

**ENGINEERING STANDARD**  
**FOR**  
**BASIC ENGINEERING DESIGN DATA**

**CONTENTS :**

**PAGE No.**

<b>0. INTRODUCTION .....</b>	<b>4</b>
<b>1. SCOPE .....</b>	<b>5</b>
<b>2. REFERENCES .....</b>	<b>5</b>
<b>3. DEFINITIONS AND TERMINOLOGY.....</b>	<b>5</b>
<b>4. SYMBOLS AND ABBREVIATIONS.....</b>	<b>6</b>
<b>5. UNITS .....</b>	<b>7</b>
<b>6. PREPARATION OF BASIC ENGINEERING DESIGN DATA (BEDD).....</b>	<b>7</b>
<b>6.1 General.....</b>	<b>7</b>
<b>6.2 Contents of "BEDD".....</b>	<b>7</b>
<b>6.2.1 General matters .....</b>	<b>7</b>
<b>6.2.2 Numbering system.....</b>	<b>7</b>
<b>6.2.3 Utility conditions.....</b>	<b>7</b>
<b>6.2.4 Flare and blow down conditions.....</b>	<b>7</b>
<b>6.2.5 Bases for equipment.....</b>	<b>7</b>
<b>6.2.6 Bases for instrumentation.....</b>	<b>8</b>
<b>6.2.7 Equipment layout.....</b>	<b>8</b>
<b>6.2.8 Environmental regulations.....</b>	<b>8</b>
<b>6.2.9 Site conditions.....</b>	<b>8</b>
<b>6.2.10 Miscellaneous.....</b>	<b>8</b>
<b>6.3 Timing .....</b>	<b>8</b>
<b>6.4 Procedure .....</b>	<b>8</b>
<b>6.5 Explanations on Individual Items of "BEDD".....</b>	<b>8</b>
<b>6.5.1 General matters .....</b>	<b>8</b>
<b>6.5.2 Numbering system.....</b>	<b>9</b>
<b>6.5.3 Utility conditions.....</b>	<b>9</b>
<b>6.5.4 Flare and blow-down conditions.....</b>	<b>14</b>
<b>6.5.5 Bases for equipment.....</b>	<b>15</b>
<b>6.5.6 Basic requirements for instrumentation.....</b>	<b>18</b>
<b>6.5.7 Equipment layout.....</b>	<b>19</b>
<b>6.5.8 Environmental regulations.....</b>	<b>19</b>
<b>6.5.9 Site conditions.....</b>	<b>20</b>

<b>7. DATA PREPARATION OF UTILITIES (UTILITY SUMMARY TABLES).....</b>	<b>22</b>
7.1 Format.....	22
7.2 General.....	22
7.2.1 Types of utilities.....	22
7.2.2 Operational cases .....	22
7.3 Utilities to be Specified.....	22
7.3.1 Normal operation.....	23
7.3.2 Peak operation.....	23
7.3.3 Block operation .....	23
7.3.4 Start-up operation .....	23
7.3.5 Shut-down operation .....	23
7.3.6 Emergency shut-down.....	23
7.3.7 Reduced operation.....	23
7.4 Necessary Informations .....	23
7.4.1 Normal operation.....	23
7.4.2 Block operation / reduced operation.....	25
7.4.3 Start-up operation .....	25
7.4.4 Shut-down operation .....	26
7.4.5 Emergency shut-down.....	26
7.5 Other Informations.....	28
7.6 Utility Summary.....	28
7.6.1 Preparation .....	28
7.6.2 Change .....	28
<b>8. DATA PREPARATION OF EFFLUENTS.....</b>	<b>28</b>
8.1 General.....	28
8.2 Units of Measuring.....	28
8.3 Gaseous Effluents.....	29
8.4 Liquid Effluents.....	29
<b>9. DATA PREPARATION OF CATALYSTS AND CHEMICALS.....</b>	<b>29</b>
9.1 General.....	29
9.2 Catalysts and Packings.....	30
9.3 Chemicals and Additives.....	30
9.4 Others .....	30

## **APPENDICES:**

<b>APPENDIX A</b> .....	<b>31</b>
<b>TABLE A.1 - STEAM</b> .....	<b>31</b>
<b>TABLE A.2 - STEAM</b> .....	<b>32</b>
<b>TABLE A.3 - WATER</b> .....	<b>33</b>
<b>TABLE A.4 - WATER</b> .....	<b>34</b>
<b>TABLE A.5 - CONDENSATE</b> .....	<b>35</b>
<b>TABLE A.6 - ELECTRICAL POWER</b> .....	<b>36</b>
<b>TABLE A.7 - FUEL</b> .....	<b>37</b>
<b>TABLE A.8 - FUEL</b> .....	<b>38</b>
<b>TABLE A.9 - AIR</b> .....	<b>38</b>
<b>TABLE A.10 - AIR</b> .....	<b>39</b>
<b>TABLE A.11 - INSTRUMENTS</b> .....	<b>39</b>
<b>APPENDIX B NOZZLES IDENTIFICATION</b> .....	<b>40</b>
<b>APPENDIX C UTILITY SUMMARY TABLES</b> .....	<b>41</b>

## 0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" are 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 projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every 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 eleven 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:

<b><u>STANDARD CODE</u></b>	<b><u>STANDARD TITLE</u></b>
-----------------------------	------------------------------

**I) Manuals of phase I (Numbers 1 - 11):**

IPS-E-PR-110	"Introduction to IPS Codes and Standards"
IPS-E-PR-120	"Feasibility Studies and Basic Design Philosophies"
IPS-E-PR-130	"Process Evaluation and Selection"
IPS-E-PR-140	"Execution of Basic Design"
IPS-E-PR-150	"Basic Design Package"
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 and Instrument Diagrams (P & IDs)"
IPS-E-PR-250	"Performance Guarantee"

**II) Manuals of phase II (Number 12 - 14):**

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 (Number 15 - 16):**

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

This Engineering Standard Specification covers:

**"BASIC ENGINEERING DESIGN DATA"**

## 1. SCOPE

This Engineering Standard Specification covers the minimum requirements for preparation of the following documents in the execution of basic design stage of the projects applicable to the oil and gas refineries and petrochemical plants under the direction of Process Engineering Department.

- Section 6:** Preparation of Basic Engineering Design Data (BEDD),
- Section 7:** Data Preparation of Utilities (Utility Summary Tables),
- Section 8:** Data Preparation of Effluents (Preparation of Data Sheets in Relation to Gaseous and Liquid Effluents),
- Section 9:** Data Preparation of Catalysts and Chemicals.

