| | VENDOR DOCUMENT REVIEW COVER SHEET | Petrofac |
|---|---|---|

NEW GATHERING CENTRE, GC-29 IN NORTH KUWAIT
Company Contract No. : 14050476
Petrofac Job No. : JI-2027

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|---|---|---|---|
| Purchase Order No.: | JI2027-PF-PM004 | | |
| Purchase Order Description : | Desalter Package | | |
| Vendor Name: | CAMERON CANADA CORPORATION | | |
| SDRL Code: | C05 | | |
| Petrofac Document Number: | 50476-529-041-PM001-MAN-V001 | Rev: | AB1 |
| Vendor Document Number: | P-AC004-1E-PE-360-0001 | Rev: | 01 |
| Document Description: | INSTALLATION,OPERATION AND MAINTENANCE MANUAL FOR CRUDE DESALTERS-TRAIN A & B | | |
| Equipment/Tag Number: | 529-C-102/529-C-103 (Train A)<br>529-C-202/529-C-203 (Train B) | | |

**KUWAIT OIL COMPANY (K.S.C) APPROVAL**

- ☐ A. Approved / Reviewed
- ☐ B. Approved / Reviewed as Noted. Incorporate and Resubmit
- ☐ C. Rejected - Resubmit
- ☐ D. Information Reviewed

Approval by the Company related to the work shall in no way relieve the Contractor from the obligation to fulfil all the requirements of the Contract

By ______________ Date ______________

**CONTRACTOR DISPOSITION**

| Status | Status Code | Code Description |
|---|---|---|
| ☐ | A | Approved / Reviewed |
| ☐ | B | Approved / Revived as Noted - Revise and resubmit - work may proceed subject to incorporation of changes indicated |
| ☐ | C | Rejected - Revise and resubmit. |
| ☐ | I | Information Reviewed |
| ■ | F | Vendor certified Final/As built/Accepted as Final |
| ☐ | G | Void / Cancelled/Superseded |

"Code A", "Code B", "Code F" and "Code G" endorsed on Vendor data by Contractor and/or Company shall not relieve the Vendor from full responsibility for any errors or omissions, therein, or limit the Vendor's obligations for conformance to Specification and Purchase Order or Contract requirements

Contractor Reviewing Engineer's Name (IN BLOCK LETTERS), Sign and Date

Name: Ravi Upadhyay Signature: Date: 14-11-17

**VENDOR's DOCUMENT / DRAWING ISSUE RECORD** (CAMERON)

| Vendor's Rev. | Issued Description | Prepared (Initial & signature) | Checked (Initial & signature) | Approved (Initial & signature) | Date |
|---|---|---|---|---|---|
| 01 | As—Built | RI | AG | AG | 12-Oct-2017 |
| B | Issued for Approval | RI | AG | SDG | 16-Sep-2016 |
| A | Issued for review | RI | AG | SDG | 17-Aug-2016 |

The document consists of this front sheet plus 124 pages.

# INSTALLATION, OPERATION AND MAINTENANCE MANUAL-DESALTERS (TRAIN A & B)

**PROJECT NAME:** **NEW GATHERING CENTRE FOR GC-29 IN NORTH KUWAIT**

**EQUIPMENT:** **DUAL FREQUENCY ELECTROSTATIC DESALTERS**

**Tag Numbers:** **529-C-102 / 529-C-103 (Train A)**
**529-C-202 / 529-C-203 (Train B)**

**PROJECT No.:** **P-AC004**

**CAMERON DOC.NO.:** **P-AC004-1E-PM-130-0004**

**CLIENT DOC. No. :** **50476-529-041-PM001-MAN-V001**

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| 01 | As-Built | 12-Oct-2017 | RI | AG | AG |
| B | Issued for Approval | 16-Nov-2016 | RI | AG | SDG |
| A | Issued for Review | 17-Aug-2016 | RI | AG | SDG |
| REV | DESCRIPTION | DATE | ORIGINATOR | CHECKED | APPROVED |
| DOCUMENT No: P-AC004-1E-PM-130-0005 | | | | | |



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## INTRODUCTION

This Installation, Operation & Maintenance Manual is for the Dual Frequency® Electrostatic Desalters for Desalting Package within the Gathering Centre GC-29 which is to be located in the North of Kuwait The Desalting Package consists of 2 identical Two Stage Desalting trains to treat in total a maximum capacity of 112,334 STB/D per train, each train consisting of two Desalter vessels and 3 x 50% Recycle effluent Water pumps and ancillary equipment.

Cameron's scope of supply consists of the following main equipment items:-

### Train A

- 2 off Desalter Vessels (529-C-102/103) – Train A
  - Dry oil Capacity: 56,167 STB/D or STBOPD / (372.1 $Sm^3/hr$).
- 3 off 50% duty Recycle Effluent Water Pumps (529-G-103A/B/C) – Train A {PIL Scope}
  - Capacity: 3437.25 STB/D or STBWPD / (22.7 $Sm^3/hr$)

### Train B

- 2 off Desalter Vessels (529-C-202/203) – Train B
  - Dry oil Capacity: 56,167 STB/D or STBOPD / (372.1 $Sm^3/hr$)
- 3 off 50% duty Recycle Effluent Water Pumps (529-G-203A/B/C) – Train B {PIL Scope}
  - Capacity: 3437.25 STB/D or STBWPD / (22.7 $Sm^3/hr$)

Each train (A/B) is also equipped with the following ancillary equipment:

- 2 off DF Power units (1 per vessel)
- 2 off Step-up Transformers ( 1 per vessel)
- 2 off Mixing valve (1 per vessel)
- 1 off Static mixers (only for Second stage Desalter vessel of both trains)

In addition, instruments mounted on piping, interconnecting pipework, collection manifolds, vent system, drain system and flow distribution between trains shall be supplied by PIL.

These instructions are intended to serve as a guide to the installation, commissioning and normal operation of Cameron supplied equipment and are not intended to conflict with any instructions covered by the Site procedures.

Read and understand the entire operating and maintenance manual before starting to work. Observe and comply with all cautions and warnings given here, in other sections of the manual, and in vendor literature.

This installation, operation and maintenance manual has been compiled on the basis of the CAMERON scope of supply together with customer information available at the date of its composition.

This manual is provided to acquaint the equipment operator with design parameters, start-up and operating procedures for these units. It must be emphasised that the operation of any equipment outside the CAMERON scope of supply is not covered within this document.

It is imperative that this manual is read completely prior to the start-up of this unit and that a copy of this manual be located at the plant site at all times.

It must be noted by the reader that no manual or set of instructions can foresee all possible situations due to the myriad of combinations of pressure, temperature, and other operating conditions possible. The reader is, therefore, advised that the services of a competent on-site technical consultant during start-up and operation of this equipment is essential for prudent and safe operation. This manual is furnished for information purposes only and CAMERON shall not be liable for the use of this manual or any of the information contained in whole or in part.

## A - PROCESS

### Desalting Process Description

Refer to the Piping & Instrument diagrams and Process flow Diagrams listed in Section I (Cameron Drawings) & Section J (Contractor-PIL Drawings) of this manual.

Crude oil often contains unwanted sediment, water (BS&W), and consequently salt, at the well head. These are most efficiently removed by the use of an electrostatic dehydrating/desalting system. The quantity of BS&W contained in the oil depends on many factors, including the gravity and viscosity of the oil, the production rate and temperature, secondary recovery techniques in use such as water re-injection, and the age of the oil field.

The Dehydrating/Desalting process scheme varies depending on the quantity of formation water associated with the crude oil, and the treated crude specifications. A dehydrator is used to remove large quantities of water from an oil stream, and is often the first stage in a two or three-stage dehydrating/desalting system, depending on the product quality required. A Desalter performs the same basic function as a dehydrator, but here fresh water is injected into the oil stream to dilute the saline formation water, and is mixed with the oil using a static mixer and a mixing valve. The water/oil separation in both vessels is enhanced by an electrostatic field created via an internal grid system connected to power units mounted on top of each vessel.

The crude oil from the existing system is fed to the Crude Desalting System. The Crude Desalting system consists of 2 stages, 1$^{st}$ Stage Desalter (Dehydrator) and 2$^{nd}$ Stage Desalter. The crude oil from the existing system is mixed with the recycle effluent water from the 2$^{nd}$ Stage Desalter before entering the 1$^{st}$ Stage Desalter (529-C-102/202), through 1st Stage static mixer (PIL SCOPE) and Mixing valve and is evenly distributed below the electrostatic grids. The wet oil flows up through the grid where the water is coalesced and falls to the bottom of the vessel. The effluent water in the 1$^{st}$ Stage Desalter is controlled by an effluent water control valve. The effluent water from the 1$^{st}$ Stage Desalter is removed under level control and flows off to treatment/disposal (by PIL).

The crude oil from the 1$^{st}$ Stage Desalter is collected on the top of the vessel and is then mixed with fresh water through 2$^{nd}$ Stage Static Mixer and Mixing valve before entering 2$^{nd}$ Stage Desalter. The oil water mix from the 2$^{nd}$ Stage Mixing valve then enters the 2$^{nd}$ Stage Desalter, 529-C-103/203, and is evenly distributed below the electrostatic grids. The wet oil flows up through the grid where the water is coalesced and falls to the bottom of the vessel. The effluent water in the 2$^{nd}$ Stage Desalter is controlled by an effluent water control Valve and is then recycled back to the 1$^{st}$ Stage Desalter via Recycle Water Pumps, 529-G-103A/B/C (Train A ) & 529-G-203 A/B/C (Train B) {Both trains recycle effluent water pumps comes under PIL scope}.

The crude oil is collected on the top of the 2$^{nd}$ Stage Desalter and piped to further treatment (by PIL).

Wash Water is provided by Wash Water Pumps, 529-G-102A/B/C (For Train A) & 529-G-202-A/B/C (For train B) {Both trains wash water pumps come under PIL scope}.

Sand washing for the Desalters is manual process initiated from the field by diverting a portion of the wash water flow. Sand from the Sand wash is sent to Sand drain.
Demulsifier chemical injection package (by PIL / Chemical Vendor / KOC), comprising of a storage tank with duty/standby injection pumps, is available as required to deal with varying oil quality and inlet conditions.

## Technology

To achieve efficient DeSalting there are a number of important design features to be considered which are described below. For this application Cameron Dual Frequency Technology® has been selected for the Coalescer vessels.

## Dual Frequency® Electrostatic System

The term Dual Frequency® refers to CAMERON's exclusive AC/DC electrostatic system, which encompasses positive and negative charged plates as well as a standard AC electrostatic field between these plates and the oil-water interface for more efficient water removal.

The CAMERON Dual Frequency® electrostatic system is the single most effective method of crude oil dehydrating and desalting. This patented system provides increased efficiency to handle larger volumes in a smaller vessel. In place of the conventional alternating current (AC) electrical system, the CAMERON Dual Frequency® Desalter uses a system with both AC and DC fields.

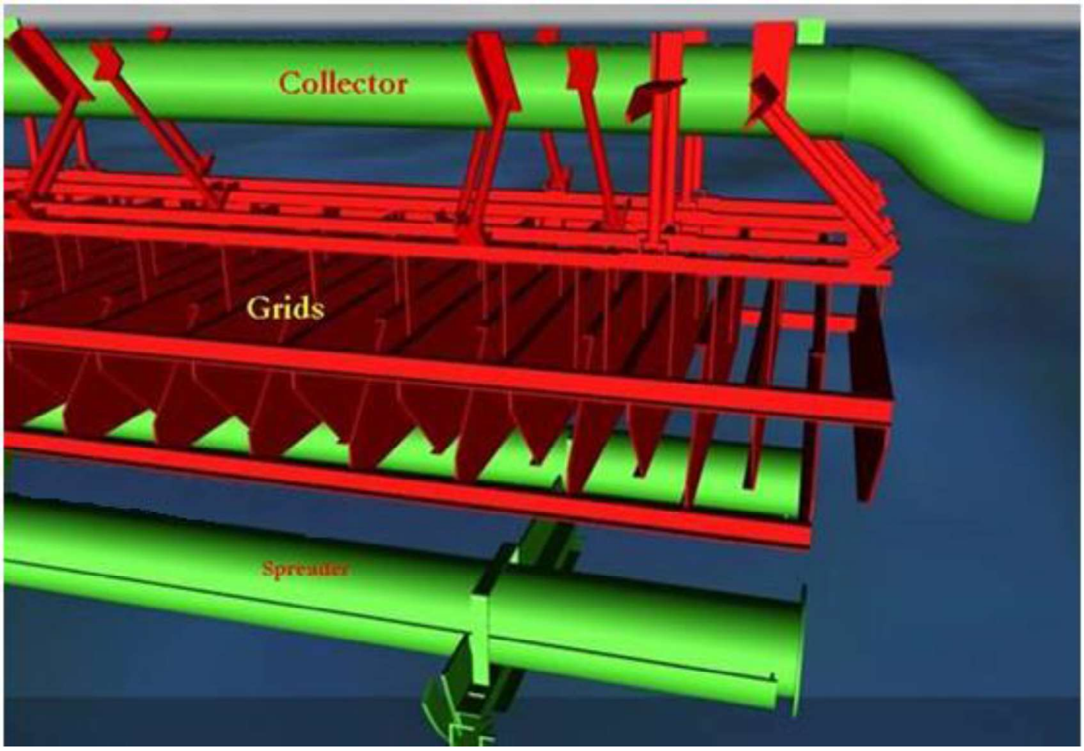


Figure 1: Internals of a Typical Dual Frequency® Unit

When the emulsion leaves the inlet distributors, it enters a low gradient AC field that coalesces the bulk of the dispersed water. Emulsion bearing smaller water droplets continues upward into a high gradient DC field. The DC field acts as a polishing section to coalesce and separate the smallest water droplets.

Using the same dependable AC power supply as a conventional electrostatic Desalter the CAMERON Dual Frequency® splits the high voltage, with rectifiers, into positive / negative components. Pairs of electrode plates are charged in opposition. Water droplets entering the field are elongated and attracted to one or the other plate, accepting the charge of the electrode plate they are approaching.

The Dual Frequency® field delivers twice the voltage gradient as an AC field, while using the same power supply/transformer requirements as an AC field. Because of the unchanging polarity of the DC field, water droplets have time to respond by migrating between electrodes. Once water droplets approach one of the electrode plates, they become charged with the same high voltage charge that is on that plate. In a pure AC field no net charge is imparted to water droplets; only the attraction of polarisation is available to cause coalescence.

In an emulsion containing thousands of water droplets, roughly half will accept positive charges and the other half, negative. Particles are electro kinetically driven toward the plate of opposite charge; they collide with droplets of opposite static charge head-on and coalesce. As the droplets grow in size, gravity overcomes the DC field that suspends them between the plates, and they fall to the water phase.

Dual Frequency® electrostatic Desalters incorporate CAMERON's exclusive "Composite" electrodes. Composite electrodes are a combination of a graphite conductive material within fibreglass composite that provides unique electrical properties to improve oil dehydrating and desalting efficiency.

Such units use high voltage positive (+) and negative (-) potentials on opposite electrodes for coalescing of the water droplets in the final phase of processing. The electrodes are located just above the centre-line of the vessel and are suspended from the upper portion of the vessel shell. Insulated hangers ensure isolation of these electrodes from the conductive metals of the vessel.

An externally mounted, oil immersed, high voltage power unit provides the power to the electrodes. The power unit is specially developed step-up three phase power unit with 10% reactance.

The high voltage secondary of the power unit is connected to the electrodes through two specially designed high voltage entrance bushings, which insulates it from the surrounding metals.

**Dual Frequency® Electrostatic System**

The Dual Frequency® concept combines two modes of voltage modulation, namely Base frequency and Modulation frequency. Base frequency is used to enhance the droplet growth and used to limit field decay due to oil conductivity or water cut. Modulation frequency is used to shift the droplet size distribution to improve separation.

The Dual Frequency® electrostatic technology utilises a proprietary process controller and transformer package to produce an electrostatic field that can be readily optimised for any crude oil.

Figure 2 shows the arrangement of a Desalter designed with the Dual Frequency® electrostatic technology.

The transformer consists of three primary components that are packaged in a single oil-filled enclosure. Designed to operate on three phase, 480 VAC (50 Hz), the technology enables a balanced electrical load. For this application each Desalter has a 100% duty power unit. As the site Low Voltage power supply is at 440VAC, three-phase, a 136 kVA 440/480V step-up Dual Frequency auto-transformer is used to lift the voltage to 480 volts to each power unit. The 480 volts is conditioned to produce a variable amplitude and variable frequency voltage supply for the primary of the transformer. Second, the medium frequency transformer steps up the input voltage to a secondary voltage level necessary to promote effective coalescence. Third, the secondary voltage is rectified into positive and negative half-wave outputs. These polarised, half-wave voltages are then applied to the electrodes to create the benefits of both AC and DC fields.

A PC-based process controller defines the voltage production. For example, with highly conductive crude oils the frequency can be increased to maximise the energy delivered to the oil dehydration process. Utilising a medium frequency transformer overcomes the voltage decay associated with conventional 50 Hz transformers. In wet crude oils the effective impedance may be very low, resulting in rapid voltage decay from the process electrodes. This decay reduces the effectiveness of the dehydration process by pulling the voltage below the threshold level required for effective dehydration. Operating with an increased frequency, the Dual Frequency® controller reduces this voltage decay and effectively sustains the applied voltage above the required threshold. Also, where the interfacial tension between the oil and water is low the waveform can be reduced to minimise destruction of the water droplets normally caused by the application of 50 Hz power.
Chemicals, temperature, salts and applied voltages combine to reduce the interfacial tension between the dispersed water droplets and the crude oil. This low interfacial tension reduces the natural frequency of the entrained water droplets. Reducing the frequency of the waveform through the use of the Dual Frequency® controls can prevent the destruction of the large water droplet required for effective dehydration. Furthermore, the shape of the voltage waveform can be selected to achieve the best dehydration results.

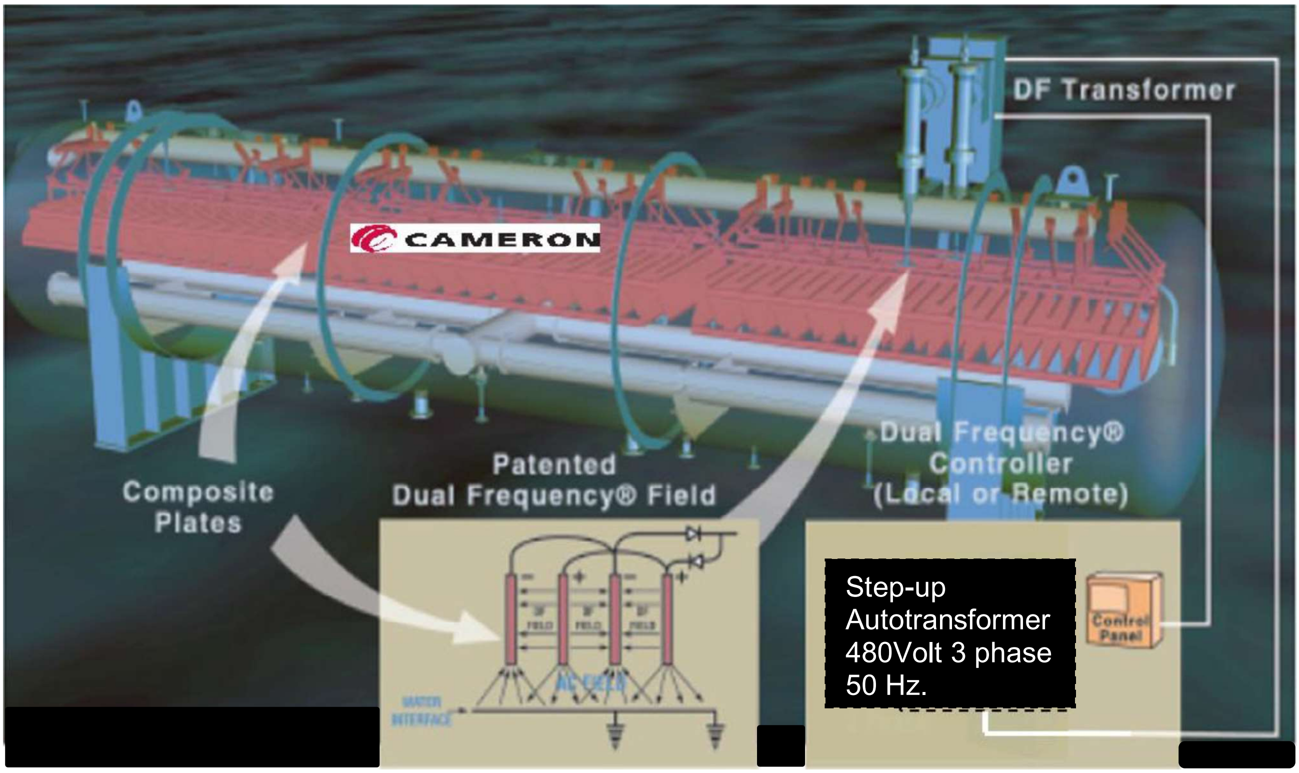



Figure 2: Dual Frequency® Electrostatic Technology

Finally, the minimum and maximum voltage levels can be set on the Dual Frequency® controller to increase the percentage of the entrained water that is swept by the electrostatic voltage. Maximum voltages reach the smallest water droplets with sufficient energy to develop a surface charge and promote coalescence. Reducing the voltage to a minimum level will maximize the droplet growth to promote a rapid sedimentation rate.

In conclusion, the PC-based Dual Frequency® load responsive control system can control the output of the variable voltage / frequency transformer to produce an infinite variety of waveform configurations. The unique waveform generated is optimized to the specific oil's physical properties, and enables higher treatment rates and lower BS&W levels than conventional technology.

### A.1.1 Process Operation

#### A.1.1.1 Control Overview:

This section describes the intent and functionality of the basic regulatory controls. The information shall be used to develop the detailed design of the controls to meet this intent. Implementation of this Control Philosophy shall be performed by the client.

In preparing the descriptions of the control loops the following conventions have been followed:

- Controller actions are selected on the basis that 100% output represents 100% valve open for fail closed valves, and 100% controller output represents valve fully closed for fail open valves.
- Direct acting controllers are those in which an increase in error (where error = positive deviation from set point) causes an increase in controller output. Similarly reverse acting controllers are those in which an increase in error causes a decrease in controller output.
- Unless stated otherwise, all controllers are standard PID type.
- Fail open valve will have 4mA - open, and 20mA - close.
- Fail open will thus require 20mA to close and less than or equal to 4mA to open.
- Where a single controller is used to manipulate two or more final control elements, e.g. a split range control scheme, facilities shall be provided such that in manual mode the operator can manipulate each final control element independently of the others.
- Where a duty/standby pump is provided only one duty pump will be able to run at any one time and standby pump operation will be inhibited.
- Alarms shall be suppressed and trips overridden in the following scenarios:
    - Standby Equipment
    - Shutdown Equipment
    - During start-up (limited to the first 10secs unless stated otherwise in this document.

A LRC II panel for DF Power Units Monitoring & Control will be provided for control of all 4 vessels. The LRC II shall be remotely mounted inside the Electrical room of the Control Building. This panel will act as the monitoring and commissioning/testing station for the vessel power units. Modbus cabling between power unit and LRC II panel is included. Junction boxes and cabling for all the Instruments and mixing valves provided within the scope of Cameron's 2 trains. Interface cabling and hook-up between junction boxes and the UCP, DCS or ESD systems are not included.

The individual LRC II panel shall interface with the DCS system via a Redundant Multidrop RS-485 connection and the ESD system via a hardwire link to allow overall plant control and shutdown to be facilitated through the ICSS (by PIL). The Purpose of Redundant Multidrop RS-485 connections" is to transfer the current status of available operating signals of Power unit in LRC II panel to the client DCS system.

There is no Fire and Gas (F&G) detection system considered as applicable within Cameron's scope of work.

#### B.1.1.1 POWER UNIT/ LRC-II CONTROL PANEL

The 1$^{st}$ Stage Desalter (Dehydrator), 529-C-102/202 and 2$^{nd}$ Stage Desalter, 529-C-103/203 vessels are supplied with Dual Frequency Power units. The interface with these units will be a LRC II Control Panel housed in a safe area that will act as the monitoring and commissioning/testing station for the vessel power units. The DF power units are rated at 100kVA and require a 480Vac 50/60Hz three-phase supply. As available primary electrical supply is in the range of 440 VAC +/- 6% and DF power units accept 480 VAC as standard primary, each DF power unit will come with Step-up Transformer.

Each power units is fitted with local oil level and temperature gauges, one TSV, one pressure switch, one temperature switch and three internal level switches [One in each tank, which are wired in series to a common terminal in the junction box in the DF power unit]. Each of these switches will be wired through customer ESD, so they will get a proper alarm and open the main contactor in the MCC through the DCS control circuit. The remote ESD shut down status, (Dry contact) in LRC shall be wired to Customer MCC to open the main Contactor in the MCC.

The LRC® II provides supervision, communication, reporting, and control of the Dual Frequency system. The operator adjusts and sets the following parameters to optimize the process:

- Base Frequency
- Modulation Frequency
- Wave Form
- Skew Factor
- Minimum Voltage
- Maximum Voltage

By adjustment of these parameters, the operator can create a unique waveform that is optimized to the specific oil's physical properties, to provide all of the benefits of the Dual Frequency System. For additional details, refer Specification to LRC-II Panel "50476-529-041-PM001-SPC-V001".

#### C.1.1.1 1ST STAGE DESALTER TRAIN A (529-C-102) AND TRAIN B (529-C-202)

Degassed Oil and Water enter the 1st Stage Desalter inlet distributor. The vessel operates completely full of liquid.

As the crude feed and low saline water enters the 1st Stage Desalter it is resolved by coalescence in a high voltage electrical field and subsequently separated. The water drops under gravity to the bottom of the vessel where it is removed. A water/oil interface is established, and controlled at a level above the vessel bottom.

A Demulsifier Chemical addition point (By PIL) is provided in the suction of the Desalter Feed Pumps (Comes under PIL scope of supply) [529-G-101A/B/C (Train A) & 529-G-201A/B/C (Train B)] based on AIC-1027/2027 and AIC-1035/2035 (Analyser for Emulsion on 1st Stage and 2nd Stage Desalter.

