

ENGINEERING STANDARD

FOR

PROCESS DESIGN OF CRUDE OIL ELECTROSTATIC

DESALTERS

FIRST EDITION

MAY 2015

FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS are based on internationally acceptable standards and include selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and/or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, National Petrochemical Company and National Iranian Oil Refinery And Distribution Company.

PURCHASER :

Means the "Company" where this standard is a part of direct purchaser order by the "Company", and the "Contractor" where this Standard is a part of contract document.

VENDOR AND SUPPLIER:

Refers to firm or person who will supply and/or fabricate the equipment or material.

CONTRACTOR:

Refers to the persons, firm or company whose tender has been accepted by the company.

EXECUTOR :

Executor is the party which carries out all or part of construction and/or commissioning for the project.

INSPECTOR :

The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work.

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

Is normally used in connection with the action by the "Company" rather than by a contractor, supplier or vendor.

MAY:

Is used where a provision is completely discretionary.

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0. INTRODUCTION

The crude oil produced in production unit and/or delivered to refineries for processing always contains salts in addition to other impurities. These salts occur mainly in dissolved form in the water and sometimes also in crystalline form in the crude oil. Due to the corrosive effects of the salts on metals, damage can be caused in pipelines and downstream refineries. It is therefore essential to reduce the salt and water content of the crude oil. The crude oil is primarily desalted before being delivered to refineries.

As is well known, when oil is distilled the chloride salts dissociate and as a result hydrochloric acid (HCl) is formed, causing severe corrosion effects in refinery downstream Units.

Further forms of damage which can occur with inadequate desalting are deposits and blockages in heat exchangers, furnace tubes and distillation tower bottoms. This may reduce the throughput, change the degree of fractionation and finally impair the quality of some end products.

A further function of the desalter is to remove left-over impurities such as finely divided sand particles, clays, iron oxide, drilling muds, iron sulphide, arsenic, etc., from the crude oil.

Since, as already mentioned, the salt normally occurs dissolved in water and salt crystals are found only in a few types of crude oil, the desalter has to deal both with the aqueous solution and also with any soluble salt crystals. For this purpose water is normally added to the crude oil stream, which is preheated to the required temperature.

The two are then mixed to form an emulsion in order to dissolve the salt in the added water. The degree of mixing can be controlled by means of a mixing valve. A water-clarifying chemical (demulsifier) will be added to the crude oil charge ahead of the mixing valve, the demulsifier helps reducing the amount of the oil entrained (trapped) in the water, thus reducing the amount of oil carried out of the desalter with the effluent water. After mixing, the added wash water is as completely as possible removed in the desalting drum. This can be accomplished by electrical and/or chemical means.

In the electrical desalter, the water-oil emulsion is subjected to the action of a high voltage field. This breaks down the oil film which surrounds the individual water droplets, thus making possible the combination of a number of droplets.

Because of the higher relative density (specific gravity) of the droplets thus increased in size, they drop to the bottom of the drum and are withdrawn for disposal.

Relative densities (specific gravities), surface tension, chemical impurities of contaminants in the crude oil and water, determine the size, stability and distribution of the emulsion particles. Surface-affecting media such as asphalt, resins, waxes, solid bodies, clays or organic acids, which occur in the crude oil, can act as emulsion stabilizers. The desalter must therefore be able to dissociate even the most complex emulsions.

1. SCOPE

This Standard specification covers minimum process design requirements and design considerations for electrostatic desalters.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on June. 2000. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 105 on June. 2000. These modifications are included in the present issue of IPS.

Note 2:

This is a revised version of this standard, which is issued as revision (1)-2015. Revision (0)-1995 of the said standard specification is withdrawn.

2. REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

ASTM (AMERICAN SOCIETY FOR TESTING OF MATERIALS)

ASTM D4007	"Standard Test Methods for Water & Sediment in Crude Oil by the Centrifuge Method (Laboratory Procedure)"
ASTM D3230	"Standard Test Method for Salts & Sediment in Crude Oil by the Centrifuge Method (Laboratory Procedure)"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-850	"Engineering Standard for Process Requirements of Vessels and Separators"
IPS-E-TP-700	"Engineering Standard for Thermal Insulation"

3. DEFINITIONS AND TERMINOLOGY

3.1 BS&W

Is a technical specification of certain impurities in crude oil. When extracted from an oil reservoir, the crude oil will contain some amount of water and suspended solids from the reservoir formation. In desalting process, BS&W – is being monitored in inlet and outlet of the desalter – Usually, BS&W gives total % of water present in crude oil.

3.2 Salt content

Desalters are a process unit in an oil refinery that removes salt from the crude oil. The salt is dissolved in the water in the crude oil, not in the crude oil itself. The salt content after the desalters is usually measured in PTB – (pounds of salt per thousand barrels of crude oil).

4. SYMBOLS AND ABBREVIATIONS

API	=	American Petroleum Institute
bbbl/day	=	Barrel per Day
BS&W	=	Basic Sediment and Water; Bottom Sediment and Water
CCR	=	Central Control Room
FCV	=	Flow Control Valve
FI	=	Flow Indicator
FIC	=	Flow Indicator and Controller
FRIC	=	Flow Ratio Indicator Control
lb/1000 bbl	=	Pound per Thousand Barrels (gr/m ³)
LIIC	=	Level Interface Indicator Control
LICV	=	Level Interface Control Valve
LS	=	Level Switch
PI	=	Pressure Indicator
P & ID	=	Piping and Instrumentation Diagram
ppm	=	Parts per Million
PSV	=	Pressure Safety Valve
PTB	=	Pounds of Salt per Thousand Barrels of Crude Oil
RVP	=	Reid Vapor Pressure
TDS	=	Total Dissolved Solids
TI	=	Temperature Indicator
vol%	=	Volume Percent.

5. UNITS

This standard is based on international system of units (SI), as per [IPS-E-GN-100](#) except where otherwise specified.

6. DESIGN CRITERIA

6.1 Process Requirements

6.1.1 Crude properties

The following properties have to be specified for desalter design:

ITEM	DESCRIPTION	UNIT
1	selected crude oil (PVT data, crude assay, composition)
2	gravity	API
3	BS & W,	vol%
4	salt content	lb/1000 bbl or (gr/m ³)
5	viscosity at three temperatures,	cSt
6	sulfur content	mass %;
7	pour point,	°C
8	RVP	Psia(Kpa)
9	delivery pressure (at inlet of the mixing valve),	kPa or bar (gage)
10	temperature	°C

6.1.2 Wash/Dilution water properties

Water to refinery desalter can be supplied from sour water stripper. Vendor shall confirm suitability of wash/dilution water and recommend any change if necessary. Vendor shall specify the required water rate. Other wash/dilution water sources may also be specified. The following characteristics shall be specified for all specified types of water.

- H₂S** (mg/kg)
- NH₃** (mg/kg)
- CN** (mg/kg)
- Phenols** (mg/kg)
- Thiocyanides** (mg/kg)
- Free oil** (mg/kg)
- Ca⁺⁺** (mg/kg as CaCO₃)
- Mg⁺⁺** (mg/kg as CaCO₃)
- Na⁺** (mg/kg as CaCO₃)
- K⁺** (mg/kg as CaCO₃)
- HCO₃** (mg/kg as CaCO₃)
- SO₄** (mg/kg as CaCO₃)
- Cl** (mg/kg as CaCO₃)
- NO₃** (mg/kg as CaCO₃)
- Free O₂** (mg/kg)
- SiO₂** (mg/kg)
- TDS** (mg/kg)
- Iron** (mg/kg)
- pH**

The expected water temperature at the tie in point has to be specified by the Company.

Typical wash water injection rates are between 3-7 (vol % of crude).