## 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:

IPS	(IRANIAN PETROLEUM STANDARDS)
E-GN-100	"Units"
E-PR-190	"Layout and Spacing"
E-PR-308	"Numbering System"
E-PR-330	"Process Design of Production and Distribution of Compressed Air Systems"
E-PR-340	"Process Design of Fuel Systems"
E-PR-810	"Process Design of Furnaces"

## METEOROLOGICAL YEAR BOOKS OF IRANIAN METEOROLOGICAL DEPARTMENT

## 3. DEFINITIONS AND TERMINOLOGY

Throughout this Standard words have specific meaning as described below:

**- "Company" / "Employer" / "Owner"**

Means as mentioned in General Definitions of Foreword.

**- "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.

**- "Employer" / "Owner"**

Refers to the "Company" as above.

**- "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"**

Refers to one or all process, offsite and/or utility Units and facilities as applicable to form a complete operable refinery and/or complex/plant.

#### **4. SYMBOLS AND ABBREVIATIONS**

Symbols/Abbreviations mentioned in this Engineering Standard are according to the following table:

<b><u>SYMBOL / ABBREVIATION</u></b>	<b><u>DESCRIPTION</u></b>
<b>AFC</b>	Air Fin Cooler
<b>BEDD</b>	Basic Engineering Design Data
<b>BEDQ</b>	Basic Engineering Design Questionnaire
<b>BFW</b>	Boiler Feed Water
<b>BHP</b>	Break Horse Power
<b>BkW</b>	Identical to Break Horse Power Converted to kilowatts
<b>BOD</b>	Biological Oxygen Demand
<b>BOD<sub>5</sub></b>	The 5 Day Biological Oxygen Demand
<b>BWG</b>	Birmingham Wire Gage
<b>COD</b>	Chemical Oxygen Demand
<b>CON</b>	Contractor
<b>CRT</b>	Cathode Ray Tube
<b>DCS</b>	Distributed Control System
<b>DEA</b>	di-Ethanol Amine
<b>DEDD</b>	Detailed Engineering Design Data
<b>DGA</b>	di-Glycol Amine
<b>DN</b>	Diameter Nominal, in (mm)
<b>FDFs</b>	Forced Draft Fans
<b>HP</b>	High Pressure
<b>HPS</b>	High Pressure Steam
<b>ID</b>	Inside Diameter
<b>KO Drum</b>	Knockout Drum
<b>LHV</b>	Low Heating Value
<b>LLP</b>	Low Low Pressure
<b>LLPS</b>	Low Low Pressure Steam
<b>LP</b>	Low Pressure
<b>LPS</b>	Low Pressure Steam
<b>MEA</b>	mono-Ethanol Amine
<b>MP</b>	Medium Pressure
<b>MPS</b>	Medium Pressure Steam
<b>PD-Meter</b>	Positive Displacement Meter
<b>ppm</b>	Part Per Million
<b>TI</b>	Temperature Indicator
<b>TSS</b>	Total Suspended Solids
<b>UOP</b>	Universal Oil Products
<b>UPS</b>	Uninterruptible Power System
<b>vol</b>	Volume
<b>W</b>	Water

## **5. UNITS**

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

## **6. PREPARATION OF BASIC ENGINEERING DESIGN DATA (BEDD)**

### **6.1 General**

**6.1.1** The Basic Engineering Design Data is abbreviated to "BEDD" and shall be confirmed in writing before starting the design work.

**6.1.2** The Basic Engineering Design Data is a summary of basic points to be followed in the basic and detailed design which range over all speciality fields.

**6.1.3** BEDD should be prepared in advance using similar blank forms as shown in Appendix A (Tables A.1 - A.11) of this Standard.

It shall be filled under the following items by reviewing and deciding each item individually prior to starting of the design work.

### **6.2 Contents of "BEDD"**

The contents of "BEDD" can be classified as follow:

#### **6.2.1 General matters**

- Design capacity of all process Units, utility facilities, offsite and auxiliary systems. Turn down ratio may be specified if required.
- System of measurements.
- Applicable laws, codes, standards and/or design criteria to be followed and so forth.

#### **6.2.2 Numbering system**

#### **6.2.3 Utility conditions**

Conditions of utilities such as air, raw water, cooling water, steam, condensate, fuel and electric power which will be used in the plant.

#### **6.2.4 Flare and blow down conditions**

Specifications of relieving fluid during emergency cases, depressuring of flare at emergencies and requirements for waste disposal.

#### **6.2.5 Bases for equipment**

Basic requirements such as interchangeability, selection basis, etc. for the standardization of equipment in the entire plant.



### **6.2.6 Bases for instrumentation**

Basic requirements for the standardization of control systems and instruments in the entire plant.

### **6.2.7 Equipment layout**

Lay out for safety distances and limitations of erection and maintenance work of the equipment in the plant site.

### **6.2.8 Environmental regulations**

Limitations on the emissions of noise, waste water, and other disposed wastes.

### **6.2.9 Site conditions**

Weather conditions, soil conditions, sea conditions (if applicable), site location and geographical data, meteorological data and elevations.

### **6.2.10 Miscellaneous**

Owner's requests, desires and thoughts such as those on entire plants and plant buildings which are to be reflected in the basic design.

## **6.3 Timing**

**6.3.1** Generally, all items of BEDD should be decided before starting of the process design. However, any item which is not needed to be filled at this stage shall be settled with the progress of the project work.

**6.3.2** Since some detailed requirements of the detailed design can not be covered by BEDD, detailed engineering design data (abbreviated to DEDD) are prepared in some cases to maintain the unification of equipment detailed design (if required).

## **6.4 Procedure**

BEDD shall be prepared by Company's or consultant's project engineer under the cooperation of specialist engineers, but many items of BEDD shall be decided from the standpoints of overall plant safety and maintenance rather than from the standpoints of a single Unit. Also, future/existing plants shall be taken into consideration in the preparation of "BEDD".

## **6.5 Explanations on Individual Items of "BEDD"**

### **6.5.1 General matters**

#### **6.5.1.1 Design capacities**

Design capacity and /or philosophy of capacity selection for all Units including process, offsite and utilities and all auxiliary facilities/systems such as air, water, fuel, product loading, flare, etc. shall be indicated.

### **6.5.1.2 System of measurements**

The International System of Units, (SI) shall be utilized for the development of the project according to "IPS-E-GN-100", "Units". However, the units to be utilized for the following main properties shall be adhered to, in order to avoid cross references of the user to the above mentioned Standard.

