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# INTRODUCTION

## Purpose

* The purpose of this “Control Narrative Description” is to describe the Electric Marine loading arm control system. This analysis is divided in several chapters to describe the equipment, the associated functions, and the safety part.

## Commonly used definitions / abbreviations

| **Abb.** | **Description** |  |
| --- | --- | --- |
| CPMS | Constant Position Monitoring System |  |
| Customer | Means the Contractor or the End user |  |
| DCS: | Distributed Control System |  |
| eMLA | Electrical Marine Loading Arm |  |
| ERS: | Emergency release system |  |
| ESD1: | Emergency Shut Down level 1 - Stop loading sequence |  |
| ESD2: | Emergency Shut Down level 2 - Emergency disconnection sequence |  |
| I/O: | Inputs / Outputs |  |
| LCP: | Local Control Panel |  |
| MCC: | Motor Control Cabinet |  |
| MLA: | Marine Loading Arm |  |
| N2 | Nitrogen Gas |  |
| N/A | Not Applicable |  |
| NG | Natural Gas |  |
| OP | Operating Pressure |  |
| OT | Operating Temperature |  |
| P/N | Part Number |  |
| PERC: | Powered Emergency Release Coupler |  |
| PLC: | Programmable Logic Controller |  |
| QCDC | Quick Connect / Disconnect Coupler |  |
| RRC | Radio Remote Controller |  |
| SIL | Safety Integrity Level |  |
| SOV | Shut Of Valve |  |
| STD | Standard |  |
| T.EN | Technip Energies |  |
| TBA | To Be Advised |  |

Typical Loading ARM

***STYLE 40***



Base riser

Inlet flange

Main

counterweights

Additional counterweights

Pantograph wire ropes

Inboard arm

Balancing sheave

Style 40 sheave

Outboard

arm

***STYLE 80***

***STYLE 50***

Base plate

Style 80 Assembly:



Coupler

ERS valves

Powered Emergency Release Coupler (PERC)

## Marine loading arm alarm philosophy

* The drawings below show the different zones or envelopes which have to be considered for a marine loading / unloading arm. The angles are given **as typical values**: refer to the project specific data.
* Work envelope: (Side View)

Arm max operating envelope

Stop loading area (after first step alarm)

CPMS prealarm area

Emergency disconnection area

(After second step alarm)

***JETTY***

1

2

M

P

P

1

2

M

P

First step of alarm (ESD1) activated by proximity switch

Second step of alarm (ESD2) activated by proximity switch

Maximum operating envelope of the loading arm

CPMS prealarm step activated by CPMS device only

High

Low

Flanging area

* Work envelope: Top View

Arm max operating envelope

Stop loading area (after first step alarm)

CPMS prealarm area

Emergency disconnection area

(After second step alarm)

***JETTY***

1

2

M

P

P

1

2

M

P

First step of alarm (ESD1) activated by proximity switch

Second step of alarm (ESD2) activated by proximity switch

Maximum operating envelope of the loading arm

CPMS prealarm step activated by CPMS device only

# EQUIPMENT DESCRIPTION

## General

* The electrical installation is designed to control and manage several marine loading arms. The control system could be separated into units.

1. Electrical Control Cabinet including Power Supply Distribution, PLC, speed drives
2. Local Control Panel including HMI
3. UPS (Uninterrupted Power Supplies)
4. Position monitoring system CPMS
5. Remote Control
6. Proximity switches and angle sensors on each marine loading arms

## Electrical Control Cabinet

* The electric logic and commands of the loading arms are integrated in the PLC cabinet.
* The heart of the system is an electric circuit composed of PLC, power supply, push buttons and selector switches, indicating lights, terminal blocks and other electric basic components.
* The heart of the system, the PLC, is integrated completely in it.

## Local Control Panel

* The electric logic and commands of the loading arms are integrated in the local control panel.
* The external alarms, horn and indicating lamp, are installed on the roof or deported.
* It is proposed to locate the local control panel on the jetty, near the loading arms, fitted with all arms control commands, indicating lights and display.
* On this project, the following options are available:
  + - Explosion proof boxes or pressurized panel for hazardous area
    - Safety PLC with possibility of different SIL classification level, up to SIL 2 for the entire loop.
    - Integrated radio cordless and/or pendant control
    - Integrated positioning monitoring system (with LCD display on Local Control Panel)
    - Integral cabinet

## UPS

* The capacity of the UPS depends on the number of arms installed on the jetty, of the accessories on the arms and of the enhanced safety system used. UPS unit can be custom designed to fit the requirements of a specific installation. This will determine the final dimensions and weight of the unit.

## Constant Position Monitoring System (CPMS)

* A Constant Position Monitoring System installed in a safe area is mainly composed of a desktop computer and a communication interface with the main PLC.
* The CPMS read the analogue inputs from the loading arm, displays its position and can activate the alarms (Pre-alarm, 1st step and 2nd step).

## Remote Control Device

* The remote control device allows the operator to move the Marine loading arm in addition to the control panel.
* The following functions are available from the Remote (Radio) control device:
  + On/Off Remote control device
  + Inboard Back / forward
  + Slewing Left / Right
  + Outboard in / out
  + Arm selection
  + Function selection
    - Pump Start / Stop *(Not used on this project)*
    - Lock/Unlock function
    - Coupler Open / Close
    - ERS Valve Open / Close
    - Storm lock / unlock in rest position
    - Style 80 slewing left / right
    - Blind flange Open / Close
  + Selected function ON / / OFF
  + Emergency Stop
  + Automatic Connection / Disconnection
  + Drive Mode selection
    - Conventional mode
    - Easy drive mode
    - Automatic mode

Diagram

Description automatically generated

* For safety reasons the three joysticks integrate a Dead Man switch on top. The joystick must be pressed before getting the function.
* The functions from selection switch can be activated only if the corresponding function is existing on the project. The yellow Led of the not-existing function will remain Off at any time.

