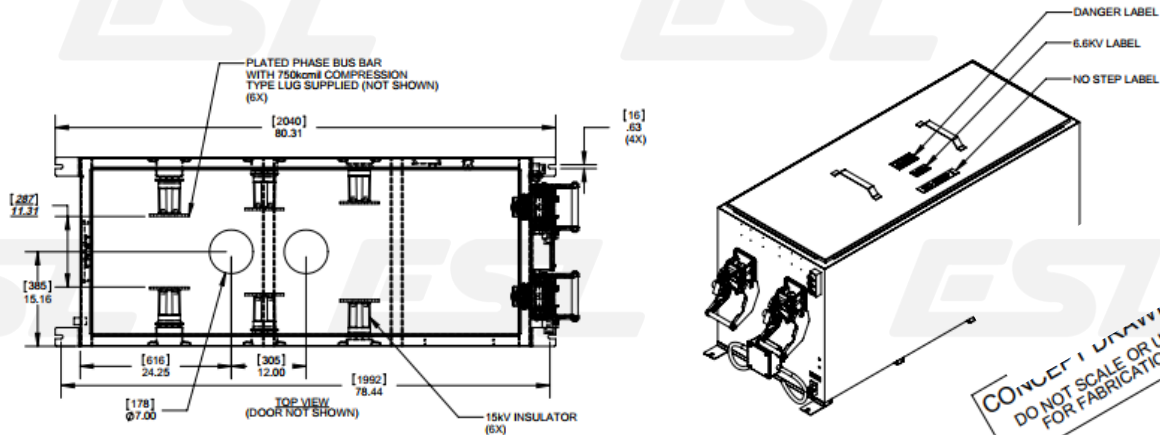
Container Vessel Shore Power

“ESL has manufactured 95% of all SPO boxes for container terminals in USA”

- Nominal Voltage - 6.6kV
- Maximum power demand - 7.5MVA with parallel cables
- 304 or 316SS powder coated enclosures
- Heater/thermostat to comply
- Receptacles compliant with IEC/IEEE 80005-1 Annex D including 3 pilot pins
- Pilot wires, electrical insulated from MV conductors and terminated in Terminal Blocks for field connection to switchgear
- Option for key interlocks for proper operation sequence
- MV termination at internal bus bar or socket (more compact unit)



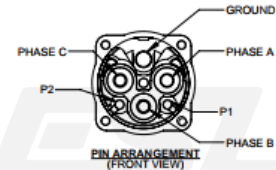
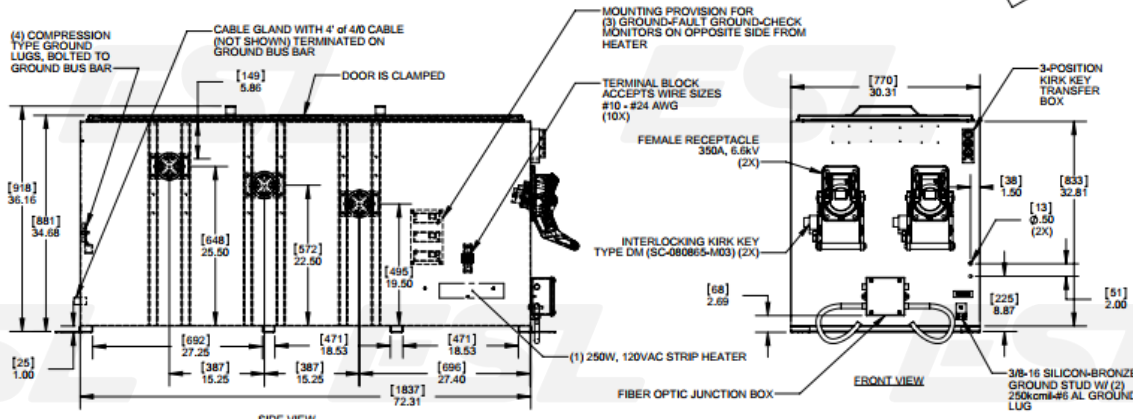
Container Vessel Shore Power