Temperature; Pressure; Mass; Length; Volume; Time; Relative Density; Absolute Density; Enthalpy; Viscosity; Power; Standard Conditions and Normal Conditions.

### **6.5.1.3 Laws, codes and standards**

#### **6.5.1.3.1 Standards for design and construction**

The Standards/Specifications to be followed by the Basic Designer shall be clarified and a complete list of such Standards/Specifications should be added in "BEDD".

In case that the list of standards is excluded and will be provided separately, reference to the relevant document shall be made.

#### **6.5.1.3.2 Laws and codes**

Various laws, codes and regulations are enforced by the national or local governments to secure the safety of plant facilities and around the plant, and to prevent the environmental pollution (air, water, noise, etc.). In the design of plants, the legal requirements shall be satisfied and the applicable laws and codes should be mentioned.

#### **6.5.1.4 Design criteria**

The applicable document (if any) covering design criteria which is supposed to be followed through the project design phase shall be referred to.

Design criteria, normally is issued apart from BEDD and is agreed upon in advance by the Company and Designer.

#### **6.5.1.5 Products and product specifications**

A table shall be provided to demonstrate all products which are supposed to be produced during plant normal/design operations. Product specifications to be followed in the design stage shall be clarified and reference to the applicable document shall be made. Finished products and by-products shall be separately noted.

### **6.5.2 Numbering system**

Usually, a numbering system which is an effective means to identify each individual item of equipment, instrumentation, electrical, piping, drawings and all other engineering documents is issued through a separate specification apart from BEDD. The document covering numbering system (IPS-E-PR-308) shall be referred to in BEDD.

### **6.5.3 Utility conditions**

#### **6.5.3.1 General considerations**

**6.5.3.1.1** In order to proceed with the design of process Units, it is necessary to decide the utility conditions to equalize design bases for each process Unit.

**6.5.3.1.2** The utility conditions shall be decided based on the requirements on the plant design. They may be affected by the approximate consumptions, weather conditions, plot plan, waste heat recovery methods, locality conditions, etc.

**6.5.3.1.3** Generally as many factors remain uncertain at the stage when the utility conditions must be decided, economic studies cannot be conducted precisely at that state. Hence, when the basic plan is marked out, the utility conditions are preliminarily determined by fully studying the economics, and subsequent the utility conditions shall be finally decided, so that the efficiency of each equipment can be maximized.

**6.5.3.1.4** The following note should be added to the first sheet of the utility conditions:

"All utility information set forth in this BEDD will be confirmed during the detailed engineering stage."

### **6.5.3.2 Utility services**

The following utility services shall be covered in the BEDD as applicable.

- Steam.
- Water.
- Condensate.
- Fuel.
- Air.
- Nitrogen.
- Electrical Power.
- Others.

#### **6.5.3.2.1 Steam**

**6.5.3.2.1.1** Steam shall include all various types of steams as foreseen in the plant design (e.g., HPS, MPS, LPS, LLPS, etc.).

**6.5.3.2.1.2** A table shall be provided to show process and utility battery limit conditions as well as equipment mechanical design conditions as presented in Table A.1 of Appendix A for all types of steams.

**6.5.3.2.1.3** The process and utility battery limit conditions shall cover the followings:

- a) Producer Battery Limit (Pressure and Temperature).
- b) Consumer Battery Limit (Pressure and Temperature).

**6.5.3.2.1.4** The equipment mechanical design conditions shall cover the followings:

- a) Piping (Design Pressure and Design Temperature).
- b) Vessels and Exchangers (Design Pressure and Design Temperature).
- c) Turbines (Design Pressure and Design Temperature).

**6.5.3.2.1.5** Where required, the pressure and temperature mentioned under the battery limit conditions shall cover minimum, normal and maximum cases.

**6.5.3.2.1.6** Design Pressure specified for equipment mechanical design shall be system safety valve set pressure.

**6.5.3.2.1.7** Desuperheating conditions of any type of supplied steams in the plant shall be taken into consideration and a note to be added to define the conditions where required.

**6.5.3.2.1.8** Operating temperature for the reboilers for process design considerations shall be noted.

**6.5.3.2.1.9** A separate table shall be provided to present turbine inlet conditions for HPS and MPS cases in process and utility areas (see Table A.2 of Appendix A).

The table shall include pressure and temperature for the following conditions:

- a) Minimum.
- b) Normal.
- c) Maximum.
- d) Mechanical Design.

### 6.5.3.2.2 Water

#### 6.5.3.2.2.1 Water operating and design conditions

This section shall include the following types of waters where applicable:

- a) HP Boiler Feed Water.
- b) MP Boiler Feed Water.
- c) Cooling Water Supply.
- d) Cooling Water Return.
- e) Raw Water.
- f) Plant (Service) Water.
- g) Drinking Water.
- h) Fire Water.
- i) Demineralized Water.
- j) Desalinated Water.

A table shall be provided to show process/utility battery limit conditions and equipment mechanical design conditions for each type of water as presented in Table A.3 of Appendix A for all types of waters.

The process and utility battery limit conditions shall cover the followings:

- a) Producer Battery Limit (Pressure and Temperature).
- b) Consumer Battery Limit (Pressure and Temperature).

The equipment mechanical design conditions shall include design pressure and design temperature for the following items:

- a) Piping.
- b) Vessels and Exchangers.
- c) Turbines.
- d) Compressors/Pumps(if applicable).

Where required, the pressure and temperature mentioned under the battery limit conditions shall cover minimum, normal and maximum cases.

Allowable pressure drop for cooler, condenser and machinery cooling equipment to be mentioned as a note.

Maximum cooling water return temperature (cooling tower design case) shall be noted.

#### 6.5.3.2.2.2 Water specification

A table (see Table A.4 in Appendix A) shall be provided to cover the following characteristics for the services such as circulating cooling water, cooling tower make-up, raw water/sea water and treated boiler feed water (where applicable):

- a) Source and Return (if needed).
- b) Availability over use, in (dm<sup>3</sup>/s).
- c) Value, in (cent/1,000 dm<sup>3</sup>).
- d) pH.
- e) Total Hardness as CaCO<sub>3</sub>, in (mg/kg).
- f) Calcium as CaCO<sub>3</sub>, in (mg/kg).
- g) Magnesium as CaCO<sub>3</sub>, in (mg/kg).
- h) Total Alkalinity as CaCO<sub>3</sub>, in (mg/kg).
- i) Sodium as CaCO<sub>3</sub>, in (mg/kg).
- l) Potassium as CaCO<sub>3</sub>, in (mg/kg).

