

ENGINEERING STANDARD
FOR
PLANT OPERATING MANUALS

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0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Required for the Project Design and Engineering" is intended for convenience of use and a pattern of follow-up and also a guidance.

These Standard Engineering Practice Manuals, also indicate the check points to be considered by the process engineers for assurance of fulfillment of prerequisites at any stage in the implementation of process plant projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every process project, but they reflect the stages that exist in general in process projects of oil, gas and petrochemical industries of Iran.

These preparation stages describe the following three main phases which can be distinguished in every project & include, but not be limited to:

Phase I) Feasibility Studies, Process Evaluation and the Basic Design Stages (Containing Nine Standards)

Phase II) Detailed Design, Engineering and Procurement Stages (Containing Three Standards)

Phase III) Start-Up Sequence and General Commissioning Procedures (Containing Two Standards)

The process engineering standards of this group include the following 16 Standards:

STANDARD CODE

STANDARD TITLE

I) Manuals of Phase I (Numbers 1 - 9)

| | |
|--------------|---|
| IPS-E-PR-130 | "Process Evaluation and Selection" |
| IPS-E-PR-140 | "Execution of Basic Design" |
| IPS-E-PR-150 | "Basic Design Package & Recommended Practice for Feasibility Study" |
| IPS-E-PR-170 | "Process Flow Diagram" |
| IPS-E-PR-190 | "Layout and Spacing" |
| IPS-E-PR-200 | "Basic Engineering Design Data" |
| IPS-E-PR-220 | "Process Control" |
| IPS-E-PR-230 | "Piping & Instrument Diagrams (P&IDs)" |
| IPS-E-PR-250 | "Performance Guarantee" |

II) Manuals of Phase II (Numbers 10 - 12)

| | |
|--------------|--|
| IPS-E-PR-260 | "Detailed Design, Engineering and Procurement" |
| IPS-E-PR-300 | "Plant Technical and Equipment Manuals (Engineering Dossiers)" |
| IPS-E-PR-308 | "Numbering System" |

III) Manuals of Phase III (Numbers 13 - 14)

| | |
|--------------|--|
| IPS-E-PR-280 | "Start-up Sequence and General Commissioning Procedures" |
| IPS-E-PR-290 | "Plant Operating Manuals" |

This Engineering Standard Specification covers:

" PLANT OPERATING MANUALS "

1. SCOPE

This Engineering Standard covers the minimum requirements of format, in preparing process and/or utility units operating manuals, including essential instructions and points of noteworthy.

The purpose of this Manual is to standardize the content and format of operating manuals which shall be prepared by the Contractor. Although operating manuals differ to some extent from process to process, the basic philosophy and general aspects shall conform to the concepts of this Standard.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor / Consultant.

IPS (IRANIAN PETROLEUM STANDARDS)

| | |
|----------|---|
| E-PR-170 | "Process Flow Diagram" |
| E-PR-260 | "Detailed Design, Engineering and Procurement" |
| E-PR-725 | "Process Design of Plant Waste Water Sewer Systems" |

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

| | |
|---------------|---|
| 6708-1980 (E) | "Pipe Component Definition of Nominal Size", 1st. Ed., 1980 |
|---------------|---|

3. DEFINITIONS AND TERMINOLOGY

- **"Company or "Employer"/"Owner"**: Refers to one of the related affiliated companies of the petroleum industries of Iran such as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), etc., as parts of the Ministry of Petroleum.
- **"Contractor"**: Refers to the persons, firm or company whose tender has been accepted by the "Employer", and includes the contractor's personnel representative, successors and permitted assigns.
- **"Project"**: Refers to the equipment, machinery and materials to be procured by the "Contractor" and the works and/or all activities to be performed and rendered by the "Contractor" in accordance with the terms and conditions of the contract documents.
- **"Unit" or "Units"**: Refer to one or all process, offsite and/ or utility units and facilities as applicable to form a complete operable refinery/and or plant.