Injection point should be ahead of the mixing valve and /or ahead of heat exchanger train (not fired heater).

6.1.3 Operating and mechanical design conditions

The following conditions shall be specified:

6.1.3.1 Operating pressure of the desalter (minimum pressure must be sufficient to maintain desalter content in liquid phase).

6.1.3.2 Operating temperature at the inlet of the desalter (range may be specified).

6.1.3.3 Allowable pressure drop for the desalter (including the mixing valve).

6.1.3.4 Design flow rate of crude oil (bbl/d).

6.1.3.5 Maximum anticipated system pressure and temperature.

6.2 Performance Requirements

The desalter shall produce a treated crude, under steady state conditions, which conforms to the following requirements:

6.2.1 Specified design throughput (bbl/d).

6.2.2 The desalted crude salt content shall be specified by the Company.

6.2.3 Desalter shall be able to perform its duty with specified water types.

6.3 Instrumentation and Control System

Independent of safety devices like safety valves, the instrumentation and control system shall protect all items of the system against maloperation by operators, equipment failure, etc., but also enable the operators to undertake suitable actions during operation. A typical Piping and Instrumentation Diagram (P & ID) for a desalter is also shown in Appendix B.

Vendor shall submit the proposed instrument and control schematic drawings, adequate to fulfill the requirements of his process and mechanical guarantees for Company's approval. All instrumentation shall be suitable for continuous working in the conditions of their location.

Provision shall be made for local tripping of critical equipment. The desalter Supplier shall be responsible for the satisfactory design and operating capability of the instruments, controls and safety equipment associated with the desalter and he shall submit details to the Company for approval.

The type of valves/control valves shall be selected according to the service. Special valves shall be used where cavitation, noise, flashing or erosion may occur. All shut-down systems shall be capable of full function testing from primary sensor up to final actuation device while the plant is on line. Test key-operated override switches shall be provided for this function. These shall override the minimum number of function components. Alarms shall be provided to show automatically when the trip circuit is being overridden for test. All override test facilities shall be mechanically protected and shall be accessible only to the personnel authorized to carry out testing.

Instrumentation shall include but not limited to the following:

- Vapor alarm and Trip switch
- Bushing alarm and Trip switch
- Water/Crude mix valve
- Sight flow indicators (supplied by other).

- Crude/Water interface level transmitter/controller
- Level transmitter
- Pressure tap
- Temperature tap
- Pressure safety valve
- Process water flow indicator
- Process water flow controller
- PH meter

The items listed below are regarded as the minimum required instrumentation/control components of the electrostatic desalting system.

6.3.1 Mixing valve

The desalter shall be furnished with a suitably sized valve in the crude oil entrance line. A local differential pressure indicator, connected to the upstream and downstream sides of the mixing valve, shall be provided for reading of the adjusted pressure drop. Pressure drop across the mixing valve shall also be monitored in CCR. This valve shall be operated automatically and be equipped with a manual hand wheel for dispersion of process water into the crude oil. This mixing shall be accomplished with a minimum pressure drop for creating a water-in-oil emulsion.

6.3.2 Level interface controller (LIC)

Level interface controller shall receive measurement information from the level interface transmitter. The transmitter shall be connected to the displacer at the water/oil interface. The controller uses this measurement information to control the action of the level interface control valve and is provided with high and low level interface alarms. This control valve shall maintain the vessel's water-oil interface at the desired level.

6.3.3 Level interface indicator controller (LIIC)

This control valve shall be installed in the vessels effluent water line to control the flow rate of water leaving the vessel.

6.3.4 Pressure indicator (PI)

Pressure indicator (local/remote) shall be furnished to show the operating pressure of the vessel.

6.3.5 Temperature indicator (TI)

Temperature indicator (local/remote) shall be furnished to show the operating temperature of vessel.

6.3.6 Level switch (LS)

A level switch shall be provided for the purpose of switching off the power in case the vessel is not completely full of liquid (cut-off and alarm). In no case the power must be applied on the desalter if vessel is not totally filled with liquid.