- j) Sulfate as  $\text{CaCO}_3$ , in (mg/kg).
- k) Chloride as  $\text{CaCO}_3$ , in (mg/kg).
- m) Nitrate as  $\text{CaCO}_3$ , in (mg/kg).
- n) Silica as  $\text{SiO}_2$ , in (mg/kg).
- o) Total Iron, in (mg/kg).
- p) Suspended Solids, in (mg/kg).
- q) Dissolved Solids, in (mg/kg).
- r) COD, in (mg/kg).
- s) Others.

**6.5.3.2.2.3** Cooling tower design conditions such as wet bulb temperature, type of treating system, cycles of concentration, filtration, etc., shall be noted.

#### **6.5.3.2.3 Condensate**

**6.5.3.2.3.1** All various types of condensates such as HP Hot Condensate, LP Hot Condensate, Cold Condensate and Pump Flashed Condensate as foreseen in the plant design shall be included.

**6.5.3.2.3.2** A table shall be provided to show process and utility battery limit conditions as well as equipment mechanical design conditions as presented in Table A.5 of Appendix A for all types of condensates.

**6.5.3.2.3.3** The process and utility battery limit conditions shall cover pressure and temperature for the following cases:

- a) Producer Battery Limit.
- b) Consumer Battery Limit.

**6.5.3.2.3.4** The equipment mechanical design conditions shall cover design pressure and design temperature for the following items:

- a) Piping.
- b) Vessels and Exchangers.
- c) Turbines.

#### **6.5.3.2.4 Electrical power**

**6.5.3.2.4.1** The frequency of the whole electrical system shall be specified.

**6.5.3.2.4.2** The electrical system voltage levels throughout the plant as shown in Table A.6.1 of Appendix A shall be indicated.

**6.5.3.2.4.3** Conformity of the voltages to the motors shall be tabulated according to the motor size (see Table A.6.2 of Appendix A).

**6.5.3.2.4.4** Control voltage for the motor starter shall be mentioned.

#### **6.5.3.2.5 Fuel**

##### **6.5.3.2.5.1 Fuel specification**

- A table (see Table A.7 of Appendix A) shall be provided to include:

- a) The following types of fuels as applicable:
  - a.1) Fuel Oil.
  - a.2) Naphtha.
  - a.3) Start-up Oil.

- a.4) Blended Plant Fuel Gas (minimum LHV conditions).
- a.5) Blended Plant Fuel Gas (maximum LHV conditions).
- a.6) Natural Gas.
- b) The following characteristics for each type of the fuels mentioned under item a above.
  - b.1) API Gravity for liquid fuels and Relative Density at 15.6°C for all types of fuels.
  - b.2) Viscosity at 100°C for liquid fuels, in (Pa.s).
  - b.3) Viscosity at the burner operating temperature for liquid fuels, in (Pa.s).
  - b.4) Temperature at burners, in (°C).
  - b.5) Lower Heating Value for liquid fuels, in (kJ/kg).
  - b.6) Lower Heating Value for gas fuels, in (MJ/Nm³).
  - b.7) Availability over use, in (m³/h).
  - b.8) Vanadium/Nickel, in (mg/kg).
  - b.9) Sodium, in (mg/kg).
  - b.10) Sulfur, in (mg/kg).
  - b.11) Ash Content, in (mg/kg).
  - b.12) Flash Point, in (°C).
  - b.13) H<sub>2</sub>S, in (mg/kg).
  - b.14) Header Pressure, in normal [bar(ga)].
  - b.15) Header Temperature, in (°C).
- The following notes shall be added under the fuel specification table:
  - a) Maximum amount of Hydrogen content for the Blended Plant Fuel Gas.
  - b) Sources and compositions of the Blended Plant Fuel Gas.
  - c) Source (s) of the Fuel Oil and Start-up Oil.
  - d) Composition of the Natural Gas.
  - e) Source (s) of the Naphtha Fuel.

#### 6.5.3.2.5.2 Operating and design conditions

A table shall be provided to show process and utility battery limit conditions as well as equipment mechanical design conditions as presented in Table A.8 of Appendix A for the following items and any other types of fuels as required:

- Fuel Oil Supply.
- Fuel Oil Return.
- Blended Plant Fuel Gas.
- Naphtha (if applicable).
- Natural Gas.

The process and utility battery limit conditions shall cover the pressure and temperature for the following cases:

- Producer Battery Limit.
- Consumer Battery Limit.

The equipment mechanical design conditions shall cover the design pressure and design temperature for piping, vessels and exchangers.

#### 6.5.3.2.5.3 The following requirement to be added:

The fuel system shall be designed in accordance with the requirements stipulated in IPS-E-PR-340, "Process Design of Fuel Systems"

#### **6.5.3.2.6 Nitrogen gas**

- Pressure and temperature shall be specified for the following requirements:
  - a) Producer (Operating conditions) at unit battery limit.
  - b) Consumer (Operating conditions) at unit battery limit.
  - c) Mechanical Equipment (Design conditions).
- Nitrogen composition shall be specified.
- Indication of provision for any independent and dedicated Nitrogen distribution system for the catalytic units (if any).

#### **6.5.3.2.7 Air**

**6.5.3.2.7.1** A table similar to the fuel case described under Article 6.5.3.2.5.2 above shall be provided to cover the following services as shown in Appendix A (see Table A.9).

- a) Plant Air.
- b) Instrument Air.
- c) Catalyst regeneration Air.

**6.5.3.2.7.2** A separate table (see Table A.10 of Appendix A) shall be provided to cover all services mentioned in 6.5.3.2.7.1 above for the following informations:

- a) Availability, N m<sup>3</sup>/h.
- b) Driver Type of Compressor.
- c) Dry Air Dew Point.
- d) Oil Free Air Requirement.

**6.5.3.2.7.3** Total number of compressors and the compressors in continuous operation shall be noted. Reference shall also be made to IPS-E-PR-330, "Process Design of Production and Distribution of Compressed Air Systems".