4. SYMBOLS AND ABBREVIATIONS

| Symbol/Abbreviation | Description |
|---------------------|------------------------------|
| API | American Petroleum Institute |
| BFW | Boiler Feed Water |

| | |
|------------|--|
| BhP | Break horsepower |
| BkW | Break kilowatt |
| BPSD | Barrel Per Stream Day (bbl/sd) |
| Cond | Condensate |
| DN | Diameter Nominal, (mm) |
| FBP | Final Boiling Point |
| GN | General |
| h | hour |
| HP | High Pressure |
| IBP | Initial Boiling Point |
| kg | kilogram |
| kJ | kilojoule |
| kW | kilowatt |
| L | Liquid |
| LHV | Low Heating Value |
| LLP | Low Low Pressure |
| LP | Low Pressure |
| NPS | Nominal Pipe Size, (inch) |
| Mass (ppm) | Mass parts per million, (mg/kg) |
| MW | Molecular mass (weight) |
| PFD | Process Flow Diagram |
| P & IDs | Piping & Instrument Diagrams |
| PONA | Paraffinic, Olefinic, Naphthenic, and Aromatic |
| RVP | Reid Vapor Pressure |
| s | second |
| sd | stream day |
| Sp Gr | Specific Gravity (Relative Mass Density) |
| UOP K | Universal Oil Products Factor |
| V | Vapor |
| vol | Volume |
| wt | Weight (mass). |

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise is specified.

6. FORMAT

6.1 General

In principle, a separate operating manual shall be prepared for each process and/or utility unit. However, in the case of short volumes, operating manuals for two or maximum three units can be integrated into one book upon approval of the Company. The compiled operating manuals should consist of related units, where possible.

6.2 Covers and Size

The format of operating manuals shall essentially conform to the following requirements:

6.2.1 Size of covers:

225 mm (Width) × 300 mm (Length) - bound on 300 mm side.

6.2.2 Size and type of bottom covers:

- a) Size : Free thickness, up to 70 mm maximum
- b) Type : Integral types with covers

6.2.3 Color of front and bottom covers: Dark blue without window.

6.2.4 Color of title on front and bottom covers: Golden.

6.2.5 Form of title character: Helvetica light.

6.2.6 Printing of character: Leaf stamping.

6.2.7 Size of papers shall be A4 - size (210 mm × 297 mm).

6.3 Titles

6.3.1 The manual shall be named as:

" Operating Manual"

6.3.2 The titles on the front cover shall include:

- a) Company name.
- b) Refinery/Factory name.
- c) Printing of "Operating Manual".
- d) Plant or unit name.
- e) Plant or unit number.
- f) Contractor (s) name and Logo.
- g) Contract number.
- h) Date, it shall be referred to the month and year of the plant commissioning date.

6.3.3 A typical arrangement of the front cover titles is illustrated in Appendix A.

6.3.4 The titles on the bottom cover shall include all requirements as outlined in 6.3.2 above. Appendix B presents a typical arrangements of the bottom cover titles.

6.4 Dividers

Dividers should be provided to separate each chapter with appropriate designations of the concerned subject.

7. BASIC CONSIDERATIONS IN PREPARING OPERATING MANUALS

7.1 Non-licensed Processes

7.1.1 Purpose

The purpose of an operating manual, is not only to help the operation engineers and staff at the customer side to operate the plant safely, but also to present all detailed procedures for the plant start-up and shut down in the various operation cases.

7.1.2 Extent of description

7.1.2.1 Operating manuals should contain all operating procedures, guidances, hints, cautions and trouble shooting guides necessary for plant safe and correct operation.

7.1.2.2 The detailed operation procedures should also include the sequence of valve operation, time schedule, etc.

7.1.2.3 The Contractor should carefully study the past history of troubles experienced and countermeasures, employed in similar processes and provide the latest instructions.

7.1.2.4 Abnormal levels of operating variables (temperature, pressure, flow rate, fluid level in vessel, etc.) together with appropriate countermeasures should be listed in the operating manual as far as possible to avoid similar troubles.

7.1.3 Final check of basic design

7.1.3.1 Operating manual, should be checked carefully against basic design latest revision.

7.1.3.2 The operation philosophy which was prepared at the early stages of the basic design shall be reviewed.

7.1.3.3 The necessary facilities, equipment, instruments and lines, etc., for each operation mode (namely start-up, normal shut down, emergency, regeneration, maintenance, etc.) must be taken into consideration.

