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	PROGETTO / IMPIANTO FSRU Ravenna e Collegamento alla Rete Nazionale Gasdotti		Rev. 0

Rif. TRR: 72341

EMERGENZA GAS
INCREMENTO DI CAPACITÀ DI RIGASSIFICAZIONE (DL 17.05.2022, n. 50)
FSRU Ravenna e Collegamento alla Rete Nazionale Gasdotti

Rapporto Preliminare di Sicurezza
per la fase di Nulla Osta di Fattibilità (NOF)
ai sensi del D.Lgs. 105/15

ALLEGATO C.7.10
Matrice Causa-Effetti e Dettagli Sistema di Controllo FSRU

0	Emissione per permessi	A. Visigoti	A. Romano	G. Romano	06/07/2022
Rev.	Descrizione	Elaborato	Verificato	Approvato	Data

Illustration 4.14.1a Control Flow for ESD and Tank Protection System (DFDE Mode)

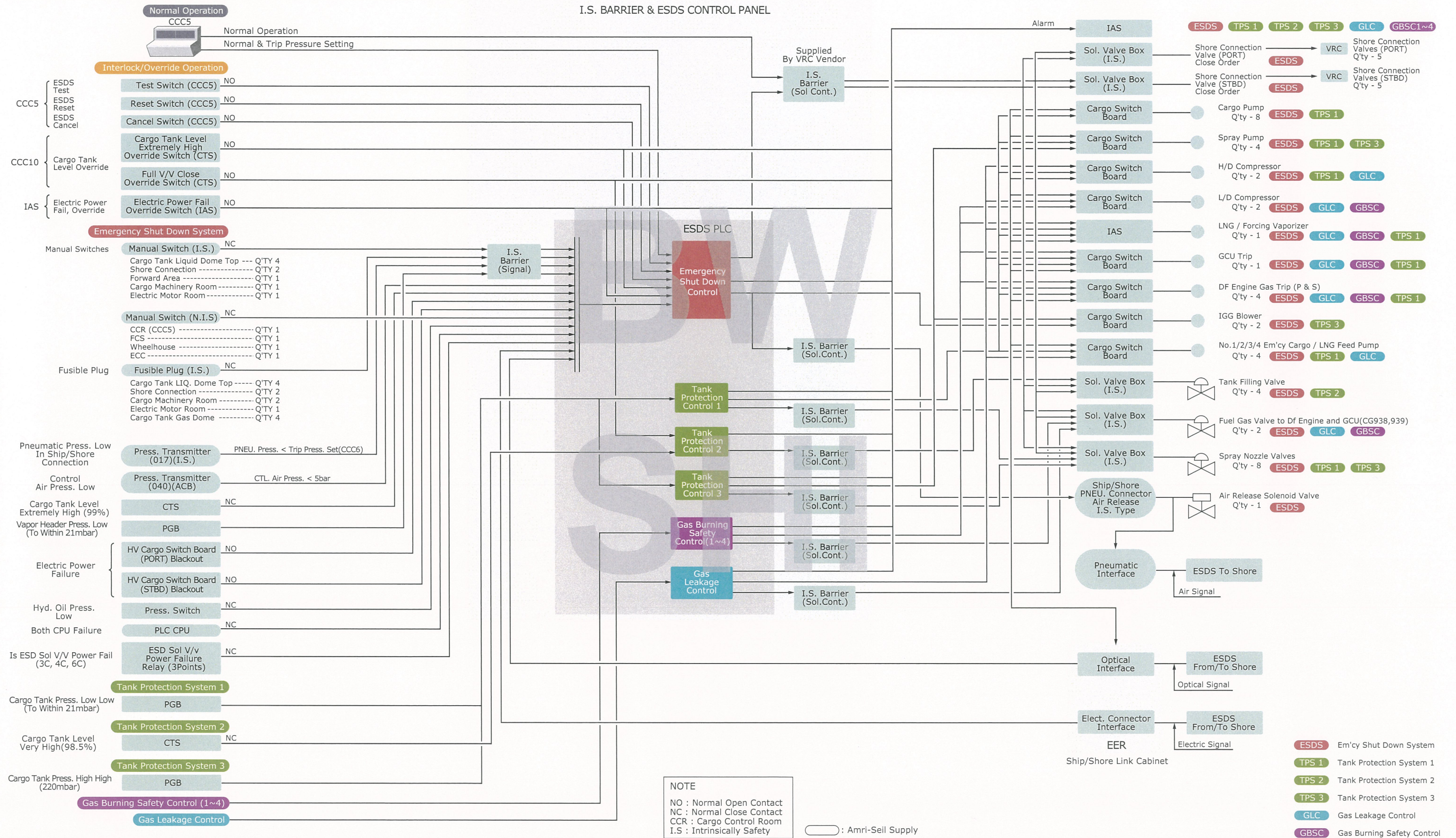


Illustration 4.14.1b Control Flow for ESD and Tank Protection System (FSRU Mode)