#### **6.5.4 Flare and blow-down conditions**

Basic design data of the flare and blow-down systems which are intended to dispose gas and liquid discharged at emergencies shall cover the following:

**6.5.4.1** Selection criteria of pressure relieving valves for atmospheric or closed discharge blow-down including the following requirements:

**6.5.4.1.1** The pressure relieve valves which shall be discharged to the closed system.

**6.5.4.1.2** The pressure relieve valves which may be discharged to the atmosphere.

**6.5.4.1.3** Disposal of voluntary and involuntary liquid relief streams discharges.

**6.5.4.2** Total number of flare stacks including H<sub>2</sub>S flare.

**6.5.4.3** Total number and service of flare KO Drums.

**6.5.4.4** Status of H<sub>2</sub>S flare stack.

**6.5.4.5** Selection criteria for pressure relieve valves which shall be discharged into the H<sub>2</sub>S flare (acid flare).

**6.5.4.6** Flare system design pressure and maximum allowable built-up back pressure for safety relief valve calculations.

**6.5.4.7** Number of main flare headers through the whole plant.

**6.5.4.8** Disposal of recovered oil and oily water from the flare KO Drums and flare seal drum (s).

## **6.5.5 Bases for equipment**

### **6.5.5.1 Vessels and columns**

The following basic design data requirements shall be included in "BEDD" if not specified in the design criteria:

**6.5.5.1.1** Types of trays, packing and/or materials which are required.

**6.5.5.1.2** Minimum tray spacing.

**6.5.5.1.3** Flooding factors for hydraulic design of towers.

**6.5.5.1.4** Required residence time for all vessels, columns, KO Drums and all draw-offs.

**6.5.5.1.5** Minimum and maximum percent of normal flow rate which shall be considered for design of tower hydraulic.

**6.5.5.1.6** Towers, vessels and vessel boots minimum diameter.

**6.5.5.1.7** Any known diameter, length, or mass limitation for shipping or shop fabrication of vessels (if any).

**6.5.5.1.8** Provision of separate steam out nozzle on all vessels.

**6.5.5.1.9** Vessel nozzle identification shall be according to the table shown in Appendix B.

**6.5.5.1.10** Vent, steam out and drain nozzles shall be according to the following table:

<u>VESSEL ID</u>	<u>DRAIN SIZE</u>	<u>VENT SIZE</u>	<u>STEAM OUT NOZZLE</u>
1200 mm and less	DN 40 (1½")	DN 40 (1½")	DN 25 (1")
1200 to 2500	DN 50 (2")	DN 50 (2")	DN 40 (1½")
2500 to 3500	DN 80 (3")	DN 80 (3")	DN 40 (1½")
3500 to 6000	DN 80 (3")	DN 100 (4")	DN 50 (2")
6000 and larger	DN 80 (3")	DN 100 (4")	DN 80 (3")

Vent connections must be located on the top of the vessels.

**6.5.5.1.11** On all horizontal vessels, a blanked off ventilation nozzle shall be provided on the top of the vessel near the end opposite the manway. The ventilation nozzle will be sized as follows:

- DN 100 (4") nozzle for vessels up to 4,450 mm tangent length;
- DN 150 (6") nozzle for vessels 4500 to 7450 mm tangent length;
- DN 200 (8") nozzle for vessels 7500 mm and longer tangent length.

### **6.5.5.2 Storage tanks and offsite facilities**

The following requirements shall be specified on "BEDD".

**6.5.5.2.1** Numbers and capacity selection policy of storage tanks, separately for the following cases:

- Feed Tanks.
- Intermediate Product Tanks.
- Finished Product Tanks.

**6.5.5.2.2** Maximum blending time for preparation of each finished product.



**6.5.5.2.3** Type of blending of the finished products.

**6.5.5.2.4** Basic philosophy for selection of type of the tanks.

**6.5.5.2.5** Height of the tanks.

**6.5.5.2.6** Type of fire fighting facilities to be considered for various types of tanks.

**6.5.5.2.7** Type of product loading and maximum operating time per day of the loading facilities.

**6.5.5.2.8** Gas blanketing source and requirement for the storage tanks.

### **6.5.5.3 Heat exchangers**

#### **6.5.5.3.1 Air coolers**

**6.5.5.3.1.1** The following notes shall be specified in this section:

- a) Air cooled exchangers shall be used to maximum extent unless otherwise specified.
- b) For air coolers a 100 tone tower crane should be able to remove the bundle from its installed point.
- c) Preferred tube length is 9,114 mm. Standard lengths are 4,572, 6,096, 7,315 and 9,114 mm.
- d) Process fluid shall be cooled to 60°C unless otherwise noted on the process data sheet.
- e) Overdesign capacity should be considered whenever required.

**6.5.5.3.1.2** Dry bulb temperature and relative humidity for air cooler sizing to be noted.

#### **6.5.5.3.2 Shell and tube heat exchangers**

The following requirements shall be noted.

**6.5.5.3.2.1** Preferred straight tube lengths are: 3,048, 4,877, and 6,096 mm. For U-tube units the maximum nominal length (from tube ends to bend tangent) will be limited to the straight tube length.

**6.5.5.3.2.2** Preferred carbon steel and low alloy (up to and including 5 Cr-½Mo) tube size is DN 25 (1 inch), 12 BWG and DN 20 (¾ inch), 14 BWG.

**6.5.5.3.2.3** Preferred brass or admiralty tube size is DN 25 (1 inch), 14 BWG and DN 20 (¾ inch), 16 BWG.

**6.5.5.3.2.4** The limitation of bundle diameter is 1,140 mm maximum for heat exchangers and 1,524 mm for kettle type.

**6.5.5.3.2.5** Positions of temperature indicators around heat exchangers shall be as follow:

- a) All shell and tube process/process exchangers shall have a TI in the control room at the inlet and outlet of each stream.
- b) For Water coolers, the water side outlet shall be provided with a local TI. The shell side in and out shall be provided with board TIs.
- c) Thermowells shall be provided between each shell side and tube side of the same service.

**6.5.5.3.3** The fouling factors of all services for air coolers and shell and tube heat exchangers should be tabulated for standardization.

**6.5.5.3.4** Provision of four way back flushing valves for all water cooled exchangers shall be noted.

**6.5.5.3.5** Overdesign capacity should be considered whenever required.

#### 6.5.5.4 Heaters

##### 6.5.5.4.1 Burners

**6.5.5.4.1.1** Type of the burners for all processes and utility areas shall be tabulated based on the following categories:

- a) Gas burners only, without provisions for the future installation of oil burners.
- b) Gas burners initially, with provision for the future installation of oil burners.
- c) Gas burners for on-stream operation, with oil burners for start-up and stand-by purposes.
- d) Oil burners only.
- e) Combination of oil and gas burners arranged to fire either or both fuels alternately or simultaneously at full load conditions.
- f) Special burners designed for the process waste gas or liquid.
- g) Others.