7.2 Licensed Processes

7.2.1 Detail designer shall prepare an operating manual for the Licensed Unit in accordance with the conditions stipulated in this Standard for non-licensed Units and based on the contents of operating manual furnished by the Licensor. All modifications/changes resulted from the detailed engineering activities should be reflected in the final revision of the operating manuals.

7.2.2 Before making any unavoidable modifications/changes by the Contractor, it is necessary to obtain the approval of the process licensor.

8. CONTENTS OF OPERATING MANUAL

8.1 In order to standardize the quality of the operating manual, the chapters which shall be included in the operating manual, are listed in Appendix C.

8.2 Some of the items specified in Appendix C may be modified and/or changed depending upon the particular process and shall be approved by the Company.

9. NOTEWORTHY POINTS

9.1 General

9.1.1 Generally, the necessary documents providing a guide to operation comprise:

- a) Operating manual.
- b) Analytical manual.
- c) Vendor's instruction manuals.

Vendor's Instruction Manuals have priority over the operating manual prepared by the Contractor in order to place the responsibility for maloperation on the Vendors.

9.1.2 The following figures and tables to be inserted in the operating manual for the operator's convenience and easy comprehension.

a) Figures:

- (i) Trip sequence (flow) diagram.
- (ii) Simplified flow scheme of plant heat-up.
- (iii) Simplified flow scheme of catalyst reduction, activation, oxidation and regeneration (generally, for Licensed Units).
- (iv) Simplified flow scheme of feed cut-in, shut-down and other operation modes.
- (v) Furnace drying curve.
- (vi) Other charts as needed.

b) Tables:

- (i) Pressure relief valves load summary tables.
- (ii) Setting point list for instruments (especially alarm and trip elements).
- (iii) Analytical schedule.
- (iv) Utility summary tables.
- (v) Heat and material balance tables.

9.2 Chapter II (Design Basis)*

9.2.1 Sections A, B, C

9.2.1.1 Type and source of feed and unit different operating modes to be specified.

9.2.1.2 The characteristics of feed, products and by-products (if necessary) shall be specified. The typical feed and product characteristics for refinery are presented in Appendix D.

* For Chapter I "Introduction" see Appendix C.

9.2.2 Section D

Utility conditions shall cover operating pressure and temperature as well as application of each type for all utilities concerned in the plant.

9.2.3 Section E

9.2.3.1 Heat and Material Balance Tables including the following characteristics of each stream as marked on the relevant process flow diagram to be covered in this section.

A typical refinery Heat and Material Balance Table is demonstrated in Appendix E.

9.2.3.2 Enthalpy basis (datum level) for all fluids to be identified. Computer program used for preparation of Heat and Material Balance Tables shall also be clarified.

9.2.4 Section F

Utility Summary Tables shall cover the following requirements (where applicable) as shown below typical tables (are presented in Appendix F):

- Item number.
- Service.
- Load BkW (BhP), kW.
- Electrical power, kW.
- Steam, 1000 kg/h.
 - HP steam, pressure in, bar (ga).
 - MP steam, pressure in, bar (ga).
 - LP steam, pressure in, bar (ga).
 - LLP steam, pressure in, bar (ga).
- Condensate, 1000 kg/h
 - Cold Cond., Pressure in, bar (ga).
 - HP hot Cond., Pressure in, bar (ga).
 - LP hot Cond., Pressure in, bar (ga).
 - LLP hot Cond., Pressure in, bar (ga).
- BFW, 1000 kg/h
- Pure demineralized water, 1000 kg/h.
- Loss (steam, condensate, BFW, ...), 1000 kg/h.
- Cooling water.
 - Tempered water, m³/h.
 - Fresh water, m³/h.
 - Temperature rise, °C.
- Fuel (LHV)
 - Oil, 1000 kJ/s.
 - Gas, 1000 kJ/s.

- Nitrogen, Nm³/h.
- Air, Nm³/h.
- Instrument
- Plant.
- Plant water, m³/h.
- Potable water, m³/h.
- Inert gas, Nm³/h.
- Natural gas, Nm³/h.

Utility Summary Tables shall be provided separately for summer and winter operating cases when the unit is operated under design flow rate. Additional cases may be included upon the Company's request.

9.2.5 Section G

9.2.5.1 Effluent summary shall cover all unit effluents except those streams considered as the unit products/by-products as presented in section C.

