PART 1 - GENERAL

1.1 APPROVAL BY THE DEPARTMENT REPRESENTATIVE

.1 Human Machine Interface (HMI) screens for process operation will be approved at least three (3) weeks before commissioning by the Department Representative. Operation of each control loop, and each logical control sequence must be signed off by the Department Representative during commissioning. Each HMI screen must be signed off by the Department Representative during commissioning. All alarms and warnings must also be signed off by the Department Representative.

1.2 STANDARDS

.1 Programming and commissioning of the process is to be performed step-wise, and in a modular fashion. Coding is to be well commented, so that a layman will be able to understand each automation sequence and/or control loop. Commissioning is to be performed in the presence of the Department Representative, and is to fully demonstrate the working of each functionality of the present section.

1.3 GENERAL PROJECT DESCRIPTION

.1 This specification describes the supply, installation, and commissioning of two total dissolved gas detectors (TDGDs), one pressure indicator transmitter (PIT), and two level switches.

.2 The TDGDs shall measure the pressure of the dissolved gas in the Reservoirs.

.3 The PIT shall measure barometric pressure, which shall be compared to the gaseous pressure in the Reservoirs by the PLC. This comparison is described later in this Section.

.4 The level switches shall detect the presence of seawater in the curbed area. When seawater is detected, an alarm shall be issued from the PLC to the HMI. This sequence is discussed later in this Section.

1.4 GENERAL CONTROLS OPERATION

.1 This subsection provides a note on notation convention used herein. DI is to be interpreted as "discrete input", DO as "discrete output", AI as "analog input" and AO as "analog output". Alarm tags typically include an L or H, which are to be interpreted as "Low" and "High" respectively. "XXX" is to be interpreted as an analog register to be configured by the Contractor. This register may be the signal from an analog instrument, or a calculated value based on instrument readings.

1.5 HMI FUNCTIONALITY

.1 The Contractor is responsible for modification of existing HMI screens only. No new HMI screens are required.

.2 The Contractor shall modify the HMI so that the style and look is not different from the existing style. More specifically, the Contractor shall ensure that input and output displays are the same colour, font, and font size as the original installation.

.3 Modifications to the HMI described herein shall appear upon all HMI units. There shall be no HMI screens that are not updated with the changes described herein.

.4 All modifications to HMI screens shall be approved by the Departmental Representative.

.5 It is possible the existing HMI screen "RESERVOIR" may need to be rearranged in order to make space for the modifications. This may include making graphi c representations smaller or bigger. The Contractor shall be responsible for all required modifications. Any modifications to the HMI screen are to be approved by the Departmental Representative.

1.6 GAS SUPERSATURATION DISPLAY

.1 Gas supersaturation is to be displayed on the HMI screen "RESERVOIR" for both Reservoirs. Gas supersaturation is to be calculated by the PLC using "Formula 1" and "Formula 2", which are described below.

.2 On the HMI screen "RESERVOIR", near the graphic for Reservoir 1, shall be placed the following: "Supersaturation XXX%". In the analog input field ("XXX")shall be the result of the calculation performed by Formula 1.

.3 On the HMI screen "RESERVOIR", near the graphic for Reservoir 2, shall be placed the following: "Supersaturation XXX%". In the analog input field ("XXX")shall be the result of the calculation performed by Formula 2.

1.7 GAS SUPERSATURATION DISPLAY

.1 Nitrogen gas concentration is to be displayed on the HMI screen "RESERVOIR" for both Reservoirs. Nitrogen gas concentration is to be calculated by the PLC using "Formula 3" and "Formula 4", which are described below.

.2 On the HMI screen "RESERVOIR", near the graphic for Reservoir 1, shall be placed the following: "Nitrogen XXX mmol/m3". In the analog register shall be the result of the calculation performed by Formula 3.

.3 On the HMI screen "RESERVOIR", near the graphic for Reservoir 2, shall be placed the following: "Nitrogen XXX mmol/m3". In the analog register shall be the result of the calculation performed by Formula 4.

1.8 LEVEL SWITCH DISPLAY

.1 Two discrete input text blocks shall be configured on the graphic "RESERVOIR". Each shall be placed at the top of the graphic, and directly above of the tanks.