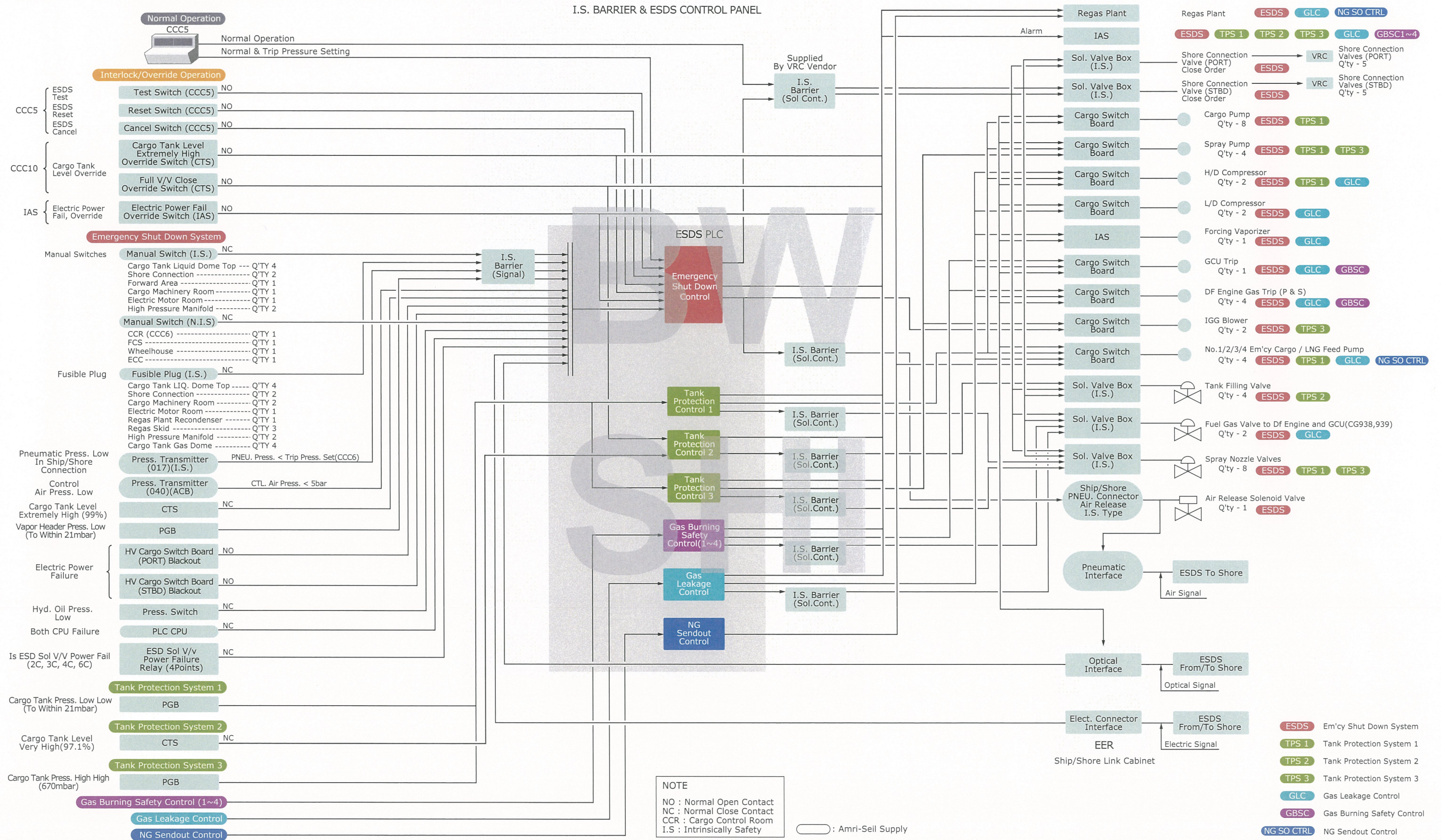


Illustration 4.14.1c ESDS Screen Shot

Home Page

EMERGENCY SHUTDOWN SYSTEM

Cause Of ESD Trip

☐ ESD Total Alarm
☐ Hydr Oil Press Low
☐ 1 Cargo Tank level Extream High
☐ 2 Cargo Tank level Extream High
☐ 3 Cargo Tank level Extream High
☐ 4 Cargo Tank level Extream High
☐ Vapor HDR Press LL
☐ CTL Air Pressure Low < 5bar
☒ IS ESD Sol VV Power Fail (3C)
☒ IS ESD Sol VV Power Fail (4C)
☒ IS ESD Sol VV Power Fail (8C)
☐ IS ESD Sol VV Power Fail(8C)
☒ ELECTRIC POWER FAIL (CSBD 1/2)

Manual Push Button Station(No Delay)

☐ ESD Manual Activated

Thermo Fusible Plugs

☐ ESD Fusible Plug Activated

Shore Activated ESD

☐ SHORE TO SHIP LNG ESD
☐ SHORE TO SHIP CNG ESD
☐ ESD Pneumatic Press Low Alarm

CTL Air Pressure(PT040)

0.00

ELECTRIC POWER FAIL OVERRIDE

☐

DFDE P&S Gas Trip Reset

☐

Tank Protection TPS1

☐ 1 Cargo Tank Press Low Low(TPS1)
☐ 2 Cargo Tank Press Low Low(TPS1)
☐ 3 Cargo Tank Press Low Low(TPS1)