6.3.7 Pressure safety valve (PSV)

Pressure safety valve(s) shall protect desalter in case of eventual overpressure in the system.

6.3.8 Wash/Dilution water flow indicator (FI)

This instrument shows the flow rate of the process water (local and in CCR).

6.3.9 Wash/Dilution water flow controller (FC)

This controller receives the measurement information from the wash/dilution water flow and oil flow transmitter. The amount of water shall be determined based on oil flow via a ratio controller.

6.3.10 Wash/Dilution water flow control valve (FCV)

This control valve shall be installed in the wash/dilution water line.

6.3.11 High high level switch for interface level (LSIHH)

A level switch should be provided for the purpose of switching off the power of all transformers in case the interface level reached to high high set point.

6.3.12 Low low level switch for the interface level (LSILL)

A level switch shall be provided for closing the level control valve when the interface level reaches to low low level set point.

6.4 Local Control Panel

A local control panel shall be provided as a point for engaging or disengaging the electrical supply that energizes the desalter transformers.

6.5 Chemical Injection System

The injection facility of controlled addition for demulsifier chemical shall be provided (pump, tank, measuring column, etc.). Vendor shall advise the required injection rate of the demulsifier chemical. The pressure at the injection point of the demulsifying chemical shall be specified.

6.5.1 The demulsifiers are added to crude oil to be desalted to counter the effects of emulsions within the crude. To be effective the demulsifier must be distributed uniformly throughout the crude oil.

For a successful chemical treatment it is important to choose the proper demulsifier type via relevant tests and to add it in sufficient quantity at the right point of the system.

6.5.2 Caustic injection

Some crude oils contain traces of inorganic acid from acidizing operations in the field, along with H₂S and naphthenic acids. If tests for pH reveal that the effluent water from the desalter is corrosive, a small amount of caustic should be added to the desalter makeup water. Caustic must be added cautiously, because crudes containing high values of organic acidity (naphthenic acid) can react with the caustic to produce naphthenic soaps that are emulsion stabilizers. These soaps may prevent adequate water and oil separation.

6.5.3 Wash water pH adjustment

It is sometimes necessary to adjust the pH of the brine to obtain pH values of 7.0 or less in the water. If the pH of the brine exceeds 7.0, emulsions can be formed because of the sodium naphthenate and sodium sulfide present. For most crude oils it is desirable to keep the pH below 8.0.

Better dehydration is obtained in the pH range of 6.0 to 8.0 with the best dehydration obtained at a pH near 6.0.

6.6 Mud Washing System

An on-stream mud washing system shall be provided in the water phase of the desalter system to prevent the accumulation of undissolved solids at the bottom of the vessel.

The mud washing system shall incorporate solids removal piping that extend through the length of the settling zone near the bottom of the vessel.

A connection from wash water pump be routed into the solids removal piping.

Water from the nozzles stirs up solids at the bottom of the vessel, so the solids can be carried out with the effluent water.

6.7 Vent Line

The vent line shall be opened to a visible sewer so an operator can determine when the vessel is liquid full. If the desalter is to be shut down, the vent line must be opened to relieve the vacuum inside the vessel as the vessel is pumped out.

6.8 Steam-out Connection

A permanent steam-out connection shall be provided.

6.9 Sample Connections

Adequate sample connections shall be provided. The Company may select install additional sampling lines and to route all lines to a central collection box. Sample coolers may be required at the collection point. If sample coolers are to be installed, one cooler should serve the desalted crude sampling line and another should serve the remaining sampling lines. The use of two coolers helps to prevent contamination of the desalted crude sample.