.2 These DI text blocks shall be configured so that when there is flooding detected by the level switch, the change causes text to appear. The text shall be invisible when there is no flooding. When there is flooding, the text block shall appear red. This text shall read "FLOODING", for both discrete signals.

PART 2 - PRODUCTS

2.1 INSTRUMENT AND ALARM DESCRIPTION

.1 The following Part describes the functionality of each instrument and device for the NAFC installation.

2.2 ALARM HANDLING

.1 When either of the level switches detects water in the curbed area, an alarm shall appear on the HMI alarm screen. These alarms are discussed below.

.2 An alarm will also appear on the HMI alarm screen when the result of Formula 1 or Formula 2 is higher than the threshold value of 110%. This threshold value shall be modifiable by the user.

2.3 LEVEL SWITCH ALARMS

.1 The degasser building has two level switches to signal flooding. Tag information for these switches shall be configured by the Contractor, and are listed below:
   - .1 LSH_DEGASSER_CURB_1_ALARM.
     - .1 PRIORITY - HIGH.
     - .2 DESCRIPTION - Degasser curb area above Reservoir 1 is flooded and needs immediate action by operator.
   - .2 LSH_DEGASSER_CURB_2_ALARM.
     - .1 PRIORITY - HIGH.
     - .2 DESCRIPTION - Degasser curb area above Reservoir 2 is flooded and needs immediate action by operator.

.2 These alarms are to appear on the HMI alarm screen.

2.4 TOTAL DISSOLVED GAS DETECTORS (TDGDs)

.1 There are two TDGDs to be installed. These two instruments are named TDGD1 and TDGD2 for Reservoir 1 and Reservoir 2 respectively.

.2 Each TDGD communicates a temperature and a pressure measurement. The temperature measurement is received in units of degrees Celcius. The pressure measurement is received in units of bar. The Contractor is responsible for determining the correct span of the instrument, and configuring the instrument correctly in the PLC.

.3 Temperature measurement tags shall be named TDGD1_TEMP and TDGD2_TEMP for Reservoirs 1 and 2 respectively.

.4 The pressure measurement tags shall be named TDGD1_PRESSURE and TDGD2_PRESSURE for Reservoirs 1 and 2 respectively.

PART 3 - EXECUTION

3.1 FORMULAS USED FOR NORMAL ATMOSPHERIC EQUILIBRIUM CONCENTRATION (NAEC) OF NITROGEN

.1 The next two subsections describe calculation of the Normal Atmospheric Equilibrium Concentration (NAEC). The NAEC permits the calculuation of the concentration of Nitrogen in seawater. NAEC is solely a function of temperature. The method of calculation relies on a polynomial interpolation of values presented by Susan Libes in "Introduction to Marine Biogeochemistry" 2nd edition, 2009.

.2 The formula for the NAEC is valid for temperatures from 0 to 30 deg. C and a salinity of 35.0. Changes in salinity will adversely affect on the accuracy of the NAEC value calculated.

.3 The following two subections describe steps that shall be performed by the PLC in order to calculate the NAEC for each Reservoir.

3.2 FORMULA TO CALCULATE NAEC IN RESERVOIR 1

.1 Read the temperature of Reservoir 1 using tag TDGD1_TEMP. This signal shall be in deg. Celcius.

.2 Determine the NAEC for seawater at this temperature:

.1 Create tag NAEC_1 = -2.8444e-003
.2 Create tag NAEC_2 = 2.8281e-001
.3 Create tag NAEC_3 = -1.5277e+001
.4 Create tag NAEC_4 = 6.3557e+002
.5 Create tag RESERVOIR1_NAEC, whose units are mmol/m3. A description of how to calculate this value follows below:
.6 Calculate RESERVOIR1_NAEC continuously using the following formula:
.1 RESERVOIR1_NAEC =
.1 NAEC_1*TDGD1_TEMP^3 +
.2 NAEC_2*TDGD1_TEMP^2 +
.3 NAEC_3*TDGD1_TEMP^1 +
.4 NAEC_4

.3 The following information is to be used to check the calculation during commissioning.
.1 When the TDGD1_TEMP = 0 deg C, RESERVOIR2_NAEC = 635 ± 1 mmol/m3.
.2 When the TDGD1_TEMP = 30 deg C, RESERVOIR2_NAEC = 355 ± 1 mmol/m3.

3.3 FORMULA TO CALCULATE NAEC IN RESERVOIR 2

.1 Read the temperature of Reservoir 2 using TDGD2_TEMP.