☐ 4 Cargo Tank Press Low Low(TPS1)

Tank Protection TPS2

☐ 1 Cargo Tank Level Very High(TPS2)
☐ 2 Cargo Tank Level Very High(TPS2)
☐ 3 Cargo Tank Level Very High(TPS2)
☐ 4 Cargo Tank Level Very High(TPS2)

Tank Protection TPS3

☐ 1 Cargo Tank Press High High(TPS3)
☐ 2 Cargo Tank Press High High(TPS3)
☐ 3 Cargo Tank Press High High(TPS3)
☐ 4 Cargo Tank Press High High(TPS3)

Important Alarms (Not ESD)

☐ PC CPU Fail Alarm (Both CPU Fail->ESD)
☐ 3C Sol VV Box Hyd Press
☐ 4C Sol VV Box Hyd Press
☐ 6C Sol VV Box Hyd Press
☒ 8C Sol VV Box Hyd Press

ESD Override

☐ ESD Total Alarm Override
☐ Electrical Power Fail ESD Override
☐ Shore To SHIP ESD Override
☐ Pneumatic Press Low ESD Override
☐ 1C TK Level EH ESD Override
☒ 2C TK Level EH ESD Override
☐ 3C TK Level EH ESD Override
☐ 4C TK Level EH ESD Override
☐ 1C TK level VH(FILL VV Close) Override
☐ 2C TK level VH(FILL VV Close) Override
☐ 3C TK level VH(FILL VV Close) Override
☐ 4C TK level VH(FILL VV Close) Override