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NOTES:

- ENCLOSURE SHALL BE TYPE 4X, 12GA 304 SS WITH 10GA 304 SS REINFORCED FRONT PANEL.
- RECEPTACLES: 350A, 6.6KV SHORE POWER
- FINISH POWDERCOAT SERIES W49 GRAY RAL7038.
- AFTER INSTALLATION, ALL CONDUIT ENTRIES MUST BE COMPLETELY SEALED WITH EXPANDING FOAM. FAILURE TO SEAL MAY ALLOW CONDENSATION AND WILL VOID MANUFACTURER'S WARRANTY.
- EACH RECEPTACLE TO HAVE SEPARATE KEY





**700A 6600V 50/60Hz 3 ϕ 3W
2-GANG SHORE POWER CONNECTION BOX**

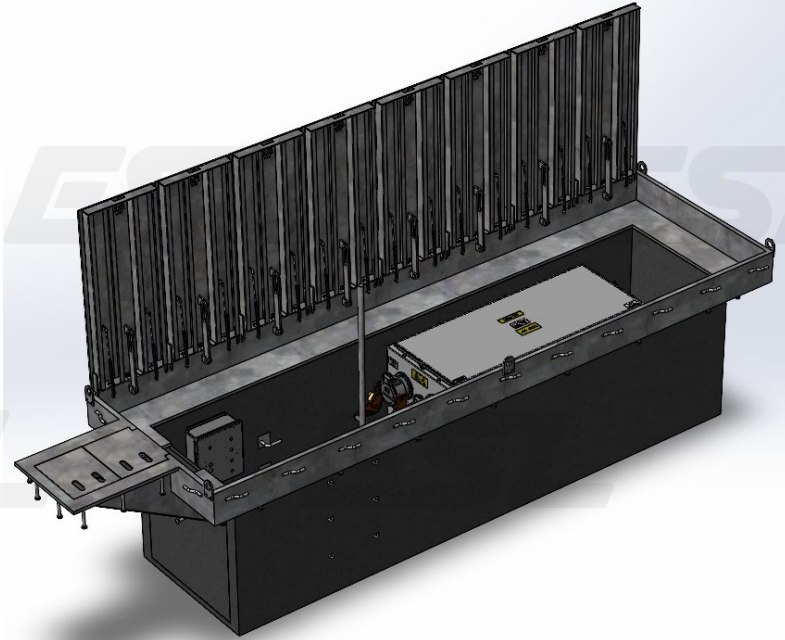
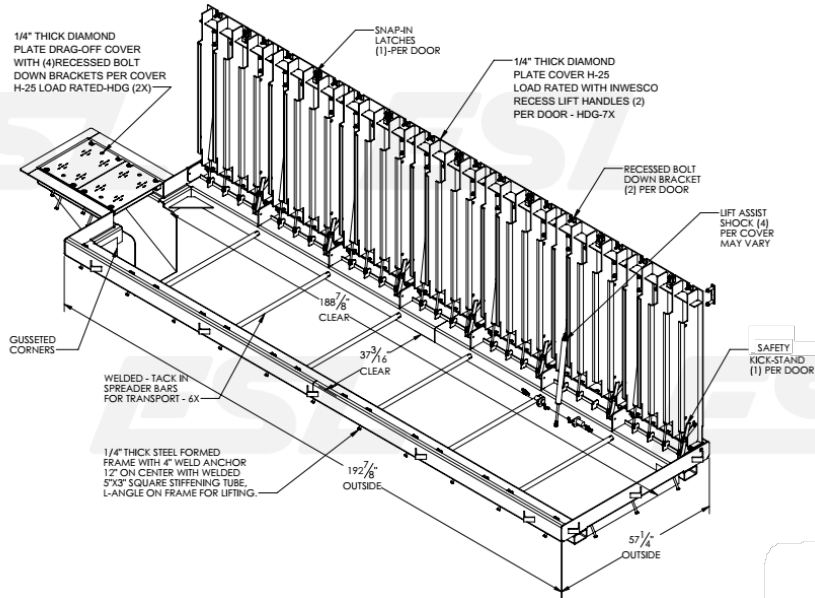
ESL CAT.# 5200-29A-1
SERIAL # _____