The effluent water removed from the 1st Stage Desalter is passed to the battery limit under level control via 029-LDCV-1026 / 029-LDCV-2026 (For Train A & Train B by PIL). The crude oil leaves the 1st Stage Desalter via the outlet header at the top of the vessel and passes on to the 2nd Stage Desalter Vessel, 529-C-103 for Train A and 529-C-203 for Train B.

a. CONTROL FUNCTIONS OF FIRST STAGE CRUDE DESALTER (TRAIN A & B):

FIRST STAGE CRUDE DESALTER TRAIN A

| **Tag No** | **Service Description** | **Instrument Description** | **Reference P&ID number** | **Engg Unit** | **Set Point** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **LL** | **L** | **N** | **H** | **HH** |
| 029-AIT-1027 | Desalter Emulsion Level | Emulsion Probe | 50476-029-020-PID-1067.002 | % $H_2O$ | NA | NA | NA | Note-1 | NA |
| 029-LDIT-1026 | Desalter Interface Level | Level Differential Transmitter (Low-High) {Interface Probe}. | 50476-029-020-PID-1067.002 | % $H_2O$ | NA | 70 | 80 | 90 | NA |
| 029-AIT-1028 | Desalter Solid/Water Level | Solid Probe | 50476-029-020-PID-1067.002 | % $H_2O$ | NA | 90 | NA | N/A | NA |
| 029-LDIT-1023 | Desalter Interface Level | Level Differential Transmitter (Low-High). | 50476-029-020-PID-1067.002 | mm | NA | 710 (10.04 mA) | NA | 910 (13.98 mA) | NA |
| 029-LDIT-1024 | Desalter Interface Level | Level Differential Transmitter (High-High). | 50476-029-020-PID-1067.002 | mm | NA | NA | NA | NA | 1010 (12.93 mA) |
| 029-LDIT-1025 | Desalter Interface Level | Level Differential Transmitter (Low-Low). | 50476-029-020-PID-1067.002 | mm | 610 (11.07 mA) | NA | NA | NA | NA |
| 029-LIT-1021 | Desalter Oil Level | Level Transmitter (Low) | 50476-029-020-PID-1067.002 | mm | NA | 3633 (10.88 mA) | NA | NA | NA |
| 029-LIT-1022 | Desalter Oil Level | Level Transmitter (Low Low) | 50476-029-020-PID-1067.002 | mm | 3558 (10.20 mA) | NA | NA | NA | NA |
| 029-LS-1748 | Desalter Oil Level | Level Switch (Low Low) | 50476-029-020-PID-1067.002 | mm | 50 | NA | NA | NA | NA |
| 029-PDIT-1060 | Mixing Valve Diff.Pressure | Differential pressure transmitter | 50476-029-020-PID-1067.001 | Bar | NA | NA | NA | 0.8 (12.5 mA) | NA |
| 029-PIT-1056 | Desalter Pressure | Pressure transmitter | 50476-029-020-PID-1067.002 | barg | NA | 7.83 (9.01 mA) | NA | 9.13 (11.10 mA) | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 029-LALL-1747 | Desalter Power Unit Oil Level | Level Switch (Internal) | 50476-029-020-PID-1067.002 | mm | 25.4mm below normal liquid level of each tank. | NA | NA | NA | NA |
| 029-PAHH-1746 | Desalter Power Unit Oil Pressure | Pressure Switch | 50476-029-020-PID-1067.002 | barg | NA | NA | NA | NA | 0.35 |
| 029-TAHH-1746 | Desalter Power Unit Oil Temperature | Temperature Switch(Chopper Tank) | 50476-029-020-PID-1067.002 | $^0$C | NA | NA | NA | NA | 90 |

**Note-1:** Agar Probe-2 (Chemical Injection Guard Probe / Emulsion Probe) High Alarm depends on the crude state, throughput etc. Some clients run an HIgh alarm at 10% while others at 30%. The easiest way to determine the correct point is to let the emulsion build upwards (by reducing chemical or raising interface level) and watching the amps. When the amp begins to climb, note the reading on the upper/emulsion probe that should be max high alarm set point. Most clients reduce this value by 20% from actual reading when amps start to increase.

FIRST STAGE CRUDE DESALTER TRAIN B

| Tag No | Service Description | Instrument Description | Reference P&ID number | Engg Unit | Set Point | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | L | N | H | HH |
| 029-AIT-2027 | Desalter Emulsion Level | Emulsion Probe | 50476-029-020-PID-2067.002 | % $H_2O$ | NA | NA | NA | Note-1 | NA |
| 029-LDIT-2026 | Desalter Interface Level | Level Differential Transmitter (Low-High) {Interface Probe}. | 50476-029-020-PID-2067.002 | % $H_2O$ | NA | 70 | 80 | 90 | NA |
| 029-AIT-2028 | Desalter Solid/Water Level | Solid Probe | 50476-029-020-PID-2067.002 | % $H_2O$ | NA | 90 | NA | N/A | NA |
| 029-LDIT-2023 | Desalter Interface Level | Level Differential Transmitter (Low-High). | 50476-029-020-PID-2067.002 | mm | NA | 710 (10.04 mA) | NA | 910 (13.98 mA) | NA |
| 029-LDIT-2024 | Desalter Interface Level | Level Differential Transmitter (High-High). | 50476-029-020-PID-2067.002 | mm | NA | NA | NA | NA | 1010 (12.93 mA) |
| 029-LDIT-2025 | Desalter Interface Level | Level Differential Transmitter (Low-Low). | 50476-029-020-PID-2067.002 | mm | 610 (11.07 mA) | NA | NA | NA | NA |
| 029-LIT-2021 | Desalter Oil Level | Level Transmitter (Low) | 50476-029-020-PID-2067.002 | mm | NA | 3633 (10.88 mA) | NA | NA | NA |
| 029-LIT-2022 | Desalter Oil Level | Level Transmitter (Low Low) | 50476-029-020-PID-2067.002 | mm | 3558 (10.20 mA) | NA | NA | NA | NA |
| 029-LS-2748 | Desalter Oil Level | Level Switch (Low Low) | 50476-029-020-PID-2067.002 | mm | 50 | NA | NA | NA | NA |
| 029-PDIT-2060 | Across Mixing Valve Diff.Pressure | Differential pressure transmitter | 50476-029-020-PID-2067.001 | Bar | NA | NA | NA | 0.8 (12.5 mA) | NA |
| 029-PIT-2056 | Desalter Pressure | Pressure transmitter | 50476-029-020-PID-2067.002 | barg | NA | 7.83 (9.01 mA) | NA | 9.13 (11.10 mA) | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 029-LALL-2747 | Desalter Power Unit Oil Level | Level Switch (Internal) | 50476-029-020-PID-2067.002 | mm | 25.4mm below normal liquid level of each tank. | NA | NA | NA | NA |
| 029-PAHH-2746 | Desalter Power Unit Oil Pressure | Pressure Switch | 50476-029-020-PID-2067.002 | barg | NA | NA | NA | NA | 0.35 |
| 029-TAHH-2746 | Desalter Power Unit Oil Temperature | Temperature Switch(Chopper Tank) | 50476-029-020-PID-2067.002 | $^0C$ | NA | NA | NA | NA | 90 |

**Note-1:** Agar Probe-2 (Chemical Injection Guard Probe / Emulsion Probe) High Alarm depends on the crude state, throughput etc. Some clients run an High alarm at 10% while others at 30%. The easiest way to determine the correct point is to let the emulsion build upwards (by reducing chemical or raising interface level) and watching the amps. When the amp begins to climb, note the reading on the upper/emulsion probe that should be max high alarm set point. Most clients reduce this value by 20% from actual reading when amps start to increase.

Control functions are as follows:

I. Interface Level Control

Each Desalter vessel is equipped with one Interface level transmitter 029-LDIT-1023/ 029-LDIT-2023 (for Train A/B) and one AGAR probe 029-LDIC-1026/ 029-LDIC-2026 (for Train A/B) to maintain and control the oil/water interface level in the vessel. Client has an option to select either of these two instrument through selector 029-HS-1008 for controlling oil/water interface level through level controller 029-LDIC-1026 / 029-LDIC-2026 (for Train A/B) via Interface level control valve 029-LDCV-1026 / 029-LDCV-2026 (for Train A/B) which controls the amount of effluent water which is drawn from the bottom of the 1$^{st}$ Stage Desalter.

Low (L) and High (H) interface level alarms are generated in the DCS from interface 029-LDIC-1026 / 029-LDIC-2026.

II. Low Low Interface Level Safety

Level transmitters 029-LDIT-1025 / 029-LDIT-2025 (for Train A/B) provides protection against low-low (LL) interface level in the 1$^{st}$ Stage Desalter by activating Level IV shut down which results in closing of interface level control valve 029-ESDV-1011 / 029-ESDV-2011.

III. High High Interface Level Safety

Level transmitters 029-LDIT-1024 / 029-LDIT-2024 (for Train A/B) provides protection against high-high (HH) interface level in the Desalters by activating Level IV shutdown which results in shutting down the Duty Recycle Water Pumps, 529-G-103A/B/C [ (for Train A) [ (RYCL EFFLUENT WTR PMP TRN-A G103A 029-XS-1004A-MT) / (RYCL EFFLUENT WTR PMP TRN-A G103B 029-XS-1004B-MT) / (RYCL EFFLUENT WTR PMP TRN-A G103C 029-XS-1004C-MT)] / 529-G-203A/B/C (for Train B) [ (RYCL EFFLUENT WTR PMP TRN-B G203A 029-XS-2004A-MT) / (RYCL EFFLUENT WTR PMP TRN-B G203B 029-XS-2004B-MT) / (RYCL EFFLUENT WTR PMP TRN-A G203C 029-XS-2004C-MT)],or shutting down the Duty Wash Water Pumps, 529-G-102A/B/C (for Train A) [ (WASH WTR FEED PMP TRN-A G102A 029-XS-1003A-MT) / (WASH WTR FEED PMP TRN-A G102B 029-XS-1003B-MT) / (WASH WTR FEED PMP TRN-A G102C 029-XS-1003C-MT)] / 529-G-202A/B/C (for Train B) [ (WASH WTR FEED PMP TRN-B G202A 029-XS-2003A-MT) / (WASH WTR FEED PMP TRN-A G202B 029-XS-2003B-MT) / (WASH WTR FEED PMP TRN-A G202C 029-XS-2003C-MT)],if the second stage Desalter is bypassed.

IV. Low Low Total Level Safety

Level Switch 029-LS-1748 / 029-LS-2748 (for Train A/B)[Connected inline with DeSalter vessel total oil level(Reference level is 50mm from Desalter vessel top ID) and the Power Unit] installed in the top of the 1st Stage Desalter provides protection against drop in total level in the vessel by killing the DF power unit [529-C-102-PU-01 (029-XS-1746) / 529-C-202-PU-01 (029-XS-2746)] (for Train A/B)) permissive

[Vapour switch (029-LS-1748 / 029-LS-2748) will be wired to the "Process enable input" of LRC- II panel. In the event of loss in the vessel total liquid level to the given set point the "Process enable input" will provide an open circuit and DF permissive is killed and LRC-II panel provides an alarm, If the level in the Desalter is re-established the power unit will auto start.] which is an activation of Level IV shutdown.

If the level in the Desalter is re-established the power unit will auto start.

V. Level Transmitter 029-LIT-1022 / 029-LIT-2022 (for Train A/B) installed in the top-side mounting of 1st Stage Desalter provides protection against drop in total level in the vessel by activating Level IV shutdown which results in tripping of (029-XS-1746 / 029-XS-2746) of First stage Desalter Power unit [529-C-102-PU-01 / 529-C-202-PU-01 (for Train A/B)], and also closing of treated crude from desalters to storage tank shutdown valve 029-ESDV-1009 / 029-ESDV-2009, in case there is significant drop in total level in the vessel and Low-Low level alarm indication will occur in DCS.

VI. Level Transmitter 029-LIT-1021 / 029-LIT-2021 (for Train A/B) installed in the top of the 1st Stage Desalter will provide low Total Level Alarm in DCS.

VII. Agar probes 029-AIT-1027 / 029-AIT-2027 (for Train A/B) monitor the emulsion layer build-up in the vessel.

Cameron believes that any interference from the emulsion probe related to demulsifier injection rate may lead to incorrect dosing and can affect the equipment performance. There will be no performance issues if the Auto demulsifier injection mode will simply regulate the demulsifier injection rate relative to the total wet oil flow rate using demulsifier chemical dosage range established during field test run.

AB1

Over-treatment or over dosing of Demulsifier chemical in crude oil results in settling water drops easily re-dispersed and Reaction of demulsifiers with contaminants may produce sludge. Hence optimum Demulsifier dosing rate must be injected. Demulsifier dosing rate is in the range of 3-20 ppm depends on emulsion stability which is purely an initial recommendation from Cameron and accurate dosing rate must come from chemical vendors based on the field testing of oil with demulsifier in presence of electric filed.

Demulsifier is injected in Desalter Feed Pump Suction Header by Automatic Variable Stroke Injection Pump. Demulsifier injection can be carried out in 3 modes of Operation which can be selected by Selector Switch HS-0591B.

HS-0591B shall have the below selection options:

1. Wet Crude Flow Control
2. Emulsion Probe (AIC) Control
3. Manual Control

<u>Wet Crude Flow Control</u>

In this mode, Demulsifier injection is controlled by FIC-1013 and FFIC-0591 under Ratio Control.FIC-1013 installed in Crude line measures the flow of crude to First Stage Desalter.

FIT-0591A installed in the discharge line of the Demulsifier Injection pump measures the flow of Demulsifier to be injected in Desalter Feed Pump Suction Header. Based on the demulsifier and Crude flow ratio setpoint, FFIC-0591 shall adjust the stroke of Injection Pumps G-841A/B.

HS-0591A is used for Pump Selections out of G-841A or B.

<u>Emulsion Probe (AIC) Control</u>

In this mode, Demulsifier injection is controlled by AIC-1027/1035 and FIC-0591A under Cascade Control. Demulsifier Injection Flow Transmitter FIC-0591A shall act as a slave controller and receives setpoint from AIC-1027/1035 via high selector AY-1035.

AIC-1027/1035 are Chemical Injection Guard Probe / Emulsion Probe that monitors the % water content from its position in the oil phase just below the lower grid. It sends a 4-20 mA signal indicating 0-60% water concentration in the oil phase. This probe is used to determine demulsifier injection requirements. If water percent is below setpoint then the Demulsifier rate can be reduced. If the water % is above set point, then Demulsifier rate shall be increased to avoid sudden slugs of emulsion causing process upsets by shorting the power unit grids.

AIC-1027 is installed on the First Stage Crude Desalter C-102 and AIC-1035 is installed on the Second Stage Crude Desalter C-103.The output of AIC-1027 or AIC-1035 shall serve as a setpoint for FIC-0591A which shall adjust the stroke of Injection Pumps G-841A/B. HS-0591A is used for Pump Selections out of G-841A or B.

Selector Switch HS-0110 shall be provided to select Emulsion Probe Stage I or Stage II output. HS-0110 shall have following selection options:

- Both Stage
- Stage I only
- Stage II only

AY-1035 is the high selector block which shall select the high output out of the AIC-1027 and AIC-1035.The output from AY-1035 shall be serving as a setpoint for FIC-0591A based upon the selection in HS-0110 and provided that HS-0591B is in Emulsion Probe Control mode. FIC-0591A shall adjust the stroke of Injection Pumps G-841A/B.

Manual Control

In this mode, Operator shall manually adjust the stroke of Injection Pumps G-841A/B via Manual loader (HIC-0591A/B), thereby controlling the Injection rate of Demulsifier to be injected in Desalter Feed Pump Suction Header. When manual mode is selected in HS-0591B by operator, DCS shall force the controllers FFIC-0591 and FIC-0591A to MANUAL.

VIII. Sand Build Up

Build-up of solids on the bottom of the 1st Stage Desalter is detrimental to the operation. To prevent this build-up in the 1st Stage Desalter 529-C-102 / 202 (for Train A/B),

- Vessel is equipped with Sand wash headers. The headers spray the bottom of the vessel with water to lift the solids off the bottom. The sand wash system needs to be regularly operated in offline mode. For effective sand washing, a minimum of 35 psi or 2.41 bar pressure difference shall be maintained between the sand wash pressure and the vessel operating pressure. The source of the sand wash is a divert from the wash water pumps, 529-G-102 A/B/C (Train A) / 529-G-202 A/B/C (For Train B).
- The flow for the sand wash and header wash is set manually by ball valve.

IX. Agar probes 029-AIT-1028 / 2028 (for Train A/B) monitor the solid hydrocarbon build-up in the vessel.

High (H) hydrocarbon solid build-up alarm is generated in the DCS from AI-1028 / 2028 (for Train A/B).

X. Pressure Transmitter 029-PIT-1056 / 2056 (for Train A/B) installed in the top of the 1st Stage Desalter will provide low & High Pressure Alarms in DCS from 029-PI-1056 / 2056 (for Train A/B).

XI. Temperature Transmitter 029-TIT-1029 / 2029 (for Train A/B) installed in the top of the 1st Stage Desalter is to monitor the operating temperature of the Desalter in DCS from 029-TI-1029 / 2029 (for Train A/B).

### D.1.1.1 2ND STAGE DESALTER TRAIN A (529-C-103) AND TRAIN B (529-C-203)

Before entering the 2nd stage Desalter the partially treated oil from the first stage is mixed with wash water from the Wash Water Pumps 529-G-102 A/B/C (For Train A by PIL) & 529-G-202 A/B/C (For Train B By PIL). Sufficient fresh water pressure at the injection point is to be maintained for injection into the crude feed upstream of the 2nd Stage mixing valve, 029-PDCV-1071 / 029-PDCV-2071 (for Train A/B).

After the mixing valve 029-PDCV-1071 / 029-PDCV-2071 (for Train A/B) the crude feed and wash water enters the 2nd Stage Desalter inlet distributor. The vessel operates completely full of liquid.

As the crude feed and low saline water enters the 2nd Stage Desalter it is resolved by coalescence in a high voltage electrical field, and subsequently separated. The water drops under gravity to the bottom of the vessel where it is removed and then recycled to the 1st Stage Desalter (529-C-102/202 for Train A/B) via the Recycle Water Pumps (529-G-103A/B/C or 529-G-203A/B/C for Train A/B). A water/oil interface is established, and controlled in the vessel bottom.

A Demulsifier Chemical addition point (By PIL) is provided in the suction of the Desalter Feed Pump by PIL [529-G-101A/B/C (Train A) & 529-G-201A/B/C (Train B)].

Effluent water from the 2nd Stage Desalter, 529-C-103 / 203 (for Train A/B), is fed under system pressure to the suction of the Recycle Water pumps (529-G-103A/B/C or 529-G-203A/B/C for Train A/B) where it is pumped to the 1st Stage Desalter, 529-C-102/202 (for Train A/B). The flow is controlled to maintain the correct interface level in the 2nd Stage Desalter.

The treated crude oil leaves the 2nd Stage Desalter, 529-C-103/203 (for Train A/B) via the outlet collector at the top of 2nd Stage Desalter and is sent to the treated crude outlet.

b. CONTROL FUNCTIONS OF SECOND STAGE CRUDE DESALTER (TRAIN A & B):

SECOND STAGE CRUDE DESALTER TRAIN A

| **Tag No** | **Service Description** | **Instrument Description** | **Reference P&ID number** | **Engg Unit** | **Set Point** | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | **LL** | **L** | **N** | **H** | **HH** |
| 029-AIT-1035 | Desalter Emulsion Level | Emulsion Probe | 50476-029-020-PID-1069.002 | % $H_2O$ | NA | NA | NA | Note-1 | NA |
| 029-LDIT-1034 | Desalter Interface Level | Level Differential Transmitter (Low-High) {Interface Probe}. | 50476-029-020-PID-1069.002 | % $H_2O$ | NA | 70 | 80 | 90 | NA |
| 029-AIT-1036 | Desalter Solid/Water Level | Solid Probe | 50476-029-020-PID-1069.002 | % $H_2O$ | NA | 90 | NA | N/A | NA |
| 029-LDIT-1031 | Desalter Interface Level | Level Differential Transmitter (Low-High). | 50476-029-020-PID-1069.002 | mm | NA | 710 (10.04 mA) | NA | 910 (13.98 mA) | NA |
| 029-LDIT-1032 | Desalter Interface Level | Level Differential Transmitter (High-High). | 50476-029-020-PID-1069.002 | mm | NA | NA | NA | NA | 1010 (12.93 mA) |
| 029-LDIT-1033 | Desalter Interface Level | Level Differential Transmitter (Low-Low). | 50476-029-020-PID-1069.002 | mm | 610 (11.07 mA) | NA | NA | NA | NA |
| 029-LIT-1029 | Desalter Oil Level | Level Transmitter (Low) | 50476-029-020-PID-1069.002 | mm | NA | 3633 (10.88 mA) | NA | NA | NA |
| 029-LIT-1030 | Desalter Oil Level | Level Transmitter (Low Low) | 50476-029-020-PID-1069.002 | mm | 3558 (10.20 mA) | NA | NA | NA | NA |
| 029-LS-1768 | Desalter Oil Level | Level Switch (Low Low) | 50476-029-020-PID-1069.002 | mm | 50 | NA | NA | NA | NA |
| 029-PDIT-1071 | Across Mixing Valve Diff.Pressure | Differential pressure transmitter | 50476-029-020-PID-1069.001 | Bar | NA | NA | NA | 0.8 (10.4 mA) | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 029-PIT-1069 | Desalter Pressure | Pressure transmitter | 50476-029-020-PID-1069.002 | barg | NA | 5.76 (9.7 mA) | NA | 8.82 (12.8 mA) | NA |
| 029-LALL-1767 | Desalter Power Unit Oil Level | Level Switch (Internal) | 50476-029-020-PID-1069.002 | mm | 25.4mm below normal liquid level of each tank. | NA | NA | NA | NA |
| 029-PAHH-1766 | Desalter Power Unit Oil Pressure | Pressure Switch | 50476-029-020-PID-1069.002 | barg | NA | NA | NA | NA | 0.35 |
| 029-TAHH-1766 | Desalter Power Unit Oil Temperature | Temperature Switch (Chopper Tank) | 50476-029-020-PID-1069.002 | $^0$C | NA | NA | NA | NA | 90 |

**Note-1:** Agar Probe-2 (Chemical Injection Guard Probe / Emulsion Probe) High Alarm depends on the crude state, throughput etc. Some clients run an HIgh alarm at 10% while others at 30%. The easiest way to determine the correct point is to let the emulsion build upwards (by reducing chemical or raising interface level) and watching the amps. When the amp begins to climb, note the reading on the upper/emulsion probe that should be max high alarm set point. Most clients reduce this value by 20% from actual reading when amps start to increase.

**SECOND STAGE CRUDE DESALTER TRAIN B**

| Tag No | Service Description | Instrument Description | Reference P&ID number | Engg Unit | Set Point | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | LL | L | N | H | HH |
| 029-AIT-2035 | Desalter Emulsion Level | Emulsion Probe | 50476-029-020-PID-2069.002 | % $H_2O$ | NA | NA | NA | Note-1 | NA |
| 029-LDIT-2034 | Desalter Interface Level | Level Differential Transmitter (Low-High) {Interface Probe}. | 50476-029-020-PID-2069.002 | % $H_2O$ | NA | 70 | 80 | 90 | NA |
| 029-AIT-2036 | Desalter Solid/Water Level | Solid Probe | 50476-029-020-PID-2069.002 | % $H_2O$ | NA | 90 | NA | N/A | NA |
| 029-LDIT-2031 | Desalter Interface Level | Level Differential Transmitter (Low-High). | 50476-029-020-PID-2069.002 | mm | NA | 710 (10.04 mA) | NA | 910 (13.98 mA) | NA |
| 029-LDIT-2032 | Desalter Interface Level | Level Differential Transmitter (High-High). | 50476-029-020-PID-2069.002 | mm | NA | NA | NA | NA | 1010 (12.93 mA) |
| 029-LDIT-2033 | Desalter Interface Level | Level Differential Transmitter (Low-Low). | 50476-029-020-PID-2069.002 | mm | 610 (11.07mA) | NA | NA | NA | NA |
| 029-LIT-2029 | Desalter Oil Level | Level Transmitter (Low) | 50476-029-020-PID-2069.002 | mm | NA | 3633 (10.88 mA) | NA | NA | NA |
| 029-LIT-2030 | Desalter Oil Level | Level Transmitter (Low Low) | 50476-029-020-PID-2069.002 | mm | 3558 (10.20 mA) | NA | NA | NA | NA |
| 029-LS-2768 | Desalter Oil Level | Level Switch (Low Low) | 50476-029-020-PID-2069.002 | mm | 50 | NA | NA | NA | NA |
| 029-PDIT-2071 | Across Mixing Valve Diff.Pressure | Differential pressure transmitter | 50476-029-020-PID-2069.001 | Bar | NA | NA | NA | 0.8 (10.4 mA) | NA |
| 029-PIT-2069 | Desalter Pressure | Pressure transmitter | 50476-029-020-PID-2069.002 | barg | NA | 5.76 (9.7 mA) | NA | 8.82 (12.8 mA) | NA |
| 029-LALL-2767 | Desalter Power | Level Switch (Internal) | 50476-029-020-PID-2069.002 | mm | 25.4mm below normal | NA | NA | NA | NA |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Unit Oil Level | | | | liquid level of each tank. | | | | |
| 029-PAHH-2766 | Desalter Power Unit Oil Pressure | Pressure Switch | 50476-029-020-PID-2069.002 | barg | NA | NA | NA | NA | 0.35 |
| 029-TAHH-2766 | Desalter Power Unit Oil Temperature | Temperature Switch(Chopper Tank) | 50476-029-020-PID-2069.002 | $^{0}$C | NA | NA | NA | NA | 90 |

**Note-1:** Agar Probe-2 (Chemical Injection Guard Probe / Emulsion Probe) High Alarm depends on the crude state, throughput etc. Some clients run an HIgh alarm at 10% while others at 30%. The easiest way to determine the correct point is to let the emulsion build upwards (by reducing chemical or raising interface level) and watching the amps. When the amp begins to climb, note the reading on the upper/emulsion probe that should be max high alarm set point. Most clients reduce this value by 20% from actual reading when amps start to increase.

Control functions are as follows:

I. Interface Level Control

Each Desalter vessel is equipped with one Interface level transmitter 029-LDIT-1031/ 029-LDIT-2031 (for Train A/B) and one AGAR probe 029-LDIT-1034 / 029-LDIT-2034 (for Train A/B) to maintain and control the oil/water interface level in the vessel. Client has an option to select either of these two instrument through selector 029-HS-1010 for controlling oil/water interface level through level controller 029-LDIC-1034 / 029-LDIT-2034 (for Train A/B) via Interface level control valve 029-LDCV-1034 / 029-LDIT-2034 (for Train A/B) which controls the amount of effluent water which is drawn from the bottom of the 2$^{nd}$ Stage Desalter.

Low (L) and High (H) interface level alarms are generated in the DCS from interface 029-LDIC-1034 / 029-LDIC-2034(Train A & Train B).

II. Low Low Interface Level Safety

Level transmitters 029-LDIT-1033 / 029-LDIT-2033 (for Train A/B) provides protection against low-low (LL) interface level in the 2$^{nd}$ Stage Desalter by activating Level IV shutdown which results in shutting down of the duty Recycle Water Pumps, 529-G-103A/B/C [ (for Train A) [ (RYCL EFFLUENT WTR PMP TRN-A G103A 029-XS-1004A-MT) / (RYCL EFFLUENT WTR PMP TRN-A G103B 029-XS-1004B-MT) / (RYCL EFFLUENT WTR PMP TRN-A G103C 029-XS-1004C-MT)] / 529-G-203A/B/C (for Train B) [ (RYCL EFFLUENT

WTR PMP TRN-B G203A 029-XS-2004A-MT) / (RYCL EFFLUENT WTR PMP TRN-B G203B 029-XS-2004B-MT) / (RYCL EFFLUENT WTR PMP TRN-A G203C 029-XS-2004C-MT)] and closing the E102 - EFL EFFLUENT WATER/WASH WATER EXCHANGER (TRAIN A) WTR OUTLET VALVE 029-ESDV-1011.

III. High High Interface Level Safety

Level transmitters 029-LDIT-1032 / 029-LDIT-2032 (for Train A/B) provides protection against high-high (HH) interface level in the 2nd Stage Desalter by activating Level IV shutdown which results in shutting down the Duty Wash Water Pumps, 529-G-102A/B/C (for Train A) [ (WASH WTR FEED PMP TRN-A G102A 029-XS-1003A-MT) / (WASH WTR FEED PMP TRN-A G102B 029-XS-1003B-MT) / (WASH WTR FEED PMP TRN-A G102C 029-XS-1003C-MT)] / 529-G-202A/B/C (for Train B) [ (WASH WTR FEED PMP TRN-B G202A 029-XS-2003A-MT) / (WASH WTR FEED PMP TRN-A G202B 029-XS-2003B-MT) / (WASH WTR FEED PMP TRN-A G202C 029-XS-2003C-MT)].