6.10 Other design consideration

6.10.1 The desalter shall be supplied as a complete package and shall include but not be limited to the following:

- Internal headers.
- Internal crude oil & water distributors.
- Sludge wash headers (on-stream mud washing system).
- Internal stilling well for internal level float.
- All necessary nozzles and man ways.
- Any other nozzle connections if required.
- Ladder and platform.
- At least two support saddles.
- External clips for insulation & platforms.
- Electrode assembly.
- Internal clips for electrodes.
- Support frame and electrode insulator assembly.
- High voltage assembly.

- High pressure bushing assembly and entrance bushings.
- Power unit.
- Chemical injection connection.
- Local control panel.
- Lifting lug.
- External insulation.
- Internal coating.

6.10.2 Each electrostatic desalter shall be equipped with two or three transformer . it shall function adequately in case of loss one of the transformer.

6.10.3 In case when more than one stage is specified, facilities for series and parallel flow should be provided.

7. PROCESS GUARANTEE

Vendor shall guarantee the followings:

- 1) Desalter capacity under the specified operating conditions.
- 2) Equipment and accessories are of sufficient size to fulfill satisfactorily the specified operating conditions.
- 3) Desalter shall be able to perform its duty with either of the specified types of wash water.
- 4) Specified desalted crude salt content and BS&W content.

8. TESTING

Within 30 days after the plant has been placed into operation, Company may subject it to such tests as are necessary to demonstrate a 72 hours performance test to demonstrate that the plant will meet the process guarantees. These tests may be witnessed during this period by Company and Vendor's representative.

If during these tests the equipment fails to meet the specifications, the Vendor shall take the necessary steps at his expence, to make the equipment meet guaranteed performance.

Vendor shall propose the test methods by which operating results shall be measured. These methods are subject to Company's approval.

9. DOCUMENTATION

The minimum documents which shall be provided by vendor are:

- 1) At quotation stage Suppliers shall provide the following in the numbers requested at the time of quotation:
 - a) Comprehensive descriptive literature.
 - b) List of recommended commissioning spares with prices.
 - c) Details of any special tools required.
- 2) At ordering stage Suppliers shall provide the following in quantities and at times as detailed in the order:
 - a) List of recommended spares for two years continuous operation.
 - b) Illustrated comprehensive spare parts manual with part numbers suitable for warehouse stocking.
 - c) Illustrated installation and operating instructions, e.g.,
 - Desalter general drawing
 - Desalter vessel fabrication drawing
 - Desalter vessel internals drawing

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- Desalter vessel external attachments drawings
 - Desalter vessel internal electrode parts drawings
 - Schematic control diagram
 - Instruments data sheets
 - Control panel wiring diagram
 - Data sheet of chemical feed system
 - Other relevant data sheets/diagrams/drawings manuals, P&ID, pfd, ...

d) Maintenance manuals.