## Proximity switches and ANGLE SENSORS at each MLA

* Each loading arms is equipped with limit switches and inclinometers destined to control its motion inside the operating envelope and positioned as follows:
* Four limit switches on base riser swivel to control the slewing angle in horizontal level and by consequence the longitudinal drift of tanker.
* Four limit switches on counterweight beam to control the inboard/outboard arm opening by consequence the lateral drift of tanker.
* Other limit switches indicate that the PERC is armed, the PERC collar is engaged, PERC axis is in position, the ERS valve at style 80 is opened/closed, the arm is in storm lock position.
* Three inclinometers to control the instantaneous position of the loading arm.

# FUNCTIONAL DESCRIPTION

## Local/Radio Mode selection

### Input/Output Overview

TBC

### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | 2 fixed positions selector switch:  LOCAL/RADIO | Selection | Selection of the controlling mode:   * LOCAL * REMOTE |
| Local Control Panel (HMI) | GREEN Pilot light  RADIO ON | Lamp Off  Lamp On | Mode Local  Mode Radio |
| Local Control Panel (HMI) | RED Pilot light  RADIO FAULT | Lamp Off  Lamp On  Lamp flashing | RADIO OK  RADIO FAULT  RADIO FAULT not acquitted |
| Remote control | GREEN Pilot light | Lamp Off  Lamp On  Lamp flashing | RADIO OFF  RADIO ON  Communication failure |

### Function Description

* The loading arms could be controlled from:
  + - the local control panel
    - the radio control device
* The control could not be done from two different places simultaneously.
* In case of simultaneous failure with HMI and RADIO, the system shall stay in the last state known and all speed reference shall be at null.

Local control panel

* The operator selects the Local / Remote mode from the Local Control Panel. The visual indication “RADIO ON” shall be in accordance with the above rules:
  + - Mode Local -> OFF
    - Mode Radio -> ON
* In case of HMI failure, the installation shall switch automatically on RADIO MODE.

Remote control device

* When radio mode is selected on LCP The start of the Remote Control is done by the switch on/off.
* In case of joystick inactivity and selection switch in 0 position, the Remote Control device is automatically switched off after 30 minutes (managed directly inside the base unit).
* In case of RADIO FAULT, the operator presses then the “ALARM / HORN ACKNOWLEDGE”. The RADIO FAULT on the control panel and the external visual alarm are steady and the external audio alarm is switched off.
* The fault is cleared by a human intervention or by itself. The operator presses then the “ALARM RESET”. The RADIO FAULT and external visual alarm are switched off.
* In case of communication fault between the radio and the base unit, the Remote Control light will flash (0.5s ON, 0.5s OFF). The arm selection will stay as it was just before the failure. The operator selects the arm and switch to the Local Mode on the local control panel. And the operator can press ALARM / HORN ACKNOWLEDGE followed by ALARM RESET in order to reset the RADIO FAULT signal.

Pendant mode (if existing)

* To be included in the future as an option.

## Arm Selection

### Input/Output Overview

ARM SELECTION

MCC

ARM SELECTED

REMOTE MODE

LOCAL CONTROL PANEL (HMI)

ARM SELECTED

REMOTE CONTROL

OUTBOARD ARM ENABLE

INBOARD ARM ENABLE

SLEWING ENABLE

ST80 SLEWING ENABLE

LOCAL / REMOTE

LOCAL CONTROL PANEL

ARM SELECTION

ARM SELECTION

REMOTE CONTROL

### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel | Push button  ARM SELECTION (HMI) | Selection | Selection of the ARM |
| Local Control Panel | Yellow Pilot light  ARM SELECTED (HMI) | Lamp Off  Lamp On  Lamp Flashing | ARM not selected  ARM locked  ARM selected |
| Remote control | Selector switch  ARM SELECTION | Selection | Selection of the ARM |
| Remote control | Red Led  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | ARM not selected  ARM locked  ARM selected |

### Function Description

* In normal operation, the “ARM SELECTION” is on “0” position on the local control panel and the Selector switch is on “0” on the Remote control. The arm is in “freewheel” mode.
* When the arm is not selected, the arm is in “freewheel”.
* The selection of the arm can be done either from the local panel or the remote control.
* The operator selects the desired mode “LOCAL/REMOTE” from the local control panel.
* In local mode, the operator pushes the selector switch “ARM SELECTION” from the local control panel to select the ARM, and the corresponding four “ENABLE” output are activated (Inboard, outboard, slewing and ST80 slewing). The corresponding yellow pilot light “ARM SELECTED” on the local control panel is flashing.
* In Remote mode, the operator could select the arm from the remote control with the selector switch. The corresponding four “ENABLE” output are activated (Inboard, outboard, slewing and ST80 slewing). The corresponding red Led “ARM SELECTED” on the remote control and the yellow pilot light “ARM SELECTED” on the local control panel are flashing.
* When the operator switches from Local mode to Remote mode, the selection of the arm is lost if the selector switches are not in the same position.
* When the operator arms the PERC valve located on the local control panel, the selection of the arm is lost.
* When proximity switch indicates that PERC axis is installed, all arm motions are inhibited.