IV. Low Low Total Level Safety

Level Switch 029-LS-1768 / 029-LS-2768 (for Train A/B) installed in the top of the 2nd Stage Desalter provides protection against drop in total level in the vessel by killing the Second stage Desalter DF power unit [529-C-103-PU-01 (029-XS-1766) / 529-C-203-PU-01 (029-XS-2766)] (for Train A/B)) permissive

[Vapour switch (029-LS-1768 / 029-LS-2768) will be wired to the "Process enable input" of LRC- II panel. In the event of loss in the vessel total liquid level to the given set point the "Process enable input" will provide an open circuit and DF permissive is killed and LRC-II panel provides an alarm, If the level in the Desalter is re-established the power unit will auto start.]If the level in the Desalter is re-established the power unit will auto start which is an activation of level IV shutdown.

V. Level Transmitter 029-LIT-1030 / 029-LIT-2030 (for Train A/B) installed in the top of the 2nd Stage Desalter provides protection against drop in total level in the vessel by activating Level IV shutdown which results in tripping of (029-XS-1766 / 029-XS-2766) of Second stage Desalter Power unit [529-C-103-PU-01 / 529-C-203-PU-01 (for Train A/B)], also closing of treated crude from desalters to storage tank shutdown valve 029-ESDV-1009 / 029-ESDV-1009, in case there is significant drop in Total level in the vessel and Low-Low alarm indication will occur in DCS.

VI. Level Transmitters 029-LIT-1029 / 029-LIT-2029 (for Train A/B) installed in the top of the 2nd Stage Desalter will provide low Total Level Alarm in DCS.

VII. Agar probes 029-AIT-1035 / 029-AIT-2035 (for Train A/B) monitor the emulsion layer build-up in the vessel.

Cameron believes that any interference from the emulsion probe related to demulsifier injection rate may lead to incorrect dosing and can affect the equipment performance. There will be no performance issues if the Auto demulsifier injection mode will simply regulate the demulsifier injection rate relative to the total wet oil flow rate using demulsifier chemical dosage range established during field test run.

Over-treatment or over dosing of Demulsifier chemical in crude oil results in settling water drops easily re-dispersed and Reaction of demulsifiers with contaminants may produce sludge. Hence optimum Demulsifier dosing rate must be injected

Demulsifier is injected in Desalter Feed Pump Suction Header by Automatic Variable Stroke Injection Pump. Demulsifier injection can be carried out in 3 modes of Operation which can be selected by Selector Switch HS-0591D.

HS-0591D shall have the below selection options:

1. Wet Crude Flow Control
2. Emulsion Probe (AIC) Control
3. Manual Control

Wet Crude Flow Control

In this mode, Demulsifier injection is controlled by FIC-2013 and FFIC-0591C under Ratio Control.FIC-2013 installed in Crude line measures the flow of crude to Desalter.

FIT-0591C installed in the discharge line of the Demulsifier Injection pump measures the flow of Demulsifier to be injected in Desalter Feed Pump Suction Header. Based on the demulsifier and Crude flow ratio setpoint, FFIC-0591 shall adjust the stroke of Injection Pumps G-841C/B.

HS-0591C is used for Pump Selections out of G-841C or B.

Emulsion Probe (AIC) Control

In this mode, Demulsifier injection is controlled by AIC-2027/2035 and FIC-0591C under Cascade Control. Demulsifier Injection Flow Transmitter FIC-0591C shall act as a slave controller and receives setpoint from AIC-2027/2035 via high selector AY-2035.

AIC-2027/2035 are Chemical Injection Guard Probe / Emulsion Probe that monitors the % water content from its position in the oil phase just below the lower grid. It sends a 4-20 mA signal indicating 0-60% water concentration in the oil phase. This probe is used to determine demulsifier injection requirements. If water percent is below setpoint then the Demulsifier rate can be reduced. If the water % is above set point, then Demulsifier rate shall be increased to avoid sudden slugs of emulsion causing process upsets by shorting the power unit grids.

AIC-2027 is installed on the First Stage Crude Desalter C-202 and AIC-2035 is installed on the Second Stage Crude Desalter C-203.The output of AIC-2027 or AIC-2035 shall serve as a setpoint for FIC-0591C which shall adjust the stroke of Injection Pumps G-841C/B. HS-0591C is used for Pump Selections out of G-841C or B.

Selector Switch HS-0111 shall be provided to select Emulsion Probe Stage I or Stage II output. HS-0111 shall have following selection options:

- Both Stage
- Stage I only
- Stage II only

AY-2035 is the high selector block which shall select the high output out of the AIC-2027 and AIC-2035.The output from AY-2035 shall be serving as a setpoint for FIC-0591C based upon the selection in HS-0111 and provided that HS-0591D is in Emulsion Probe Control mode. FIC-0591C shall adjust the stroke of Injection Pumps G-841C/B.

Manual Control

In this mode, Operator shall manually adjust the stroke of Injection Pumps G-841C/B via Manual loader (HIC-0591C/B), thereby controlling the Injection rate of Demulsifier to be injected in Desalter Feed Pump Suction Header. When manual mode is selected in HS-0591D by operator, DCS shall force the controllers FFIC-0591 and FIC-0591C to MANUAL.

VIII. Sand Build Up

Build-up of solids on the bottom of the 2nd Stage Desalter is detrimental to the operation. To prevent this build-up in the 2nd Stage Desalter 529-C-103 / 529-C-203 (for Train A/B),

- Vessel is equipped with sand wash headers. The headers spray the bottom of the vessel with water to lift the solids off the bottom. The sand wash system needs to be regularly operated in offline mode. For effective sand washing, a minimum of 35 psi or 2.42 bar pressure difference shall be maintained between the sand wash pressure and the vessel operating pressure. The source of the sand wash is a divert from the wash water pumps, 529-G-102 A/B/C(For Train A) or 529-G-202 A/B/C (For Train B).
- The flow for the sand wash and header wash is set manually by ball valve.
- Agar probes 029-AIT-1036 / 029-AIT-2036 (for Train A/B) monitor the solid hydrocarbon build-up in the vessel.

High (H) hydrocarbon solid build-up alarm is generated in the DCS from 029-AI-1036 / 029-AI-2036 (for Train A/B).

IX. Pressure Transmitter 029-PIT-1069 / 029-PIT-2069 (for Train A/B) installed in the top of the 2nd Stage Desalter will provide low & High Pressure Alarms in DCS from 029-AI-1069 / 029-AI-2069 (for Train A & B).

X. Temperature Transmitter 029-TIT-1033 / 2033 (for Train A/B) installed in the top of the 1st Stage Desalter is to monitor the operating temperature of the Desalter in DCS from 029-TI-1033 / 2033 (for Train A/B).

c. MIXING VALVE DIFFERENTIAL PRESSURE

PDIT ACROSS 1ST STAGE MIXING VALVE:
Pressure Transmitter 029-PDIT-1060 / 029-PDIT-2060 (for Train A/B) installed across 1st Stage Mixing valve to monitor and control the differential pressure across this valve which is one of the key parameter as it affects the mixing efficiency of the system.
High (H) differential pressure alarm across 1st Stage mixing valve is generated in the DCS from 029-PDIC-1060 / 029-PDIC-2060 (for Train A/B).

PDIT ACROSS 2ND STAGE MIXING VALVE:
Pressure Transmitter 029-PDIT-1071 / 029-PDIT-2071 (for Train A/B) installed across 2nd Stage Mixing valve to monitor and control the differential pressure across this valve which is one of the key parameter as it affects the mixing efficiency of the system.
High (H) differential pressure alarm across 2nd stage mixing valve is generated in the DCS from 029-PDIC-1071 / 029-PDIC-2071 (for Train A/B).

A.1.2 Advantages of Dual Frequency® system in desalting process

It is a solution for high conductivity because it:

a. Energises electrodes at high frequency:
- Minimises voltage decay from electrodes
- Maximises useful coalescing power

b. Modulates voltage at low frequency:

- Between threshold and critical levels
- Maximises film stretch
- Improves droplet growth

c. Offers the Bimodal “Dual Frequency®” Benefits:

- Reduced effluent water cut

- More efficient power utilisation
- Increased vessel flux

All this features allow high performance in the dehydration process:

- DF® Desalter can increase vessel throughput without compromising the outlet BSW.
- DF® Desalter can operate at lower temperature than the other Desalters.
- Using DF® Desalter can reduce demulsifier consumption by 40% over conventional Desalters.
- Electrostatic Desalting using Dual Frequency® is effective for:

  - Higher oil conductivity
  - Reduced Vessel Size
  - Consistent Performance
  - Reduced Temperatures

### A.1.3 Dual Frequency® components

The Dual Frequency electrostatic technology has the following main components:

a. Transformer (Power Unit)
- Three phase design – balanced load
- Very low reactance (~10%)
- Increases power utilisation up to 80%
- Soft-Start Electronics enable transformer electronics then applies power to the system

b. LRC II Interface (Control Panel)

- Responsible for Supervisory, Dialogue, Reporting and Control (SDRC) of Dual Frequency® system.
- Voltage profile consists of max and min operating voltages, Base and modulation frequencies, waveform and skew factor.

Each power unit will have its own control panel.

#### *A.1.3.1 Dual Frequency® power unit*

The function of the Dual Frequency® Power Supply Unit is to convert three phase 480V from electrical distribution lines to high frequency, high Secondary voltage signals (around 34KVDC peak @ 2.94A). The 50 Hz input power is rectified, modulated and inverted to obtain a modulated high frequency signal. The Power Supply Unit is connected to the electrostatic internals through two bushing connections.

A step-up transformer for Each Desalter is supplied for each power unit to increase the power supply from 440 V to 480 V.

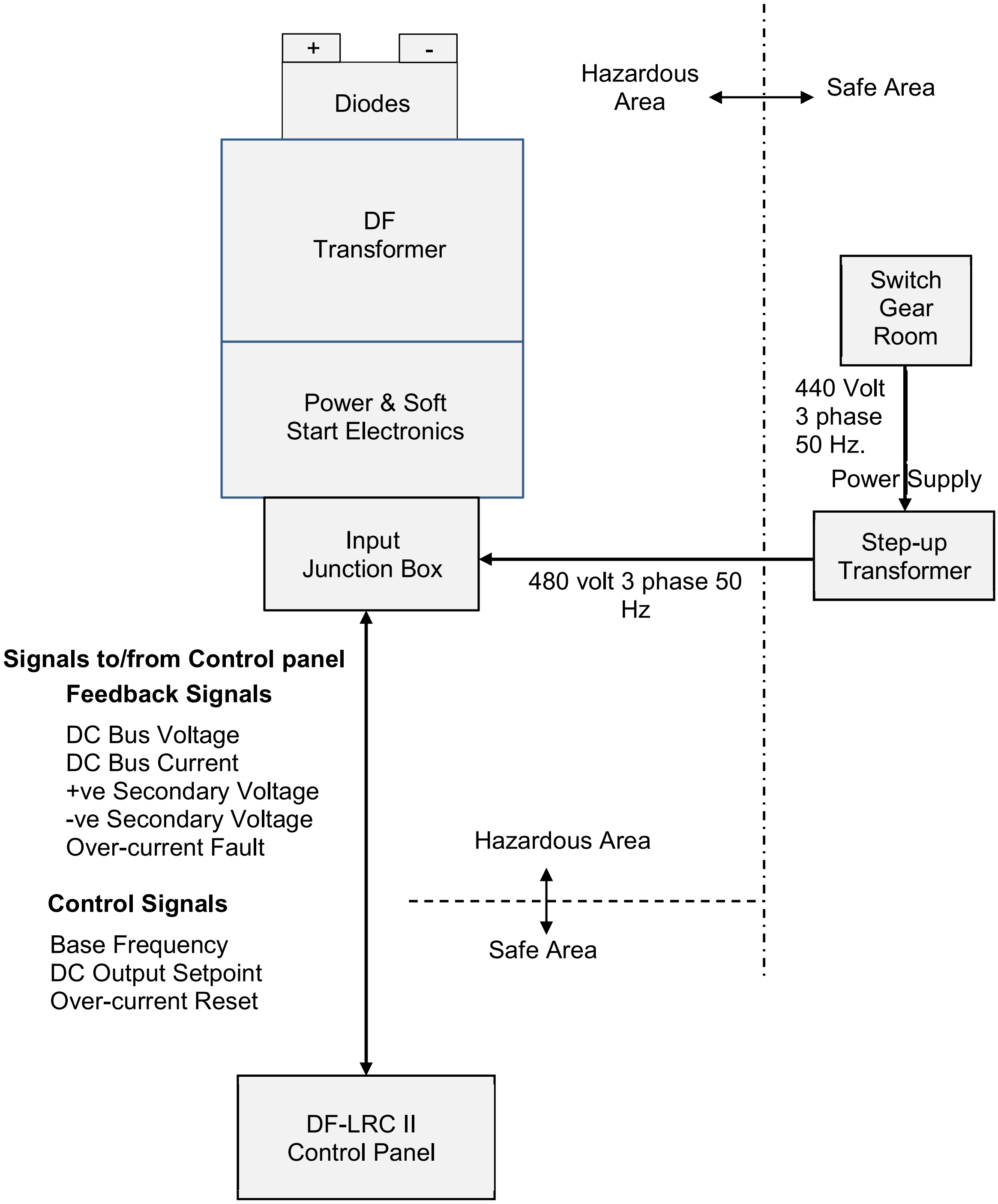



Figure 3: DF LRC II POWER UNIT SCHEMATIC

The Power Unit includes the following compartments:

1. **Input junction box.** This unit receives all signal cabling to/from the DF-LRC II Control Panel and the 480 volt power supply from the DF Auto transformer.

2. **DF Power & Soft Start Electronics.** The purpose of the soft start electronics is to apply the three-phase, 480 Volts to power the electronics module of the transformer in two sequenced voltage steps. By applying a low voltage for 600 milliseconds prior to applying full voltage, switching transients are reduced. This unit comprises driver electronic boards, power supply and chopper/inverter assembly, fully immersed into the transformer oil

3. **DF Transformer.** This unit incorporates the secondary windings and is a compartment filled with transformer oil.

4. **Diode Box.** This box incorporates the voltage dividers and diodes and is also filled with transformer oil. The high voltage cables (positive and negative) from the diode box are connected to the Power unit entrance bushings.

### *A.1.3.2 Dual Frequency® LRC II Control Panel with software*

The Dual Frequency® Panel contains:

- the LRC II controller
- an LCD screen
- Indicating lamps and power switch for turning the computer on and off.

The purpose of the LRC II is to send and receive signals from the DF Power Unit and the Step/Start Electronics, set the operating parameters of the transformer, start, stop the transformer and emergency stop the transformer.

The LRC-II board is the heart of the LRC-II Smart Interface and performs the essential functions. It is located inside the control panel. The board interacts with the LCD panel and the power unit.

The main functions performed by the LRC-II board are as follows:

- Process the parameter changes requested by the user.
- Monitor the power unit performance (voltage, current etc) and pass appropriate information to the LCD panel.
- Monitor arcing inside the vessel and safely reset the power unit.
- Invoke warning/caution messages on the LCD Panel whenever upsets are noted in the power unit.

All the inputs and outputs are wired to the LRC-II board via jack plugs on the board.

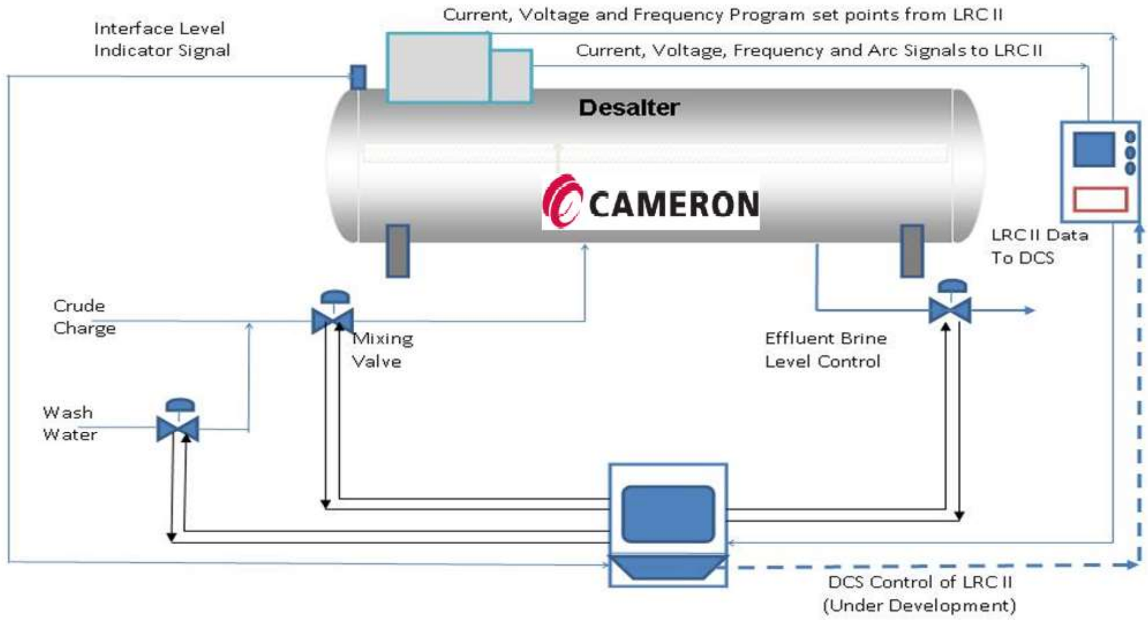



Figure No. 4 - Dual Frequency® Power Supply Unit and LRC Panel
(details the interface of the two panels)

**Pulse & Base Frequency Effects**

- Energises drops at resonant frequency
- Deformed drops more readily coalesced
- Allows the electrostatic process to be optimised for additional crude oil characteristics
    - Interfacial tension (Pulse modulation)
    - Oil Conductivity (Base frequency)
    - Density
    - Viscosity
- More Efficient Power Utilisation
    - Can deliver full current at rated voltage level
    - Lower transformer reactance (10% total) than conventional transformer

**Composite Electrode Plates**

Electrostatic coalescence generally proceeds through a mechanism of drop polarisation, alignment of the polarised drops, and "chaining" of these drops along the lines of force of the electrostatic field. These conductive chains lead to frequent electrical discharges or arcing between the electrodes. The arcs are a normal part of the process, and because they are submerged in oil, they do not produce any damage. However, a steel electrode array is momentarily discharged by an arc, and if the arcs occur with sufficient frequency (as in a wet emulsion), the electrodes may be discharged for a sufficient duration for slippage of process fluids without adequate exposure to the field. Composite plate electrodes may be used to increase the water tolerance of the system under such conditions. These electrodes consist of plates of composite (fibre reinforced plastic) construction with graphite or carbon embedded in the central portion of the plate to impart conductivity along the length of the plate. Refer to Figure 2.

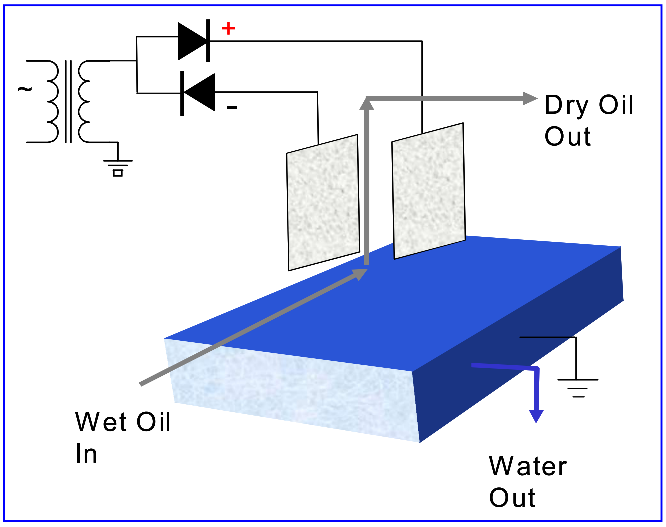



Figure 5: Composite Electrodes Configuration

The remainder of the plate contains filler materials that lead to the adsorption of a layer of water on the plate surface. This adsorbed water layer then becomes the conductive medium along the height of the plate. Since such an adsorbed layer is quite resistive, any arcing that occurs is quickly quenched. As a result, only the area in the immediate vicinity of the arc is discharged and slippage is almost eliminated. Composite plates are normally spaced on 125 – 150 mm (5 to 6 inch) centres and are approximately 406 mm (16 inches) high. They are used on Dual Polarity® and Dual Frequency® processes for increased water tolerance and in all Electro-Dynamic® Desalters.

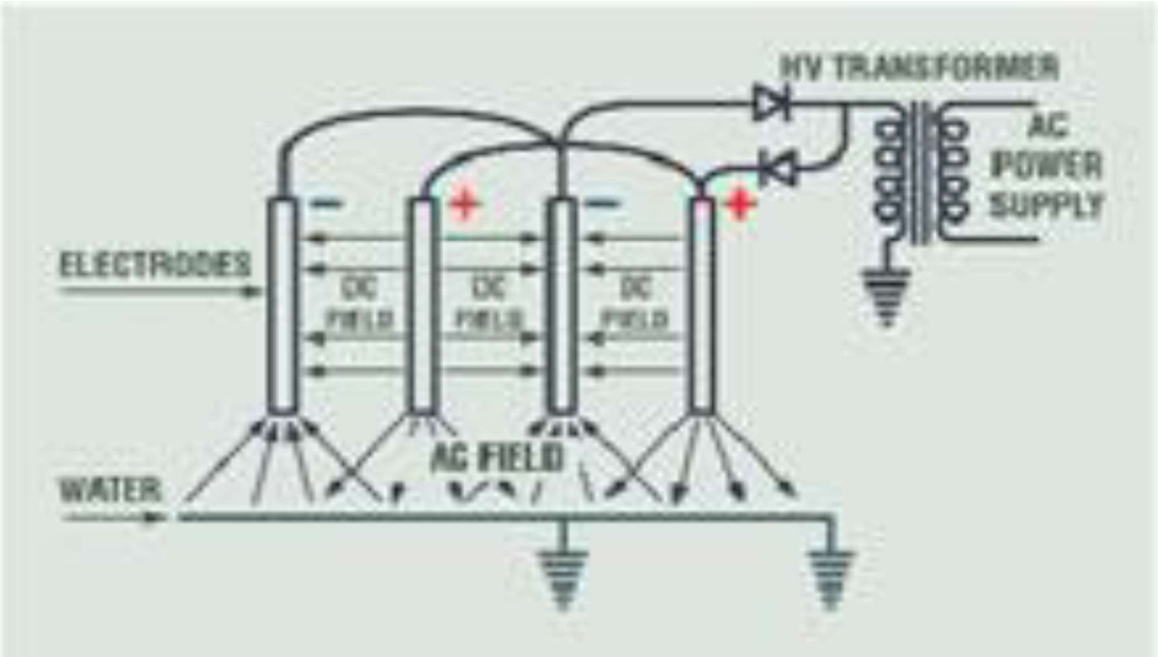



Figure 6: Composite Electrodes Field

Advantages of Composite Electrodes

- Tolerant of high water content dispersions
- More effective treatment of conductive liquids
- Produce a graduated field for better drop growth
- Less slippage or by-passing of untreated process liquids due to arcs
- Provide greater retention time in the electrode zone
- Resistant to vessel motion due to mechanically stable array

**Power Unit Design**

The Power Unit is a proprietary design utilising a three phase power supply for a balanced electrical load and a 10% primary reactance for maximum power utilisation. The high voltage secondary of the Power Unit is connected to the electrodes through two specially designed high voltage entrance bushings, see figure 7 below.

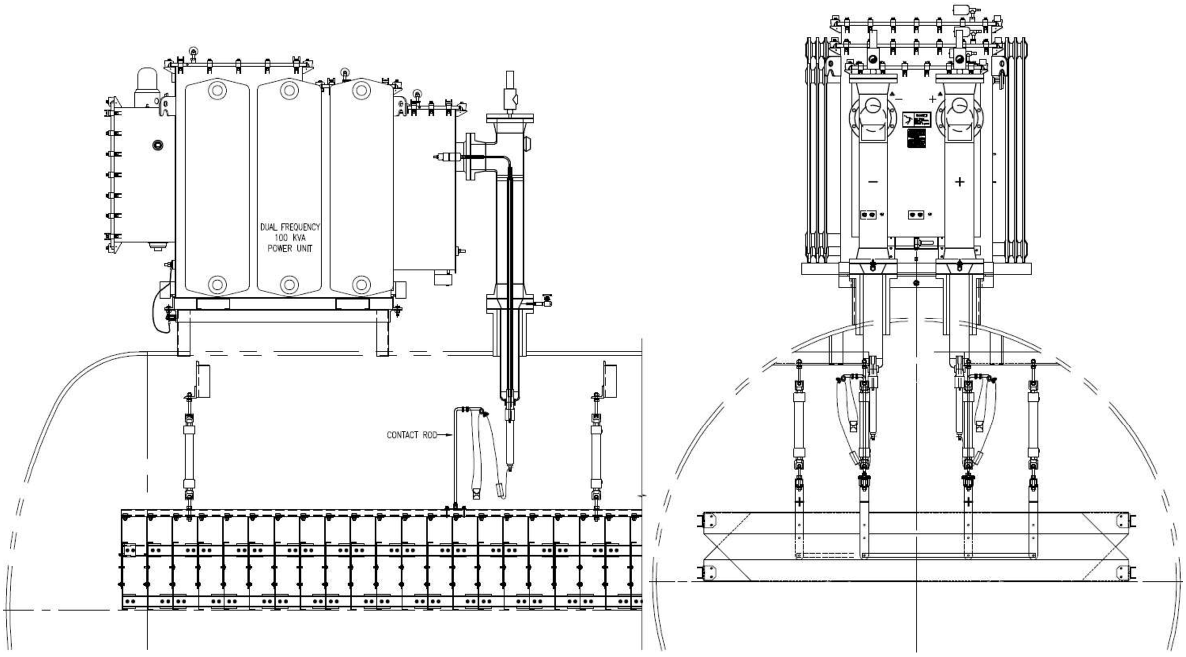



Figure 7 – Typical Electrical Assembly

## Bushings & Insulators

The CAMERON designs feature the use of PTFE for both the entrance bushings and the electrode insulators for reliable and trouble free operation. The entrance bushings are critical specialist items, which take the high voltage from the power unit through the vessel shell to the electrode system. The insulators support the electrode system inside the vessel. All these items can be subject to high operating temperatures and pressures.

PTFE combines good electrical insulation with non-stick properties and has high safety factors. These features make PTFE the most suitable material for this duty.

**Vessel Internal Headers – Coalescing Section**

An important requirement in the design of the coalescing section is minimum turbulence inside the vessel. For optimum throughput and performance it is critical that each part of the electrode system receives equal volumes of emulsion to process. This is achieved by the distribution and collection devices.

## A.1.4 Oil / Water Distributors

The coalescing section is fitted with CAMERON HiFlo® distributors located just above the oil / water interface. This allows only minimal disturbance of the interface pad. The distributors consist of holes placed near and along the bottom portion of the spreaders which prevents the accumulation of sand or other material in the pipe. These holes project the fluid into a “deflector” which runs alongside the pipes. The deflector reduces the velocity of the fluid and directs it around the distribution pipe focusing the bulk flow evenly across the electrode plane.

The distributor holes are designed with consideration of the pressure losses through the holes and down the pipe. The resulting balance ensures that each hole projects an equal volume of fluid. The deflector is positioned with respect to the pipe, to provide optimum fluid velocity for even distribution.

Through the use of Computational Fluid Dynamics (CFD), CAMERON patented the shrouded inlet spreader. The shroud functions as a momentum absorber that reduces the fluid velocity prior to release into the vessel’s fluid body.

### *A.1.4.1 Inlet Location*

The location of the crude oil inlet distributor is an important design feature. If the distributor is set too low, such that it is in the water phase, then this can cause an increase in turbulence in the water phase which in turn could cause an increase in the quantity of crude oil carried under with the effluent water.