**6.5.5.4.1.2** Any vertical or horizontal firing arrangement requirement for either fuel oil or fuel gas firing shall be noted.

**6.5.5.4.1.3** The following provision shall be considered:

- a) "A pilot burner shall be provided for each burner unless otherwise indicated."
- b) "When fuel oil firing is specified, the heater convection section shall be bare tubes only and provision for initial installation of soot blowers in the convection section shall be made."

**6.5.5.4.1.4** When fuel oil firing is required, the atomizing medium and the respective pressure and temperature at the Unit battery limit to be specified.

##### 6.5.5.4.2 Heater efficiency

**6.5.5.4.2.1** Minimum heater efficiency to be indicated for each item. Respectively, the bases of efficiency calculations shall be clarified for the following items:

- Heater throughput (e.g., normal, design, etc.).
- Low heating value of fuel.
- Excess air for fuel oil and fuel gas.
- Ambient temperature.
- Heater maximum heat loss.

**6.5.5.4.2.2** As it is intended to achieve higher heater efficiency, provision of the following facilities for recovery of waste heat from flue gas for each heater shall be clarified:

- a) Steam Generation.
  - Pressure at Unit battery limit (normal and maximum).
  - Temperature at Unit battery limit (normal and maximum).
- b) Air Preheating
  - b.1) Preferred type:**
    - Recuperative (stationary).
    - Regenerative (rotary).
    - Others.

**b.2)** Spare requirements for forced and induced draft fans. For induced and forced draft fans reference shall be made to IPS-E-PR-810, "Process Design of Furnaces".

**b.3)** Air preheater section failure would require shut- down of heater. It should be indicated, if bypass of air preheat section is desired and percent of normal heater duty to be provided.

**c)** Others.

#### **6.5.5.4.3 Stacks**

**6.5.5.4.3.1** Provision of individual or common stacks for heaters and boilers to be noted.

**6.5.5.4.3.2** Minimum stack height above grade to be specified.

**6.5.5.4.3.3** Any special heater design requirements relating to flue gas emissions such as "Low NO<sub>x</sub> emissions" shall be indicated.

**6.5.5.4.4** Overdesign capacity should be considered whenever required.

#### **6.5.5.5 Pumps and compressors**

**6.5.5.5.1** Any necessary instructions relating to selection of drivers for rotating equipment shall be specified.

**6.5.5.5.2** Spare selection philosophy for the pumps and compressors shall be clarified in "BEDD".

**6.5.5.5.3** The following information for air blower design shall be specified:

- a)** Relative humidity.
- b)** Dry bulb temperature.

**6.5.5.5.4** The following requirement to be added to "BEDD":

"For critical services, where steam and electrical drivers are provided, automatic start-up of stand-by pump shall be considered."

**6.5.5.5.5** Any provision for construction of pumps and compressors building(s)/shelter(s) to be noted.

#### **6.5.6 Basic requirements for instrumentation**

**6.5.6.1** The basic requirements for instrumentation should be reviewed fully and decided so as to meet future plant expansion, and standardization policy. Further requirements such as upgradability and open system characteristics should be highly valued.

**6.5.6.2** The following requirements should be clarified:

**6.5.6.2.1** Type of control system:

**a)** Micro-processor based digital control system (either single loop or distributed control system-shared display). In this case the following requirements to be specified:

- Maximum number of loops per controller.
- Status of the automatic back-up controllers in case of micro-processor based controllers.
- Safety requirement in designing control systems such as redundancy of data high way, redundancy of consoles, etc.
- Extent of application if digital control system is required or mixed with analog system.
- Any other additional requirement.

b) Analog (Pneumatic or electronic) - extent of application in the plant if required for special cases..

**6.5.6.2.2** Type of recorders.

**6.5.6.2.3** Type of transmitters.

**6.5.6.2.4** Type of temperature measuring sensor required.

**6.5.6.2.5** The extent of metering for utility streams to be provided at the individual Unit battery limit (see Table A.11 of Appendix A).

**6.5.6.2.6** Process stream analyzers required for any specific service including environmental protection requirements.

**6.5.6.2.7** Any specific requirement to be considered for location selection of control room(s).

**6.5.6.2.8** Distribution of control activities and responsibilities between control room(s) and control stations considering:

- Number of stations per control room.
- Maximum number of loops per station.
- Number of CRT consoles per each station.

**6.5.6.3** Extent of provision for advanced control system and optimization to be clarified.

**6.5.6.4** Instrument calibrations to be specified according to the following table:

a) Pressure: bar (ga).

b) Temperature: °C.

c) Flow:

- Liquid: m<sup>3</sup>/h.
- Vapor: Nm<sup>3</sup>/h.
- Steam: kg/h.
- Chemicals: m<sup>3</sup>/h or dm<sup>3</sup>/s.
- Water: m<sup>3</sup>/h.

**6.5.6.5** Any special flow metering requirements such as PD-meters are to be specified.

## **6.5.7 Equipment layout**

For safety distances and limitations of erection work of the equipment, reference shall be made to the Engineering Standard Specification IPS-E-PR-190, "Layout and Spacing".

## **6.5.8 Environmental regulations**

**6.5.8.1** Any specific Environmental Regulations which is to be considered in design of the plant shall be noted.

**6.5.8.2** A table shall be provided to cover the maximum levels of the pollutants in air such as:

- |                     |           |
|---------------------|-----------|
| - H <sub>2</sub> S, | in mg/kg. |
| - CO,               | in mg/kg. |
| - SO <sub>2</sub> , | in mg/kg. |
| - NO <sub>x</sub> , | in mg/kg. |
| - Hydrocarbons,     | in mg/kg. |
| - Particles,        | in mg/kg. |

**6.5.8.3** Disposal of the waste waters effluent from the plant shall be clarified.

The allowable limits of the following characteristics of the effluent water discharged to the public waters and/or recycled to the process shall be specified:

- BOD<sub>5</sub> in mg/L.
- COD in mg/L.
- Phenol in mg/L.
- Any toxic material in mg/L.
- Oil in mg/L.
- TSS in mg/L.
- TDS in mg/L.

#### **6.5.9 Site conditions**

The following information shall be indicated:

##### **6.5.9.1 Site location geographical data.**

###### **6.5.9.1.1 Longitude.**

###### **6.5.9.1.2 Latitude.**

###### **6.5.9.1.3 Site location with respect to the nearest city.**

###### **6.5.9.1.4 Site boundary (at four directions).**

###### **6.5.9.1.5 Co-ordinates.**

###### **6.5.9.1.6 Accessibility (for heavy equipment and large apparatus).**

###### **6.5.9.1.7 Site condition and soil report.**

(Reference to the site soil report and topographical survey drawings shall be made).