## Arm Lock / Unlock

### Input/Output Overview

LOCAL CONTROL PANEL

ARM SELECTION

ARM LOCK / UNLOCK

LOCAL / REMOTE

ARM SELECTION

ARM SELECTED

REMOTE CONTROL

LOCAL CONTROL PANEL

ARM SELECTED

REMOTE MODE

LOCK / UNLOCK

LOCK / UNLOCK

REMOTE CONTROL

### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Yellow push-button  ARM SELECTION | Selection | Selection of the ARM: |
| Local Control Panel (HMI) | Selector switch 2 positions  LOCK / UNLOCK | Selection | Selection of the ARM:   * LOCK * UNLOCK |
| Local Control Panel (HMI) | Yellow Pilot light  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | ARM not selected  ARM locked  ARM selected |
| Remote control | Selector switch  ARM SELECTION | Selection | Selection of the ARM:   * 0   … up to 10 Arms |
| Remote control | Led red  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | Arm X not selected  Arm X locked  Arm X selected |
| Remote control | Function selection rotary switch  Yellow LED | Turn  Led ON  Led OFF | * Select the desired function:   ARM LOCKED/UNLOCKED   * Function selected * Function not selected |
| Remote control | 3 positions spring return to centre selector joystick + incorporated push button | Selection | * : lock the arm  * : unlock the arm |

### Function Description

* This function allows the operator to lock one or several arms at a desired position near the tanker flange connection flange.

LOCAL MODE

* In Local mode, the arm could be locked in desired position. The operator pushes the illuminated button “ARM SELECTION / SELECTED” from the Local Control Panel to choose the desired Marine loading arm to control. The corresponding yellow Pilot light “ARM SELECTED” on the Local Control Panel is flashing.
* The operator locks the arm by putting the selector switch 2 positions “LOCK / UNLOCK” in position LOCK :
  + The corresponding four “ENABLE” output stay activated (Inboard, outboard, slewing and ST80 slewing).
  + The corresponding Pilot light yellow “ARM SELECTED” on the Local Control Panel are fixed.
  + All speed reference send to VFD are forced to “0”.
* To unlock the arm, the operator puts the selector switch 2 positions “LOCK / UNLOCK” in position UNLOCK.
* When arm is locked, the arm’s motions are not allowed.
* The ARM stay locked even if the operator unselects the loading arm.

REMOTE MODE

* In Remote mode, the arm could be locked in position. The operator selects the desired arm with Selector switch “ARM SELECTION”. The corresponding red Led “ARM SELECTED” on the remote control and the yellow Pilot light “ARM SELECTED” on the Local Control Panel are flashing.
* The operator selects the function “Arm lock” with the rotary switch on the side of the remote (the dedicated yellow LED shall be steady ON) and actuate the position “” of the 3 positions spring return to centre selector joystick “ / / ” from the remote control device in remote mode :
  + The corresponding Led red “ARM SELECTED” on the Radio remote control and Pilot light yellow “ARM SELECTED” on the Local Control Panel are fixed.
  + The corresponding four “ENABLE” output stay activated (Inboard, outboard, slewing and ST80 slewing).
  + All speed reference send to VFD are forced to “0”.
* To unlock the arm, the operator selects the function “Arm lock” with the rotary switch on the side of the remote (the dedicated yellow LED shall be steady ON) and actuate the position “” of the 3 positions spring return to centre selector joystick “ / / ” from the remote control device in remote mode.
* When arm is locked, the arm’s motions are not allowed.
* The arm stays locked even if the operator unselects the loading arm.

AUTOMATIC MODE

* During ESD2 Sequence “EMERGENCY DISCONNECTION”, all the connected arms are locked after the opening of the PERC (See paragraph 3.11). The corresponding yellow pilot lights “ARM SELECTED” on the Local Control Panel are fixed. When the operator selects manually by the local control panel or the remote control an arm to secure the installation, the corresponding light “ARM SELECTED” is flashing.
* When arm is selected, arm is locked automatically if CAVOTEC radio is in “Fault”

To use the arm the operator will have to unlock it manually by the radio.

## Arm parking

### Input/Output overview

### Human machine interface

### Function description

LOCAL MODE

TBC

REMOTE MODE

* When the radio is switched on, the ARM lock function is automatically selected.

AUTOMATIC MODE

## Arm motions

### 2 motion modes: description

The arm motion can be managed in “Conventional” mode, in “Easy Drive” mode or in “Automatic” mode.

In “Conventional mode, the motion is managed swivel by swivel, individually (from the LCP or the remote device). The motion of the coupler flange is based on angular displacement around each swivel (slewing, inboard, outboard). The motion speed is proportional to the joystick position.

In “Easy Drive mode, the motion is based on cartesian axis displacement. This function helps the operator to meet the vessel flange quicker and easier. It permits the arm connection in stronger sea conditions than the conventional mode

In “Automatic” mode, the motion is managed automatically by the PLC in order to achieve the connection. It permits the arm connection in stronger sea conditions than the conventional or easy drive mode.