If on the other hand it is set too high, i.e. in the electrode system, then this puts more water between the electrodes and will cause an increase in power consumption and a greater tendency for carryover of water with the crude oil.

CAMERON locates the inlet distributor in the optimum position, i.e. in the crude oil phase beneath the electrodes.

### *A.1.4.2 Hi-FloTM Distributors*

Advance patented flow distribution

Good flow distribution is critical to any separation vessel, and CAMERON understands flow distribution design. Through the use of Computational Fluid Dynamics (CFD), CAMERON has patented the shrouded inlet spreader. The shroud functions as a momentum absorber that reduces the fluid velocity prior to release into the vessel’s fluid body.

The figure below shows on the left scattered and turbulent distribution while the summary on the right shows minimal turbulence with equal distribution in the vertical plane.

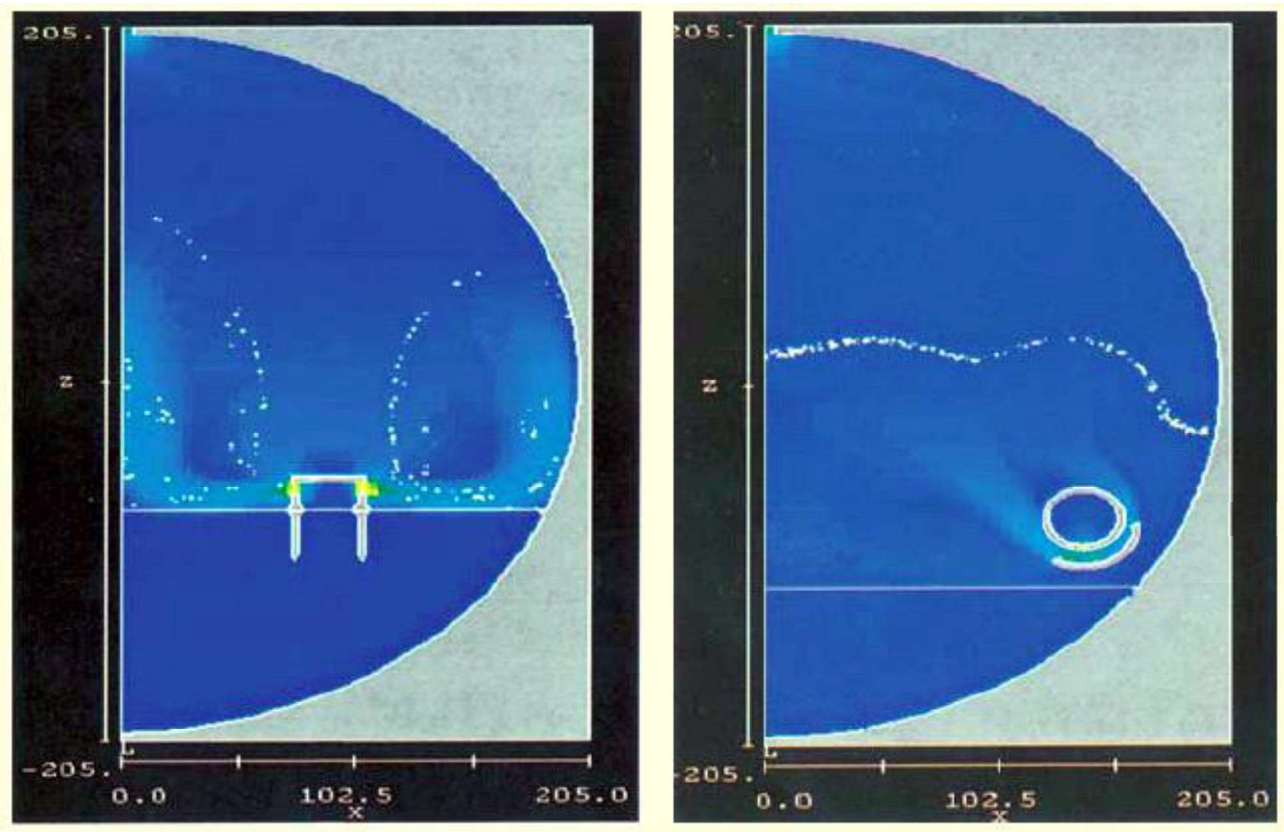



Figure 7: CFD Summary

Performance improvements include:

- Elimination of parasitic circulations within the vessel
- Vessel Hydraulic efficiency approaches 100%
- Elimination of fluid bypassing the grid sections

## A.1.5 Oil Collector Header

The treated heavy Crude oil is collected evenly at the top of the Desalter by means of a single outlet collection header pipe. The holes in the collector pipe are sized to provide sufficient pressure drop to ensure equal collection along the length of the vessel.

### A.1.6 Effluent Water Outlet Headers

The effluent water outlet header draws-off the effluent water at the bottom of the coalescing section. The number, size and spacing of the collection holes along the header are calculated to ensure even flow along the length of the vessel.

### A.1.7 Sand wash Headers

Sand wash or Sand jetting headers are fitted in the Desalters of each train. The Sand wash headers assist the removal of solids/sludge deposited in the bottom of the vessel, whilst the plant is on line. The number and spacing of the sludge wash water jets along the headers are calculated to ensure total coverage of the bottom of the vessel. There are two headers in each vessel.

### A.1.8 Interface Draw-Off Headers

Two interface draw-off headers evenly remove any emulsion/sludge layer that may build up at the interface between the heavy Crude oil and the effluent water. The number, size and spacing of the collection holes along the header are calculated to ensure even draw-off along the length of the vessel.

A.1.9 Process Design Data

The design basis for Desalter Package is summarized below.

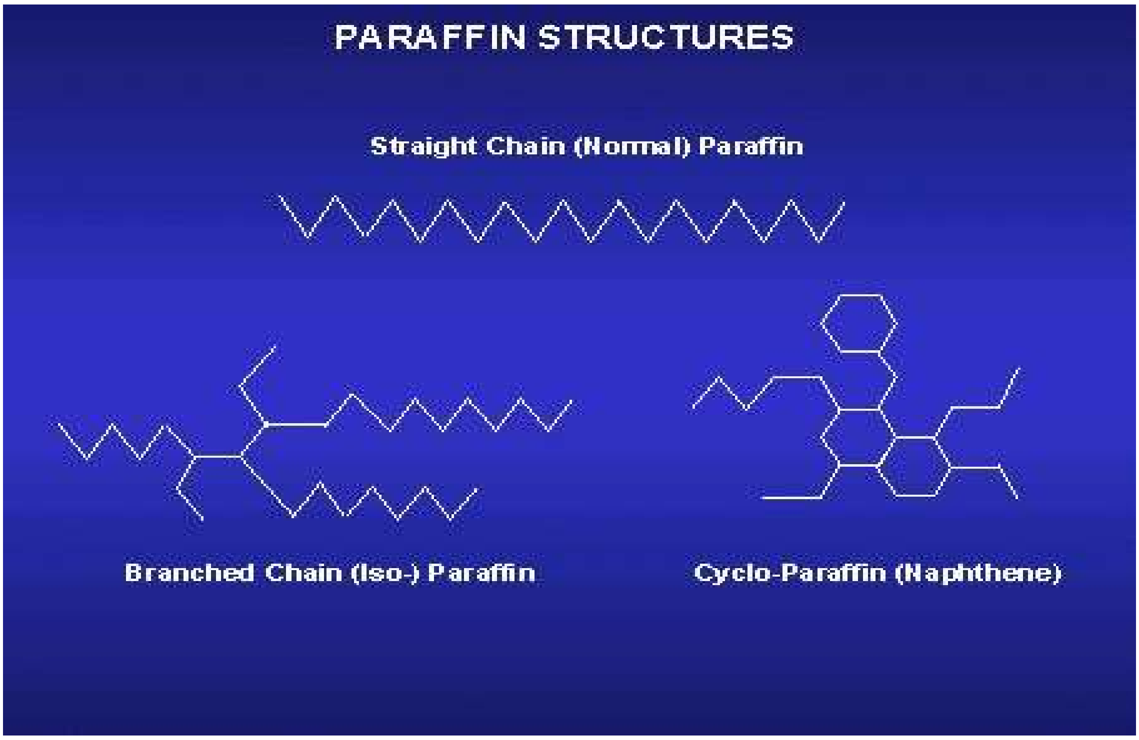
TWO STAGE DESALTING SYSTEM (2 X 100%)

| **Process Variable** | **Units** | **Quantity** |
|---|---|---|
| Dry Oil Design Rate (Per Train) @ 60°F | STB/D or STBOPD / (Sm$^3$/hr) | 56167 / (372.1 ) |
| Turndown Rate (Per Train) @ 60°F | STB/D or STBWPD / (Sm$^3$/hr) | 25000 / (165.61) |
| Formation Water Design Rate (Per Train) @ 60°F | STB/D or STBWPD / (Sm$^3$/hr) | 6232 / (41.29) |
| Wash Water Design Rate (Per Train) 60°F | STB/D or STBWPD / (Sm$^3$/hr) | 3370 / (22.33) |
| Operating Pressure (1st Stage & 2nd Stage) (Max.) – Note 1 | Bar g / Psi g | 8.7 / 126.2 & 6.4 / 92.9 |
| Design Pressure | Bar g / Psi g | 21 / 304.58 |
| Operating Temperature (1st Stage & 2nd Stage) – Note 2 | °C / °F | 71 / 159.8 & 68 / 154.4 |
| Design Temperature | °C / °F | -3 to 93 / 26.6 to 199.4 |
| Dry Oil API @ 60°F | API | 28.95 |
| Dry Oil Viscosity @ 71°C(159.8°F) / 68°C(154.4 °F) | cSt | 8.0 / 8.28 |
| Formation Water Salinity | mg/l TDS | 261,675 |
| Wash Water Salinity – Note 3 | mg/l TDS | 10,000 / 25,000 |
| Design Code | ASME VIII Div. 1 + U Stamp | |

**Notes:**

The following notes are assumptions on the design basis:

1. Operating pressure indicated must remain above the bubble point at all times.
2. Operating temperature must remain above Oil WAT (Wax Appearing Temperature) at all times. Wax = Very heavy molecular weight paraffinic compounds




The onset of wax formation is called the cloud point or wax appearance temperature (WAT). Wax can produce line blockages and stabilize emulsions.

These are generic structures for waxes. These are aliphatic compounds (contain carbon and hydrogen with no multiple bonds). Please note that, especially the cycloparaffin (naphthene) which becomes a naphthenic acid when a carboxylic acid group is attached. The cloud point is the temperature at which oil becomes visually cloudy indicating the precipitation of waxes. Since visual observation is difficult to impossible in black oils, other methods for detection of crystal formation have been devised. For example, the inflection point in a density vs. temperature curve can be used. Precipitation points determined by such methods are referred to as wax appearance temperatures. Deposits in flowlines and vessels are often called paraffins in the oilfield, but true paraffins are aliphatic hydrocarbons.

3. Dissolved oxygen content needs to be reduced to <10 ppb level by introducing Oxygen Scavenger Program (By PIL / Chemical Vendor / KOC).
4. Cameron considers all necessary overpressure scenarios as appropriate to determine the required PSV relief capacity.
5. Utilities shall be supplied as detailed in utilities and chemical list document.
6. Drains shall be collected in a dedicated closed drain header piped to enable gravity draining to a closed drain system.

A.1.10 Performance Guarantee

When the equipment is properly maintained and operated under the conditions specified in the Process Design Basis above, the equipment proposed will, during the performance test described below, meet the following process performance guarantee:

| Desalter Vessel Operating | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Both | First stage only | | | | Second stage only | | | |
| | Units | Design - Design / 2 | Design | Max | Des/4 | Max/4 | Design | Max | Des/4 | max/4 |
| Flow rate - Dry Oil | STBD | 56167 - 28084 | 56167 | 51061 | 14042 | 12765 | 56167 | 51061 | 14042 | 12765 |
| Flow rate - Water | STBD | 6232-3116 | 6232 | 5665 | 1558 | 1416 | 6232 | 5665 | 1558 | 1416 |
| Option-1, Wash water 10000ppm TDS | | | | | | | | | | |
| Crude Oil Product BS&W (insoluble water content) | %v/v | 0.1 | 0.1 | | | | 0.1 | | | |
| Crude Oil Product Salt Content | PTB | 5 | 90% Salt Removal | | | | 90% Salt Removal | | | |
| Effluent Water Product Quality | ppmv | <500 | <500 | | | | <500 | | | |
| Dilution Water Consumption | STBD | 3370-1685 | 3370 | 3064 | 843 | 766 | 3370 | 3064 | 843 | 766 |
| Mixing Valve Pressure Drop | Bar | Mixing Valve - The maximum pressure drop for each stage mixing valve will be 1 bar , Normal pressure drop for each stage mixing valve is 0.2 – 1.0 bar | | | | | | | | |
| Static Mixer Pressure Drop | Bar | Static Mixer - The maximum pressure drop for each stage static mixer will be 0.5 bar, Normal pressure drop for each stage static mixer is 0.2 bar | | | | | | | | |
| Electrical Power Consumption | KW | ~ 30 | ~ 15 | | | | ~ 15 | | | |
| Option-2, Wash water 25000ppm TDS | | | | | | | | | | |
| Crude Oil Product BS&W (insoluble water content) | %v/v | 0.1 | 0.1 | | | | 0.1 | | | |
| Crude Oil Product Salt Content | PTB | 10 | 90% Salt Removal | | | | 90% Salt Removal | | | |
| Effluent Water Product Quality | ppmv | <500 | < 500 | | | | < 500 | | | |
| Dilution Water Consumption | STBD | 3370-1685 | 3370 | 3064 | 843 | 766 | 3370 | 3064 | 843 | 766 |
| Mixing Valve Pressure Drop | Bar | Mixing Valve - The maximum pressure drop for each stage mixing valve will be 1 bar , Normal pressure drop for each stage mixing valve is 0.2 – 1.0 bar | | | | | | | | |
| Static Mixer Pressure Drop | Bar | Static Mixer - The maximum pressure drop for each stage static mixer will be 0.5 bar, Normal pressure drop for each stage static mixer is 0.2 bar | | | | | | | | |

| | | | | |
|---|---|---|---|---|
| Electrical Power Consumption | KW | ~ 25 | ~ 12.5 | ~ 12.5 |

## B - INSTALLATION & REMOVAL

### General

Applicable CAMERON drawings references are mentioned in chapter I of this manual.

Applicable Contractor and Desalter Vessel Fabricator (Sub Vendor) drawings references are mentioned in chapter J of this manual.

### Site Preparation

a. Access scaffolding must be erected to both manways of the vessels.

b. Good temporary electric lighting must be installed in the vessels.

c. Good temporary ventilation must be installed at a manway in each process vessel.

d. Hand tools will be required.

e. Adequate craneage must be available.

### Site Equipment Receipt & Storage

All equipment supplied by CAMERON will arrive at site adequately packed and marked. It is essential that all equipment is checked for correct quantities as per the packing lists supplied with the equipment.

All equipment must be inspected on arrival at site for transit.

Any damage or discrepancy in the scope of supply must be notified to CAMERON immediately.

It is the responsibility of the contractor/customer to ensure that all equipment is adequately protected and stored on arrival at site to prevent degradation and damage.

Note: Packing materials, including intermediate (inner) packing, must not be removed and sub-assemblies must not be dismantled.

B.1.1 Equipment Schedule

CAMERON scope of supply includes the design, manufacture and supply of the following specialist items. The vessels (4 Nos), by others, will be supplied loose on saddles with all internal headers installed. CAMERON scope of supply will be supplied as loose items and will be site installed.

Cameron Scope of Supplied Items:

| | | |
|---|---|---|
| i. | Dual Frequency® Desalter vessel<br>(529-C-102 / 529-C-202 / 529-C-103 / 529-C-203) | 4 Nos |
| ii. | Dual Frequency® Desalter electrode assemblies/sets | 4 sets |
| iii. | Electrode insulator assemblies (hangers) | 4 sets |
| iv. | Bushing housing & entrance bushing assemblies | 4 sets |
| v. | Vessel internal power connecting cables, weights and brackets | 4 sets |
| vi. | Power unit<br>(529-C-102-PU-01 / 529-C-202-PU-01 / 529-C-103-PU-01 / 529-C-203-PU-01) | 4 off |
| vii. | Dual Frequency Auto-transformer<br>(529-C-102-TR-01 / 529-C-202-TR-01 / 529-C-103-TR-01 / 529-C-203-TR-01) | 4 off |
| viii. | LRC-II® control panel (Dual Frequency®)<br>(529-C-102-CP-01 / 529-C-202-CP-01 / 529-C-103-CP-01 / 529-C-203-CP-01) | 4 off |
| ix. | Mixing Valves<br>(029-PDCV-1060 / 029-PDCV-2060 / 029-PDCV-1071 / 029-PDCV-2071 ) | 4 off |
| x. | Static mixers (Only in 2nd Stage Desalters)<br>(529-A-103 / 529-A-203) | 2 off |
| xi. | Level Switches (1 per Desalter Vessel)<br>(029-LS-1748 / 029-LS-2748 / 029-LS-1768 / 029-LS-2768) | 1 off |

The equipment must be treated as fragile and placed in the site “dry store”.

For details of equipment refer to the Manufacturer Record Book “50476-529-041-PM001-MRB-V002".

**Installation Work**

Notes:

When working inside the vessel, caution is advised to prevent injury and possible damage to the internal headers.

Before commencing work all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the circuit breaker and breaker must be locked "OFF".

During pre-commissioning certain instrumentation, controls and valves will have to be removed. Accordingly, do not finally fix these items until pre-commissioning is completed. For further details please see sections C and D of this manual.

The Electrostatic Desalter Vessels will be installed in site by PIL (Vessel Foundations are also by PIL scope).

The internal headers have been installed at the vessel fabricator's workshop. It is only necessary to check all connections for tightness or damage.

Position and fix the access ladders and platforms (by PIL) on to the Process Vessels.

The following information covers the installation of each Desalting train.

B.1.2 Mechanical - Equipment supplied by CAMERON:-

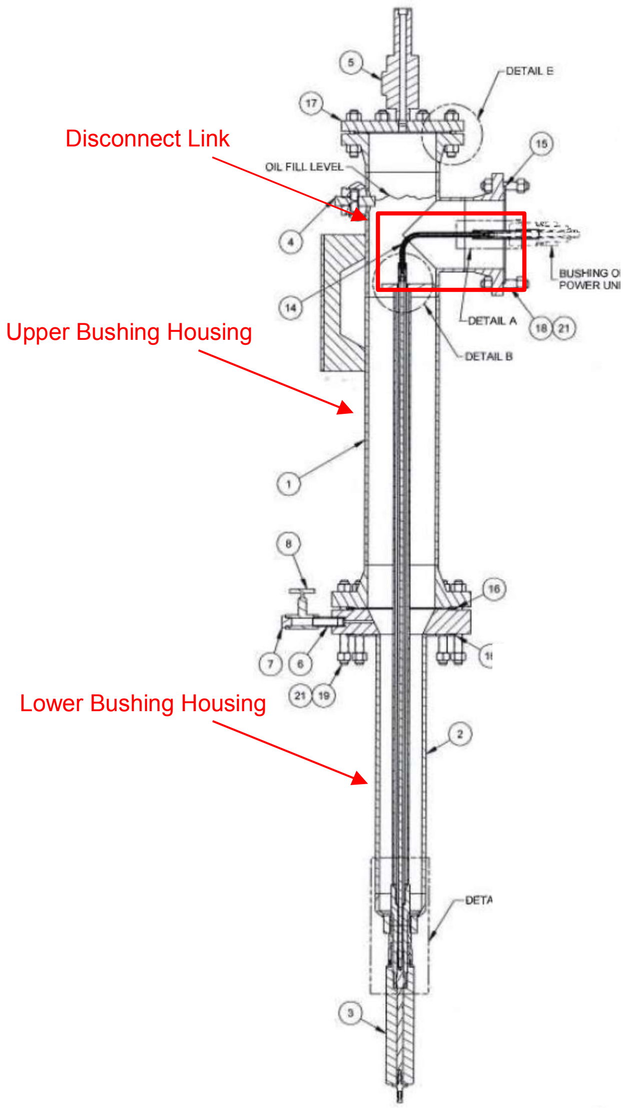
Following Procedure to be followed to install the Electrodes inside the Vessel at the fabrication shop:

I. Install the electrode assemblies following the process described below:

   a. Fit the titanium straps to the electrode plates using the nuts, bolts and washers provided. Ensure that the star washers, installed between the straps and the composite plates, are positioned with the sharp side to the conductive strip on the composite plate. When both straps are fitted to a plate, check that there is electrical continuity between the straps.
   b. Fit the insulator assemblies to the clips inside the vessel.
   c. Fit the electrode grid support rails to the to the insulator assemblies.
   d. Fit the crossover rails to the grid support rails.
   e. Starting at one end of the vessel fasten electrode plate A to the support rails. Fit electrode plate B to the support rail and fit the grid spacing rods between the plates.
   f. Continue fitting the A and B plates alternatively down the vessel separating each with the grid spacing rods.

II. Position and fix bushing housings and bushing assemblies on to the power inlet nozzles situated on the topside of each Electrostatic Desalter vessel, using the gaskets and fixings supplied following the process described below;

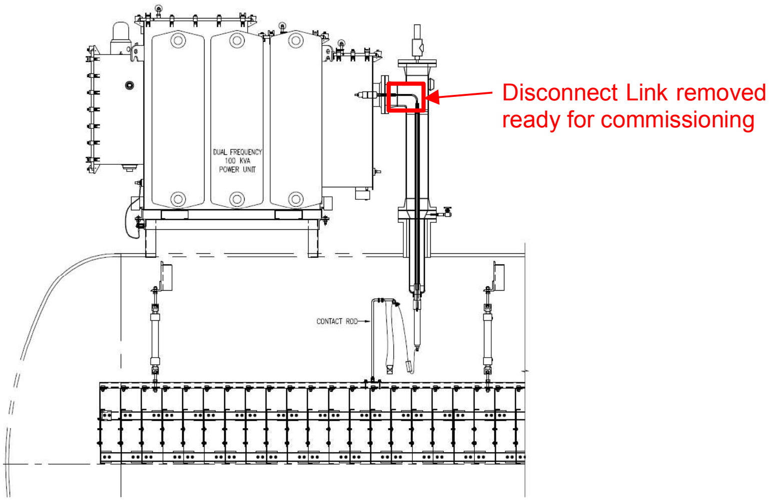
a. Refer to the figures below for information on mechanical installation
b. The bushing housing assembly is used in conjunction with a power unit and high pressure bushing that is connected to the grid internals of an electrostatic coalescer vessel. It is assumed that the vessel internal components have been fitted prior to the installation of the bushing housing assembly.
c. Install the lower bushing housing, gaskets and high pressure bushing (EBE-1500) onto the power unit nozzles on the top of the vessels. Loosely secure with supplied bolting to allow later installation of the bushing housing assembly.
d. Screw the Power Conductor Rod connection into the High Pressure Entrance Bushing (EBE-1500) until tight.
e. Slide the PFA sleeve over the rod as far as possible until it bottoms out in the high pressure entrance bushing.
f. Ensure the bushing housings are clean and dry and carefully lower the upper bushing housing over the lower bushing and power conductor rod and fix the assembly to the vessel using the gaskets and fixings provided.




g. With both upper and lower bushing housings in position, remove the top cover flange ready to install the disconnect link and connections to the power unit output bushings.

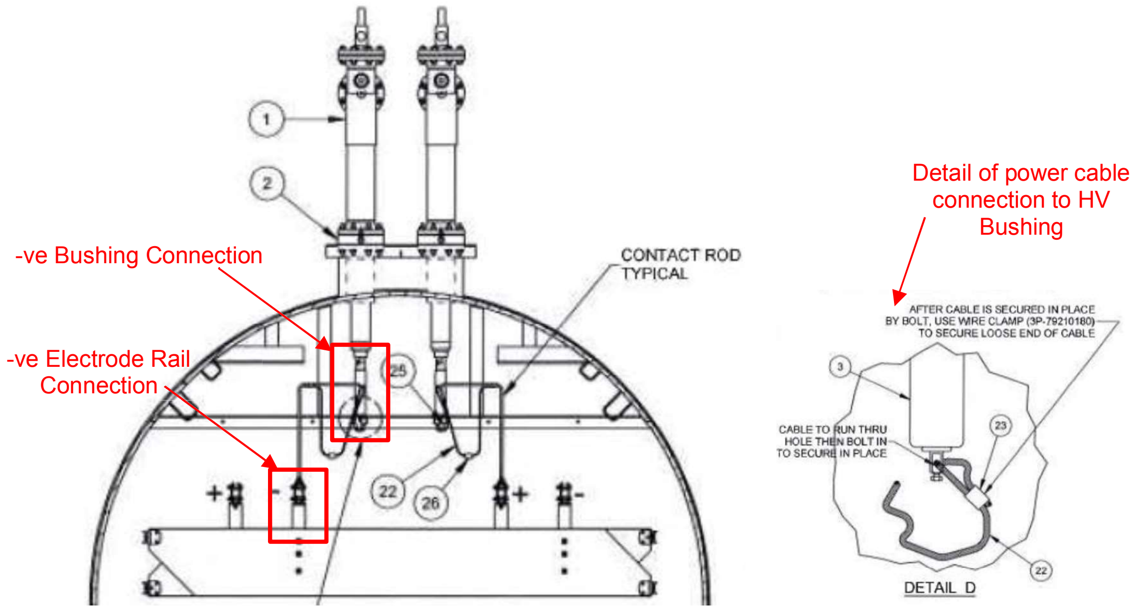
III. With the bushing assemblies installed, position and fix the power units onto the process vessels. Install earth cable as required.
IV. With the power unit in position, slide the PFA tubing over the disconnect link and connect one end to the Power Unit Bushing. Pass the other end into the upper bushing housing.
V. Reach down via the top cover of the bushing housing and insert the power conductor rod centring ring. Test fit the disconnect link to the top of the power conductor rod.
VI. Remove the disconnect link ready for commissioning.

VII. Replace the cover flange of the upper bushing housing to protect against adverse weather during commissioning.




VIII. Fit the power connecting bars with power cables and weights to the connecting brackets on the electrode grids.

IX. Connect the power cable, with weights, from the –ve connecting bracket on the –ve electrode rail to the –ve bushing and check the cable and weights give a minimum clearance of 150 mm from all internal accessories. Similarly, connect the power cable, with weights, from the +ve connecting bracket on the +ve electrode rail to the +ve bushing and check the cable and weights give a minimum clearance of 150 mm from all internal accessories. See figure below for detail;




X. Install the Mixing Valves and differential pressure transmitters during the pipework installation process. Connect the instrument air and control systems to theses valves.

XI. Install low low level switch (vapour switch) and hook up to control system.

XII. Install level transmitters (control and alarm) and connect to control system.

XIII. Install level gauges.

XIV. Install pressure indicators.

XV. Install temperature indicators.

B.1.3 Mechanical - Equipment supplied by OTHERS:-

i. Install control valves during the pipework installation process.

ii. Install and fix any chemical injection packages.

iii. Install and fix any pump/motor packages

iv. Install and fix any Heat Exchanger package.

v. Install and fix the pressure relief valve system.

vi. Install the interconnecting pipework, supplied by others, complete with valves and fittings, including:

- Crude oil pipework
- Wash water pipework
- Effluent water pipework
- Interface draw-off pipe work
- Sand wash pipework,
- Chemical injection pipework
- Vent and drain pipework, including instrument vents and drains as and when the instruments are installed
- Instrument air pipework

vii. Drain and pressure relief pipework around the bushing housings on the Electrostatic Desalter Vessel can be installed once these items have themselves been installed and fixed.