###### **6.5.9.1.8 Direction of Mecca.**

##### **6.5.9.2 Climatic data**

###### **6.5.9.2.1 Temperature:**

- Maximum recorded.
- Minimum recorded.
- Winterizing.
- Wet bulb\*.
- Dry bulb.

**\* Note:**

**The wet bulb temperature used for cooling tower design should be based on the local conditions and effect of cooling tower vaporization.**

###### **6.5.9.2.2 Precipitation**

- Maximum in 24 hours.
- Maximum in 1 hour.
- Rainy season months.

###### **6.5.9.2.3 Prevailing wind direction.**

###### **6.5.9.2.4 Design wind velocity.**

**6.5.9.2.5** Design Snow loading.

**6.5.9.2.6** Frost line.

**6.5.9.2.7** Water table.

**6.5.9.2.8** Seismic conditions.

**6.5.9.2.9** Barometric normal pressure [bar (abs)].

**6.5.9.2.10** Humidity of air (relative humidity percent for maximum, normal and minimum conditions).

**6.5.9.2.11** The following phrase shall be noted:

"For all informations regarding to the meteorological data refer to "Meteorological Year Books of Iranian Meteorological Department", Ministry of Roads and Transportation."

### **6.5.9.3 Soil conditions**

**6.5.9.3.1** Bearing value:

- For combined dead + live load.
- For all loads + wind and seismic.

**6.5.9.3.2** Foundation depth.

**6.5.9.3.3** Ground water level.

**6.5.9.3.4** Number of piles required.

**6.5.9.3.5** The following phrase shall be noted:

" For further information on the soil conditions refer to soil investigation report";

### **6.5.9.4 Site elevations**

**6.5.9.4.1** Refinery and or complex/plant site elevation above sea level.

**6.5.9.4.2** Designated area elevations:

(Reference should be made to the relevant topographical drawings).

**6.5.9.4.3** Base line:

Base line shall be 200 mm above high point of finished grade. This figure should be used for hydraulic design calculations.

**6.5.9.4.4** Minimum height for finished top of foundations and high points of finished floors in building: At base line, unless otherwise noted.

**6.5.9.4.5** Units elevations.

**6.5.9.4.6** Elevations difference between two adjacent Units.

**6.5.9.5** Sea conditions such as waves, currents, tides, etc., where applicable.

## **6.5.10 Miscellaneous**

### **6.5.10.1 Buildings**

Indicate the preferred type, number and construction of buildings for control houses, substations, pumps and compressors shelters and other buildings as required.

### **6.5.10.2 Fireproofing**

Extent of fireproofing for process vessel skirts, supporting structural steelwork and pipe racks shall be specified.

## **7. DATA PREPARATION OF UTILITIES (UTILITY SUMMARY TABLES)**

### **7.1 Format**

The utilities such as water, steam, electrical power, etc. used in processing plant shall be specified in the "Utility Summary Tables" as shown in Appendix C.

The Summary tables shall also indicate for instrument and plant air, nitrogen and inert gas, as necessity thereof arises.

### **7.2 General**

#### **7.2.1 Types of utilities**

Utilities, herein referred to, are the following items:

- 1) Electricity.
- 2) Steam.
- 3) Condensate and boiler feed water.
- 4) Cooling water (including tempered water and cooling water for mechanical cooling).
- 5) Industrial water such as demineralized water.
- 6) Fuel oil and fuel gas.
- 7) Instrument air and plant air.
- 8) Natural gas.
- 9) Nitrogen (and any other inert gases).
- 10) Potable (drinking) water.
- 11) Raw water.

#### **7.2.2 Operational cases**

The following operation modes shall be considered as required:

- 1) Normal operation.
- 2) Peak operation.
- 3) Block operation.
- 4) Start-up operation.
- 5) Emergency.
- 6) Shut-down;
- 7) Reduced operation.

### **7.3 Utilities to be Specified**

The operational cases specified under Article 7.2.2 above will be design basis for all facilities (including utility facilities) and shall be precisely defined in the design criteria which is to be used for the entire project.

The following matters shall be at least specified.

### **7.3.1 Normal operation**

Number of operating modes as design basis according to the differences in the quantity and specification of raw materials or products shall be specified.

### **7.3.2 Peak operation**

The operation of the process Units at the maximum throughput in steady state conditions and production of on specification products shall be clarified.

### **7.3.3 Block operation**

Where the operation of part of process Units is stopped extending over a long period of time, it is necessary to give definite form to such combination of process Units. For example, periodic shut-down of residue desulfurization Unit for the change of catalyst with shut-down of hydrogen plant.

### **7.3.4 Start-up operation**

A Start-up sequence for each process Unit shall be made clear.

### **7.3.5 Shut-down operation**

Utility requirements for the normal shut-down operation shall be clarified.

### **7.3.6 Emergency shut-down**

In most cases, power failure becomes the severest condition for the design of utility facilities.

Utility facilities, therefore, shall be designed solely to cope with such condition. However, where part of utilities is supplied by the outside facilities, it is necessary to check the conditions that such utility supply has been suspended.

### **7.3.7 Reduced operation**

The requirements for the operation of process Units extending over long periods of time at loads lower than the design load, shall be made clear.

## **7.4 Necessary Informations**

### **7.4.1 Normal operation**

#### **7.4.1.1 Method of preparing utility summary**

**7.4.1.1.1** The utility summary shall be prepared for all necessary utilities, using the forms presented in Appendix C.

**7.4.1.1.2** Where there are several operating modes, a utility summary shall be prepared for the mode which may become the severest conditions for the utility facilities. Where several operating modes become critical, a utility summary shall be prepared for such modes.



#### **7.4.1.2 Precautions**

##### **7.4.1.2.1 Seasonal fluctuations**

Seasonal fluctuations in utility consumption for onsite and offsite Units shall be clearly prepared. Utility consumption of the following items fluctuate seasonally:

- a)** Heating equipment for buildings.
- b)** Tank heaters.
- c)** Piping traces.
- d)** Winterizing tracing.

It is necessary, therefore, to indicate steam and cooling water consumption while respectively assuming winter and summer seasons. Should the seasonal fluctuation of utility consumption of process Units be required, due consideration shall be given to such requirement and an utility summary in midwinter based on winterizing temperature shall be prepared.