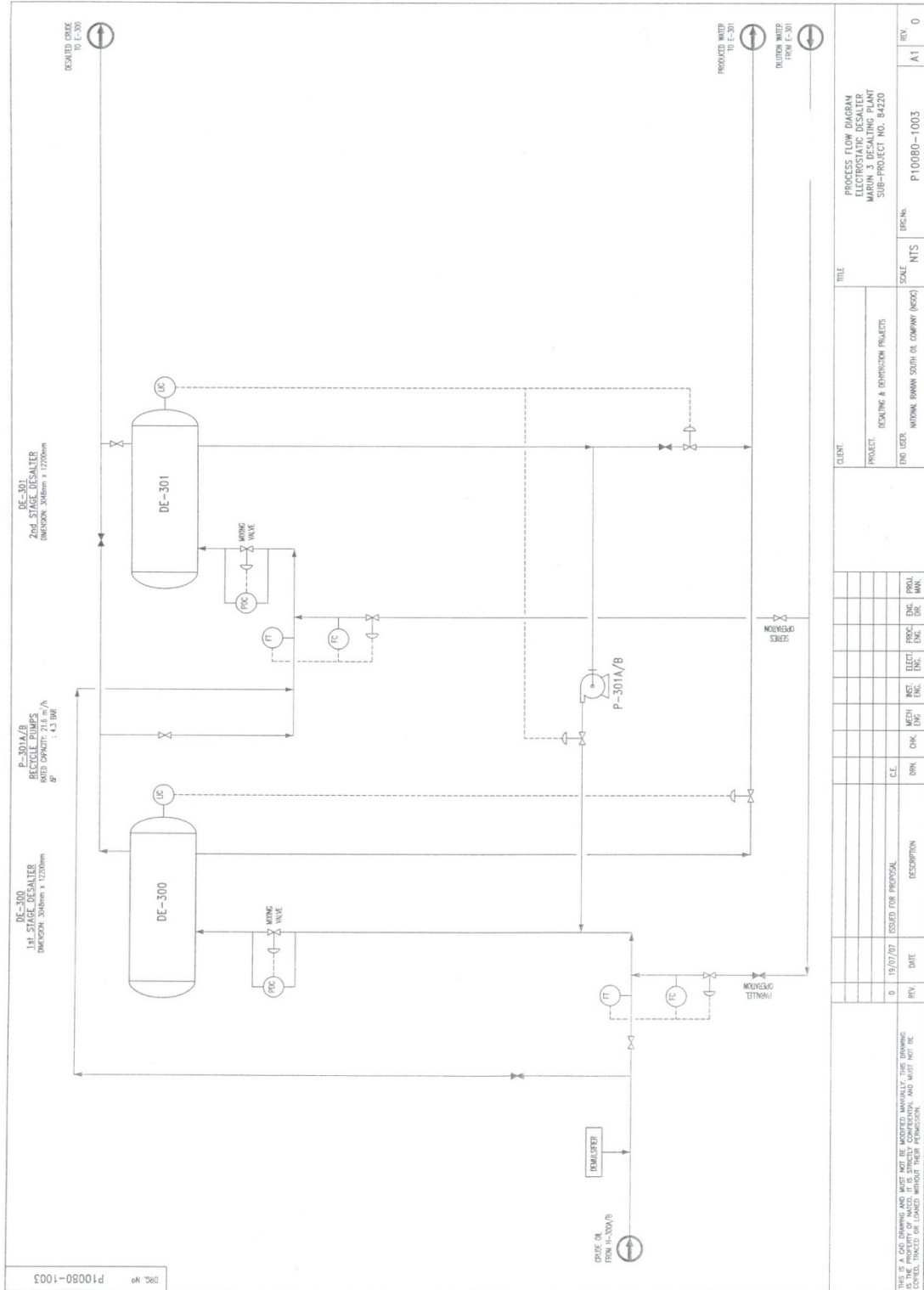
10. PACKING AND SHIPPING

Equipment shall be carefully protected and packed to provide adequate protection during transit to destination and shall be in accordance with any special provision contained in the specification or order. Special attention shall be given to protection against corrosion during transit. All bright and machined parts must be painted with a rust preventative. Ancillary items forming an integral part of the equipment should be packed preferably in a separate container if the equipment is normally cased or crated. Alternatively the ancillary items should be fixed securely to the equipment and adequate precaution taken to ensure that the items do not come loose in transit or be otherwise damaged. Instruments having delicate movements and assembled into panels for inspection and test shall be replaced in makers special shock absorbing packages for transit, all connections being marked for remounting in IRAN. Such instruments shall be packed in same case as associated panel, but protected by a bulkhead or equivalent packing arrangement.