And any other equipment not included within the CAMERON schedule.

### B.1.4 Electrical & Instrumentation - Equipment supplied by CAMERON

WARNING

Before connecting the main supply cables to the power units, the main fuses must be removed from the circuit breaker and the breaker must be locked “OFF”. All the electrical tests should be carried out in the presence of the CAMERON engineer, when first commissioning the Desalter system.

CAMERON will not be responsible for any mishap resulting from disregard of this instruction. In the event that the power units are energised without the prior consent of CAMERON, all guarantees, both process and mechanical become null and void.

The High Voltage Assembly comprises of Power Unit, upper bushing housing, lower bushing housing and high pressure bushing. The respective installation instructions and datasheets define strict compliance requirements. Failure to comply with the requirements or modification to the equipment in any way will invalidate the warranty issued for the equipment.

The Entrance Bushing Housing is fitted with a ball valve for draining insulation oil when required. The ball valve shall be LOCKED CLOSED for operation to prevent the inadvertent loss of insulating oil.

The power unit tank is sealed for life and any attempt to sample or replace the insulating oil will render the mechanical guarantee for the power units null and void.

Notes:

**When working inside the vessel, caution is advised to prevent injury and possible damage to the internal headers and electrode assembly.**

Remember:

**Before commencing work all electrical supplies to the power and control circuits must be switched “OFF”. The main fuses must be removed from the circuit breaker and breaker must be locked “OFF”.**

It is recommended that all instruments are tested at a site workshop before final installation. All necessary test equipment should be available at workshop.

Heavy or large instruments which cannot be removed from their location should be tested locally.

The range and action of valves should be checked carefully.

Continuity and insulation of cables should be checked. Correct installation and tightening of all cable glands should be checked.

Cables should be visually checked in order to detect any damage that may have occurred during the erection phase.

i. Install the Dual Frequency Powerunit and Auto transformers and confirm the fuses and MOVs are installed and connected in the output terminal chamber. Refer the procedure from Power Unit IOM (Installation, Operation and Maintenance manual) document from MRB Section 2.1 and the Autotransformer IOM (Installation, Operation and Maintenance manual) from MRB Section 2.4.

ii. Position and fix the LRC-II® control panels in the equipment room. Connect panel to control/power system.

iii. Connect the power units to the control/power/instrument systems and confirm that the instrument tag numbers on the control panels match up with the power unit tag numbers.

B.1.5 Electrical & Instrumentation - Equipment supplied by OTHERS:-

Any equipment supplied by others must also be installed & connected, including the following:

- ESD system
- Additional control/electrical works.
- Additional control room instrumentation.

And all other equipment that may be required, but not listed above.

**Installation Check List**

Before moving on to the pre-commissioning of the Desalter vessel this check list must be completed to confirm installation has been finished:

Table 1 - Installation Check List

| Description | 529-C-102 | 529-C-103 | 529-C-202 | 529-C-203 |
|---|---|---|---|---|
| Equipment inspected on receipt and checked against packing list and all damage documented and reported | | | | |
| Desalter internals – Installed / Inspected | | | | |
| Ladders and platforms - Installed | | | | |
| Bushing housing assemblies – installed and disconnect link removed | | | | |
| Power Units – Installed and connected | | | | |
| Dual Frequency Auto-transformers – Installed and connected | | | | |
| LRC II panels installed | | | | |
| Instruments installed and connected | | | | |
| Mixing Valves installed | | | | |
| Static Mixers installed | | | | |
| All pipework and accessories installed in accordance with P&ID's and assembly drawings | | | | |
| All pipework and accessories have been checked for tightness | | | | |

### B.1.6 Entries

Vessel entry refers to any tank, vessel, equipment or other enclosed place where there is a hazard of:

- a toxic, corrosive or flammable substance;
- insufficient oxygen;
- severe restrictions that would hinder escape or rescue. Vessel entry normally requires specific approval by plant supervision.

Vessel entry should include tank, gauging, sampling and blow down.

All vessels should be assumed unsafe for normal entry until the following entry procedures have been followed:

1. Disconnect and blank off all lines to the vessel.

2. Remove all sources of ignition before removing manway covers.

3. Check all liquid traps and internal lines to assure they are free of hazardous liquid.

4. Clean the vessel as thoroughly as possible by draining, washing with water, steaming, ventilating or other suitable means. If steam is used, guard against static electricity by grounding the steam nozzle. After steaming, allow the vessel to cool slowly. Sudden cooling with water spray may cause a static electrical charge.

5. Test the atmosphere for:

   - Oxygen: Air must contain 20%-21% oxygen and the vessel should have adequate ventilation, either forced or natural.
   - Explosive Mixture: A vessel may not be entered if the testing instrument indicated an air vapor mixture that exceeds 50% of the lower explosive limit.
   - Toxic Fumes: The presence of any toxic fumes requires the use of respiratory protective equipment, normally an air supplied mask with hand blower, or a self-contained breathing unit; otherwise, additional cleaning or purging of the vessel is indicated.

6. Safety Harness or Belts - The person using respiratory equipment when entering the vessel should wear either a safety harness or belt.

7. Clothing - Personal protective clothing suitable for the job inside the vessel should be worn.

8. Observer - An observer should be stationed outside the vessel. His only duty should be watching the person inside the vessel. When respiratory equipment is required for the person entering the vessel, the observer should also have suitable respiratory equipment available handy.

9. Emergency Equipment - Fire extinguisher and other emergency equipment should be available as required.

### B.1.7 Desalter Vessel

Remove all sludge and solids from vessel paying particular attention to internal headers to ensure all openings are free of solids build up. Check electrode supports for tightness of bolts etc., and look for corrosion effects. Clean the electrode insulators, in situ, with hydrocarbon solvent and inspect for surface tracking, cracks etc. Any insulator showing such marks should be replaced.

**Note**: Do not exceed 170°C (340°F) during steam-out operation to avoid damage to PTFE (Teflon) insulating components.

### B.1.8 Power Unit

**Notes: Before commencing work all electrical supplies to the power and control circuits must be switched “OFF”. The main fuses must be removed from the contactor feeders and contactor feeders must be locked “OFF”.**

**Oil must be drained from the bushing housing assembly prior to mechanical disconnection from the power unit.**

Before lifting and withdrawing the Power Unit, remove the connecting link from the power unit bushing and the entrance bushing power connecting rod. Refer to Power Unit Hook up Drawing 50476-529-041-PM001-WRD-V002 for additional details.

### B.1.9 Bushing Housing and Entrance Bushing Assembly

**Notes: Before commencing work all electrical supplies to the power and control circuits must be switched “OFF”. The main fuses must be removed from the circuit breakers and breakers must be locked “OFF”.**

**Before inserting other tools or hands into the Bushing Housing Assembly, touch the Disconnect Link with an Earthing Hot Rod connected to the Power Unit Earth connection to discharge any residual voltage on the High Voltage Assembly.**

- Remove oil via drain.
- Remove disconnect link via top flange of high voltage assembly.
- Disconnect the bushing housing from the power unit
- Disconnect the upper bushing housing from the lower bushing housing.
- Carefully lift the upper bushing housing over and away from the bushing connecting rod.

- Remove the lower bushing housing with the high pressure bushing, clean with hydrocarbon solvent and inspect for surface tracking, cracks, etc. Any bushing showing such marks should be replaced.

If the bushing is to be replaced the end of the power connecting cable should be secured outside of the vessel to prevent it falling into the vessel. Refer to Power Unit Hook up Drawing 50476-529-041-PM001-WRD-V002 for additional details.

B.1.10 Removal

When any equipment is to be removed or repaired, it should be totally isolated from other equipment that contains flammables. Connecting piping should be disconnected or blanked, or both, in accordance with a definite procedure. Valves should not be relied on for blanking purposes, blanks of suitable thickness should either be blind flanges or full-face steel plates inserted between gaskets against line flanges. Definite responsibility for their installation and removal should be assigned.

When hot work is to be done on equipment that has been vented, mechanical and electrical connections to the equipment should be removed.

Care should be taken if sludge and scale remain in tanks, vessels, and piping after flushing and washing operations. Such materials often contain flammables and may give off vapours that can be ignited during repairs. Continued ventilation may be necessary.

Before hot repair work is started on equipment that has contained or does still contain flammable liquids or gases, careful plans should be made as to the manner in which the work will be done. In most cases, it is desirable to open and completely vent equipment before repairs are made; but there are instances when repairs may proceed after some inert material such as flue gas or water has displaced the flammable material.

Firefighting facilities should be readily available when repairs are being made. Minor fires may be quickly extinguished when facilities are readily accessible and employees are trained in their quick and effective use.

**C - <u>PRE-COMMISSIONING</u>**

When working inside the vessel, caution is advised to prevent injury and possible damage to the internals.

Before commencing work, all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the circuit breaker and breaker must be locked "OFF".

Mechanical

C.1.1 Electrostatic Coalescer Internals

When working inside the vessels, extreme care must be taken not to damage the internal headers and electrode grid assembly.

*C.1.1.1 Mechanical*

Inspect the following internal fittings of the Desalter vessels for correct installation, compliance with drawings and report any damage:

- Hi flow distributor
- Oil collector
- Interface drain header
- water collector
- Outlet effluent header
- Sand wash or Sandjet inlet header
- Sand trough & grid hanger bracket

Please refer the CAMERON drawings, listed in Section I.

Examine the inside of the vessel for foreign objects and remove, clean down interior carefully.
Close and lock all manways temporarily with a chain and padlock.
Inspect the skids and all loose pipework and report any damage.

*C.1.1.2 Electrical*

i. Inspect the following internal fittings of the Desalter vessels for correct installation, compliance with drawings and report any damage:

- Electrostatic grid array
- Electrical clearances

Check the alignment of the electrodes. Electrode plates should be on a uniform spacing. It should be possible to maintain a tolerance of 152.5 mm ± 10 mm (6” ±0.5”) between the electrodes.

Thoroughly examine the electrode grid array of the Desalter vessel. All electrical components must be at least 125 mm (5”) from any earthed vessel component.

Refer to CAMERON drawings listed in Section I.

ii. Ensure all insulating surfaces are clean and perfectly dry, using a lint free cloth. These include:

- High pressure bushing assembly
- Electrode insulators

Finally close and lock the Desalter manways temporarily with a chain and padlock.

*C.1.1.3 External Inspection*

i. Inspect process and utility piping for correct installation, compliance with drawings and damage, with the purchaser's representative, including:

- Crude oil lines and sample points
- Wash water lines
- Water injection points
- Chemical injection points
- Effluent water lines
- Interface draw-off lines
- Vent and drain lines

ii. Carry out a line check against the P&IDs to confirm installation of all pipework, valves, relief valves, fittings and instrumentation.

### *C.1.1.4 Pneumatic Checkout Procedure*

- Turn on instrument air supply to the Desalter instrumentation.
- Blow down the instrument air header and pipework to remove any dirt and scale.
- Refer to the instrument instruction manuals and follow the detail instructions for each pneumatic instrument and/or control valve.
- Adjust the instrument air regulators to set the supply pressure for each instrument.
- Check all connections and fittings for leaks.
- Stroke the control valves from full open to full close several times to confirm functional operation.

### *C.1.1.5 Electrical & Instrumentation Tests and Pre-Commissioning*

Prior to any testing of the electrical installation field power and control cabling, control panels, power units & transformers etc., items should be mechanically checked and insulation, continuity and correct operation tests carried out. Completed mechanical check sheets and electrical test sheets must be completed prior to any commissioning work being carried out.

Before commencing work, all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the circuit breakers and the breakers locked "OFF".

FOR EACH VESSEL IN TURN

- Hook up field wiring to junction boxes.
- Make continuity checks on all field wiring.
- Turn on instrument power supply to the Desalter and functionally check each instrument for correct operation.

## C.1.2 Low Low Liquid Level (vapour) Switch Operation

Carefully remove low low liquid level instrument (vapour) 029-LS-1748/029-LS-2748/029-LS-1768/029-LS-2768 mounted on top of the Electrostatic Desalter. Operate the instrument using manual means to confirm the correct action.

Note: The set point should be verified on site, with the instrument in position and the vessels initially empty of liquid.

## C.1.3 Vessel Interface Level Transmitters Operation

Verify calibration using normal site methods.

On completion of the tests re-install the transmitters permanently.

C.1.4 Pressure Indicator Operation

Verify calibration using normal site methods.

On completion of the tests, re-install permanently.

C.1.5 Temperature Indicator Operation

Verify calibration using normal site methods.

On completion of the tests re-install the Indicator permanently.

C.1.6 Vessel Total level (Oil Level) Transmitters Operation

Verify calibration using normal site methods.

On completion of the tests re-install the Indicator permanently.

**Electrode Grid Integrity**

C.1.7 Electrode Grid Continuity

When working inside the vessel, caution is advised to prevent injury and possible damage to the internals.

Before commencing work, all electrical supplies to the power and control circuits must be switched “OFF”. The main fuses must be removed from the circuit breaker and the breaker must be locked “OFF”.

Make sure that the disconnect links between the HT bushings on the power unit and the high pressure bushings are DISCONNECTED.

Using a Megger tester, or similar, the electrical continuity of every +ve / -ve electrode plate to its respective +ve / -ve electrode plate support rails must be checked and confirmed. (Plate A -ve, Plate B +ve).

The continuity between each grid plate and both electrode plate support rails must be confirmed.

Follow the procedures for operation of the Megger tester used to check this continuity.

Where the continuity is suspect, detach the grid plate and electrode support straps from the electrode plate support rails, clean all joints and reconnect the grid plate. Confirm the continuity.

C.1.8 Electrode Grid Insulation

Before commencing work, all electrical supplies to the power and control circuits must be switched “OFF”. The main fuses must be removed from the circuit breaker and the breaker must be locked “OFF”.

Do not remove cover flange from Bushing Housing Assembly without taking precautions to prevent dirt /moisture ingress into the housing.

Make sure that the disconnect links between the HT bushings on the power unit and the high pressure bushings are DISCONNECTED.

Confirm that manways are closed and temporarily locked before continuing. Ensure there are no other personnel present who might contact the components under test.

i. To confirm that the +ve / -ve segments of the grid are adequately insulated from the shell of the Desalters, an insulation test must be carried out.

Use a Megger tester, or similar (preferably 5,000 volt capacity unit).

Confirm that the disconnect links are removed from the power unit HT bushings.

Connect the Megger tester, or similar, between the +ve grid high pressure bushing assembly top connection (N15 A) and the power unit earth boss.

Operate the tester and confirm that, based on using a 5,000 volt unit, the insulation resistance reading is 5 mega-ohms / infinity.

If it is less then follow the procedure given below to ensure that the capacitive voltage is discharged and check all the insulators for condensation and dampness. Dry as necessary and test again

Switch off the tester.

DO NOT REMOVE TESTER.

Use an insulated “shorting” conductor to discharge any capacitive voltage remaining in the grid by connecting between the high pressure bushing assembly and the power unit earth boss.

Now the tester can be removed.

A low Megger reading during the test indicates one or more of the following problems:

a. Condensation and/or dampness of the insulators

b. The high voltage electrodes are in contact with the vessel at some point

c. The high pressure bushings are internally shorted to the vessel

ii. Repeat the above procedure for the –ve segment of the grid at the high pressure bushing assembly (N15 B)

C.1.9 Electrode Grid Isolation +ve/-ve

Before commencing work, all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the circuit breaker and the breaker locked "OFF".

Make sure that the disconnect links between the HT bushings on each power unit and the high pressure bushings are DISCONNECTED.

Confirm that manways are closed and temporarily locked before continuing.

i. Connect the Megger tester between the two high voltage entrance bushings and check the resistance. The resistance reading should be near infinity.

ii. Switch off the tester.

iii. DO NOT REMOVE THE TESTER.

iv. Use an insulated "shorting" conductor to discharge any capacitive voltage remaining in the grid by connecting between the high pressure bushing assemblies and the power unit earth boss.

v. Now the tester can be removed.

vi. A low Megger reading during this test indicates a short between the electrode plates. A short circuit can be created by improper installation of the electrodes (adjacent electrodes are not connected to alternate support rails) or the high pressure bushing assemblies have been connected to the same electrode set (A or B). Re-enter the vessel and check for locations where adjacent electrodes might be touching each other. Once the problem is corrected, re-check the installation by repeating the Megger test.

**Electrical Tests**

Before commencing work, all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the circuit breaker and the breaker must be locked "OFF".

Make sure that the disconnect links between the HT bushings on the power unit and the high pressure bushings are DISCONNECTED.

Confirm that manways are closed and temporarily locked before continuing.

C.1.10 Electrical Test No. 1 – System Voltage

Carry out the following procedure:

i. Since the vessel is empty at this stage ensure the low-low coalescer oil level ('vapour') trip has been disabled from level switches 029-LS-1748 / 029-LS-2748 / 029-LS-1768/029-LS-2768.

ii. Ensure any additional trip conditions that would prevent the operation of the power supply from the switchboard to the dual frequency power units are also disabled.

iii. Ensure the interconnect cables have been installed, are of the correct size and type and tested for earth continuity and resistance, correct circuit continuity and for satisfactory insulation resistance according to local standards.

iv. Ensure the electrical equipment is in a condition for power up.

v. Refit the main fuses and make the contactor feeders ready for operation.

vi. Switch "ON" contactor feeder and any other inline device e.g. contactor.

vii. Then check for the correct voltage levels:

- 440 VAC at the Dual Frequency autotransformer inlet termination.
- 480 VAC at the Dual Frequency autotransformer outlet termination.
- 480 VAC at Dual frequency power unit inlet terminals

viii. Switch off the contactor feeder and replace any the termination covers.

If the Dual frequency power unit is not powered at 480VAC, switch OFF the contactor feeder. Re-check the cable installation and configuration. Restore power and starting at the Switch board check the supply voltage at the incoming and outgoing termination points of all the electrical equipment to determine the fault location. Switch OFF the contactor feeder. Rectify the fault and repeat the procedure.
Contact Cameron services engineer if the voltage levels are not 480 Vac at the inlet to the Dual frequency power unit.

ix. Switch OFF the contactor feeder (if not already OFF)

Repeat the procedure for the second Dual Frequency autotransformer and Dual Frequency Power units.

Switch OFF the contactor feeder (if not already OFF).

C.1.11 Electrical Test No. 2 – LRCII Panel (529-C-102-CP-01), Power Unit (529-C-102-PU-01) and Vapour Switch (029-LS-1748) Function Tests

Once the panel has been installed in the Local Equipment Room a few checks can be made to be sure the panel is functioning properly. Since each panel design complies with CAMERON's standards, it is likely to have minor changes based on customer specifications which might differ from the actual functions in this discussion.

i. Turn all switches to the OFF position.

ii. Be sure the mains power to the power unit is OFF.

iii. Verify that all connections have been made to all boards.

iv. Verify that all wires to the terminal strip are secure.

v. Verify that the panel 230Vac supply breaker is in the ON position.

vi. Apply power to the LRC-II control panel - Power unit Disable / Enable Switch in Enable position.

vii. Verify the 120Vac power ON yellow LED is lit on the LRC-II front panel board. For logic control purposes, this is a discrete input to monitor the 120Vac power supply via relay closure. When the 120Vac power is on this input is closed (LED is lit), when the power is off this input is open (LED off).

viii. Verify the 12Vdc Power ON yellow LED is lit on the LRC-II front panel board.

ix. Verify with a voltmeter the reading through the CB-J3 jack connector at the LRC-II board. It should read approximately 12Vdc.

x. Verify the Limits Clear red LED is ON at the LRC-II front panel. This confirms that the customer limits are NOT clear. Since the vessel is empty at this stage the low-low coalesce oil level ('vapour') trip will be preventing operation of the LRC panel. If not, investigate the issue before proceeding.

xi. Simulate a healthy state from low-low desalter oil level ('vapour') trip switch 029-LS-1748 and verify that the Limits Clear red LED is OFF at the LRC-II front panel. This confirms that the customer limits are clear. If not, check the conditions that might be preventing clearance of the limits (other customer alarms).

xii. Remove the simulation from level switch 029-LS-1748 and confirm that the Limits Clear red LED is ON indicating the customer limits are NOT clear.

xiii. Repeat the process for the other remaining LRC panels (529-C-103-CP-01 / 529-C-202-CP-01 / 529-C-203-CP-01) and level switches (029-LS-2748 / 029-LS-1768 / 029-LS-2768).

xiv. Check the light on the LRC-II Control board CB-J9 jack (Heart Beat) - the light on the jack should flash continuously when the board is functioning normally, if the heartbeat stops (light stop flashing), the LRC-II Control Board has to be replaced.

If the LRC-II Control Panel passes these function tests, the power unit function can be verified.

Confirm the function of the LRC-II Control Panel before conducting a function test of the power unit.

**Prior to performing these checks, disconnect and isolate the power voltage to the power unit.**

i. Confirm the primary voltage to the Dual Frequency Autotransformer is OFF by measuring the voltage between terminals L1 and L2 in the Autotransformer input junction box (400Vac section). Also measure L1 to earth and L2 to earth and between L1 & L3 and L2 & L3.

ii. Confirm the fuse in the Dual Frequency Autotransformer output junction box is healthy by measuring the resistance between terminals T1 and F1, T2 and F2 and T3 and F3, zero ohms indicates a good fuse. Infinity indicates a bad fuse or an open circuit.

iii. Confirm the primary voltage to the power unit is OFF by measuring the voltage between terminals T1 and T2 in the power unit junction box (480Vac section). Also measure T1 to earth and T2 to earth and between T1 & T3 and T2 & T3.

iv. Confirm the control voltage to the power unit is OFF by measuring the voltage between terminals 17 and 18 (120Vac enable) and terminals 21 and 22 (120Vac control power) in the power unit junction box.

If these tests are satisfactory, close and secure all of the terminal enclosures so that power can be applied to the power unit for more function testing. If one or more of these checks fail, then contact CAMERON Spares and Service Department for power unit diagnostics.

### C.1.12 Leak Test

The complete plant should be leak tested, including the process vessel, in a logical sequence of sections, in accordance with site and/or national standards.

All leaks must be corrected and that section re-tested.

### C.1.13 Testing of Insulating Oil in Bushing Housings

Testing of the insulating oil should not be necessary if the drums are in good condition, the seals are unbroken and the oil has been delivered within the previous twelve months. Refer to section F.1.6 of this manual for the dielectric strength testing procedure if required.

The dielectric strength of the insulating oil in the main power unit tank, junction box and bushing housings should not drop below 35 kV (when measured across a 2.5mm electrode gap).

C.1.14 Filling of Bushing Housings with Oil

***Ensure that the power unit power supplies are isolated before proceeding.***

Once all pre-commissioning is completed the bushing housing disconnect link can be installed.

Bushing Housings (8 off) can now be filled with Cross 206 insulating liquid to the fill level. This level is defined for ambient temperatures of 10°C. If the ambient temperature is significantly different store the insulating liquid in a temperature controlled environment prior to filling and check the temperature is 10°C ± 2°C before filling.

Approximately 35 litres will be required to fill each bushing housing.

Extreme care must be taken when filling the bushing housing not to contaminate the insulating liquid with dust, water or other particles.

Once filled install the bushing housing cover flange and secure with gaskets and fixings provided. Confirm Pressure Relief Valve is installed, free from damage and the outlet port piped to appropriate drain.

C.1.15 Additional Testing/Pre-Commissioning

Other work will be required to be carried out by the purchaser prior to the start-up of the desalting system, including additional testing/commissioning. This will be determined by upstream and downstream equipment supplied by others, good engineering practice and site/national standards.

These areas are outside of the responsibility of CAMERON. However, a typical scope of work could include but not be limited to the following:

a. The complete plant should be leak tested, including the process vessels, in a logical sequence of sections, in accordance with site and/or national standards.

b. All leaks must be corrected and that section re-tested.

c. All instrumentation should be inspected/tested/calibrated.

d. The individual LRC II panel shall interface with the DCS system via a Redundant Multidrop RS-485 connection and the ESD system via a hardwire link to allow overall plant control and shutdown to be facilitated through the ICSS (by PIL). The Purpose of Redundant Multidrop RS-485 connections" is to transfer the current status of available operating signals of Power unit in LRC II panel to the client DCS system.

e. Desalter vessel relief valve operation and set point must be confirmed

f. Pumps and motors should be checked, including alignment and running tests.

C.1.16 Final Checks

a. Remove the main fuses from the circuit breaker and breaker must be locked “OFF”.

b. Restore the level switches to their abnormal (alarm) position. These alarms will clear during the filling of the vessels.

c. Check all nozzles/flanges are connected or blanked-off.

d. Check inside vessels and remove any foreign objects.

e. Close all vessel openings.

f. Permanently close all manways.

g. Permanently close the bushing housing.

h. Check that all covers are firmly closed on all electrical equipment.

IMPORTANT NOTES

i. The CAMERON engineer must be the last person to leave the process vessels before permanent closure is made.

ii. Permanent closure must **not** be made if any other nozzle on the vessels is open.

C.1.17 Pre-Commissioning Check List

Before moving on to the start-up of the process plant this check list must be completed to confirm pre-commissioning has been completed.

| | Check | | | |
|---|---|---|---|---|
| **Process Vessel** | 529-C-102 | 529-C-103 | 529-C-202 | 529-C-203 |
| Commissioning team and operators have read and are thoroughly familiar with the instruction manual and vendor catalogues | | | | |
| Level switch floats installed correctly | | | | |
| Insulators/high pressure bushings clean and dry | | | | |
| Grid system inspected | | | | |
| Vessel internal fittings inspected | | | | |
| Vessel clean internally | | | | |
| Grid sections Megger tested | | | | |
| **Electrical Tests** | | | | |
| Number 1 Completed and Satisfactory | | | | |
| Number 2 Completed and Satisfactory | | | | |
| 029-LS-2748 / 029-LS-1768 / 029-LS-2768 Level Switches Installed and Simulation Removed | | | | |
| Circuit earth continuity and resistance | | | | |
| Check for correct circuit continuity | | | | |
| Check for satisfactory insulation resistance | | | | |
| Operation of circuit breaker trip devices verified | | | | |
| Additional testing/pre-commissioning completed | | | | |
| LRC Panel Modbus Communication Confirmed | | | | |
| **Final Checks** | | | | |
| Main fuses removed | | | | |
| “OFF” Contactor Feeders locked | | | | |
| No nozzles left open | | | | |
| Vessel internally cleaned/cleared | | | | |
| Vessel opening all closed | | | | |
| Manways permanently closed | | | | |
| All bushing housing permanently closed<br>Bushing Housing Drain Valve – Locked Closed | | | | |

| | | | | |
|---|---|---|---|---|
| Electrical equipment covers firmly closed | | | | |
| The pneumatic hook-up has been checked | | | | |
| Electrical wiring has been checked | | | | |
| Vessels, power units and instrumentation are properly grounded | | | | |
| LRC II Control panel operation verified | | | | |
| Vendor literature has been reviewed and all instructions for pre-commissioning or adjusting equipment and accessories have been followed | | | | |
| Leak test completed | | | | |
| Insulating oil testing completed and installed to fill level within bushing housing | | | | |
| Bushing Housing Disconnect Link Installed | | | | |
| Bushing Housing Cover Flange Installed complete with PRV. | | | | |
| Chemical injection system readied with first fill of chemicals | | | | |

## D - OPERATION, START-UP / COMMISSIONING PROCEDURE

This procedure is provided as a general guideline and is not intended to replace the services of an experienced commissioning engineer.

The desalting plant has been designed for operation as a two-stage unit, and the start-up philosophy associated with this design is set out in this section. It is based on the process design data, Section A.1.9 of this manual.

The following instructions are for the first start-up of the desalting plant. They will take the operator from initial start-up to normal operation in a series of logical steps for the particular desalting plant that has been supplied under this contract. However, they may need to modified or revised during the start-up period to meet the requirements of changing conditions.