### Proportional Conventional mode

#### Input/Output Overview

ARM MOTION

RADIO ON

RADIO FAULT

RADIO

LOCAL CONTROL PANEL

ARM SELECTION

LOCAL / RADIO

ARM SELECTION

ARM SELECTED

ARM SELECTED

INBOARD BACK / FORWARD

OUTBOARD IN / OUT

SLEWING LEFT / RIGHT

INBOARD SPEED REFERENCE

LOCAL CONTROL PANEL

INBOARD BACK / FORWARD

ARM SELECTION

RADIO

OUTBOARD SPEED REFERENCE

OUTBOARD IN / OUT

SLEWING LEFT / RIGHT

SLEWING SPEED REFERENCE

MCC

#### Human machine interface

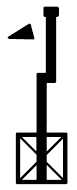
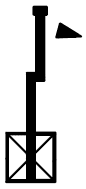
| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Yellow push-button  ARM SELECTION | Selection | Selection of the ARM |
| Local Control Panel (HMI) | Yellow Pilot light  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | ARM not selected  ARM locked  ARM selected |
| Local Control Panel | Black push-button  INBOARD BACK  INBOARD FORWARD | Selection | Selection of inboard motion   * BACK * FORWARD |
| Local Control Panel | Black push-button  OUTBOARD IN  OUTBOARD OUT | Selection | Selection of outboard motion   * IN * OUT |
| Local Control Panel | Black push-button  SLEWING LEFT  SLEWING RIGHT | Selection | Selection of slewing motion   * LEFT * RIGHT |
| Radio | Selector switch  ARM SELECTION | Selection | Selection of the ARM |
| Radio | Red Led  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | ARM not selected  ARM locked  ARM selected |
| Radio | Joystick spring return to centre + incorporated push button  INBOARD  / | Selection + press | Selection of inboard motion   * BACK * FORWARD |
| Radio | Joystick spring return to centre + incorporated push button  OUTBOARD  /  SLEWING  / | Selection + press | Selection of outboard motion   * BACK * FORWARD   Selection of slewing motion   * LEFT * RIGHT |

#### Function description

LOCAL MODE

* The operator pushes the illuminated button “ARM x SELECTION / SELECTED” from the Local Control Panel to choose the desired Marine loading arm to control.
* The loading arm is driven from the Jetty Control Panel
* Black push-button INBOARD BACK and FORWARD
* Black push-button OUTBOARD IN and OUT
* Black push-button SLEWING LEFT and RIGHT

REMOTE MODE

* The mode REMOTE is selected with the selector switch from the Local control panel.
* The operator rotates the selector “ARM SELECTION” to choose the desired Marine loading arm to control.
* The operator rotates the selector switch CONVENTIONAL / EASY DRIVE / AUTOMATIC on CONVENTIONAL in order to activate the CONVENTIONAL function.
* The dedicated yellow pilot light should be steady on.
* The triple swivels of the loading arm are driven from the Pendant / Radio remote control
* Joystick spring return to centre INBOARD  / 
* Joystick spring return to centre OUTBOARD  /  and SLEWING  / 
* In this mode, the arm speed in proportional to the joystick position.

NOTE:

* When the Perc Axis is installed: loading arm movements are not allowed.

### Easy drive mode

#### Input/Output Overview

ARM MOTION

RADIO ON

RADIO FAULT

LOCAL CONTROL PANEL

LOCAL / RADIO

ARM SELECTED

ARM SELECTED

EASY DRIVE ON

RADIO

SELECTOR VALVE

ARM SELECTION

INBOARD SPEED REFERENCE

OUTBOARD SPEED REFERENCE

SLEWING SPEED REFERENCE

LOCAL CONTROL PANEL

INBOARD BACK / FORWARD

ARM SELECTION

RADIO

OUTBOARD IN / OUT SLEWING LEFT / RIGHT

EASY DRIVE Switch ON

CPMS SLEWING ARM ANGLE SENSOR

MLA

CPMS OUTBOARD ARM ANGLE SENSOR

CPMS INBOARD ARM ANGLE SENSOR

#### Human Machine Interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Radio | Switch CONVENTIONAL / EASY DRIVE MODE | Easy Drive | Easy Drive mode selected |
| Radio | Green LED  Easy Drive ON | LED ff  LED On | See detail below |
| Radio | Switch  CONVENTIONAL / EASY DRIVE MODE | Easy Drive | Easy Drive mode selected |
| Radio | Joystick spring return to center + incorporated push button  / | Selection + press | Selection of **Y** arm motion   * BACK * FORWARD |
| Radio | Joystick spring return to center + incorporated push button  / | Selection + press | Selection of **Z** arm motion   * UP * DOWN |
| Radio | Joystick spring return to center + incorporated push button  / | Selection + press | Selection of **X** arm motion   * LEFT * RIGHT |

#### Function description

LOCAL MODE

* Easy drive cannot be activated from the local control panel.

REMOTE MODE

* The mode REMOTE is selected with the selector switch from the Local control panel.
* The operator rotates the selector “ARM SELECTION” to choose the desired Marine loading arm to control.
* The operator rotates the selector switch CONVENTIONAL / EASY DRIVE / AUTOMATIC on EASY DRIVE in order to activate the EASY DRIVE function.
* The dedicated green pilot light should be on only if:
* Arm is not locked
* AND Radio mode is selected
* AND Arm is selected
* AND PMS Sensor Failure not displayed
* The triple swivels of the loading arm are driven from the Pendant / Radio remote control
* Joystick spring return to centre INBOARD Shape, arrow

  Description automatically generated / Shape, arrow

  Description automatically generated
* Joystick spring return to centre OUTBOARD Icon

  Description automatically generated / Shape, arrow

  Description automatically generated and SLEWING Icon

  Description automatically generated with low confidence / A picture containing shape

  Description automatically generated
* In this mode, the arm speed in proportional to the joystick position.

NOTE:

* When the Perc Axis is installed: loading arm movements are not allowed.

### Automatic mode

#### Input/Output Overview

#### Human machine interface

#### Function description

LOCAL MODE

REMOTE MODE

### Over-drift angle alarms

#### Input/Output Overview

ARM MOTION

Position control

FIRST STEP SLEWING

SECOND STEP SLEWING

SECOND STEP REDUNDANT

SLEWING

LOCAL CONTROL PANEL

ARM IN ALARM

FIRST STEP EXTENSION

SECOND STEP EXTENSION

SECOND STEP REDUNDANT EXTENSION

ARM

#### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Red Pilot light  ARM IN ALARM | Lamp Off  Lamp Flashing (0,5s on, 0,5s off)  Lamp On | Arm Ok  Arm in 1st Step alarm  Arm in 2nd Step alarm |

NOTE:

* When ESD sequence started by push-button and the arm in the working area then ‘’ARM IN ALARM’’ light remains OFF.