Gas Burning Saftey Control

☐ Gas Burning Safety Controller 1 Activated P DFDE
☐ Gas Burning Safety Controller 2 Activated S DFDE
☐ Gas Burning Safety Controller 3 Activated P&S DFDE
☐ Gas Burning Safety Controller 4 Activated GCU

Gas Leakage Control

☐ Gas Leakage Controller Activated IN EMR Or CMR
☐ Port DFDE RM Or GVU RM Gas Leakage
☐ Stbd DFDE RM Or GVU RM GAS Leakage
☐ GCU AREA GAS Leakage

Misc Alarms

☐ Master Gas VV(CG938(DFDE))
☐ Master Gas VV (CG938(GCU))
☒ Port DFDE Fuel Gas Valve (CG946) Trip
☒ Stbd DFDE Fuel Gas Valve (CG947) Trip
☐ LNG / Forcing Vaporizer Stop
☐ NO 2 & NO 3 EIR Supply Fans Stop(P&S)
☐ Port GVU RM Or NO 3 EIR Fans Stop
☐ Stbd GVU RM Or NO 2 EIR Fans Stop
☐ GCU GVU RM EXT Fans Stop
☐ BOG Temp HH/LL For CG939(GCU)
☐ BOG Temp HH/LL For CG938(DFDE)
☐ LD Comp. Stop & Master Gas VV Close(W/H)
☐ LD Comp. Stop & Master Gas VV Close(CCC)
☐ LD Comp. Stop & Master Gas VV Close(ECC)
☐ LD Comp. Stop & Master Gas VV Close(FCS)
☐ Normal Source Power Fail
☐ UPS Source Power Fail
☒ UPS abnormal alarm

SHIP SHORE LINK SYSTEM

☐ Ship Shore Link System Abnormal
☐ Ship Shore Link System Inhibit Ind

REGAS SYSTEM

☒ Fusible Plug Activated For Regas Plant
☒ Regas Plant EMCY Stop
☒ NG Sendout ESD VV Closed

Illustration 4.14.1d Cause and Effect Chart (DFDE Mode_1/2)

Note

1. Categories in Action part mean the following

ESD: ESD related action

TPS1/2/3: Tank Protection Action Type 1/2/3

GBSC : Gas Burning Safety Control

GLC : Gas Leakage Control

2. Symbol(signal status) and abbreviation

○ : On at activated condition, ● : Off at activated condition

NE : Normal Energized, NDE : Normal De-energized

3. ESD Cause Time Delay: Time delay to be adjustable

Manual Switch: Time delay 0sec.

Fusible Plug: Time delay 5sec.

S/S Link: Time delay 5sec.

Tank Level: Time delay 5sec.

Press. Low/High: Time delay 5sec. (except for Hydraulic Oil Press. Low => 10sec.)

Power Fail: Time delay 5sec.