Note: These instructions are for one train of two-stage Desalters. Two trains have been supplied.

### Plant Start Up

All support systems should be tested and commissioned before start-up of the Desalters. Refer to suppliers' instructions for each system.

- Instrument air system and pneumatic instruments
- Monitoring panel and instrumentation
- Power supply to the power units must remain "off" until the Desalters are full of oil.
- Mixing valves
- Desalter vessel pressure relief valves
- Pre-commissioning procedures completed

D.1.1 Manual Valves

i. Close all block valves on drain lines.

ii. Open all block valves on oil outlet line, safety relief line, gas outlet and back pressure line where applicable.

iii. Open all block valves and gauge valves on gauge columns.

iv. Open isolating valves on pressure gauges.

v. Close all sample cocks.

D.1.2 Controls

i. Refer to installation instructions. Instrument air should be on and regulators set as required.

ii. The vessels are furnished with high level alarms or low level shutdown controls, these must be operated manually.

### D.1.3 Electrical

The power unit main circuit breakers and contactors local control switches are to be in the OFF position.

### D.1.4 Start Fluid Flow to the Desalter System

i. Safely displace all the air from the Electrostatic Desalter vessels, using nitrogen, other inert gas or using normal site practices.

ii. If an inert gas has been used, the process vessels should be partially filled with water, up to the normal interface level.

iii. Open the block valves on the oil inlet, oil outlet and pressure relief lines. Open isolation valves on instruments, close all vent and drain valves.

iv. The Electrostatic Desalters can now be filled with crude oil. With the Mixing valves fully open, the inlet valve should be opened to fill the Electrostatic Desalters and piping slowly.

Note: If displacing water, only reduce the water level down to the normal crude/water interface.

Verify the operation of all the level and interface level transmitters during this phase.

v. The Desalter system is now ready for the oil production to be started through the system.

vi. Close vents once all vapour has been dissipated.

vii. Start partial oil flow through the system and set the system back pressure control loop to maintain the desired system pressure.

Note: We suggest an initial flow rate of 20% of the volumetric design flow rate or the minimum continuous flow rate of the crude feed pumps, whichever is the greater. The back pressure control valve should be set to maintain the pressure at the outlet from the Desalter.

viii. Start demulsifier chemical injection.

Note: The chemical injection is by others. After commissioning/start-up, the chemical injection rate should be optimised to the lowest possible level, consistent with good effluent water quality.

ix. Carryout LRC-II Control Panel and Power Unit tests as Section D.1.5 below.

x. Start wash water injection to the second stage Desalter.

xi. Start effluent water recycle from the second stage Desalter back to the first stage Desalter.

xii. The Desalter interface level control systems should now be placed in service.

xiii. Allow the Crude oil to flow through the vessel until all the operating conditions are steady, i.e. flow, temperature and pressure.

xiv. With the oil flow established through the system, the power unit can be energised.

Note: Actual temperatures and pressures may vary from the design operating conditions in Section A.1.1, “Process Design Data”, of this manual. The important thing is to achieve steady conditions at this time.

xv. The CAMERON engineer will then make recommendations for the optimisation of the process variables, including the power unit settings. To assist the optimising, analyses of the insoluble water in the Crude oil product should be reported every two hours and salt analyses every four hours.

xvi. After the wash water injection rate is set and only if necessary, increase the mixing valve pressure drop until the mixing is sufficient to reduce the salt content of the desalted Crude oil to specification. The pressure drop should be gradually increased in 0.2 bar increments. Allow a sufficient time to elapse after each increase (1 hour) before taking a sample. Analyse several samples at each pressure drop setting.

The optimum mixing differential pressure is impossible to predict accurately. This is because the emulsifying characteristics of the mixture may be influenced by the type of Crude Oil, the operating temperature, the flow velocities in the Crude Oil lines, the method of water injection, the process water quality, the type and the injection rate of the demulsifying chemical, and other factors. In general, increasing the mixing valve pressure drop improves water/Crude oil mixing and reduces the salt content of the desalted Crude oil.

Care should be taken not to over mix, since this will result in an emulsion that the Desalter cannot break. Over mixing will be indicated when the water content of the desalted Crude oil and the Crude oil content of the effluent water start to increase. The correct setting for each different crude oil must be determined by experience. The CAMERON commissioning engineer will be able to give advice on this matter.

xix. The Crude oil/water interface level must be checked frequently during the preliminary days of operation using the try cocks on the Desalter vessels. The interface level should be controlled approximately at the middle turncock.

xx. When flow conditions have stabilised, samples of effluent water should be checked for pH. If the pH is below 5, the injection of a suitable alkaline solution is recommended. Adjust the rate to maintain the effluent water pH in the range 5-7.

xxi. During the preliminary start-up period, frequent analyses of the treated Crude oil should be made.

Since it is sometimes difficult to get consistent salt analyses at the salt levels that will occur in the desalted crude oil, it is recommended that a “salt balance” be made around the vessels to help final optimisation of the operating variables.

The frequency of analysing treated samples of Crude oil for water and salt content is, of course, at the option of the Owner. Samples shall be taken on every 4 hours once during initial stage of operation and shall be optimised based on the operation requirements. Once personnel are trained and the operation of the plant is stabilised, routine sampling may be reduced to once a day.

Proper sampling procedures are essential if the results of the analyses are to be representative of the process, and since very small concentrations of impurities must be determined in a salt analysis, it is urged that special attention be given to the following:

a) Sample bottles must be clean and dry.

b) Sample lines, particularly for the desalted Crude oil must be thoroughly purged before taking each sample.

c) A separate sample cooler should be used for desalted Crude oil samples. Where a common sample cooler is used for other sampling streams, contamination of the desalted Crude oil sample is possible.

d) Sample bottles must be carefully labelled with the contents, the time taken, the analysis required, etc., before sending to the laboratory.

e) Samples should be taken at approximately the same time each day, preferably early morning, so that adjustments can be made during the day if they are required.

The plant is designed to run continuously and efficiently with a minimum of operator attention during normal operation. However, it is recommended that samples be taken and analysed with sufficient frequency to ensure good control during the abnormal operating period. For example, when the plant operation is out of the ordinary, such as a significant change in the Crude oil flow rate, the operating temperature, or other setting in the established operation.

## D.1.5 LRC-II Control Panel & Power Unit Function Test

### *D.1.5.1 LRC-II Control Panel Function Test*

Once the panel has been installed in the Local Equipment Room a few checks can be made to be sure the panel is functioning properly.

i. Turn all switches to the OFF position.

ii. Be sure the mains power to the power unit is OFF.

iii. Verify that the panel 110VAC supply breaker is in the ON position.

iv. Apply power to the LRC-II control panel - Power unit Disable / Enable Switch in Enable position.

v. Verify the 110V AC power ON yellow LED is lit on the LRC-II front panel board. For logic control purposes, this is a discrete input to monitor the 110 VAC power supply via relay closure. When the 110 VAC power is on this input is closed (LED is lit), when the power is off this input is open (LED off).

vi. Verify the 12V DC Power ON yellow LED is lit on the LRC-II front panel board.

vii. Verify the Limits Clear red LED is OFF at the LRC-II front panel. This confirms that the customer limits are clear. If not, check the conditions that might be preventing clearance of the limits.

If the LRC-II Control Panel passes these function tests, the power unit function can be verified

### *D.1.5.2 Power Unit Function Test*

Confirm the function of the LRC-II Control Panel before conducting a function test of the power unit.

***The following tests will apply high voltage to the electrodes. Prior to proceeding further be sure the vessel has been closed and filled with production fluid.***

Before proceeding, confirm all high voltage connections have been completed and the Power Unit internal oil levels are correct. If entrance bushing housings are installed be sure they are also filled with oil and closed.

v. Apply 110VAC power to the LRC-II control panel. Make sure the heartbeat signal to the DF unit is active and check the settings on the LRC-II Smart Interface display on the front panel.

vi. Turn on the main 3-phase supply to the Power Unit.

vii. Push the “High Voltage ON” push button at the LRC-II control panel and switch the Power Unit Enable switch to ON. (Note: all interlocks must be clear to allow operation e.g. Desalter Level (i.e. vapour detection).

viii. After a brief period the LRC-II control panel display should show the feedback voltage on the Performance screen (note if the production fluid is wet, the current may read high and the voltage low, this situation may not correct itself until more voltage is applied).

ix. Measure the true RMS voltage (equivalent current signal) at J14 on the LRC-II control board

x. After a brief period the control panel display should show the feedback voltage on the power unit screen.

xi. Set the target voltage, timing and other slate settings at the recommended values and send them to the LRC-II board for operation.

If these results are satisfactory, the power unit can be operated and optimised as needed to meet processing requirements. If one or more of these checks fail, then contact CAMERON Spares and Service Department for power unit diagnostics.

### D.1.6 Test Run Procedure

After the mechanical operation has been checked, adjustments may be made in operating variables to obtain the optimum performance.

It is extremely important to maintain a consistent normal feed condition for any period of time during optimisation and testing of the plant. The flow rate and composition of the feed must be constant. Variations in feed conditions may invalidate conclusions drawn from test data. Abnormal conditions must be avoided.

Provisions must be made for running BS&W and salt content tests on the treated Crude oil, plus oil in the effluent water. These facilities may be portable or temporary, but they must be available during system testing.

Sending samples to a remote laboratory will delay reporting of results and increase the length of time needed to optimize the operation.

Confirm that levels, temperatures, pressures, flow rates and other operating variables are at the recommended initial set points, and record all of the following information

#### *D.1.6.1 Measurements*

| Date / Time | | | | |
|---|---|---|---|---|
| **Vessel** | 529-C-102 | 529-C-202 | 529-C-103 | 529-C-203 |
| **Temperature** | | | | |
| **Pressure** | | | | |
| **Oil Flow Rate** | | | | |
| **BS&W** | | | | |
| Inlet | | | | |
| Outlet | | | | |
| **Salt Content in Oil** | | | | |
| Inlet | | | | |
| Outlet | | | | |
| **Salt Content of Effluent Water** | | | | |
| **Oil/Water Interface Level** | | | | |
| **Power Unit** | | | | |
| Primary Current | | | | |
| Primary Voltage | | | | |
| **Demulsifier dosing rate** | | | | |
| **Wash Water Flow Rate** | | | | |
| Wash Water Salinity | | | | |
| **Mixing Valve Pressure Drop** | | | | |

*D.1.6.2 Other useful data includes:*

- API gravity of dry heavy Crude oil
- pH of effluent water
- Oil viscosity - dry (at 3 temperatures)
- Analysis of water in the feed Crude oil
- Ambient temperature
- Data from other sample points as necessary

Maintain stable operating conditions for a minimum of four hours and record all of the data points.

Check all of the data for credibility. For example:

- The outlet BS&W of the unit should not be more than the inlet.

If the data is consistent for two consecutive sets of samples and the data is credible, proceed with the plant optimisation.

D.1.7 Sampling and Analysis Procedure

The method of collecting and handling the samples is extremely important if accurate and repeatable results are expected.

Very small concentrations of impurities must be determined in a salt analysis, therefore it is urged that special attention be given to the following:

a. The sample system should be arranged to eliminate as far as possible any trap or pocket where phase separation may occur.

b. Sample containers must be clean and dry.

c. Sample lines should be a short and as small a diameter as practical.

d. Sample lines (and sample coolers if used), particularly for the desalted crude oil must be thoroughly purged before taking each sample.

e. Samples should be taken from the centre of flowing lines through a quill or similar.

f. Sample containers must be carefully labelled with the contents, the time taken, the analysis required, etc., before sending to the laboratory.

g. Samples should be taken at approximately the same time each day, preferably early morning, so that adjustments can be made during the day if they are required.

The most repeatable results may be obtained by collecting the samples directly into a clean centrifuge tube, beaker, or flask in which the test is to be run. If this is not possible, then the samples should be caught in a clean container and transported immediately. At the laboratory the sample container must be shaken vigorously and samples poured out and tested immediately.

### D.1.8 Plant Optimisation

Only one variable should be changed during a test period. There should be a minimum of four (4) hours between changes. The selection of a starting point for the testing will depend on the results of the initial samples and data.
It is important to understand that any change in the inlet production or operating variables will result in some variation of equipment performance. The magnitude of variations in performance will depend on the magnitude or importance of any change in inlet fluid or operating variable.

#### *D.1.8.1 Oil / Water Interface*

Raise and lower the oil/water interface to determine the maximum and minimum operating points.

#### *D.1.8.2 Operating Temperature*

i. Reduce the operating temperature until the lower limit is determined.

ii. Increase the operating temperature if necessary to improve performance.

#### *D.1.8.3 Mixing Pressure Drop*

After the wash water injection rate is set and only if necessary, increase the mixing valve pressure drop until the mixing is sufficient to reduce the salt content of the desalted Crude oil to specification. The pressure drop should be gradually increased in 0.2 bar increments. Allow a sufficient time to elapse after each increase (4 hour) before taking a sample. Analyse several samples at each pressure drop setting.

The optimum mixing differential pressure is impossible to predict accurately. This is because the emulsifying characteristics of the mixture may be influenced by the type of Crude oil, the operating temperature, the flow velocities in the Crude oil lines, the method of water injection, the process water quality, the type and the injection rate of the demulsifying chemical, and other factors. In general, increasing the mixing valve pressure drop improves water/Crude oil mixing and reduces the salt content of the desalted Crude oil.

Care should be taken not to over mix, since this will result in an emulsion that the Desalter cannot break. Over mixing will be indicated when the water content of the desalted Crude oil and the Crude oil content of the effluent water start to increase. The correct setting must be determined by experience. The CAMERON commissioning engineer will be able to give advice on this matter. The maximum pressure drop for each stage mixing valve will be 1 bar , Normal pressure drop for each stage mixing valve is 0.2 – 1.0 bar

#### *D.1.8.4 Effluent Water*

When flow conditions have stabilised, samples of effluent water should be checked for pH. If the pH is below 5.0, the injection of a suitable alkaline solution is recommended for plant operability and maintenance. Adjust any alkaline solution injection rate to maintain the effluent water pH in the range 5-7.

*D.1.8.5 Salt Analysis*

Since it is sometimes difficult to get consistent salt analyses at the salt levels that will occur in the desalted Crude oil, it is recommended that a “salt balance” be made around the vessel to help final optimisation of the operating variables.

**Plant Restart**

If the system is shutdown at any time a restart is necessary.

There are three basic reasons for a system/vessels shutdown, i.e. planned maintenance, emergency and trip. Any instruction for a safe restart of the system will depend on the specific reason for the shutdown. Further, the length of the shutdown must also be taken into consideration.

D.1.9 Restart from Programmed Shutdown

A programmed shutdown is interpreted as a system/vessels shut down for maintenance / refurbishment etc., and that this shutdown will cover an extended period, i.e. several days or more.

a. Assuming the system vessel has been drained and opened then all the procedures, actions and checks that were carried out during pre-commissioning and start-up must be repeated, see sections C and D of this manual.

D.1.10 Restart from Emergency Shutdown

The cause of the shutdown must be established and corrected before the desalting system / vessels are restarted.

a. Assuming the vessel has remained full of crude oil oil/water then all the procedures, actions and checks that were carried out during start-up must be repeated see the necessary parts of section D of this manual.

b. If the vessel has been drained then all the procedures, actions and checks that were carried out during the start-up must be repeated, see section 0 of this manual.

c. Assuming the vessel has been drained and opened then all the procedures, actions and checks that were carried out during pre-commissioning and start-up must be repeated, see sections C and D of this manual.

Any emergency shutdown initiated outside of the system would presumably be handled and diagnosed by the client's system. All appropriate actions to restart the desalting system would have to be undertaken, including any within sections C and D of this manual.

B

D.1.11 Restart from Trip

A process upset may trip the power unit on the Desalter. If it is adjudged safe to re-energise the grids within a few minutes, then it would be assumed that the desalting vessel operation was unchanged. No further action would be necessary, other than to initially keep a close check on all operating parameters until satisfied that normal operation had been re-established.

A power failure could trip the power unit or the whole plant. Again the cause would have to be established and corrected before the power unit/whole plant was restarted.

When the power supply is restored and the desalting vessel has remained full of Crude oil/water then all the procedures, actions and checks that were carried out during the start-up must be repeated, see the necessary parts of section D of this manual.

If the desalting vessel has been drained then all the procedures, actions and checks that were carried out during the start-up must be repeated, see section D of this manual.

Any trip initiated outside of the desalting system would presumably be handled and diagnosed by the client's system. All appropriate actions to restart the desalting system would have to be undertaken, including any within sections C and D of this manual.

**Plant Shutdown**

It should be noted that once the wash water injection to the desalting unit has been discontinued, there is nothing about the operation of the Desalters that could cause upset to other processing equipment.

D.1.12 Programmed Plant Shutdown

To shut down the desalting equipment the following procedure is recommended:

i. Shut down the wash water system.

ii. Open the mixing valves.

iii. Shut down the crude oil charge pumps, assuming the total plant is to be shutdown

OR

Isolate the Desalter, if it is only the desalting system being shut down.

iv. When the Crude oil flow through the Desalter system has been discontinued turn the auxiliary power switch on the LRC-II panel to the ‘Off’ position.

v. Shutdown the demulsifying chemical system.

vi. Pull out the ESD Stop Button on the LRC-II panel.

vii. Turn off the LRC-II panel isolator.

viii. Ensure the main three phase power from the switch gear is isolated and locked-off in accordance with the client's procedures.

ix. Confirm the light on the Power Unit is off.

x. Dump the water layer to the drain at a controlled rate to avoid any flooding of the drain system. After discarding the water layer, discharge the Crude oil.

xi. If the Desalter is to be opened, blind flanges (spades) must be inserted in all upstream and downstream pipework to prevent accidental ingress of fluids.

xii. Then steam out the Desalter as required by the site/national safety procedures. DO NOT EXCEED 170°C (340°F) DURING THE STEAM OUT OPERATION to avoid damage to the PTFE insulation components.

xiii. Backwash the vessel with water & dump the backwash water to the drain.

xiv. Vent the residual gases and open the manways.

xv. A high pressure fire hose can be used to wash any residual sediment from vessel internals.

This is only an advised procedure. It may be modified by the Owner to comply with site/national standard practices in venting, steaming and isolating of vessels involved.

D.1.13 Emergency Shutdown

If vapour forms in the Desalter then the oil level switch (029-LS-1748 / 029-LS-2748 / 029-LS-1768 /. 029-LS-2768) will disable the associated power unit secondary voltage and initiate an alarm by LRC-II panel. The associated power unit will re-start automatically without any manual intervention by LRC-II panel once the level in the Desalter has been re-established.

This does not require an Emergency Shut Down of the site, (or even the Desalter package if the out-of specification product can be handled).

In the event of any other emergency/trip/alarm situation (out of the CAMERON scope) it is assumed that there is a plant shutdown/trip/alarm procedure (provide by others).

**Normal Operation**

D.1.14 Routine Work

The operation is automatic and the normal routine only involves checking and recording the following items on a regular (once-per-shift) basis:

- Interface level
- Operating temperature/pressure
- Oil flow rate
- Primary amps on transformer
- BS&W
- Salt content

**Process Variables**

Once a desalting system has been started-up and the operation has been optimised on each electrostatic desalter very little operator attention is required. It is however important to keep a record of at least the feed and product salt content, and the product water content. We strongly recommend that the performance record sheet in Section D.1.25 of this manual be completed each day and that these sheets be periodically mailed to CAMERON, so that we may advise you of possible ways to improve the performance of your plant.

The main desalting process variables are discussed below. If, after adjustment of the appropriate variable(s), the desalting performance is not satisfactory, please inform CAMERON of ALL the conditions listed in the performance record sheet.

D.1.15 Crude Oil Flow Rate

The electrostatic desalt system is designed to dehydrate Crude oil of the type and at the rate specified in section A.1.1,"Process design Data" of this manual. Increasing the Crude oil flow rate above the design rate will tend to increase the salt and water content of the product oil. An increase in the salt and water content of the product will be progressive as the Crude oil flow rate is gradually increased above the design flow rate. Decreasing the Crude oil flow rate below the design flow rate should improve the dehydration performance in most cases.

D.1.16 Crude Oil Temperature

- Design operating temperatures are specified in the process data sheets.
- Normally, operating temperature should be maintained as per Design Specific conditions for stable operation and meeting required product quality

D.1.17 Crude Oil Pressure

- Operating pressure should always be above the crude oil vapour pressure (bubble point) atleast by 30 psi throughout the coalescing system

- If the operating pressure of the Desalter drops below the “Bubble Point”, gas bubbles can be formed. Formation of gas inside the Desalter or carry-over of gas from the degasser vessel can disrupt the oil/water separation process and result in high outlet BS&W. Quick opening of any of the control valves (Oil-Water mixing valves [(029-PDCV-1060 / 030-PDCV-2060) {For Train A/B}] / [(030-PDCV-1071 / 030-PDCV-2071) {For Train A/B}], Effluent water flow (030-LDCV-1026 / 030-LDCV-2026) (030-LDCV-1034 / 030-LDCV-2034) ,etc can cause the operating pressure to drop too low.

D.1.18 Mixing valve Pressure Drop

The degree of mixing imparted to the Crude oil and water as they flow through the mixing valve is a function of the pressure differential across the valve and this can be varied.

It is desirable to disperse the wash water in the Crude oil as thoroughly as possible without forming an emulsion that is so highly stabilised that it is difficult or impossible to break. The optimum pressure drop can be determined as outlined in section D.1.8 of this manual. Other variables, such as the Crude oil charge rate, temperature, water flow etc., are held constant whilst changing the pressure drop. The maximum pressure drop for each stage mixing valve will be 1 bar , Normal pressure drop for each stage mixing valve is 0.2 – 1.0 bar

D.1.19 Wash Water Flow Rate

AB1

The wash water flow rate (6% of Design Dry Oil Flowrate (56167 STB/D (372.1 Sm3/hr) which is equal to 3370 STB/D or 22.33 Sm3/hr) should be maintained as shown in the Process Design Section A.1.9, of this manual.
Insufficient water injection results in poor desalting because the residual brine drops in the Crude oil are not thoroughly contacted and diluted by the wash water and the scrubbing action, important in removing suspended solids is correspondingly reduced.

It is always advantageous to optimize the wash water usage being a premium utility. Also, excessive wash water injection will not only increase the utility consumption and associated cost but will increase effluent water disposal cost due to higher effluent water generation. Excessive wash water will also increase the total water content within the Desalter which may cause short circuiting and loss of voltage in the event of increase in %age water entering to electrostatic grid of the Desalter. Therefore, it is advantageous to minimize wash water usage.

D.1.20 Wash Water temperature

The temperature of the process water is not in itself important. However, it may become important in its effect on the Crude oil temperature, i.e., by lowering the temperature of the Crude oil charge and causing such problems as the formation of free wax, thus reducing the performance of the desalting process.

The wash water must be heated to a temperature as much close to the crude oil temperature as possible for the optimum performance of the Desalter. Typical recommendation is to heat the wash water stream to a temperature within 15°F/ 8.3°C of the desalter operating temperature.

### D.1.21 Crude Oil/Water Interface Level

It is very important that the Crude oil/water interface level in the electrostatic desalter vessel be controlled. There are five trycocks and an interface level transmitter installed on each vessel.

It is recommended that the interface level be checked at least once each shift. High interface levels will usually increase the electrical load and sometimes cause a short circuit between the electrodes as indicated by the feedback on the LRCII panel. Low interface levels may allow slugs of Crude oil to be discharged with the effluent water. As a general guide, the interface level should be controlled approximately at the middle trycock. During the commissioning/initial start-up the CAMERON engineer will give further advice on this matter.

### D.1.22 Demulsifying Chemical

Demulsifying chemical may be required to enhance product quality.
The demulsifying chemical used will be one of many compounds stocked by the chemical manufacturer. These demulsifying chemicals are scientifically selected for each application and only the chemical manufacturer is qualified to recommend the most efficient compound for a given Crude oil. In many cases a blend of compounds is made to achieve the most efficient result.

- Demulsifier chemical injection rate or type may be varied to suit process conditions.
- Demulsifier type and Dozing range (50-70 ppmv) must be finalized by field-testing to obtain optimum performance of the system.

### D.1.23 Interface Sludge Layer

When oil and water reside for long periods in contact, an intermediate emulsion layer may form between the two liquids. This emulsion layer in the electrostatic desalter may vary in thickness from several centimetres to as much as 600 mm and may cause excessive electrical loading, erratic voltage readings and dirty effluent water. The injection rate of demulsifying chemical should be increased to the maximum rate possible during such periods.

The thickness and composition of the interfacial layer depends on several factors, such as:

i. Naturally occurring emulsifying agents in the oil.

ii. Waxy constituents of the oil.

iii. Suspended solids in the oil or process water.

iv. Degree of emulsification of water in the oil.

v. An unsuitable demulsifying chemical.

Excessive interface sludge should be removed via the interface Draw-off header.

D.1.24 Solids Removal from the Desalter

i. Sand Washing Philosophy

Separate sand wash and sand removal facility is provided for 2 compartments. This allows for each compartment to be de-sanded separately thereby minimising the amount of desanding water required and also providing minimum upset to the vessel operation.

Occasionally, when the solids content of the crude oil feed rate is very high or the wash water flow rate is very low, solids may build up in the Desalter vessel. The build-up of solids can be prevented by regular injection of high pressure water through a sludge wash cleaning facility and into the water phase of the Desalter. This washes solids from the vessel walls, stirs the water phase and allows the solids to be carried out of the vessel via the internal effluent water header, where high water velocities are used to prevent the settling of these solids in the pipework.
The sand wash system consists of 2 headers fitted with water spray jets. The spray jet water being at a pressure approximately 2.41 bar / 35 psi above the operating pressure of the Desalter vessels. The jetted water agitates the solids that have collected in the bottom of the vessel and they are removed with the effluent water whist the Desalter is on line. Each section is operated separately.

The required sand wash water flow rate and Pressure is 25 $m^3$/hr - 37.5 $m^3$/hr (110 gpm-165 gpm), 2.41 bar / 35 psi above the vessel normal operating pressure based on final estimates. The de-sanding frequency is once a day which is purely an initial recommendation, which can be modified during actual operation depending upon the amount of sand ingress and is applicable for individual desalter vessel.

ii. Sand Washing Procedure:

Desalter Feed Pumps, G-101 A/B/C, G-201 A/B/C (two operating in parallel and one standby per train), transfers the wet crude from Dual/Wet Crude Storage Tanks (D-001/D-002) to the Desalters (C-102/C-103, C-202/C-203).

Cruciform Collection Header is provided in the Wet Crude / Dual Crude Storage Tanks (D-001/002) at 7.8 meter (as measured from the bottom of the tank to the centerline of the Cruciform Collection Header) and Desalter Feed Pumps G-101 A/B/C, G-201 A/B/C takes suction from this header. Therefore, chances of the sand collection in the Desalter Train are very remote. However, each stage of the Desalter Train is provided with a Water Jet / Sparger with associated draining facility for periodic interval Solid/Sand removal.

Each stage of the Desalter is provided with

1. Spray Nozzles Inlet N19A/B : 2 Nos 3” and
2. Sand/solid removal system outlet N20A~D : 4 Nos and 2”

During the de-sanding of any stage of the Desalter, the respective stage of the Desalter will have to be bypassed and depressurized. Therefore, this de-sanding operation will be performed “offline” only.

For sand removal system, the pressure requirement is 2.41 bar (35 psi) above vessel operating pressure and Wash Water Feed Pumps (G-102A/B/C, G-202A/B/C) provides the water required for de-sanding operation. The wash water requirement during such operation is 25 m3/hr–37.5 m3/hr(110 gpm-165 gpm). Water Jet / Sparger Inlet Nozzles are provided for injecting water to break the sand layer and fluidize it.