APPENDICES

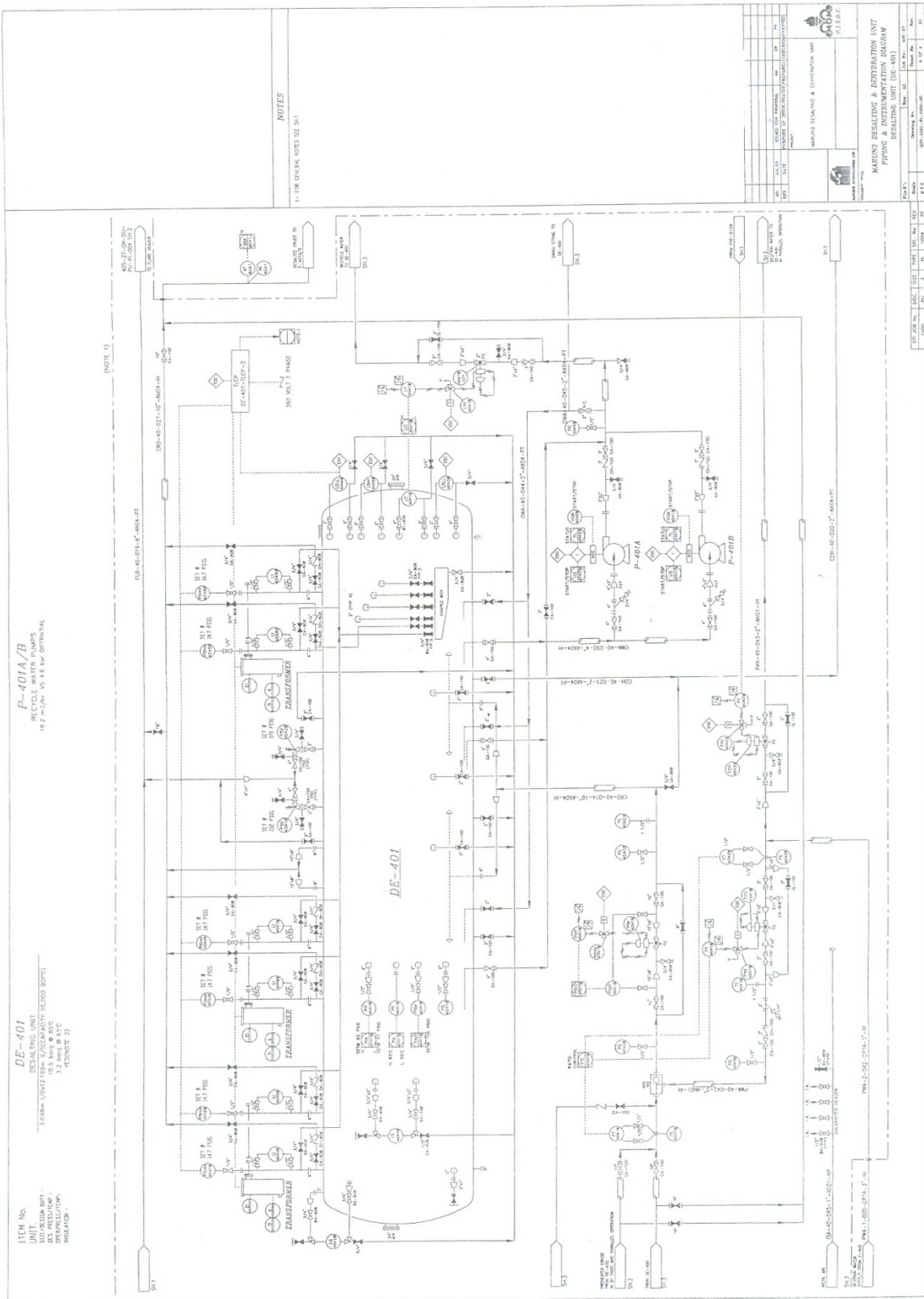
APPENDIX A

TYPICAL PIPING AND INSTRUMENTATION DIAGRAM



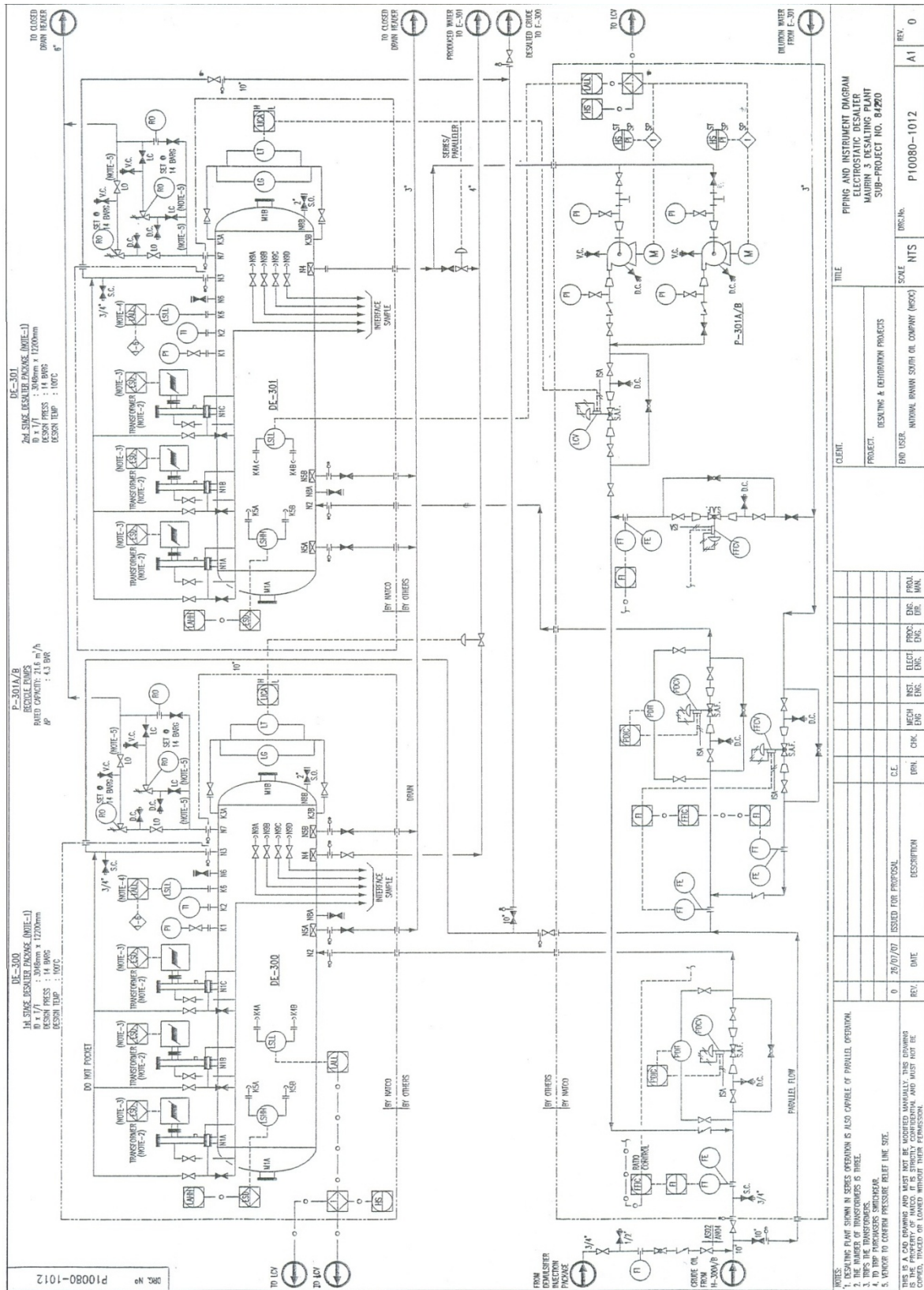
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APPENDIX A (continued)



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APPENDIX A (continued)



NOTES:
 1. DESALTING PLANT SHOWN IN SERIES OPERATION IS ALSO CAPABLE OF PARALLEL OPERATION.
 2. THE NUMBER OF TRANSFORMERS IS THREE.
 3. TRIPS THE TRANSFORMERS.
 4. VALVE TO CONTROL PRESSURE, RESET THE SIZE.
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