9.2.5.2 The effluent summary shall include the following streams where applicable:

- Sour water.
- Oily water.
- Spent caustic solution.
- Chemical sewer.
- All other disposed liquid and solid wastes.

9.2.5.3 The following characteristics for each effluent shall be specified.

- Quantity, kg/h and/or m³/h.
- Impurities such as H₂S, NH₃, Oil, Cl⁻, Na⁺, etc. in mass ppm (wt), (mg/kg)
- Sources including all equipment involved.
- Destinations such as oily water sewer, non oily water sewer, chemical sewer, etc.

Note:

All waste items disposed to environment shall comply to IPS-E-PR-725.

9.3 Chapter III (Process Description)

9.3.1 Section A

The following requirements shall be included under the "Nature of Process".

- Introduction.
- Chemistry of the process.
- Typical reactions.
- Reaction rates and heats of reaction.

9.3.2 Section B

Detailed line up of the process flow separately for each section of the unit to be provided.

9.4 Chapter IV (Operating Variables and Controls)

9.4.1 Section A

This section embodies the main process features and is prepared to help the plant operators overcome troubles not mentioned in the next chapters (start-up and shut-down procedures). Any operating variable such as pressure, temperature, chemical additions, feedstock properties, hydrogen to hydrocarbon ratio (if any), and etc. which has a significant effect on the unit operation and main product specifications shall be mentioned.

9.4.2 Section B

Any significant differences in product quality and/or unit operation resulting from any changes of operating variables shall be elaborated in this section.

9.4.3 Section C

Special attention should be paid to specify all the possible troubleshootings which the unit operators may face during the operation. The causes of and preventative actions for any troubleshooting shall be clearly demonstrated.

9.5 Chapter V (Auxiliary Systems)

The following sections shall be included with full operation description and useful operating guidelines where applicable:

- A) Tempered water system.
- B) The ram pump.
- C) The flushing oil circuit.
- D) Soot blowers.
- E) Fuel oil and fuel gas systems.
- F) Chemical injection systems.
- G) Chloride and/or condensate injection to the reactor system.
- H) Any other auxiliary system as applicable.

9.6 Chapter VI (Equipment Operation)

The detailed start-up, operation and inspection prior to operation for all main equipment as well as packaged units to be outlined in this section. Reference to the operating and maintenance instructions prepared by the equipment manufacturer for each item shall be given. Main operating points, all useful operation guidelines and description of all equipment accessories shall also be pointed out. Compressor auxiliary systems such as lube oil, seal oil, tempered water, etc. and fired heater burners, forced draft and induced draft fans operations should be explained in detail and all troubleshootings which may occur during operation of such systems to be described.

9.7 Chapter VII (Instrumentation and Control)

9.7.1 Simplified logic diagrams for the major equipment with step-wise operation guide-line to be given.

9.7.2 Main features of the advanced control systems and optimization to be specified where applicable. Reference to the relevant specifications shall be made.

9.7.3 Set points of all alarms and shut down switches shall be listed.

9.8 Chapters VIII-X (Start-Up and Shut-Down)

9.8.1 Several operating activities shall be conducted at the same time during the start-up and shut-down period. So, all such activities which shall be performed in parallel for a safe and reliable start-up and shut-down operation should be described.

9.8.2 Special attention shall be made to the Vendor's or Licensor's instruction manuals and the operating manual shall be reviewed carefully to be in congruent with the Vendor's or Licensor's instructions.

9.8.3 All start-up and shut-down procedures shall be prepared in detailed step-wise activities which will be performed by the operators with simplified start-up/shut-down sketches.

9.9 Chapter XI (Emergency Shut-Down Procedure)

9.9.1 Safeguarding systems and equipment provided to protect the plant during emergency cases shall be elaborated in section B.

9.9.2 The following data to be specified (a typical arrangement of pressure relief valves load summary table is demonstrated in Appendix G).

- Item number.
- P&I number.
- Protected equipment.
- Size and type.
- Set, bar (ga) or kPa (ga).
- Discharge to.
- Cooling water failure.
- MW.
- kg/h.
- °C.
- Fire.
- V or - L
- MW - kg/m³ at flowing conditions.
- kg/h - m³/h at flowing conditions.
- °C -°C.
- Area.
- General electrical power failure.
- MW.
- kg/h.