Preliminary check list for test

1. Cable wiring condition of ESDS local panel.

2. Operating condition of VRC, IAS and all Equipments related ESDS.

3. Supplied power for ESDS

Category	Cause	TB No. (I/O Add.)	Result	Set Value	Status	Activated Group	Effect (TB No. [Relay No.])
LNGC DFDE Mode	LNGC MODE (CCGS MODE SWITCH)	1-59.60(I:01/29)			OFF	ESD, TPS1	#1 Cargo Tank Cargo Pump #1.2 Stop (7-33.34,73.74[2016])
Test	ESD Test	2-15.16(I:02/07)			ON	ESD, TPS1	#2 Cargo Tank Cargo Pump #1.2 Stop (7-31.32,71.72[2015])
	ESD Reset	2-17.18(I:02/08)			ON	ESD, TPS1	#3 Cargo Tank Cargo Pump #1.2 Stop (7-27.28,67.68[2013])
ESD reset	No.3C Accumulator	5-53.54(I:05/26)		90 barg	ON	ESD, TPS1	#4 Cargo Tank Cargo Pump #1.2 Stop (7-25.26,65.66[2012])
	No.4C Accumulator	5-55.56(I:05/27)		90 barg	ON	ESD, TPS1, TPS3	#1 Cargo Tank Spray Pump Stop (7-37.38[2018])
Inhibit*1	No.5C Accumulator	5-57.58(I:05/28)		90 barg	ON	ESD, TPS1, TPS3	#2 Cargo Tank Spray Pump Stop (7-47.48[2023])
	No.8C Accumulator	5-59.60(I:05/29)		90 barg	ON	ESD, TPS1, TPS3	#3 Cargo Tank Spray Pump Stop (7-39.40[2019])
Manual switch	ESD Inhibit	2-19.20(I:02/09)			ON	ESD, TPS1, GLC	#4 Cargo Tank Spray Pump Stop (7-49.50[2024])
	#1 Liquid Dome	IS-1~18 (I:02/13)			OFF	ESD, TPS1, GBSC3, 4, GLC	No. 1,2 L/D Comp. Stop (7-29.30,69.70[2014])
	#2 Liquid Dome				OFF	ESD, TPS3	No. 1,2 L/D Comp. Stop (7-35.36,75.76[2017])
	#3 Liquid Dome				OFF	ESD, TPS3	IGG Blower Stop (07-45,46,51,52[2022,2025])
	#4 Liquid Dome				OFF	ESD, TPS1	No.1 LNG Feed/Emcy Pump Stop (10-47,48[5021])
	FWD. END OF TRUNK DECK				OFF	ESD, TPS1	No.2 LNG Feed/Emcy Pump Stop (10-51,52[5023])
Fusible plug	Shore Conn PORT	IS-21~32 (I:02/14)			OFF	ESD, TPS1	No.3 LNG Feed/Emcy Pump Stop (10-49,50[5022])
	Shore Conn STBD				OFF	ESD, TPS1	No.4 LNG Feed/Emcy Pump Stop (10-53,54[5024])
	Cargo Machinery Room				OFF	ESD	ESD Sig. FOR LNG (10-43,44[5019])
	Elec Motor Room				OFF	N/A	ESD Sig. FOR CNG (10-41,42[5018])
	CCC (Cargo Control console)				OFF	ESD, TPS1	Fuel Gas Master Valve Close by 6C ACC. (9-5,6[4002]) *8
S/S link	ECC (Engine Control console)	1-53.54(I:01/26)			OFF	ESD	Shore Conn. Valve Close by 4C ACC.(9-1,2[4000])
	Wheel House	2-21.22(I:02/10)			OFF	ESD	Shore Conn. Valve Close by 3C ACC.(9-3,4[4001])
Override *2	F.C.S	2-23.24(I:02/11)			OFF	ESD	Pneumatic Air Release Valve 546(5-57,58[5004])
	High Pressure manifold PORT	IS-39~42 (I:01/24)			OFF	ESD, TPS1, GBSC3, GLC	LNG / Forcing vaporizer stop(6-57,58[5028])