.2 Determine the NAEC for seawater at this temperature:
.1 Create tag RESERVOIR2_NAEC, whose units are mmol/m3. A description of how to calculate this value follows below:
.2 Calculate RESERVOIR2_NAEC continuously using the following formula:
.1 RESERVOIR2_NAEC =
.1 NAEC_1*TDGD2_TEMP^3 +
.2 NAEC_2*TDGD2_TEMP^2 +
.3 NAEC_3*TDGD2_TEMP^1 +
.4 NAEC_4

.3 The following information is to be used to check the calculation during commissioning.
.1 When the TDGD2_TEMP = 0 deg C, RESERVOIR2_NAEC = 635 ± 1 mmol/m3.
.2 When the TDGD2_TEMP = 30 deg C, RESERVOIR2_NAEC = 355 ± 1 mmol/m3.

3.4 FORMULA 1: CALCULATING SUPERSATURATION OF GAS IN RESERVOIR 1

.1 This subsection describes the formula required to accurately measure gas supersaturation in seawater present in Reservoir 1.

.2 Read pressure from TDGD1 (tag TDGD1_PRESSURE).

.3 Read the atmospheric pressure measured by ATM_PRESSURE in units of bar. This signal should normally vary between 0.94 and 1.2 bar.

.4 Create tag RESERVOIR_1_SUPERSATURATION and make it equal to the following result:
.1 RESERVOIR_1_SUPERSATURATION = TDGD1_PRESSURE / ATM_PRESSURE * 100.
.2 This value represents the supersaturation of gas, and has units of percent (%).
.3 The value of RESERVOIR_1_SUPERSATURATION is expected to vary between 0.95 and 1.1 at all times.

.5 If the low level float in Reservoir 1 indicates a low level (LSH_DEGASSER_CURB_1_ALARM is ON), then RESERVOIR_1_SUPERSATURATION shall be equal to zero (0).

3.5 FORMULA 2: CALCULATING SUPERSATURATION OF GAS IN RESERVOIR 2

.1 This subsection describes the formula required to accurately measure gas supersaturation in seawater present in Reservoir 2.

.2 Read pressure from TDGD2 (tag TDGD2_PRESSURE).

.3 Read the atmospheric pressure measured by ATM_PRESSURE in units of bar. This signal should normally vary between 0.94 and 1.2 bar.

.4 Create tag RESERVOIR_2_SUPERSATURATION and make it equal to the following result:
.1 RESERVOIR_2_SUPERSATURATION = TDGD2_PRESSURE / ATM_PRESSURE * 100.
.2 This value represents the supersaturation of gas, and has units of percent (%).
.3 The value of RESERVOIR_2_SUPERSATURATION is expected to vary between 0.95 and 1.1 at all times.

.5 If the low level float in Reservoir 2 indicates a low level (LSH_DEGASSER_CURB_2_ALARM is ON), then RESERVOIR_2_SUPERSATURATION shall be equal to zero (0).

3.6 FORMULA 3: CALCULATING CONCENTRATION OF NITROGEN IN RESERVOIR 1

.1 Create tag RESERVOIR_1_NITROGEN and calculate concentration of nitrogen in Reservoir 1 as follows:

.1 RESERVOIR_1_NITROGEN = RESERVOIR_1_SUPERSATURATION / 100 * NAEC_NITROGEN

.2 RESERVOIR_1_NITROGEN has units of mmol/m3.

.2 If the low level float in Reservoir 1 indicates a low level (LSH_DEGASSER_CURB_1_ALARM is ON), then RESERVOIR_1_NITROGEN shall be equal to zero (0).

3.7 FORMULA 4: CALCULATING CONCENTRATION OF NITROGEN IN RESERVOIR 2

.1 Create tag RESERVOIR_2_NITROGEN and calculate concentration of nitrogen in Reservoir 2 as follows:

.1 RESERVOIR_2_NITROGEN = RESERVOIR_2_SUPERSATURATION / 100 * NAEC_NITROGEN

.2 RESERVOIR_2_NITROGEN has units of mmol/m3.

.2 If the low level float in Reservoir 2 indicates a low level (LSH_DEGASSER_CURB_2_ALARM is ON), then RESERVOIR_2_NITROGEN shall be equal to zero (0).