- °C.
- Other causes.
- V or - L
- MW - kg/m³ at flowing conditions.
- kg/h - m³/h at flowing conditions.
- °C - °C
- Cause
- Notes.

9.9.3 Since measures to be considered in an emergency vary according to the type, degree and duration of the emergency encountered, the operation supervisor dispatched by the Contractor (or chief operation engineers) shall be responsible for determining measures to be taken into account. This should be emphasized in the operating manual.

9.9.4 Steps to be taken in each emergency case shall be outlined in full description such that to help operators to recognize and act upon immediately.

Since, hard and fast rules cannot be made to cover all situations which may arise, examples of some typical emergencies are taken up in this chapter. Generally, a double failure or multiple failure cannot be discussed because of its complexity, though it often occurs in an actual emergency.

9.10 Chapter XII (Miscellaneous Procedures)

9.10.1 Miscellaneous procedures called by the nature of unit process and/or special equipment operation not included in the other chapters shall be covered as required.

9.11 Chapter XIII (Safety)

Safety instructions issued by the competent local authorities shall take precedence over this chapter.

9.12 Chapter XIV (Analytical Tests)

The analytical plan shall comprise the following requirements:

- Stream name.
- Test name.
- Test number (Analytical methods).
- Sampling point.
- Normal sampling frequency.
- Start-up sampling frequency.

Detailed analytical procedures shall be prepared separately in the form of Analytical Manual.

9.13 Chapter XV (Catalysts, Chemicals, and Packings)

Summary of catalysts, chemicals and packings requirements comprising of the following information shall be tabulated.

- Description of the catalyst/chemical/packing.
- Manufacturer name and type.

- Quantity required for initial charge, m³ or kg.
- Vessel number/where used.
- Vessel name.
- Estimated consumption rate [daily (d) and /or yearly (y)], m³ or kg.

9.14 Chapter XVI (Drawings)

9.14.1 An equipment item index shall be provided to show at least the following requirements in section A for the operator's easy reference:

- Equipment category (e.g., tower, vessel, heat exchanger, pumps, compressors, etc.).
- Equipment number.
- Equipment service name.
- Quantity.
- Referenced P & IDs.

9.14.2 A project general legend diagram (if any) shall be inserted in this section.

APPENDICES**APPENDIX A
TYPICAL FRONT COVER TITLE**

Islamic Republic of Iran

Ministry of Petroleum

NATIONAL IRANIAN OIL COMPANY

ESFAHAN REFINERY

OPERATING MANUAL

NITROGEN PLANT

PLANT 11



FLUOR-THYSSEN JOINT VENTURE

THYSSEN RHEINSTAUL TECHNIK GmbH

FLUOR ATLANTIC LTD.

CONTRACT 4573

AUGUST 1977

APPENDIX B

TYPICAL BOTTOM COVER TITLE

| | | |
|---|----------------------------|---|
| NATIONAL IRANIAN OIL COMPANY ESFAHAN REFINERY | NITROGEN PLANT PLANT 11 | FLOUR-THYSSEN JOINT VENTURE CONTRACT 4573 AUGUST 1977 |
|---|----------------------------|---|

APPENDIX C**CONTENTS OF OPERATING MANUAL****I. INTRODUCTION****II. DESIGN BASIS**

- A) PLANT DESIGN, NORMAL AND TURN DOWN CAPACITY**
- B) FEED CHARACTERISTICS**
- C) PRODUCT (AND BY-PRODUCT) SPECIFICATIONS**
- D) UTILITY CONDITIONS**
- E) HEAT AND MATERIAL BALANCE TABLES**
- F) UTILITY SUMMARY TABLES**
- G) EFFLUENT SUMMARY**

III. PROCESS DESCRIPTION

- A) NATURE OF PROCESS**
- B) PROCESS OF FLOW**

IV. OPERATING VARIABLES AND CONTROLS

- A) CONTROL POINTS**
- B) EFFECT OF OPERATING VARIABLES**
- C) TROUBLESHOOTING GUIDE**

V. AUXILIARY SYSTEMS**VI. EQUIPMENT OPERATION**

- A) PUMPS AND COMPRESSORS**
- B) EXCHANGERS**
- C) FIRED HEATERS**
- D) VESSELS AND REACTORS**
- E) PACKAGE UNITS**

VII. INSTRUMENTATION AND CONTROL

- A) GENERAL**
- B) ADVANCED CONTROL SYSTEMS AND OPTIMIZATION**
- C) SETTING POINT LIST**

(to be continued)