ESD	High Pressure manifold SWBD	IS-21~32 (I:02/14)			OFF	ESD, TPS1, GBSC3, GLC	GPU trip(7-21,22[2010]) Trip signal pulse 3sec.
	#1 Liquid Dome				OFF	ESD, TPS1, GBSC4, GLC	DF engine gas trip(P)(10-27,28,31,32[5012,5014])
	#2 Liquid Dome				OFF	ESD, TPS1, GBSC3, 3, GLC	DF engine gas trip(S)(10-19,20,23,24[5009,5011])
	#3 Liquid Dome				OFF	ESD, TPS1, GBSC3, GLC	CG938 fuel gas valve to DF engine (P&S) closed(10-3,4[5001])
	#4 Liquid Dome				OFF	ESD, TPS1, GBSC4, GLC	CG939 fuel gas valve to GCU closed(10-7,8[5003])
Tank Level *3	#1 Gas Dome	IS-33~38 (I:01/25)			OFF	ESD, TPS1, GBSC1,3, GLC	CG946 fuel gas valve to DF engine (P) closed(6-61,62[1030])
	#2 Gas Dome				OFF	ESD, TPS1, GBSC2,3, GLC	CG947 fuel gas valve to DF engine (S) closed(6-63,64[1031])
	#3 Gas Dome				OFF	ESD, TPS1, TPS3	#1 Cargo Tank Spray Nozzle Valve 1,2 Close (9-13,14,17,18[4006,4008])
	#4 Gas Dome				OFF	ESD, TPS1, TPS3	#2 Cargo Tank Spray Nozzle Valve 1,2 Close (9-25,26,29,30[4012,4014])
	Shore Conn PORT				OFF	ESD, TPS1, TPS3	#3 Cargo Tank Spray Nozzle Valve 1,2 Close (9-37,38,41,42[4018,4020])
Override *2	Shore Conn STBD			OFF	ESD, TPS1, TPS3	#4 Cargo Tank Spray Nozzle Valve 1,2 Close (9-53,54,57,58[4026,4028])	
	Cargo Machinery Room 1			OFF	ESD, TPS2	#1 Cargo Tank Fill Valve Close (9-9,10[4004])	
	Cargo Machinery Room 2			OFF	ESD, TPS2	#2 Cargo Tank Fill Valve Close (9-21,22[4010])	
	Electric Motor Room			OFF	ESD, TPS2	#3 Cargo Tank Fill Valve Close (9-33,34[4016])	
	Regas Plant Recondenser			OFF	ESD, TPS2	#4 Cargo Tank Fill Valve Close (9-49,50[4024])	
S/S link	Regas Train 1 OR 2 OR 3 (Anyone)	IS-41~48 (I:01/30)			OFF	N/A	REGAS Plant EMCY Stop (10-35,36[5015])
	NG sendout HP manifold Port OR Stbd (Anyone)	IS-49~54(I:02/31)			OFF	N/A	REGAS SKID 1 LNG Booster P/P A Stop (10-67,68[5025])
	ESD SIG. FOR LNG	1-35.36(I:01/17)			OFF	N/A	REGAS SKID 1 LNG Booster P/P B Stop (10-79,80[5028])
	ESD SIG. FOR CNG	1-33.34(I:01/16)			OFF	N/A	REGAS SKID 2 LNG Booster P/P A Stop (10-69,70[5026])
	#1 Cargo Tank (EH 99%)	2-31.32(I:02/15)		99%	OFF	N/A	REGAS SKID 3 LNG Booster P/P A Stop (10-71,72[5027])
Tank Level *3	#2 Cargo Tank (EH 99%)	2-33.34(I:02/16)		99%	OFF	N/A	REGAS SKID 3 LNG Booster P/P B Stop (10-83,84[5030])
	#3 Cargo Tank (EH 99%)	2-35.36(I:02/17)		99%	OFF	N/A	CG660 NG SENDOUT ESD Valve Close (9-61,62[4030])
	#4 Cargo Tank (EH 99%)	2-37.38(I:02/18)		99%	OFF	N/A	Electric Total Alarm (7-53,54 [2026])