Use Listed ESL Plugs & Modules Cat.# M1 or M4 ONLY.
Corona, CA <> (800)922-4188 <> (951)739-7000 <> info@eslpr.com

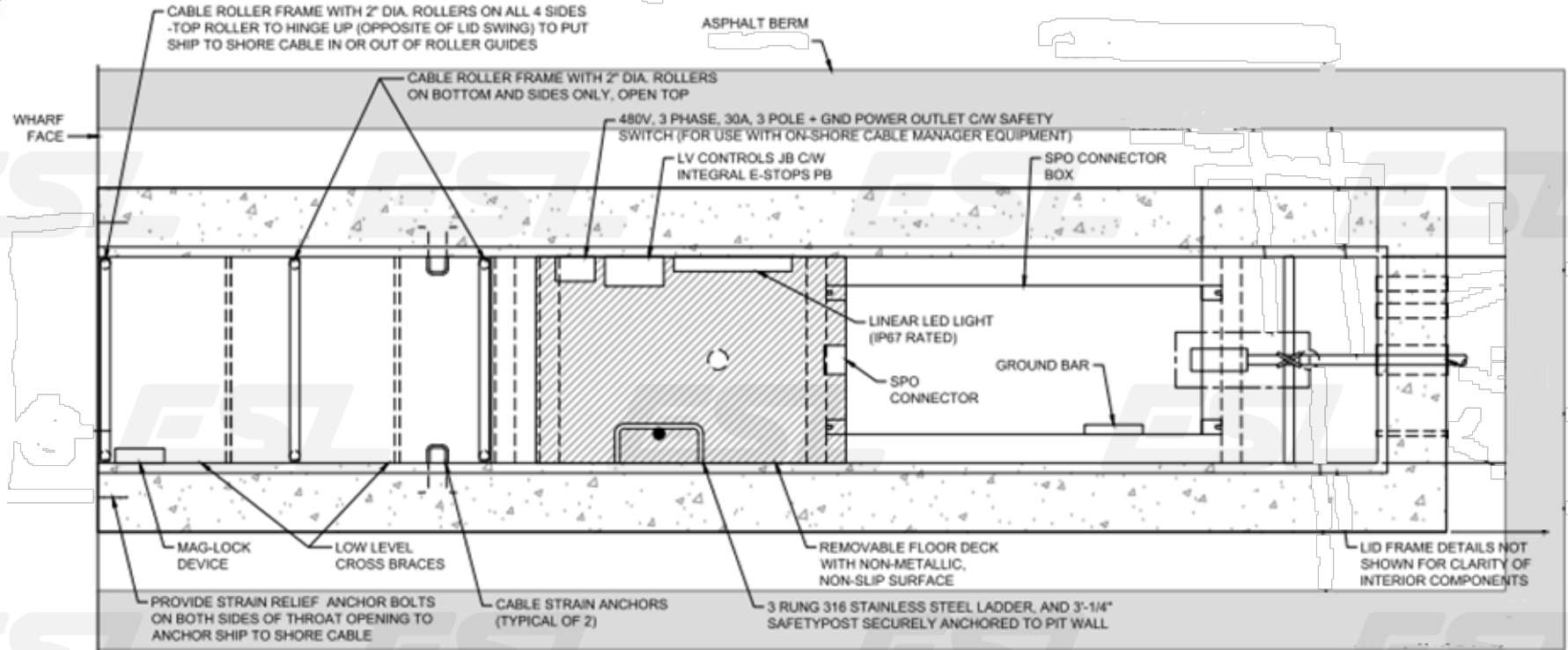
TYPE: 4X



Shore Power Vault Solution

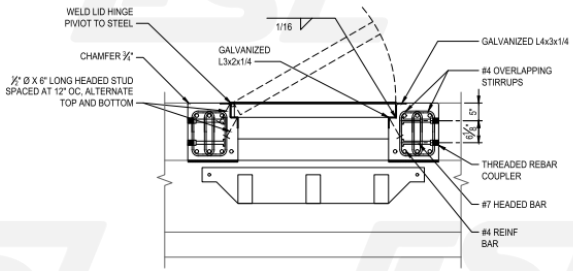


Typical Shore Power Vault Pit Equipment Plan View

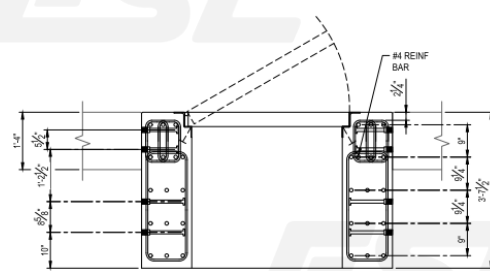