APPENDIX C (continued)**VIII. START-UP PROCEDURES****A. INITIAL START-UP PREPARATION****A.1 PLANT INSPECTION AFTER COMPLETION OF MECHANICAL SIDE****A.1.1 FIELD CHECKING****A.1.2 COMMISSIONING OF UTILITIES****A.1.3 MECHANICAL RUNNING TEST OF ROTARY MACHINERY****A.2 CLEANING AND WASHING OF PIPING SYSTEM****A.3 HEATER INSPECTION AND DRY-OUT****A.4 SYSTEM DRYING****A.5 CHEMICAL CLEANING AND PREPARATION OF CHEMICALS****A.6 CATALYST LOADING****A.7 LEAKAGE AND PRESSURE TEST****A.8 PURGING AIR WITH NITROGEN****B. INITIAL START-UP PROCEDURE****B.1 GENERAL****B.2 PREPARE UNITS FOR CHARGING****B.3 STEAM OUT AND PURGE****B.4 PRESSURIZE SYSTEMS****B.5 REDUCTION AND ACTIVATION OF CATALYST****B.6 ESTABLISH GAS CIRCULATION THROUGH CATALYTIC REACTOR SECTIONS****B.7 FEED IN AND CIRCULATION****B.8 HEATING UP OF PLANT****B.9 ESTABLISH OPERATION****B.10 START CHEMICAL INJECTION****B.11 LINE OUT****C. NORMAL START-UP PROCEDURE****C.1 GENERAL****C.2 RE-START-UP AFTER SHORT SHUT-DOWN DURATION (HOT START)****C.3 RE-START-UP AFTER LONG SHUT-DOWN DURATION (COLD START)**

(to be continued)

APPENDIX C (continued)

IX NORMAL OPERATION

- A. GENERAL
- B. NORMAL OPERATING CONDITIONS
- C. CHECK POINTS AND ADJUSTMENTS
- D. REDUCED OPERATION

X NORMAL SHUT-DOWN PROCEDURE

- A. GENERAL
- B. LOAD DOWN
- C. SHUT-DOWN PROCEDURE

XI EMERGENCY SHUT-DOWN PROCEDURE

- A. GENERAL
- B. SAFEGUARDING SYSTEMS AND EQUIPMENT
 - B.1 TRIP SEQUENCE SYSTEM
 - B.2 SAFETY RELIEF VALVES LOAD SUMMARY TABLE
- C. CAUSES OF EMERGENCY SHUT-DOWN
 - C.1 FEED FAILURE
 - C.2 POWER FAILURE
 - C.3 STEAM FAILURE
 - C.4 COOLING WATER FAILURE
 - C.5 INSTRUMENT AIR FAILURE
 - C.6 FUEL FAILURE
 - C.7 MACHINE (MECHANICAL) FAILURE
 - C.8 EXPLOSION, FIRE, LINE RUPTURE, SERIOUS LEAKS
 - C.9 OTHER FAULTS AND FAILURES

XII. MISCELLANEOUS PROCEDURES

- A. CATALYST OXIDATION
- B. CATALYST REGENERATION
- C. CATALYST UNLOADING
- D. DECOKING
- E. NEUTRALIZATION

(to be continued)

APPENDIX C (continued)**XIII. SAFETY**

- A. GENERAL
- B. SAFE PLACE TO WORK
- C. HAZARDS
- D. GOOD HOUSEKEEPING
- E. REQUIREMENTS FOR WELDING PERMITS
- F. HAZARDOUS CHEMICALS
- G. FLAMMABLE GAS/AIR MIXTURE
- H. FIRE-FIGHTING EQUIPMENT

XIV. ANALYTICAL TESTS**XV. CATALYSTS, CHEMICALS, AND PACKINGS****XVI. DRAWINGS**

- A. GENERAL
- B. PROCESS FLOW DIAGRAMS
- C. PIPING AND INSTRUMENT DIAGRAMS
- D. UTILITY FLOW DIAGRAMS
- E. PLOT PLAN.