Sand / Solid Removal Nozzles are provided for draining the mixture of sand / solid and water to the Sand Washing Drain Vessel (V-058).

Sand washing is an manual sequence that can be carried out with the Dehydrator/Desalter offline which allows the removal of any sludge/solids from the bottom of the vessels. Sand wash headers along with drains are distributed along the bottom of the vessel which allows for the removal of solids/sand from each section. When Sand washing is initiated the Mudwash Header Valve opens to spray water into the bottom of the vessel so solids are dispersed, at the same time the Drain Valve is opened to allow the dispersed solids to drain away.

- The Desalters are equipped with a “sand jet” and drain system. This system is used to fluidize and remove solids from the bottom of the vessel. To be effective, the system must be used on a regular basis. The required operating frequency depends on the amounts of solids in the inlet production and is determined by operator experience.
- If the solids build up too deep and plug the openings in the “sand” troughs, the system will not work. Even though the operation is automatic, it would be required to optimize all the timing of the operation and the frequency.
- The operator will manually open and close each individual drain valve and Sand wash header valve.

Jet and drain only one section of the vessel at one time. Jetting water should be furnished at 2.41 bar (35 psi) above the vessel operating pressure. The sand jetting procedure outlined below can be performed while the Desalter vessel is in normal operation.

1. Ensure the Sand Jet Water feed pumps (Wash Water feed pumps 529-G-102A/B/C) are running before starting the operation.
2. Ensure that the required Sand wash pressure and flowrate achieved in the Desalter before starting the operation.
3. Open the isolation valve for the sand jet water and jet one side for 10 seconds.
4. After 10 seconds and with the jets still running, open the sand drain valves for 10 seconds.
5. Close the drain valves.

6. If necessary, continue running the jetting water to re-establish the proper oil/water interface level.
7. Shut off the jet water valve.
8. Repeat the procedure for each section of the vessel.

Using the above procedure, the interface level should remain relatively stable. If a problem occurs and the interface level rises unexpectedly, the Desalter should operate effectively until the oil/water interface level approaches a level of approximately 12” below the grids. Depending on the crude properties, current process conditions, and chemical effectiveness, this may cause the grid load to increase; which will be evident from the voltage and amperage readings from the powerunit. If the inlet process is not stopped by an interface level shutdown, the increasing oil/water interface level will eventually result in the Powerunit shorting to ground.

The following points should be considered when using the system:

a) Never agitate the solids longer than necessary as this may lead to poor performance of the desalting process.
b) It is better to use the Sand wash system for short periods on a frequent basis rather than for long periods on an infrequent basis.

D.1.25 Electrostatic Desalter Plant Performance Record

| CAMERON LIMITED | | ELECTROSTATIC DESALTER PLANT PERFORMANCE RECORD | | | | |
|---|---|---|---|---|---|---|
| CAMERON Job No.<br><br>Date<br><br>Report By | | Client<br>Plant location | | | | |
| | | | Time | | | |
| CRUDE OIL FEED | Name | | | | | |
| | Flow rate | | | | | |
| | SG | | | | | |
| | Viscosity | | | | | |
| | Salt content | | | | | |
| | BS&W content | | | | | |
| | Water content | | | | | |
| SLOPS/RECYCLE | | | | | | |
| WASH WATER | Source | | | | | |
| | pH | | | | | |
| | Temperature | | | | | |
| | Chloride content | | | | | |
| | Oil content | | | | | |
| | Flow rate | | | | | |
| CHEMICAL | Type | | | | | |
| | Rate | | | | | |
| EFFLUENT WATER<br>Water out of 1st stage | Flow rate | | | | | |
| | pH | | | | | |
| | Chloride content | | | | | |
| | Oil content | | | | | |
| WATER OUT<br>2nd stage | Flow rate | | | | | |
| | pH | | | | | |
| | Chloride content | | | | | |
| | Oil content | | | | | |
| Desalter 1st stage | Temperature | | | | | |
| | Pressure | | | | | |
| | Mixing Valve DP | | | | | |
| | Interface level | | | | | |
| Desalter 2nd stage | Temperature | | | | | |
| | Pressure | | | | | |
| | Mixing Valve DP | | | | | |
| | Interface level | | | | | |
| OIL OUT<br>1st stage | Salt content | | | | | |
| | BS&W content | | | | | |
| OIL OUT<br>2nd stage | Salt content | | | | | |
| | BS&W content | | | | | |

| TEST METHOD | SOURCE | NOTES |
|---|---|---|
| (1) | SG | |
| (2) | Viscosity | |
| (3) | Salt content | |
| (4) | BS&W content | |

## E - TROUBLESHOOTING

The Dual Frequency® electrostatic process vessels employs much the same principles as the more conventional oil processing systems. It differs primarily in that it utilises the powerful coalescing effect of the Dual Frequency® electrostatic field, as well as the conventional coalescing aids. As with any good system where chemical, heat, time, and electricity are used in combination to provide good treatment, these components are in balance with each other. Therefore, if one component of the system is changed, or lost, another must also be changed to regain this balance. For example, if the treating temperature is reduced, it is usually necessary to increase the chemical, lower the flow rate, or both. This is necessary to compensate for the increased viscosity resulting from a lower operating temperature. Also, it should be kept in mind that this balanced treating programme is itself balanced against the emulsion which is being processed. If all components of the programme are maintained and the treatment slips, it can be assumed that the emulsion has somehow changed.

If the oil is not treating to specifications, the following trouble shooting check list should aid in identifying and correcting most of the problems that may occur.

**Irregularities**

Check the system for irregularities.

E.1.1 Low Operation Temperature

Check the heating system.

E.1.2 High Salt Content in Desalted Oil

i. Water carry-over high – see ‘High water carryover below.
ii. Feed salt content high – Increase wash water rate.
iii. Wash water rate low – increase wash water rate.
iv. Crude oil rate exceeds design flow rate – reduce Crude oil rate.
v. Insufficient mixing of the Crude oil and the wash water – increase mixing valve pressure drop.

E.1.3 High Water Carryover in Desalted Oil

i. Excessive oil/wash water mixing – reduce the mixing valve pressure drop.
ii. Wash water flow rate too high – reduce the wash water flow rate.
iii. Excessive water in the Crude oil feed – reduce the wash water flow rate and commence or increase chemical injection.
iv. Interface level too high – reduce the interface level and check the effluent water valve and level controller.
v. Disturbance in the Desalter vessel – check for an external cause and allow the unit to settle down.

vi. Sludge in the feed – reduce recycle off-spec oil and increase demulsifier dosing rate.

E.1.4 High Oil Content in Effluent Water

i. The interface level is too low – increase the interface level.
ii. Wide emulsion band at the interface – inject chemical or draw-off the layer to drain.
iii. Excessive oil/wash water mixing – reduce the mixing valve pressure drop.
iv. Poor wash water quality – check for an upset in the water source.
v. Oil temperature is too low – Increase temperature if possible.

E.1.5 Excessive Sludge Build-Up at the Vessel Interface

i. Inadequate heat
ii. May require a change or additional type of chemical
iii. It may be necessary to remove sludge from the system using the interface draw-off system.

E.1.6 High Interface Level

i. Interface control malfunction
ii. Defective interface level control valve
iii. Interface level control valve blocked

E.1.7 Increased flow rate through the system

i. Field surging
ii. Flow control set too high

E.1.8 Chemical Problems

I. Dosing pump not operating
II. No chemical in tank
III. Check valve faulty
IV. Broken chemical line

**Electrical Malfunctions**

E.1.9 Power Problems

I. Indicator light out
II. Bulb burnt out
III. Contactor Feeder open / fuse blown

E.1.10 No Voltage and No Current

Loss of electrical power to the power unit:

i. Low liquid (oil) level in the electrostatic Desalter. The low low level switch will trip the power supply to the power unit
ii. Contactor Feeder open / fuse blown

The low low liquid level could be the result of excessive water removal from the Desalter or a faulty drain or interface level control valve.

E.1.11 Voltage High / Current Too Low

This unit is equipped with a solid-state diode package. It is highly unlikely, but possible, that a voltage transient such as lightning could rupture the diode pack. This could cause an opening of the high voltage circuit. Contact CAMERON Engineered Services department for electrical troubleshooting and diagnostic of the power units and grid system malfunctions.

**Removal of rectifier cover and warranty: Refer to NWL warranty statement.**

Check as follows:

i. Turn power switch to OFF and lock.

ii. Disconnect the diode pack.

iii. Repeat the process for diode checks as shown in section 0 “Checking High Voltage Circuits (for troubleshooting)” of this manual.

**Voltage Normal / Current Normal / Treating Efficiency Down**

This could be caused by a short circuit within the diode pack.

**Removal of rectifier cover and warranty: Refer to NWL warranty statement**

Contact CAMERON Engineered Services department for electrical troubleshooting and diagnostic of the power unit malfunctions, who will then contact the vendor and advise the appropriate action.

E.1.12 Low or Zero Voltage / High Amperage

i. Be sure full power is getting to the system.

ii. Be sure the light bulb on the Power Unit is lit (If not see the LRC-II manual).

iii. Lower oil-water interface gradually and watch for increasing voltage, decrease of amperage and brighter burning of the light bulb. An accumulation at and above the oil-water interface of sulphides, paraffin, BS&W, other conductive media floating on the interface will cause an electric short.

iv. If a contaminated interface is determined, turn off the power to power unit and drain the interface. Watch the oil-water interface level in the instrumentation while draining. Lowering the interface level by 100 mm – 150 mm (4" – 6”) should be sufficient to clear the contaminated layer.

E.1.13 Low or Zero Voltage Not Resolved by Previous Step

i. Turn off electric power supply to the power unit, Isolate and Lock OFF.

ii. Confirm equipment is dead and no residual voltage is present.

iii. Remove the cover flange on the HVA chamber assembly and remove the disconnect link. Re-fit the cover flange.

iv. Repeat for the other HVA.

v. Remove the isolation and turn on the power to the transformer. Zero voltage and high amperage indicates a faulty power unit (or diodes) and that it should be replaced. Full line voltage and low amperage indicates a good power unit, and that the electrical short is in the entrance bushing (high voltage lead) or on the inside of the vessel.

vi. After the transformer test, Turn off electric power supply to the power units, Isolate and Lock OFF. Refit the disconnect links

Contact CAMERON Engineered Services department for electrical troubleshooting and diagnostic of the power unit malfunctions, who will then contact the vendor and advise the appropriate action.

E.1.14 Low or Zero Voltage Not Resolved by Previous Step

i. Turn off electrical power to unit. Isolate and Lock OFF.

ii. De-pressurise and drain the process vessel.

iii. Remove the cover flange from the bushing housing. Check the absence of voltage with a Hotstick. Drain the bushing housing and disconnect the disconnect link. Remove the entrance bushing and visually check for a burned appearance. Sulphide or BS&W build-up extending the full length of the Teflon portions of the bushing can cause a short. Be sure it is clean. If there is no visible damage the entrance bushing can be termed good. A final test of the bushing can be made with a "Megger" unit to determine if there is continuity between the wire conductor and the flange. Continuity here indicates a bad bushing. To remove the bushing for testing disconnect the bushing from the power connector rod and power pickup bucket assembly. Re-fit after testing.

iv. Refit the entrance bushing housing assembly.

E.1.15 Low or Zero Voltage Not Resolved by Previous Step

i. Drain the vessel and open one of the manways.

ii. Before entering the vessel once again, be sure the power is off and that the contactor Feeder / LV switchgear is locked in the "OFF" position.

**WARNING!**

Before entering the vessel, it is necessary to check zero voltage on the electrodes as follows:

From the Vessel entrance manhole, and with an Earthing Hot Rod connected to the Earthing System or to the vessel wall, touch the Electrode Grid layers to discharge any residual voltage. In the event that a voltage is detected, DO NOT ENTER the vessel. With no presence of voltage, the grids can then be temporarily earthed by connecting to a good earth point if the vessel is open for prolonged periods (link to be removed if megger testing etc). This link shall be removed when work/inspection inside the vessel is completed and prior to energising the power units.

Note: Follow “Confined Space” procedures.

iii. Check insulators suspending the electrode grids. Burned insulators should be replaced.

iv. Check the electrodes for any material that may be touching consecutive electrode plates (+ve and –ve) and that there is proper spacing between the vessel wall and the electrode plates and also between the electrode plates themselves.

**Proprietary Equipment**

E.1.16 Power Units

For information on the power unit see all details, included in the suppliers operating and maintenance manual.

**See Installation Manual for Warranty / Guarantee statements regarding the unauthorised opening of the power unit**.

Contact CAMERON Engineered Services department for electrical troubleshooting and diagnostic of the power unit malfunctions, who will then contact the vendor and advise the appropriate action. Contact should be made by telephone or email.

E.1.17 LRC-II Control Panel

For information on the LRC-II control panels see all details, included in the suppliers operating and maintenance manual.

**Some Desalter "DO'S and DON'TS"**

| | |
|---|---|
| ***DO*** | • Flush all the sample lines to obtain a truly representative sample.<br>• Observe the interface level, by <u>means of the trycocks,</u> and do not rely on gauge glasses or level indicators<br>• Periodically check the wash water quality.<br>• Become familiar with the Electrostatic Desalter 'normal' conditions.<br>• Keep an accurate log of the Electrostatic Desalter operation. |
| ***DO NOT*** | • Start wash water injection <u>before</u> the power is on to the Electrostatic Desalter.<br>• Change more than one process variable without confirming the results of that change.<br>• Make any change on only one <u>abnormally</u> high (or low) laboratory result. |
| ***REMEMBER*** | • It is far easier to prevent an emulsion than to break one. Get to know the oil and/or operating conditions that tend to produce emulsions and take action. Once an emulsion layer forms at the oil/water interface it is usually too late to disperse it, although chemicals may help. |

# F - MAINTENANCE

## Safety

Note: This section is intended as a general guide only and as such CAMERON shall not be liable for any loss or damage caused by reliance on the information presented herein.

### F.1.1 Special Notes

i. Make certain that all skids, vessels, and electrical equipment are properly electrically grounded.

ii. Do not enter any vessel until it is vented and checked for dangerous or explosive gas.

iii. Do not work on vessels or equipment while in operation or while under pressure.

iv. Vent all process and instrument gas pressures before working on equipment.

v. Check for explosive gases in the area before performing any work.

vi. Do not work on this equipment if any other work in the area could result in release of potentially explosive vapour.

vii. WARNING

After equipment has been in service, do not cut or weld on any process lines or vessels for any reason. Accumulations of hydrocarbons can result in explosive conditions.

Any work on the vessels or piping requires special precautions that are not covered in this manual.

viii. WARNING

Keep hands away from mechanical linkages while equipment is in operation. Operation is automatic and may occur without notice.

ix. WARNING

The control panel and control circuits operate on 120 V AC and 12 V DC electrical power. Use extreme care when servicing the control panels and control circuits. Lethal electrical shock is possible. Only qualified personnel must service this equipment.

x. WARNING

The electrostatic process vessel high voltage electrodes operate up to 34,000 V AC electrical power. Lock power "off" before servicing. Lethal electric shock is possible. Only qualified personnel must service this equipment. Make certain power is locked "off" before entering the vessel.

xi. WARNING

Before initial testing of the power unit and electrical system, the vessel must be vented and carefully checked for any combustible vapour. <u>After the initial start-up, the power must never be applied to the power unit unless the vessel is filled with liquid</u>. Any spark generated in the presence of combustible vapour may create a lethal explosion. Only qualified personnel must service this equipment.

Operate the equipment within the specified design conditions.

xii. WARNING

**CONFINED SPACE ENTRY PROCEDURES** must be followed for any entry into the vessels. Death from asphyxiation is possible.

- All process and utility connections must be blinded.
- The vessel must be certified gas free.
- Personnel must have “CONFINED SPACE ENTRY TRAINING” by an approved authority.
- An observer, outside the vessel must be provided.

If there are any questions or concerns about safety issues, please contact CAMERON HSE department.

## F.1.2 General Safety

### *F.1.2.1 Safety Procedures*

Definite safety procedures should be prepared for the plant employees. Plant supervision should make certain that employees understand their duties and responsibilities. Employees should understand that it is their personal responsibility to report to their immediate supervisor any abnormal circumstances, such as:

- Leaks.
- Accumulation of gas or vapour.
- Defective or damaged equipment.
- Abnormal conditions such as excessively high or low temperature or pressure.
- Infractions of safety regulations.
- Unauthorised vehicles or personnel in the area.

Operating personnel should be familiar with the location of fire protection and first aid equipment in the area and should be trained in the use of such equipment. Employees should know how to report a fire or an emergency and have a clear understanding of their duties during such emergencies.

*F.1.2.2 Normal Operation*

i. Procedures for the loading of product should be prepared and should be followed.

ii. Transportation vehicles should not be permitted to operate within the plant area or loading area while the area is contaminated with flammable vapour or while loading product.

iii. Regular inspections of the loading area should be made of items, such as, grounding of electrical equipment, housekeeping, lines, valves or checks for leaks, proper drainage or venting from loading area, and elimination of nearby open flames during loading operations.

iv. Procedures covering the starting up and shutting down of processing equipment and units should be reviewed and rehearsed thoroughly by those responsible for operation of the equipment.

*F.1.2.3 Emergency Operations*

i. General

When flammable liquids or vapour escape from tanks, vessels, or lines, available means should be used for limiting their spread and preventing their ignition. The extent of the contaminated area should first be defined and the area identified by suitable warning signs, and patrolled. Spills should be cleaned up as soon as possible.

ii. Liquid Leaks

If a break or serious leak occurs in a liquid line, the pumps should be shutdown and any block valves closed.

If the leak involves a tank or any relatively large vessel, portable pumps may be required to recover the liquid. Trenches, dykes, or diversion walls should be used either to confine the liquid or divert the flow. Foam may be applied to cover the spills in order to exclude air, but this is not normally necessary. Water spray applied at the point of emission of a leak may aid in the dispersal of vapour and prevent ignition.

In the case of very light leaks which give off quantities of vapour, the procedures listed for gas leaks should also be followed.

iii. Gas Leaks

In the event of a break in a gas or liquefied petroleum gas (LPG) line or vessel, all fires downwind of the break should be extinguished. Before operations are resumed, tests should be made at pits, trenches, or dykes where gas might accumulate. Portable gas indicators for making such tests will indicate if a flammable gas or vapour is present.

If a break occurs in an area where adjoining properly is owned by outside interests, prompt measures should be taken to notify those concerned of the potential hazard that exists and to eliminate any sources of ignition.

The vapour from large LPG leaks may roll along the ground and blanket large areas under certain weather conditions.

It may be possible at times to disperse flammable mixtures by means of forced ventilation or large quantities of steam or water fog.

### *F.1.2.4 Maintenance Procedures*

i. General

Fire prevention in connection with maintenance work depends primarily upon careful planning and removal of flammable liquids, vapour, and other flammable materials before work starts. In certain instances, it is not possible to remove all flammable materials and at such times, precautions must be taken to prevent ignition sources from contacting flammable mixtures or to exclude oxygen. A procedure should be set up for warning personnel and stopping maintenance work in the event of a release of flammable vapour or liquids in the area where the work is being done.

ii. Work Permit System

A written work permit system should be used whenever any maintenance or inspection work is contemplated which requires the use of spark or flame-producing equipment. The permit should be issued only after tests have indicated that no flammable vapour is present. It should also be ascertained that no work is being done or contemplated which might create a hazard during the course of the job. The authorised persons should sign the permit, indicating that the equipment to be worked on has been properly prepared for hot work. Any precautionary requirements or procedures to be observed during the work should also be outlined on the permit.

iii. Inspection

Process units and related equipment should have complete, periodic inspections. The length of time between inspections and the type of inspections conducted should be based upon the type of equipment and its condition as determined by previous inspection.

### *F.1.2.5 Repairs*

i. When any equipment is to be repaired, it should be isolated from other equipment that contains flammables. Connecting piping should be disconnected, blanked off, or both, in accordance with a definite procedure. Valves should not be relied on for blanking purposes, blanks of suitable thickness should either be blind flanges or full-face steel plates inserted between gaskets against line flanges. Definite responsibility for their installation and removal should be assigned.

When hot work is to be done on equipment that has been gas-free, connections to the equipment should be removed.

ii. Care should be taken if sludge and scale remain in tanks, vessels, and piping after flushing and washing operations. Such materials often contain flammable and may give off vapour that can be ignited during repairs. Continued ventilation may be necessary.

iii. Hot-tapping devices are available for making repairs or additions to equipment that is either in service or has not been completely cleaned of flammable. Use of such devices can be very effective, and may at times be a safer method of doing a job than would gas-freeing. Each individual instance should be carefully planned to ensure that the proper device is used and that necessary safe practices are followed.

iv. Before hot repair work is started on equipment that has contained or does still contain flammable liquids or gases, careful plans should be made as to the manner in which the work will be done. In most cases, it is desirable to open and completely gas-free equipment before repairs are made, but there are instances when repairs may proceed after some inert material such as flue gas or water has displaced the flammable material.

v. Fire fighting facilities should be readily available when repairs are being made. Minor fires may be quickly extinguished when facilities are readily accessible and employees are trained in their quick and effective use.

*F.1.2.6 Good Housekeeping*

Good housekeeping is an essential part of maintenance. Containers for scrap material and refuse should be provided at convenient locations. Scheduled emptying of such containers should be strictly adhered to. Oil and grease soaked rags should be placed only in separate metal containers provided for them.

*F.1.2.7 Entries*

i. Vessel Entry

Vessel entry refers to any tank, vessel, equipment or other enclosed place where there is a hazard of:

- A toxic, corrosive or flammable substance.
- Insufficient oxygen.
- Severe restrictions that would hinder escape or rescue.

Vessel entry normally requires specific approval by plant supervision. It should include sampling and blow down.

All vessels should be assumed unsafe for normal entry until the following entry procedures have been followed:

a. Disconnect and blank off all lines to the vessel.

b. Remove all sources of ignition before removing manway.

c. Check all liquid traps and internal lines to assure they are free of hazardous liquid.

d. Clean the vessel as thoroughly as possible by draining, washing with water, steaming, ventilating or other suitable means. If steam is used, guard against static electricity by grounding the steam nozzle. After steaming, allow the vessel to cool slowly. Sudden cooling with water spray may cause a static electrical charge.

e. Test the atmosphere for:

- Oxygen: Air must contain 20 – 21% oxygen and the vessel should have adequate ventilation, either forced or natural.

- Explosive Mixture: A vessel may not be entered if the testing instrument indicated an air/vapour mixture that exceeds 50% of the lower explosive limit.
- Toxic Fumes: The presence of any toxic fumes requires the use of respiratory protective equipment, normally an air supplied mask with hand blower, or a self-contained breathing unit. Otherwise additional cleaning or purging of the vessel is indicated.

f. Safety harness or belts - the person using respiratory equipment when entering the vessel should wear either a safety harness or belt
.

g. Clothing - personal protective clothing suitable for the job inside the vessel should be worn.

h. Observer - an observer should be stationed outside the vessel. His only duty should be watch the person inside the vessel. When respiratory equipment is required for the person entering the vessel, the observer should also have suitable respiratory equipment available.

i. Emergency equipment - fire extinguisher and other emergency equipment should be available as required.

ii. Line Entry

a. General

Line entry should include any work required on any line or valve which contains flammable liquids or vapour, or contents of which are corrosive, toxic, and/or under pressure.

The following items should be considered in all work involving line entries:

- Know the contents of each line being worked upon.

- Know the pressure ratings of the pipes and fittings. Never install low-pressure connections on high pressure lines.

- Never hammer on high pressure lines.

- Use extreme caution when thawing frozen lines.

- Never use fire to locate leaks of flammable materials.

- Be very cautious when attempting to tighten pipe fittings while pressure is on a line.
- When opening valves, do so slowly to allow pressure to equalise before opening the valve fully.
- When removing blinds, loosen bolts and allow pressure to bleed down. Gas sometimes leaks into the space between the blind and the valve.

b. Before Breaking Lines

- Drain the contents into a tank or to the lowest point.
- De-pressure the line to a safe designated area.
- Lock out the pump. All gauges and sight glasses should be checked for zero readings.
- Close and tag the nearest upstream and downstream valves.

c. When Breaking Lines

- Wear suitable personal protective equipment, full clothing and sometimes rubber suits should be worn to guard against chemical splash. Goggles should be worn to protect the eyes against chemical splash and flying particles.
- The placement of a deflector over the flange joint is usually desirable for the initial cracking of corrosive or toxic material lines.
- The worker should slowly open the bolts on the far side so that if there is a spray it will be away from him.
- Sections that have been removed should be handled carefully until they are inspected for trapped material or residues and flushed if required.

### *F.1.2.8 Electrical Equipment*

Probably everyone recognises that high voltages can be very dangerous but some people fail to realise that so-called "low voltage" can be very hazardous and under certain conditions can produce fatal injuries. Deaths have been recorded due to contact with circuits of less than 50 volts. Actually, it is not voltage but amperage that kills. Under certain conditions, as little as 1/10 ampere is sufficient to cause death. The following may be used as a guide when working with electrical equipment:

i. Electrical Equipment Repairs

When electrical equipment is to be repaired, switches must be opened and tagged. Working on "hot circuits' normally requires the permission of plant supervision. Refer to detailed plant tag-out procedures before proceeding.

ii. Earthing

- All electrical equipment is to be earthed (electrically grounded).

- If it is ever necessary to move any equipment, the earth should be replaced before the equipment is used.

iii. Conduits, Cables and Wires

- Electrical conduits should not be used to support other equipment.
- Electrical cables and conduits should be not buried underground except in accordance with engineering standards.
- Exposed ends of electric wires must be taped.
- Unused and abandoned electric wires must be removed or disconnected at each end.

iv. Fuses

- Only authorised personnel should replace fuses.
- Fuse tongs and/or rubber electrical gloves should be used. Rubber gloves must always be used for voltages in excess of 150 volts.
- Never use coins or tinfoil in lieu of fuses.
- Never use fuses of greater capacity than are specified by the equipment manufacturer.

v. Switching

- When starting electric motors, handle all switches according to instructions. Make the contact so as to prevent arcs. Stand in a safe position.
- Never pull a disconnect switch under load except in an emergency.
- Always be certain that hands and feet are dry when operating switches or plugging in electrical appliances.
- Keep rubber mats in front of switchboards where possible.
- Switch panel fronts should be kept closed.

vi. Hand Tools and Portable Equipment

- Extension lights without bulb protectors must not be used. Use only low voltage lights with isolating power units in tanks and similar places.
- All extension cords should be the earthed type. Before each period of use, examine extension cords carefully for any failure of the outer insulation, particularly at terminal points where the cord enters a plug or a fixture.
- Lights and tools should not be disconnected from an extension cord while the other end of the cords is in a socket or receptacle.
- The Earth cable with which each tool is equipped should be secured to a suitable earth before the tool is plugged in to a source of electricity.

vii. Miscellaneous

- Contact with electrical conductors should be avoided whether they are energized or not.
- Only authorised personnel should enter fenced substation areas.
- Faulty electrical equipment must not be used. Report it immediately.
- Before changing broken light bulbs, be certain the current is turned off.

- No employee should work within 4500 mm of a high voltage (>6000V) power line except by special authorisation of plant supervision.

*F.1.2.9 Fire Protection Equipment*

i. General

The responsibility of keeping the firefighting equipment in first class condition should be definitely established. Equipment should be tested periodically in accordance with standard procedures and as dictated by experience.

It is imperative that all fire protection equipment be stored, inspected periodically, and maintained for immediate emergency use. Proper records should be kept for such work. Often it is desirable to number the equipment serially to assure complete checking on schedule.