#### Function Description:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| PROXIMITY SWITCHES | | | | | | STATUS | RESULT |
| Extension Angle | | | Slew Angle | | |
| 1st stage | 2nd stage | 2nd stage redundant | 1st stage | 2nd stage | 2nd stage redundant |
| 0 | 0 | 0 | 0 | 0 | 0 | Healthy | Product transfer allowed |
| 1 | 0 | 0 | 0 | 0 | 0 | 1st Stage Alarm | - ESD1 Sequence if arm connected (Perc armed)  - Signalling if arm manoeuvring |
| 1 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 1 | x | x | x | 2nd Stage Alarm | - ESD2 Sequence if arm connected (Perc armed)  - Signalling if arm manoeuvring |
| 1 | 1 | 0 | x | x | x |
| 0 | 1 | 1 | x | x | x |
| 1 | 1 | 1 | x | x | x |
| x | x | x | 1 | 0 | 1 |
| x | x | x | 1 | 1 | 0 |
| x | x | x | 0 | 1 | 1 |
| x | x | x | 1 | 1 | 1 |

LEGEND :

1 : LOGIC SIGNAL IS ON

0 : LOGIC SIGNAL IS OFF

X : EITHER “ON” OR “OFF”

* The arm is declared in 1st stage when:
* The arm is in 1st stage alarm on extension.
* Or the arm is in 1st stage alarm on slewing.
* For safety reasons and in accordance with OCIMF, the arm is declared in 2nd stage when:
* The arm is in 1st stage alarm on extension and one of 2nd stage alarm proximity switches on extension is on.
* Or the arm is in 1st stage alarm on slewing and one of 2nd stage alarm proximity switches on slewing is on.
* Or both 2nd stage alarm proximity switches on extension are on.
* Or both 2nd stage alarm proximity switches on slewing are on.
* During arm movement operation, if operator reaches the 2nd stage on extension alarm then the inboard forward and the outboard out movements will be stopped automatically. The other movements are still available.

### Function: Pre-alarm

#### Input/Output Overview

PRE-ALARM

PRE-ALARM SLEWING

ARM IN PRE-ALARM

LOCAL CONTROL PANEL

PRE-ALARM EXTENSION

ARM

#### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Yellow Pilot light  ARM IN PRE-ALARM | Lamp Off  Lamp Flashing (0,5s on, 1,5s off) | Arm Ok  Arm in pre-alarm |

#### Function Description

* The arm is declared in pre-alarm when:
* The arm is in pre-alarm on extension.
* Or the arm is in pre-alarm on slewing.

## ERS valves operation

### Input/Output Overview

ERS VALVES OPERATION

LOCAL CONTROL PANEL

LOCAL / REMOTE

ERS VALVES

OPEN / CLOSE

CLOSE ERS VALVES

OPEN ERS VALVES

MCC

LOCAL CONTROL PANEL

ERS VALVES OPENED

ERS VALVES CLOSED

ARM SELECTION

ERS VALVES

OPEN / CLOSE

REMOTE CONTROL

### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Black Push-button  VALVES OPEN  VALVES CLOSE | Selection | Selection of ERS valves motion   * OPEN * CLOSE |
| Local Control Panel (HMI) | Pilot light green  ERS VALVES OPENED | Lamp Off  Lamp Flashing  Lamp On | ERS Valves closed  ERS Valves in intermediate position  ERS Valves opened |
| Local Control Panel (HMI) | Pilot light red  ERS VALVES CLOSED | Lamp Off  Lamp Flashing  Lamp On | ERS Valves opened  ERS Valves in intermediate position  ERS Valves closed |
| Remote control | Selector switch  ARM SELECTION | Selection | Selection of the ARM: |
| Remote Control | Red Led  ARM SELECTED | Lamp Off  Lamp On  Lamp Flashing | Arm X not selected  Arm X locked  Arm X selected |
| Remote Control | Selector switch 3 positions, spring return to centre:  / | Selection | Selection of ERS valves motion   * OPEN * CLOSE |

### Function description

* The ERS valves (located at Style 80) are a hydraulic operated isolating valve assembly for closing the product line in case of emergency request.
* The ERS valves are always in opened position.
* The ERS valves are automatically closed in ESD sequence only.
* The ERS valves are operated in normal speed
* The ERS valves can be manually opened from Local Control Panel or Remote control when
* The Perc collar is assembled (proximity switch detected if existing)
* The arm is not in storm lock position (proximity switch detected if existing)
* Arm is secured (product line depressurised and empty)
* ESD sequence is acknowledged
* Operator must maintain the Selector switch 3 positions ERS VALVES OPEN/CLOSE on OPEN position in order to fully open the valves from the Local Control Panel.
* In Remote mode, before the operator opens the valves, the arm shall be selected, then the operator must maintain the Selector switch 3 positions / on position and press on “Valid” push button simultaneously in order to fully open the valves.
* The ERS valves can be manually closed from Local Control Panel or Remote control when
* The Perc is not armed
* The arm is not “Ready for loading”
* Operator maintains the Selector switch 3 positions ERS VALVES OPEN/CLOSE on CLOSE position to fully close the valves from the Local Control Panel.
* In Remote mode, before the operator close the valve, the arm shall be selected, then the Operator maintains the Selector switch 3 positions / on position  plus press on “Valid” push button to fully close the valves.
* In ESD sequence the ERS valves are automatically closed
* The Status Perc collar could be controlled on the Local Control Panel the yellow pilot light “PERC COLLAR ENGAGED”

## Quick connect / disconnect coupler (QCDC)

### Input/Output Overview

LOCAL / REMOTE

ARM SELECTION

QCDC OPEN / CLOSE

LOCAL CONTROL PANEL

ARM SELECTION

QCDC OPEN / CLOSE

QCDC Closed on arm ?