APPENDIX D

TYPICAL FEED AND PRODUCT CHARACTERISTICS

D.1 Characteristics of Feed and Products:

- API (Sp Gr at 15.6°C) for oils and/or relative mass density for non-oils.
- UOP K.
- BPSD (bbl/sd) or m³/h at 15.6°C for oils.
- m³/h at 15.6°C for non-oils.
- kg/h.
- IBP ÷ FBP of feed and product (if required).
- Vol % on feed (for products).
- Any specific characteristic (e.g., PONA test) of feed for Licensed Units.
- "Sulfur and/or mercaptane [in mass% or mass ppm (mg/kg)].
- Molecular mass and compositions for gases.

D.2 Characteristics of Products (in Addition to Item D.1 Above) Where Applicable:

- RVP, kPa (abs.).
- Flash point, °C.
- Viscosity at two temperatures, Pa.s.
- Pour point, °C.
- Conradson Carbon, Ash Content (in mass%) for heavy oils
- etc.

APPENDIX E

TYPICAL HEAT AND MATERIAL BALANCE TABLE

| CONTRACTOR NAME | | N I O C REFINERY NAME | | HEAT AND MATERIAL BALANCES (CASE-1) | | | | | | | | | | NIOC NO. | | REV. | |
|-----------------|--------------------|--------------------------|-------------|--|------|-------|-------------|--------------------------------|--|------------------------------|---|---------|---------|----------------|--------|---------------|--|
| | | | | UNIT NAME | | | | | | | | | | NIOC PROJ. NO. | | CON PROJ. NO. | |
| | | | | CRUDE/VACUUM UNIT | | | | | | | | | | CONSPEC. NO. | | SH. OF | |
| | | | | API (Sp. Gr.) @ 15.6°C (kg/m ³) | K | M W | TEMP. °C | PRESS. bar(ga) (mmHgabs) | FLOWING Sp. Gr. (kg/m ³) | FLOWING m ³ /h | m ³ /h @ 15.6°C (kg/m ³) | Kmol/h | Kg/h | EJ/Kg | KJ/s | UNIT NO. | |
| NO. | STREAM DESCRIPTION | | | | | | | | | | | | | | | 01 | |
| 100 | CRUDE FROM STORAGE | | | | | 209.4 | 32 | 25.30 | 0.8578 | 1.008.0 | 998.7 | 4.129.3 | 864.694 | 231.1 | 80.314 | | |
| | HC LIQUID | | | 31.7 | 11.9 | 223.0 | 32 | 25.30 | 0.8572 | 1.003.0 | 993.7 | 3.654.5 | 859.739 | 231.8 | 80.130 | | |
| | WATER | | | | | 18.0 | 32 | 25.30 | 0.9950 | 5.0 | 5.0 | 375.0 | 4.955 | 134.0 | 184 | | |
| 101 | WATER FROM E-127 | | | | | 18.0 | 97 | 25.23 | 0.9803 | 15.5 | 14.9 | 827.1 | 14.900 | 406.2 | 1.881 | | |
| 102 | CRUDE TO E-105 | | | | | 177.5 | 34 | 25.17 | 0.8565 | 1.027.0 | 1.013.8 | 4.956.8 | 879.594 | 233.7 | 81.995 | | |
| | HC LIQUID | | | 31.7 | 11.9 | 223.0 | 34 | 25.17 | 0.8538 | 1.007.0 | 993.7 | 3.854.5 | 859.739 | 236.3 | 81.210 | | |
| | WATER | | | | | 18.0 | 34 | 25.17 | 0.9944 | 20.0 | 19.9 | 1.102.1 | 19.855 | 142.4 | 785 | | |
| | E-105 EXCH. DUTY | | | | | | | | | | | | | | 3.115 | | |
| 103 | CRUDE TO E-154 | | | | | 177.5 | 40 | 24.06 | 0.8524 | 1.031.9 | 1.013.6 | 4.956.8 | 879.594 | 236.5 | 83.110 | | |
| | HC LIQUID | | | 31.7 | 11.9 | 223.0 | 40 | 24.06 | 0.8496 | 1.011.9 | 993.7 | 3.854.5 | 859.739 | 238.8 | 84.187 | | |
| | WATER | | | | | 18.0 | 40 | 24.06 | 0.9923 | 20.0 | 19.8 | 1.102.1 | 19.855 | 167.4 | 925 | | |
| | E-154 EXCH. DUTY | | | | | | | | | | | | | | 11.634 | | |
| 104 | CRUDE TO E-106 | | | | | 177.5 | 63 | 22.51 | 0.8267 | 1.031.3 | 1.013.6 | 4.956.8 | 879.594 | 314.1 | 78.744 | | |
| | HC LIQUID | | | 31.7 | 11.9 | 223.0 | 63 | 22.51 | 0.8339 | 1.031.1 | 993.7 | 3.854.5 | 859.739 | 315.3 | 75.280 | | |
| | WATER | | | | | 18.0 | 63 | 22.51 | 0.9816 | 20.2 | 19.9 | 1.102.1 | 19.855 | 263.6 | 1.434 | | |
| | E-106 EXCH. DUTY | | | | | | | | | | | | | | 13.737 | | |
| 105 | CRUDE TO E-107 | | | | | 177.5 | 90 | 21.76 | 0.8180 | 1.075.3 | 1.013.6 | 4.956.8 | 879.594 | 370.3 | 90.481 | | |
| | HC LIQUID | | | 31.7 | 11.9 | 223.0 | 90 | 21.76 | 0.8151 | 1.054.7 | 993.7 | 3.854.5 | 859.739 | 370.2 | 88.403 | | |
| | WATER | | | | | 18.0 | 90 | 21.76 | 0.9651 | 20.6 | 19.9 | 1.102.1 | 19.855 | 378.9 | 2.078 | | |
| NOTES: | | | | | | | | | | | | | | | | | |
| | | 2 | | | | | | | | 5 | | | | | | | |
| | | 1 | | | | | | | | 4 | | | | | | | |
| | | 0 | | | | | | | | 3 | | | | | | | |
| | | REV | DESCRIPTION | DATE | BY | APPR | REV | DESCRIPTION | DATE | BY | APPR | | | | | | |