Shore Power Vault Solution

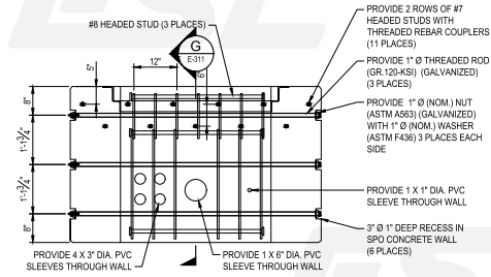
Shock-Assist Shore Power Vault Lid



D SECTION - SHORE POWER VAULT (THROAT)
SCALE: 3/4"=1'-0"



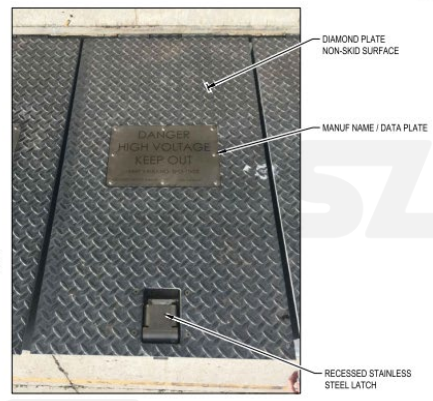
E SECTION - SHORE POWER VAULT
SCALE: 3/4"=1'-0"



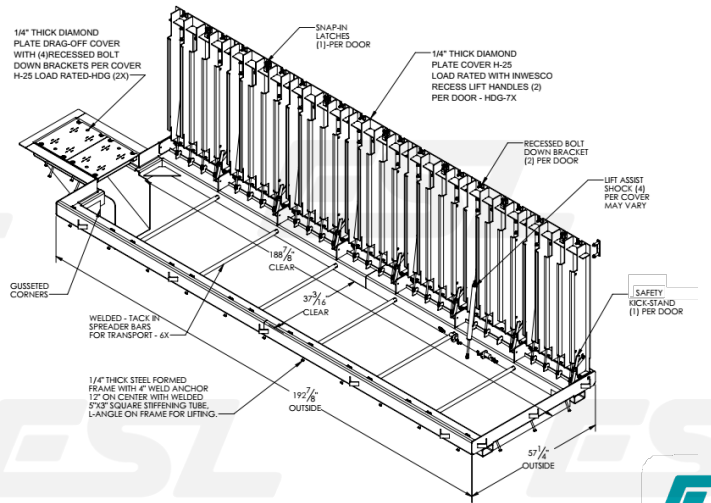
F SECTION - SHORE POWER VAULT (REAR)
SCALE: 3/4"=1'-0"