	#1 Cargo Tank (EH 99%) ESDS Override	2-47.48(I:02/23)		OFF	N/A	N/A	Electric Power Fail Override (6-41,42[1020])
	#2 Cargo Tank (EH 99%) ESDS Override	2-49.50(I:02/24)		OFF	N/A	N/A	ESD Manual Activated (7-7,8[2003])
Override *2	#3 Cargo Tank (EH 99%) ESDS Override	2-51.52(I:02/25)		OFF	N/A	N/A	ESD Fusible Plug Activated (7-9,10[2004])
	#4 Cargo Tank (EH 99%) ESDS Override	2-53.54(I:02/26)		OFF	N/A	N/A	ESD SIG. FOR LNG (07-11,12[2005])
	Hydraulic Oil Pressure Low(voting 2oo3)	3-21.22(I:03/10)			OFF	N/A	ESD SIG. FOR CNG (07-13,14[2006])
	Hydraulic Oil Pressure Low(voting 2oo3)	1-43,44(I:01/21)			OFF	N/A	#1-#4 Tank Level Ext. High Alarm (99%) (6-19-26[1009-1012]) *3
	Hydraulic Oil Pressure Low(voting 2oo3)	1-45,46(I:01/22)			OFF	N/A	#1-#4 Tank Level Ext. High Override (99%) (6-65-72[CR108-CR111])
Press. low	Vapor Header Pressure Low Low(voting 2oo3)	IS-69.70(AI:12/04)			OFF	N/A	ESD HYDR. OIL PRESS. LOW (7-19,20[2009])
	Vapor Header Pressure Low Low(voting 2oo3)	IS-71.72(AI:12/05)			OFF	N/A	Vapour header press. Low low(7-55,56[2027]) voting 2 oo 3
	Vapor Header Pressure Low Low(voting 2oo3)	IS-73.74(AI:12/06)			OFF	N/A	ESD Control Air Press. Low (6-35,36[1017])
	Control Air Pressure Low(voting 2oo3)	11-5.6(AI:11/02)			OFF	N/A	ESD Pneumatic Interface (7-15,16[2007])
	Control Air Pressure Low(voting 2oo3)	11-1-1,2(AI:11/03)			OFF	N/A	CG660 NG SENDOUT ESD Valve Closed (6-63,64[1031])
Power fail	Control Air Pressure Low(voting 2oo3)	11-1-3,4(AI:11/04)			OFF	N/A	#1-#4 cargo tank press. LL (7-57-64[2028-2031])
	Pneumatic Pressure Low	IS-59.60(AI:11/01)			OFF	N/A	#1-#4 cargo tank press. HH (6-27-34[1013-1016])
	No.1 6.6 KV CARGO SWBD	3-61.62(I:03/30)			ON	N/A	#1-#4 Cargo Tank Level Very High Alarm (98.5%) (6-11-18[1005-1008])
	No.2 6.6 KV CARGO SWBD	3-63.64(I:03/31)			ON	N/A	#1-#4 Cargo Tank Level Very High Override (98.5%) (6-73-80[CR112-CR115])
	IS ESD Sol V/V Power Fail(3C)	5-45.46(I:05/22)			OFF	N/A	ESD P.C.CPU ALARM (7-5,6[2002]) *5
Override *2	IS ESD Sol V/V Power Fail(4C)	5-47.48(I:05/23)			OFF	N/A	ESD Normal Source Power Failure (6-81,82)
	IS ESD Sol V/V Power Fail(6C)	5-49.50(I:05/24)			OFF	N/A	ESD UPS Source Power Failure (6-83,84)
	IS ESD Sol V/V Power Fail(8C)				OFF	N/A	GBSC1 activated(10-9,10[5004])
	Electric Power Fail Override	3-35,36(I:03/17)			ON	N/A	GBSC2 activated(10-11,12[5005])
						N/A	GBSC3 activated(10-13,14[5006])