Whenever an extinguisher is used, it should be set aside for inspection and recharging. Some operators seal an extinguisher or cabinet so that it may be checked more readily. Others will place the equipment in an expendable plastic bag that serves the same purpose and also keeps the extinguisher clean and free from exposure to corrosive atmosphere.

Mobile firefighting equipment such as portable foam equipment, etc., is now widely used. A periodic study should be made of this equipment to determine that it is adequate and advantageously located for use throughout the plant and at adjoining operations.

ii. Extinguishing Equipment

- Carbon Dioxide Systems

An inert gas, such as carbon dioxide, discharged into a closed room or into enclosed spaces, may be an effective extinguishing agent. For example, a carbon dioxide system is one method of extinguishing fires associated with equipment such as petroleum pump rooms, electrical installation, and special machinery or apparatus such as is used in laboratories. Care should be taken when extinguishing fire by carbon dioxide due to the fact that carbon dioxide will not support life.

- Dry Chemical System

The application of dry chemicals is effective for the control and extinguishing of fires that may occur during the processing and handling of flammable liquids, solids and gases. This extinguishing agent is composed of specially treated sodium bicarbonate in dry powder form with components for producing free flow and water repellence. Being non-conductive, it is suitable for fires that involve energized electrical equipment. The dry chemical may be used simultaneously with water fog without practical damage to the powder. The water will not only quench embers or cool hot surfaces but will also reduce flame size and thereby make the fire easier to extinguish with the dry chemical.

Portable extinguishers of the hand operated type which contain 15 kg of dry chemical or less are recommend for use as first aid equipment for small fires. Several hand operated extinguishers may be used simultaneously for the extinguishing of larger fires and reserve, or secondary protection, may be provided by wheeled of stationary extinguishers with capacity ranges up to 150 kg of dry chemical discharge.

*F.1.2.10 Fire Alarm and Integrated Activities*

There are certain functional responsibilities that should be clearly understood by all parties concerned to be sure that the various phases of the fire fighting organisation would be effective when required. If and when a general fire alarm is sounded, definite, integrated, activities should be initiated, such as:

An alarm system with annunciation in a key location, such as main office, plant area, and control room, should be installed.

An emergency call-out list for key supervisors, local municipal fire department, ambulance service, doctor, etc. In some instances, an independent agency is used for handling this emergency call-out.

**Nitrogen Safety**

F.1.3 Introduction

Nitrogen is used for purging and blanketing operations. Nitrogen is non-toxic but asphyxiates due to oxygen deficiency.

F.1.4 Basic Principles for Safety

Hazardous situations generally arise when vessel entry is required.

Ventilation and oxygen deficiency testing procedures should be implemented.

Vessel entry permits should be required to authorise vessel entry.

Nitrogen and air connections should be carefully and clearly labelled. It is good practice to utilise different couplings for air and nitrogen to prevent confusion.

F.1.5 Health Information

Nitrogen is non-toxic, but asphyxiates due to oxygen deficiency.

Affected personnel should be removed from the oxygen deficient atmosphere, if it is safe to do so, by rescuers wearing breathing apparatus. Seek immediate medical attention. Artificial respiration may be required if breathing is difficult or has stopped.

F.1.6 Safety Hazards

NITROGEN ASPHYXIATES DUE TO OXYGEN DEFICIENCY

% Oxygen

| | | |
|---|---|---|
| 21 | - | Normal air |
| 19.5 | - | Required for normal support of life |
| 14 | - | Breathing difficult, poor judgement |
| 10 | - | Unconscious |
| 8 | - | Death in 8 minutes |
| 4 | - | Death in 40 seconds |
| 0 | - | Death in 10 seconds |

**Operational Maintenance**

Very little maintenance is required by the Desalters during normal operation.
Routine preventative maintenance should be applied to all equipment associated with the Desalters.

If trouble on the treating operations occurs or part of the equipment appears to be faulty or out of order, then refer to section E.

All equipment (electricity, instruments, vessel, transformers, piping, etc.) should be kept in good condition and clean (free of rust and dust). They should be checked regularly once a year for good operation and sealing.

The geometrical shape of the electrodes, high voltage connections, electrical entrance bushings, insulators, cables, etc. must be carefully checked.

Entrance bushings and insulators (PTFE parts) must have a clean white surface, free of cracks or electrical burning.

These procedures should be carried out periodically (possible as a part of planned schedule maintenance) whilst the Desalter is in operation.

It is also recommended that, when the vessel is opened for maintenance, internal distribution and collection pipework together with the electrodes grids and the vessel shell are inspected for signs of erosion and/or corrosion.

**Unit 'Turn Around' Maintenance**

This procedure should be carried out during crude unit routine 'turn around' period:

### F.1.7 Desalter Vessels

Remove all sludge and solids from the vessels paying particular attention to internal headers to ensure all openings are free of solids build up. Check electrode supports for tightness of bolts etc., and look for corrosion effects. Clean the electrode insulators, in situ, with hydrocarbon solvent and inspect for surface tracking, cracks etc. Any insulator showing such marks should be replaced.

Note: Do not exceed 170°C (340°F) during steam-out operation to avoid damage to PTFE (Teflon) insulating components.

### F.1.8 High Voltage Assembly

**Notes:**
**Before commencing work all electrical supplies to the power and control circuits must be switched "OFF". The main fuses must be removed from the contactor feeder and contactor feeders must be locked "OFF".**

**Before inserting other tools or hands into the Bushing Housing Assembly, touch the Disconnect Link with an Earthing Hot Rod connected to the Power Unit Earth connection to discharge any residual voltage on the High Voltage Assembly.**

- Remove oil via drain.
- Remove disconnect link via top flange of high voltage assembly.
- Disconnect the upper bushing housing from the Power Unit.
- Disconnect the upper housing from the lower housing
- Carefully lift the upper bushing housing over and away from the bushing connector rod.
- Remove the bushing connector rod.
- Remove the lower bushing housing with high pressure bushing, clean with hydrocarbon solvent and inspect for surface tracking, cracks, etc. Any bushing showing such marks should be replaced.

If the bushing is to be replaced the end of the power connecting cable should be secured outside of the vessel to prevent it falling into the vessel.

### F.1.9 Power Unit

Clean the outlet bushings with hydrocarbon solvent. Check all connection boxes, etc.  Check and report any obvious oil leaks.

#### *F.1.9.1 Power Unit Removal*

To remove a damaged power unit, the following instructions MUST be followed:

- De-energise the vessel by switching off and padlocking the circuit breaker.

- Open the blind flanges on the bushing housings of the power unit to be removed.
- Drain sufficient insulating oil from the bushing housings of the power unit to be removed so that the level is below the connection to the power unit itself.
- Remove all cabling connections to the power unit. Remove the disconnect link.
- Remove the bolts securing the power unit to the bushing housings.
- Carefully remove the power unit to avoid damage to the bushing housings and the power unit itself.
- Install blind flanges, with gaskets, to the bushing housing flanges that normally connect to the power unit.
- Re-install and bolt the top blind flanges on to the bushing housings.

Re-installation of the power unit is the reverse of the above procedure.

- Reconnect the disconnect link. Refill the bushing housings with insulating oil up to the correct level as indicated on the level gauges.
- Re-install and bolt the top blind flanges on to the bushing housings.
- Unlock the main circuit breaker and switch ON.
- Restart the Desalter in line with section 0 of this manual.

### F.1.10 LRC-II Panel

Please the See the LRC-II panel Manual for Installation and Operation Procedure which was given in the Specification for LRC II Panel document "50476-529-041-PM001-SPC-V001".

### F.1.11 All Field Junction Boxes

Check for moisture, loose connections, corrosion, etc., and take action as necessary.

### F.1.12 General Inspection

Check all valves, instruments, etc. for corrosion, erosion, and cavitation, paying particular attention to water effluent lines.

### F.1.13 Re-Use Of Components

In general, all CAMERON specialist equipment can be re-used after turn around maintenance, but particular attention should be made regarding inspection of the high pressure bushing and electrode insulators. If any black spots appear on the Teflon, the bushing should be discarded.

## Service

CAMERON will, at their own discretion and with their own personnel or via associated companies, carry out routine service calls to check on the operation of the plant.

F.1.14 Emergency Service

CAMERON engineers are available in the UK office. Contact should be made by telephone, fax or E-mail.

Purchasers should make every effort to give as complete a description of the breakdown as possible to ensure the right engineer comes to the plant. The purchaser should also ascertain the spares that are to be carried by the engineer and notify this to CAMERON when requesting emergency service.

**Spare parts**

Spare parts for the electrical Desalter are available in two categories, CAMERON spare parts and sub-vendor spare parts.

The CAMERON contact for all matters relating to spare parts is as follows:

Address: Cameron Canada Corporation
9423 Shepherd Road,
Calgary,
Alberta, T2H 2H3 Canada

F.1.15 CAMERON Spare Parts

a) High Pressure Bushings
b) Electrode Insulators

These items are normally readily available, **ex stock**. Our warehouse is located close to London's Heathrow Airport, and these items, if ordered before midday (UK time), can normally be despatched by air on the same day, weather and transport permitting.

The following items are not normally held in stack:
a) Electrode grid plates
b) LRC-II components

F.1.16 Sub-Vendor Spare Parts

These spare parts are not normally held in stock by CAMERON. Availability and price would be confirmed at the time of ordering.

**Insulating Oil Dielectric Strength Test**

To test the dielectric strength of oil, the technique as specified by the American Society for Testing Materials in the test method entitled, “Test for Dielectric Strength of Insulating Oil”, Method D-877, should be followed. A 35 kV, 2 kVA test set is available and may be purchased from the General Electric Company or Westinghouse Electric Company. The following precautions and modifications must be observed:

Set the spacing of the two 25 mm (1”) diameter, flat disk electrodes at 2.5 mm (0.10”).

Wipe the test cup and electrodes clean with dry, calendared tissues or clean, dry chamois; and thoroughly rinse with clean, lead free gasoline, standard solvent or water-white kerosene.

Fill the cup with a sample of the cleaning fluid and apply the voltage at the rate of 3 kV per second until breakdown occurs. If the breakdown voltage is less than 26 kV clean the cup again with cleaning fluid and re-test. After a satisfactory result, empty the cup immediately and rinse the test unit at once.

The temperature of the oil, when tested, should be the same as that of the room which should be between 20°C and 30°C (68°F and 86°F). Testing at oil temperatures appreciably lower than room temperature is likely to give variable results and may be misleading.

In order that representative test specimens may be obtained, the oil sample container should be gently inverted and the oil swirled several times before each filling of the test cup. The purpose is to thoroughly mix any impurities present within the oil. Too rapid an agitation is undesirable, as it introduces an excessive amount of air into the mixture. Immediately after mixing, pour the oil slowly from the container so that no air bubbles will form. Fill the cup to overflowing. Gently rock the test cup a few times and allow three minutes for entrapped air to escape from the oil before applying the voltage.

When making the test, apply the voltage at the rate of 3 kV per second. Make only one test per cup filling and fill the cup at least five times. Average the results to get the breakdown voltage for the sample.

Since the oil is the major insulation of the apparatus in which it is used, its dielectric strength must be kept up to definite standards as specified previously. If the oil fails to withstand the minimum breakdown kV specified, it is a sign that impurities, particularly moisture, have entered it. In this event the oil is no longer safe for use as an insulating medium and must be filtered to remove the impurities and bring it back to its original conditions.

**Checking High Voltage Circuits (for troubleshooting)**

Circuits that are designed to operate on high voltage will sometimes develop problems that cannot be detected with normal low voltage test equipment. Although an ohmmeter is a useful tool, it can deceive you. A conductor that is shorted with high voltage applied may appear normal with low voltage. Thus an ohmmeter would not detect this type of high voltage short circuit. An insulation tester, "Megger" is a better testing device for troubleshooting high-voltage circuits. Listed below are two methods for checking out the high-voltage diode packs on the Dual polarity® unit.

See Installation Manual for Warranty / Guarantee statements regarding the unauthorized opening of the power unit.

Contact CAMERON Engineered Services department for electrical troubleshooting and diagnostic of the power unit malfunctions, who will then contact the vendor and advise the appropriate action. Contact should be made by telephone or email.

F.1.17 Method "A" - Use of Insulation Tester "Megger"

**Step 1** Disconnect and padlock power unit circuit breaker in the "OPEN" or "OFF" position. Be certain that power is NOT reaching the power unit.

**Step 2** Remove the lid on the high voltage junction box and isolate the diode pack by disconnecting the high voltage entrance bushing leads and the power unit secondary lead.

**Step 3** Connect the "line" lead from the Megger to the diode pack input terminal (centre) and connect the "ground" lead to the positive terminal on the diode pack. Activate the Megger. It should read high as shown on reading no. 1 in the attached sketch. Move the "ground" lead from the positive terminal to the negative terminal on the diode pack. Again activate the Megger and note the reading. It should read low, as shown in reading no. 2 of the attached sketch.

**Step 4** Disconnect "line" lead of the Megger from the input terminal of the diode pack and connect the "ground" lead to the diode input terminal. Connect the "line" lead to the positive terminal on the diode pack. Activate the Megger. The reading should be low as shown in reading no. 3 of the attached sketch. Move the "line" lead from the positive terminal to the negative terminal on the diode pack. Again, activate the Megger. The reading should be high as shown in reading no. 4 of the attached sketch.

**CAUTION:** Discharge voltage from the Megger after each reading. If readings do not correspond with illustrations on attached sketch, diode package is faulty.

F.1.18 Method "B" - Use of DC Powered Ohmmeter

If a Megger is not available, an ohmmeter may be used to check out the diode pack. It must, however, be done as described below.

Step 1 Same as Method "A".

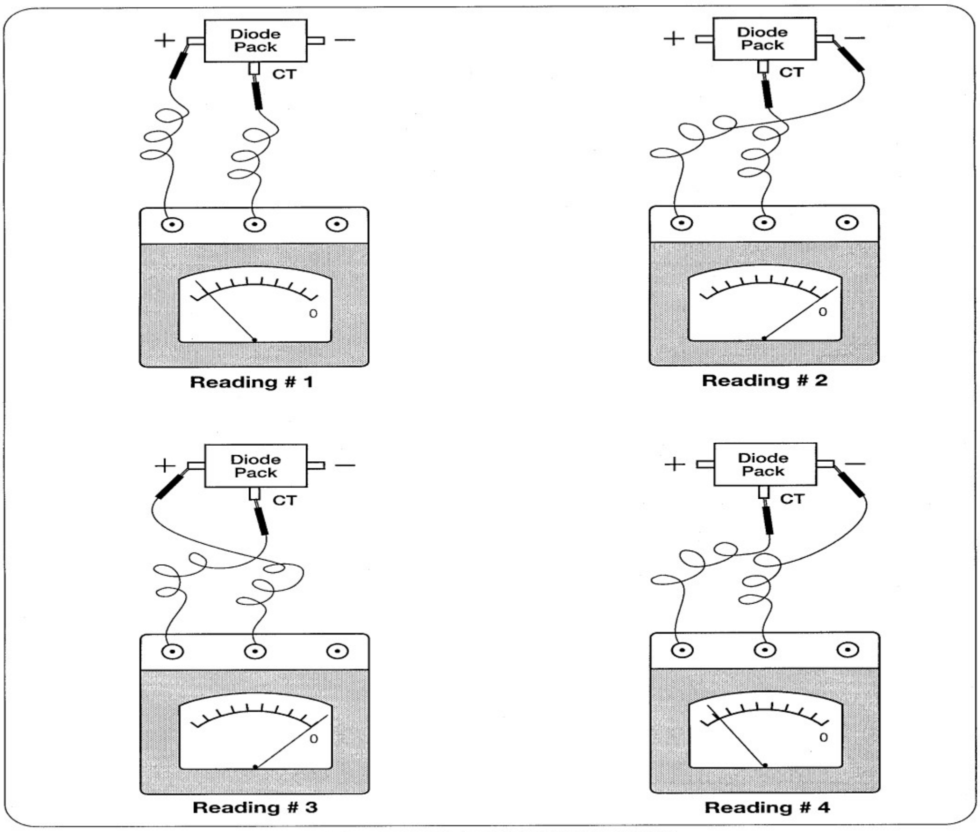
Step 2 Same Method "B".

Step 3 Set the ohmmeter to the resistance scale and place diode pack so that each "card" in the pack is accessible.

Step 4 Place one lead of the ohmmeter on the input lead to one card of the diode package and the other ohmmeter lead on the output lead of the same card. Note the reading.

Reverse the leads and again note the reading. They should be opposite - one high and one low. If not, the card or one diode on the card is defective.

Step 5 Repeat Step no. 4 for all cards. If all "cards" are good, the readings should all be relatively similar. If the reading from any card is different, the diode package is defective and should be replaced or repaired.




TYPICAL READINGS ON NORMAL DIODE SYSTEM

## G - UTILITY REQUIREMENTS

G.1.1 Electric Power (Supplied by others)

**I. Three (3) Phase Supply** (440 VAC / 3 phase / 50 HZ)

| System | Continuous Load | Peak Load | Installed |
|---|---|---|---|
| Dual Frequency Auto Transformer + DF Power Unit – 1st Stage Desalter (529-C-102) | 25 kW | 136 kVA | 1 X 136 kVA |
| Dual Frequency Auto Transformer + DF Power Unit – 2nd Stage Desalter (529-C-202) | 25 kW | 136 kVA | 1 X 136 kVA |
| Dual Frequency Auto Transformer + DF Power Unit – 1st Stage Desalter (529-C-103) | 25 kW | 136 kVA | 1 X 136 kVA |
| Dual Frequency Auto Transformer +DF Power Unit – 2nd Stage Desalter (529-C-203) | 25 kW | 136 kVA | 1 X 136 kVA |
| **Total** | 100 kW | 544 KVA | **544 KVA** |

**II. Single (1) Phase Supply (110 VAC/1 phase/50 HZ)**

| System | Continuous Load | Peak Load | Installed |
|---|---|---|---|
| LRC-II Panel Power Supply - 1st Stage Desalter (529-C-102) | 250 W | 625 VA | 1 x 625 VA |
| LRC-II Panel Power Supply - 2nd Stage Desalter (529-C-202) | 250 W | 625 VA | 1 x 625 VA |
| LRC-II Panel Power Supply - 1st Stage Desalter (529-C-103) | 250 W | 625 VA | 1 x 625 VA |
| LRC-II Panel Power Supply - 2nd Stage Desalter (529-C-203) | 250 W | 625 VA | 1 x 625 VA |

| | | | |
|---|---|---|---|
| **Total** | 1000 W | 2500 VA | **2500 VA** |

### III. 24 VDC (loop power from client ESD/ or DCS as applicable)

| Equipment | Normal (W) | Installed (W) |
|---|---|---|
| Mixing valves Positioner (4 off) | <1.0 x 4 = <4.0 | 4.0 |
| Level Switch (4 off) | <1.0 x 4 = <4.0 | 4.0 |
| **Total** | | **8.0 W** |

G.1.2 Instrument air (Supplied by others)

- Minimum Supply Pressure - 4 barg (58.02 psig)
- Maximum Supply Pressure - 8.5 barg (123.29 psig)
- Design Supply Pressure - 11.0 barg (159.55 psig)

| Equipment | Steady State (Nm$^3$/hr) | Maximum (Nm$^3$/hr) |
|---|---|---|
| Mixing valves (4 off) (Note 1) | 4 x 0.38 Nm$^3$/hr | 4 x 0.75 Nm$^3$/hr |
| **Total** | **1.52** Nm$^3$/hr | **3** Nm$^3$/hr |

G.1.3 Water

I. Wash water

Flow rate : 6% by vol of dry crude oil rate (Max.)
pH : 6-8
Dissolved $O_2$ : Less than 10 ppb
Pressure : 8.4 bar (121.84 psi)

II. Mud wash water

Flow rate : 25 m$^3$/hr – 37.5 m$^3$/hr (110 gpm-165 gpm)
Pressure : minimum 2.41 bar (35 psi) above the vessel Operating pressure.

The de-sanding frequency is once a day which is purely an initial recommendation, which can be modified during actual operation depending upon the amount of sand ingress and is applicable for individual desalter vessel

G.1.4 Chemicals

I. <u>Demulsifier Chemical</u>

Injection rate (ppmv) : 3 – 20 ppm (depends on emulsion stability)
Type : Demulsifier (Note A)
Supplier : NALCO or equivalent

Notes: -

A. Proper chemical program should be applied to determine Demulsifier type & dosage to ensure destabilization of emulsions and also for checking dehydration performance. Chemical program of applying electric field to check its performance is requested. This test shall be done by chemical supplier.

## H - <u>PERFORMANCE TESTS</u>

When operated under the design conditions specified in Section A.1.9 & A.1.10 and providing that the inlet flow rate does not fluctuate more than 5% per hour and free wax is not present, the equipment proposed will, during the performance test described below, meet the following process performance guarantee:

- The water extractable chloride salt content of the oil stream leaving the Two Stage Desalter System, as determined by ASTM D3230 modified at operating conditions will not exceed 5 / 15 / 20 PTB of water extractable chloride salts corresponds to wash water salinity with 10,000 ppm / 15,000 ppm / 25,000 ppm TDS.

- The insoluble water content (BS&W) of the oil stream leaving the proposed equipment, when measured by ASTM-D4007 at the operating temperature will not exceed 0.1 % Vol. The amount of soluble water in the sample at operating temperature will be deducted from the centrifuge test result. The remainder will be reported as the “Insoluble” water content.

- The outlet oil in water quality will be warranted not to exceed 500 ppm insoluble, non-emulsified oil in water under normal operating conditions with levels at specified set points and provided that the outlet solid content does not exceed 20 ppm solids by weight, solids content must not include iron sulfide and there must be a proper chemical treatment program including water treatment chemicals if required. Other chemicals used in the process [such as corrosion inhibitors] must not contribute to higher oil in water carryover. The vessel must be properly maintained with any collections of interface sludge, solids, or untreatable emulsion and bottom mud removed on a regular schedule. The outlet oil in water content may be exceeded during mud washing operations. Upset conditions in the operation may result in higher oil in water carryover. The analysis of the oil in water will be by ASTM-D3921with allowance for soluble and emulsified oil.

### H.1.1 Salt in Desalted Oil by ASTM D3230 Method

Please Refer ASTM D3230 document for Analysis procedure and calculation.

### H.1.2 Insoluble Water in oil (BS&W), post-electrostatic Desalter, by ASTM-D4007 Method

Please Refer ASTM-D4007 document for Analysis procedure and calculation.

H.1.3 Determination of insoluble oil in effluent water by ASTM-D3921 Method

Please Refer ASTM-D3921 for Analysis procedure and calculation.

## I - CAMERON DRAWINGS

| | | |
|---|---|---|
| 1 | Process Flow Diagram & Salt Balance sheet - Train A | 50476-529-041-PM001-DIA-V001 |
| 2 | Process Flow Diagram & Salt Balance sheet - Train B | 50476-529-041-PM001-DIA-V002 |
| 3 | P&ID First Stage Desalter Power Unit Train A | 50476-529-041-PID-V001 |
| 4 | P&ID Second Stage Desalter Power Unit Train A | 50476-529-041-PID-V002 |
| 5 | P&ID First Stage Desalter Power Unit Train B | 50476-529-041-PID-V003 |
| 6 | P&ID Second Stage Desalter Power Unit Train B | 50476-529-041-PID-V004 |

## J - FABRICATOR AND CONTRACTOR DRAWINGS

### FABRICATOR DRAWINGS

| | | |
|---|---|---|
| 1 | GA Drawing for First stage Desalter Vessel | 50476-529-041-PM001-GAD-V001 |
| 2 | GA Drawing for Second stage Desalter Vessel | 50476-529-041-PM001-GAD-V002 |
| 3 | Internal Support Detail Drawing for sand trough & grid hanger bracket - First Stage Desalter Vessels (Train A&B) - Pressure Vessels | 50476-529-041-PM001-CSD-V003 |
| 4 | Internal Support & header Detail Drawing for oil collector - First Stage - Desalter Vessels (Train A&B) - Pressure Vessels | 50476-529-041-PM001-CSD-V004 |
| 5 | Internal Support Detail Drawing for sand trough & grid hanger bracket - Second Stage Desalter Vessels ( Train & B) Pressure Vessels | 50476-529-041-PM001-CSD-V008 |
| 6 | Internal Support & header Detail Drawing for oil collector - Second Stage Desalter Vessels ( Train & B) Pressure Vessels | 50476-529-041-PM001-CSD-V009 |
| 7 | Internal Support & header Detail Drawing for Hi flow distributor - First Stage Desalter Vessels (Train A&B) PRESSURE VESSELS | 50476-529-041-PM001-CSD-V014 |
| 8 | Internal Support & header Detail Drawing for Hi flow distributor - Second Stage Desalter Vessels -PRESSURE VESSELS | 50476-529-041-PM001-CSD-V019 |
| 9 | Internal Support & header Detail Drawing for interface drain - First Stage Desalter Vessels (Train A&B) Pressure Vessels | 50476-529-041-PM001-CSD-V011 |
| 10 | Internal Support & header Detail Drawing for water collector - First Stage Desalter Vessels (Train A&B) Pressure Vessels | 50476-529-041-PM001-CSD-V012 |
| 11 | Internal Support & header Detail Drawing for sandjet inlet - First Stage Desalter Vessels (Train A&B) Pressure Vessels | 50476-529-041-PM001-CSD-V013 |
| 12 | Internal Support & header Detail Drawing for interface drain - Second Stage Desalter Vessels (Train A&B) - Pressure Vessels | 50476-529-041-PM001-CSD-V016 |

| | | |
|---|---|---|
| 13 | Internal Support & header Detail Drawing for water collector - Second Stage Desalter Vessels (Train A&B) - Pressure Vessels | 50476-529-041-PM001-CSD-V017 |
| 14 | Internal Support & header Detail Drawing for sandjet inlet - Second Stage Desalter Vessels (Train A&B) - Pressure Vessels | 50476-529-041-PM001-CSD-V018 |
| 15 | General arrangement drawing for upper bushing housing | 50476-529-041-PM001-CSD-V032 |
| 16 | General arrangement drawing for Lower EBE 1500 entrance bushing | 50476-529-041-PM001-CSD-V030 |

**CONTRACTOR DRAWINGS**

| | | |
|---|---|---|
| 1 | P&ID First Stage Desalter Train A | 50476-529-020-PID-1067.002 |
| 2 | P&ID Second Stage Desalter Train A | 50476-529-020-PID-1069.002 |
| 3 | P&ID First Stage Desalter Train B | 50476-529-020-PID-1067.004 |
| 4 | P&ID Second Stage Desalter Train B | 50476-529-020-PID-1069.004 |

**K - CAMERON REFERENCE DOCUMENTS**

| | | |
|---|---|---|
| 1 | First Stage Crude DeSalter Static Mixer-Train B | 50476-529-041-PID-1067-003 |
| 2 | Second Stage Crude DeSalter Static Mixer-Train B | 50476-529-041-PID-1069-003 |
| 3 | Utility & Chemical List | 50476-529-041-PM001-SCH-V002 |
| 4 | Datasheet for First Stage Desalter Vessel (Train A & B) | 50476-529-041-PM001-DAT-V001 |
| 5 | Datasheet for Second Stage Desalter Vessel (Train A & B) | 50476-529-041-PM001-DAT-V002 |
| 6 | Datasheet for Static Mixers-Second Stage Desalters (Train A & Train B) | 50476-529-041-PM001-DAT-V004 |
| 7 | Alarm and Trip List | 50476-529-041-PM001-LST-V002 |
| 8 | Instrument Data Sheet - Mixing Valves | 50476-529-041-PM001-DAT-V003 |
| 9 | Cause and Effect Diagram | 50476-529-041-PM001-CAE-V001 |
| 10 | Specification to LRC-II Panel | 50476-529-041-PM001-SPC-V001 |