1 VAULT LID FEATURES (OPEN)
SCALE: NTS

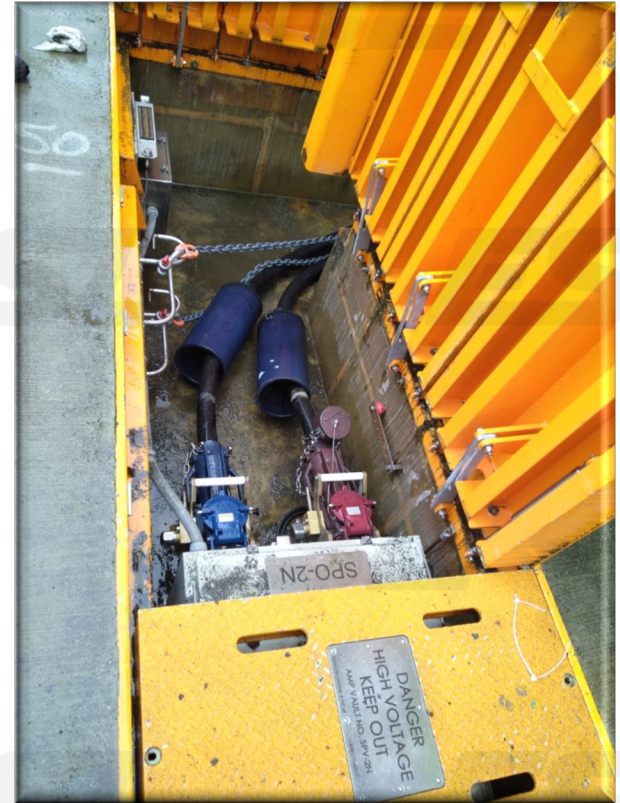


2 VAULT LID FEATURES (CLOSED)
SCALE: NTS



Shore Power Vault Solution

- Shock-assist cover with (or without*) pre-cast vault
- Shore power outlet enclosure
- Stainless steel controls junction box
- Emergency Stop pushbutton module
- Mag Lock and proximity sensors
- Integrated ladder
- Sump pump (if required)
- LED light
- Cable entry hatch interface
- Anchor tie points
- Cable rollers
- Spring assisted trench covers (if required)



Shore Power Vault Solution

Pre-cast vs Cast-in-Place

Pre-Cast

Advantages:

- Consistency & Quality Control
- Time Efficiency
- Ease of Installation
- Durability

Disadvantages:

- Transportation and Handling
- Limited Customization in terms of design mods compared to cast-in-place

Cast-in-Place

Advantages:

- Customization
 - flexibility in design & adjustments
- Integration with existing infrastructure
- Local sourcing

Disadvantages:

- Time-consuming
- Quality Control



Shore Power Lessons Learned

- High importance of early and frequent interaction and planning between:
 - Ports
 - Regulatory Agencies
 - Utilities
- Need for shore power system designs to be flexible
 - Designated locations for shore power vaults and cables to ensure all size vessels and types can connect
- System should account for future demand
 - Could include other terminals, berths, and electrification of other port equipment
 - Reliability and availability of shore power system ensures successful operations
- Having a ship pre-approval system to quickly plug in for repeat ships
- Deliver emissions reductions for the local community
 - Local residents notice when the system is not working
- Public funding sources are critical for shore power development

Source: <https://www.epa.gov/ports-initiative/shore-power-technology-assessment-us-ports>



Next Steps for Shore Power Implementation

What to do now?

1. Port authorities and marine terminal operators need to secure funding.
2. Shore Power projects can take 2 or more years from design to commissioning.
3. Consider the time required for the utility companies to do their work.
4. Prepare complete detailed design plans and specifications.
5. For existing terminals identify methods of installing shore power electrical infrastructure while minimizing operation disruptions. This could impact your project completion.
6. Utilize professional engineers experienced in the design & construction of shore power systems and expert in the international shore power standards (IEEE 80005).
7. Specify products and services of reputable manufacturers who have experience in this field.



Resources

- www.eslpwr.com
- <https://catalog.eslpwr.com/>
- <https://eslpwr.com/wp-content/uploads/2020/05/Port Container Terminal Medium Voltage brochure.pdf>

Pacific Northwest National Laboratory – Port Electrification Handbook

- [https://www.pnnl.gov/sites/default/files/media/file/Port Electrification Handbook FINAL.pdf](https://www.pnnl.gov/sites/default/files/media/file/Port_Electrification_Handbook_FINAL.pdf)



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