REMOTE CONTROL

QUICK CONNECT / DICONNECTION COUPLER

CLOSE QCDC

OPEN QCDC

MCC

ARM SELECT

### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | Selector switch 2 fixed positions:  LOCAL/REMOTE | Selection | Selection of the controlling mode:   * LOCAL * REMOTE |
| Local Control Panel (HMI) | Pilot light green  RADIO ON | Lamp Off  Lamp On | Mode Local  Mode Remote |
| Local Control Panel (HMI) | Yellow push-button  ARM SELECTION | Selection | Selection of the ARM |
| Local Control Panel (HMI) | Black Push-button  COUPLER OPEN  COUPLER CLOSE | Selection | Selection of coupler motion   * OPEN * CLOSE |
| Remote control | Selector switch  ARM SELECTION | Selection | Selection of the ARM |
| Remote control | Function selection rotary switch  Yellow LED | Turn  Led ON  Led OFF | * Select the desired function:   QCDC OPEN/CLOSE   * Function selected * Function not selected |
| Remote control | 3 positions spring return to centre selector joystick + incorporated push button | Selection | * : Open the QCDC * : Close the QCDC |

### Function description

* In local mode after checking that no handled product in the arm and that no pressure has built up inside the arm, the operator selects the desired arm with Selector switch ARM SELECTION, and the coupler can be opened or closed with the Selector switch 3 positions spring return to center COUPLER OPEN/CLOSE.
* In remote mode after checking that no handled product in the arm and that no pressure has built up inside the arm, the operator selects the function “QCDC” with the rotary switch on the side of the remote (the dedicated yellow LED shall be steady ON) and actuate the position “” or “” of the 3 positions spring return to centre selector joystick “ / / ” from the remote control device in remote mode
* The coupler could be opened if
* Arm is selected
* Perc is not armed (proximity switch detected)
* The arm is not in storm lock position (proximity switch detected)
* The coupler could be closed if
* Arm is selected
* The coupler is equipped with a closed detection proximity switch. The proximity switch is used to indicate that the arm is connected (red pilot light “Coupler Closed” is ON).

## Normal Connection / disconnection sequence

### Connection

* The operator selects one arm.
* The operator unlocks the arm from the rest position.
* The operator approaches the selected arm to the connection point.
* The operator connects the arm to the ship.
* The arm selector switch on the local panel and radio control device must be in position “0”. The lights “Arm selected” must be off.
* The PERC manual valve of the connected arms must be armed. The green pilot lights “Arm Ready for loading” of the connected arms must be on.
* The information “Arm Ready for Loading” sent to customer is:
* Perc Armed
* And Perc Axis
* And Perc COLLAR
* And DV opened
* And sensor “Arm selected” not activated
* And Maintenance override not activated
* And ESD test not activated

### Disconnection

* The PERC of the connected arms must be not armed. The lights “Arm Ready for loading” of the connected arms must be off.
* The desired arm should be selected from the Control panel or the remote-control device with the selector switch “Arm Selection”.
* The operator manually disconnects the arm.
* The operator can move the arm to the rest position and manually lock the arm.
* *For more details concerning connection/disconnection procedure please refer to Operating and Maintenance Manual.*

## Sequence stop loading – ESD1

* The sequence stop loading is initiated only if Perc is armed
* The first step of alarm, or ESD1, could be initiated by:
* a slew angle (if arm reaches the first stage limit angle of working envelope) detected by one of the proximity switches on all connected arms.
* Or an extension angle (if arm reaches the first stage limit angle of working envelope) detected by one of the proximity switches on all connected arms.
* Or locally by pushing the button “ESD1 - Stop loading” on the control panel
* Or from customer system

Step 10 of

ESD2

SEQUENCE

ARM READY FOR LOADING

0

0

-1st stage slew angle Or 1st stage extension angle

-Or pushing the button “ESD1” – Stop loading

-Or from customer system

STOP LOADING RED PILOT LIGHT FLASHES

1

ESD1 SIGNAL SENT TO CUSTOMER SYSTEM

EXTERNAL VISUAL ALARM FLASHES

EXTERNAL AUDIO ALARM SOUND INTERMITTENTLY

TIMER T1

TIMER T1 (Adjustable)

OPERATOR SECURE INSTALLATION

2

ESD2

ESD Reset And

NOT ESD2

Step 11 of

ESD2

SEQUENCE

ESD2 SEQUENCE EMERGENCY

DISCONNECTION

* Timer

T1: Depends of Customer Process – Timer dedicated to allow customer to close the product pumps and the valves before the Emergency shutdown. Value set to 2 seconds

These timers T1 is extracted from the diagram of OPERATING ENVELOPE 24002yyxxxx01.

* To exit an ESD1 sequence the operator should put the installation in safety condition and only after could reset the sequence with the key switch “ESD RESET”.
* *For more details concerning ESD reset procedure please refer to Operating and Maintenance Manual.*

## Sequence emergency disconnection – ESD2

* The sequence stop loading is initiated only if Perc is armed
* The second step of alarm, or ESD2, could be issued by:
* A slew angle (if arm reaches the second stage limit angle of working envelope) detected by two out of three proximity switches on each connected arm.
* Or an extension angle (if arm reaches the second stage limit angle of working envelope) detected by two out of three proximity switches on each connected arm.
* Or locally by pushing the button “ESD2 - Emergency disconnection” on the control panel
* Or from customer system
* Refer to paragraph 3.5.3. - for over-drift angle alarm

FROM

ESD1 – SEQUENCE

Step 2

0

ARM READY AND PERC ARMED

10

-ESD1 on first alarm slewing AND one of 2nd step alarm proximity switch on slewing is on.