* CON=Contractor

APPENDIX F

TYPICAL UTILITY SUMMARY TABLE

[illegible]

(to be continued)

24

[illegible]

APPENDIX G

TYPICAL PRESSURE RELIEF VALVES LOAD SUMMARY TABLE

| CONTRACTOR NAME | | | N I O C ARAK REFINERY PROJECT | | | PRESSURE RELIEF VALVES LOAD SUMMARY | | | N I O C ARAK REFINERY PROJECT | | | REV. | | |
|-----------------|--|--|----------------------------------|--|--|--|--|--|----------------------------------|--|--|----------|--|--|
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
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| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
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| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
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| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
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| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | UNIT NO. | | |
| UNIT NAME | | | CORE/VAPOUR UNIT | | | CON SPEC. NO. | | | UNIT NO. | | | | | |

APPENDIX H

PIPE COMPONENT - NOMINAL SIZE

The purpose of this Appendix is to present an equivalent identity for the piping components nominal size in SI System and Imperial Unit System, in accordance with ISO 6708-1980 (E).

TABLE H.1 - PIPE COMPONENT - NOMINAL SIZE

| NOMINAL SIZE | | NOMINAL SIZE | | NOMINAL SIZE | | NOMINAL SIZE | |
|--------------|---------|--------------|-----|--------------|-----|--------------|-----|
| DN (1) | NPS (2) | DN (2) | NPS | DN | NPS | DN | NPS |
| 6 | ¼ | 100 | 4 | 600 | 24 | 1100 | 44 |
| 15 | ½ | 125 | 5 | 650 | 26 | 1150 | 46 |
| 20 | ¾ | 150 | 6 | 700 | 28 | 1200 | 48 |
| 25 | 1 | 200 | 8 | 750 | 30 | 1300 | 52 |
| 32 | 1¼ | 250 | 10 | 800 | 32 | 1400 | 56 |
| 40 | 1½ | 300 | 12 | 850 | 34 | 1500 | 60 |
| 50 | 2 | 350 | 14 | 900 | 36 | 1800 | 72 |
| 65 | 2½ | 400 | 16 | 950 | 38 | | |
| 80 | 3 | 450 | 18 | 1000 | 40 | | |
| 90 | 3½ | 500 | 20 | 1050 | 42 | | |

1) Diameter Nominal, mm.

2) Nominal Pipe Size, inch.