Illustration 4.14.1e Cause and Effect Chart (DFDE Mode 2/2)

[illegible]

* Revision

Rev.0 Prepared for Approval (July 25, 2013)

*1 When ESD Inhibit is selected, ESDS is not operated.

*2 When Override is activated, ESD or TPS2 is not operated.

*3 Each tank level alarm(Ext. High or Very High) is generated according to each tank condition.

*4 When Both CPUs are failed, ESD is activated and all output signals are turned off.

*5 When one of the redundant CPU is failed, an alarm for the CPU failure is generated and passed to IAS.

* P_{TS} : Trip Pressure Set Point which can be set by "PNEU. SETTING SWITCH (TRIP)" in CCR.

Illustration 4.14.1f Cause and Effect Chart (FSRU Mode_1/2)

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Illustration 4.14.1g Cause and Effect Chart (FSRU Mode 2/2)

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Illustration 4.14.2a ESDS Pneumatic System

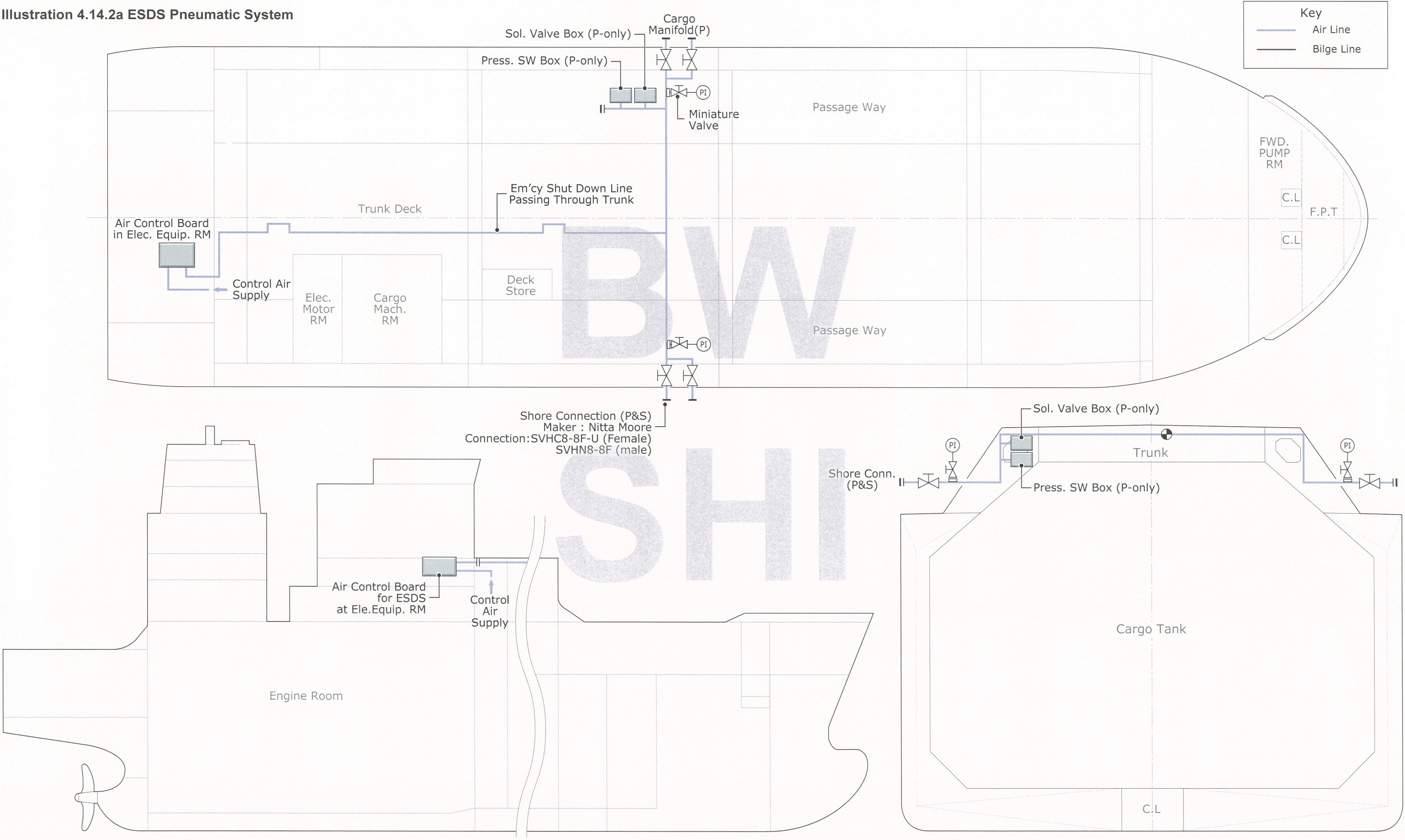


Illustration 4.14.3a Ship-Shore Link