-Or ESD1 on first alarm extension AND one of 2nd step alarm proximity switch on extension is on

-a 2nd stage slew angle (2 switches)

-Or a 2nd stage extension angle (2 switches)

-Or pushing the button “ESD2”- Emergency disconnection

-Or ESD2 from customer system

Step 1 of

ESD1

SEQUENCE

ESD1 STOP LOADING

EXTERNAL VISUAL ALARM ON

11

EMERGENCY DISCONNECTION RED PILOT LIGHT

CUSTOMER INFORMATION

EXTERNAL AUDIO ALARM ON

CLOSE DOUBLE VALVE ARM X

TIMER T2

Timer T2 (adjustable)

OPEN PERC ARM X

12

TIMER 3

Timer T3 (adjustable)

PILOT LIGHT ARM SELECTED STEADY

SELECTION ARM LOCKED

13

Maintenance override or

ESD Test

Not (Maintenance override or ESD Test)

ARM X BACK OUTBOARD SOL. VALVE ON

ARM X BACK INBOARD SOL. VALVE ON

14

STOP OUTBOARD & STOP INBOARD PROXIMITY SWITCHES

OPERATOR SECURE

INSTALLATION

15

ESD Reset

* Timer

T2: Closing time of Double valve. Default value set to 5 seconds.

T3: Opening time of PERC. Default value set to 2 seconds.

This timer T2 and T3 are extracted from the diagram of OPERATING ENVELOPE 24002yyxxxx01.

* To exit an ESD2 sequence the operator should put the installation in safety condition and only after could reset the sequence with the key switch “ESD RESET” :
  + - If PERC Axis detected (Real ESD1 / ESD2 sequence) :
* PERC axis input shall be saved.
* ESD reset key switch is operational only if the manual command of selector spool valve is detected (Selection manual override sensor).
* If PERC axis not detected (Simulated ESD sequence without ERS disconnection)
* PERC axis input not activated.
* PERC collar is detected.
* ESD reset key switch is operational.
* *For more details concerning ESD reset procedure please refer to Operating and Maintenance Manual.*

## Constant Position monitoring system (CPMS)

### Input/Output Overview

CPMS

ARM SELECTED

PERC ARMED

ARM

CPMS ON / OFF

ALARM ZONE TEST

LOCAL CONTROL PANEL

POTENTIOMETER

INBOARD

POTENTIOMETER

OUTBOARD

POTENTIOMETER

SLEWING

CALCULATION

CALCULATION

DISPLAY IN CONTROL ROOM

DISPLAY ON CONTROL ROOM

(CCPMS Plus)

ARM IN ALARM light ON

-1st step : flashing

-2nd step : continuously on

LOCAL CONTROL PANEL

### Human machine interface.

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel (HMI) | 2 Positions Selector switch  CPMS ON / OFF | Selection  CPMS ACTIVATION | Activate the alarm of the CPMS |
| Local Control Panel | Pilot Light red  ARM IN ALARM | Lamp Blink  (0.5s ON, 1.5s OFF) | Arm in Pre-Alarm. |

### Function description

* The CPMS is a package which can activate alarm (Pre-alarm, 1st Step and 2nd Step on screen display and LCP) and displays the position of the arms on a desktop in safe area and on display on the jetty.
* The CPMS does not activate ESD sequences. Only proximity switches initiate the ESD sequence.

#### Mode selection

* The operator selects the functioning mode from the Local Control Panel with the 2 Positions Selector switch” CPMS ON / OFF”.
  + - * Position OFF:
* The green LED “CPMS ON” is OFF
* The CPMS displays the real-time position of the arms (extension, slewing, inboard, outboard)
* The CPMS displays the remaining distances between the actual position and the first stage and the second stage alarm of the operating envelope.
  + - * Position ON:
* The green LED “CPMS ON” is ON
* The CPMS displays the real-time position of the arms (extension, slewing, inboard, outboard)
* The CPMS displays the remaining distances between the actual position and the first stage and the second stage alarm of the operating envelope.
* The CPMS generates alarms to the loading arm control system when the arm reaches the first stage or the second stage alarm of the operating envelope.

#### Over-drift angle alarm

* The angle alarms are designed to detect the over-drift of the flange connection (style 80) outside the working envelope.
* Three alarms type are available:
  + - * Pre-alarm:
* When the arm is connected (Ready for loading) a square of 1 m around the center of the flange of Style 80 (4m²) is created.
* When the arm is out of this area, the light “ARM IN PRE-ALARM” of the display is ON.
* When Alarms are generated, external visual alarm blink (0.5 second “ON”, 1.5 second “OFF”) and external audio alarm is intermittent (0.5 second “ON”, 1.5 second “OFF”) and “ARM IN ALARM”.
* When the Operator presses “Update Pre-Alarm” on the CPMS Display, the area of 4 m² is re-centred around the actual position, the lights and the Horn are switched off.
  + - * The first step alarm:
* When the potentiometers detect the arm in first stage alarm, an intermittent horn signal is generated, the lamp “Arm in Alarm” (of the concerned arm) is flashing,
* When Alarms are generated, external visual alarm blink (0.5 second “ON”, 0.5 second “OFF”) and external audio alarm is intermittent (0.5 second “ON”, 0.5 second “OFF”).
  + - * The second step alarm:
* When the potentiometers detect the arm in second stage alarm, a continuous horn signal is generated, the lamp “Arm in Alarm” (of the concerned arm) is ON
* When Alarms are generated, external visual alarm and external audio alarm are continuous.

#### Sensor Failure

* If the CPMS detects that the signal of a potentiometer is wrong: the lamp “CPMS sensor failure” is ON
* In case of CPMS sensor failure, the Over drift alarm are not considered.

#### CPMS Alarm Zone Test

* This function allows the operator to test the CPMS Alarms.
* When the key switch “CPMS Alarm Zone Test” is turn ON: The information “Perc Armed” is simulated on the selected arm. [ The 1st stage and 2nd stage alarm could be tested without generating any ESD1 or ESD2 sequence]
* The proximity switches are not considered.

## OTHER FUNCTIONs

### Maintenance override/ ESD test

#### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel | Selector switch 3 fixed positions with key:  ESD TEST/NORMAL/MAINTENANCE OVERRIDE | Selection | Selection of the controlling mode:   * ESD TEST * NORMAL * MAINTENANCE OVERRIDE |
| Local Control Panel | Yellow pilot light  MAINTENANCE ON | Lamp Off  Lamp On  Lamp Blink (0.5s ON, 1.5s OFF) | Mode Normal  Mode Maintenance over ride  Mode ESD test |

#### Function description

* In ESD Test mode, this function allows the operator to simulate the ESD2 sequence without the retraction movement of the loading arms and still send/receive ESD information to/from customer.
* **PERC Pin Axis shall be removed in order to avoid an ESD2 sequence in ESD test mode.**
* In Maintenance override mode, this function allows the operator to simulate the ESD2 sequence without the retraction movement of the loading arms and without sending/receiving ESD information to/from customer.

### Lamp Test

* This function allows the operator to test the pilot lights on the Local Control Panel by pressing Black push button “LAMP TEST”.
* A press of 5s on this button will allow to test the external alarms (horn and indicating lamp).

### Storm Locked

* A proximity switch “Storm Locked position” is installed on the mechanical locking device of inboard arm. The operator can control that the arm is in stored position (Manually locked) with the yellow pilot light “STORM LOCKED”.

### PLC Status

* The operator can control that the PLC is running with the white pilot light “PLC RUNNING”.

### Proximity switch fault

#### Human machine interface

| LOCATION | TYPE/LABEL | STATUS/ACTION | FUNCTIONS |
| --- | --- | --- | --- |
| Local Control Panel | Red Pilot light  PROXIMITY SWITCH FAULT | Lamp Off  Lamp On  Lamp Flashing | Proximity switch Ok  Proximity switch faulty  Proximity switch faulty not acknowledge |

#### Defect and alarm

| DEFECT | ELECTRIC PROCESSING | SOFTWARE PROCESSING | CONSEQUENCES |
| --- | --- | --- | --- |
| Proximity switch fault | Considered by PLC | Signalling | Pilot light PROXIMITY SWITCH FAULT is flashing |

* The Proximity switch fault is detected in case of:
* a short circuit
* wired break on the proximity switch loop
* Proximity switch failure

This default is working on all proximity switches.

* When Alarms are generated, external visual alarm blinks (0.5 second “ON”, 0.5 second “OFF”) and external audio alarm is intermittent (0.5 second “ON”, 0.5 second “OFF”).
* The operator presses then the “ALARM / HORN ACKNOWLEDGE” Yellow pushbutton. The Pilot light PROXIMITY SWITCH FAULT on the control panel and the external visual alarm are steady and the external audio alarm is switched off.
* The fault is cleared by a human intervention or by itself. The operator presses then the “ALARM RESET” Black pushbutton. The pilot light PROXIMITY SWITCH FAULT and external visual alarm are switched off.

### External visual alarm and external audible alarm

* The external visual and audible alarms are switched on in accordance with the following rules:
* They are flashing on first step alarm, ESD1 (0.5 second ON, 0.5 second OFF)
* They are fixed on second step alarm, ESD2
* They are flashing on other alarms (0.5 second ON, 0.5 second OFF)
* Yellow “ALARM / HORN ACKNOWLEDGE” push button: This function allows the operator to stop the horn (external audio alarm) when a default occurs.
* In case of HMI Failure, visual alarm and audible alarm shall be acknowledgeable from CPMS+

### Reset safety module (SIL)

To reset a fault resulting from a failure or disconnection of a safety module (SIL), simultaneously press the black push button '' Alarm Reset '' and the yellow push button '' Alarm / Horn Acknowledge during 5 seconds.

### Information from/to Customer – Hard wired

* From Customer to T.EN
* ESD1 Activation (Normally closed. Opened only in case of ESD1)
* ESD2 Activation (Normally closed. Opened only in case of ESD2)

These 2 electric contacts shall be maintained by Customer ESD system in closed position (Normally Closed when no electric supply) in every normal phase and be opened only in case of required ESD.

In case of power failure of the Customer ESD System, the contact shall stay in Normally Closed position to avoid an undesired ESD.

* From T.EN to Customer
* ESD1 Activated (output relay = 1 when ESD activated, Normally Closed Volt Free Dry Contact, closed when the PLC is OFF. Opened only in case of ESD1)
* ESD2 Activated (output relay = 1 when ESD activated, Normally Closed Volt Free Dry Contact, closed when the PLC is OFF. Opened only in case of ESD2)
* Arm Ready for Loading for each arm (NO contact)
* PLC CPU Running (NO contact)

### Information from/to Customer – Network communication

* Refer to data exchange table
* When alarms are transmitted though the communication line, the reset of all alarms shall be done only if defect disappeared and the operator pressed the Alarm Reset push button on the local control panel.

### Drive Monitoring