##### **7.4.1.2.2 Electricity consumption**

**7.4.1.2.2.1** Electricity consumption can be represented by motor rating, pump Break kilowatt Power (BkW) or supply electricity to motor. Accordingly, the factor, based on which the electricity consumption is represented shall be clarified.

**7.4.1.2.2.2** In the case of contracted jobs, electricity consumption shall be indicated in terms of supply electricity to motors. However, where electricity consumption must be calculated correctly, electricity consumption shall be indicated by the value obtained by dividing BkW by the motor efficiency.

**7.4.1.2.2.3** Whether motor rating or pump BkW is used, the method of calculation for electricity consumption shall be clearly mentioned.

##### **7.4.1.2.3 Intermittent users**

**7.4.1.2.3.1** Frequency in and time of utility consumption by intermittent users and combination of users which simultaneously use same utilities, shall be indicated. Intermittent users continuously using utilities for more than eight hours per day, shall be defined as continuous users.

**7.4.1.2.3.2** The purpose of defining intermittent users is to grasp loads which must be added to the utility facilities concerned.

In most cases, such additional load can be covered by the surplus capacity of the respective utility facilities. Where the frequency in use of utilities is low (several times a year), due consideration shall be given to the use of spare facilities.

##### **7.4.1.2.4 Consumption of inert gas**

**7.4.1.2.4.1** The consumption of inert gases is liable to be underestimated or overestimated. In general it is necessary to grasp the reasonable consumption not only for each equipment (to be used continuously) but also for each purpose of use. Along with this, the necessity of inert gases must be fully checked.

**7.4.1.2.4.2** Inert gases are used in particularly large quantities to seal the shaft of rotating machinery. In most cases, the amount of inert gas used to seal the shaft of rotating machinery exceeds the design values and must be fully studied with the Vendors concerned with regard to the appropriate consumption.

**7.4.1.2.4.3** Users continuously utilizing inert gases shall take measures to ensure that pressures are controlled on the onsite side and that the consumption can be monitored by installing flow meters.

#### **7.4.1.2.5 Utilities liable to be omitted**

The following utilities are liable to be omitted from initial utility summary. This poses problems in the satisfactory execution of engineering work.

- a) Atomizing steam.
- b) Soot blower steam.
- c) Steam tracing steam.
- d) Decoking and snuffing steam.

#### **7.4.1.2.6 Extra capacity allowance**

It is necessary for the utility side to determine the design flow rate of utility generating Units by adding an allowance to the maximum necessary consumption.

### **7.4.2 Block operation / reduced operation**

#### **7.4.2.1 General**

**7.4.2.1.1** Method of preparing utility summary "Block Operation" or "Reduced Operation" may have an adverse effect solely on steam balance.

**7.4.2.1.2** Utilities other than steam show same consumption or a tendency to decrease. Consequently, where the onsite facilities generate or consume steam in large quantities, utility summary shall be prepared on the onsite side solely for steam-related items (including steam, condensate and BFW).

#### **7.4.2.2 Precautions**

**7.4.2.2.1** In the case of block operation, it is necessary to check whether or not steam generation and consumption greatly fluctuate within the block concerned. If the steam generation and consumption fluctuate in large quantities, the steam balance of all facilities including the offsite facilities shall be reviewed. It is desirable that due consideration be given to the amount of steam generation being balanced with steam consumption within each block as much as possible.

**7.4.2.2.2** Special attention shall be made to the existence of a large sized steam turbine which results in an increase in steam consumption relatively in the case of reduced operation.

**7.4.2.2.3** During block operation, decoking or other operations are sometimes carried out for the Units whose operation remains stopped.

### **7.4.3 Start-up operation**

#### **7.4.3.1 General**

The utilities which may become critical during start-up operation are steam, electricity, fuel, air, nitrogen and inert gases. A utility summary, therefore, shall be prepared for these utilities.

#### **7.4.3.2 Precautions**

##### **7.4.3.2.1 Steam**

A Steam generator, where it exists within the onsite process area (if any), can be used as a steam generating source during normal operation.

However, since it is impossible to use the steam generator existing within the onsite process area as a steam generating source during start-up operation, it is necessary to supply steam (from the outside facility) to the user normally utilizing steam generated by the onsite generator. Consequently, a maximum amount of steam is supplied, during start-up operation, from the offsite steam generator.

A steam balance, therefor shall be established on the basis of the time required for start-up operation, during which a maximum amount of steam is consumed. Care shall be taken in avoiding the omission of purge steam. Where start-up operation becomes the design conditions for steam boilers, the design flow rate of steam boilers shall be reduced with due consideration given to the following points:

- a) Stagger start-up time for each Unit.
- b) Slowly start-up for each Unit.
- c) Operate the Units in steady state operation at the lower limit of turn-down.

#### **7.4.3.2.2 Inert Gas / Nitrogen**

Inert gases and nitrogen are used normally for purging and gas blanketing. It is possible to take sufficient time for purging prior to start-up operation. Purging prior to start-up operation, therefore, does not become critical, compared with purging during shut-down. From such standpoint, the maximum consumption of inert gas/nitrogen shall be determined.

In addition, it is necessary to establish purging procedures in such a way that the simultaneous use of inert gases/nitrogen can be minimized. For N<sub>2</sub> purging during initial start-up, liquid N<sub>2</sub> can be considered to be supplied by tank lorries or N<sub>2</sub> cylinders from the facilities outside the plant and/or from the N<sub>2</sub> production Unit in case of availability. Special care shall be taken to provision of a dedicated N<sub>2</sub> source and supply header to the some of the catalytic Units (e.g., Continuous Catalytic Regeneration Unit) if instructed by the Licensor.

#### **7.4.4 Shut-down operation**

**7.4.4.1** It is possible for the stipulations of the "Emergency Shut-down" set forth in Article 7.4.5 below to cover the requirements for "Shut-down Operation".

**7.4.4.2** Utility consumption for the decoking of heaters shall be checked.

#### **7.4.5 Emergency shut-down**

##### **7.4.5.1 General**

**7.4.5.1.1** In most cases, "Emergency shutdown" plays a very vital role to establish an optimum utility facility design, particularly, the philosophy of utility facility, together with "Normal Operation". For instance, where there are the Units or systems, for which emergency shut-down must be avoided, the type of utilities necessary for such Units or systems, and time and amount of use shall be established.

**7.4.5.1.2** It is necessary to design utility facilities in such a manner that the onsite process Units can be shut-down safely. From such a standpoint, the following cases can be cited as precautionary points.

- a) Where there is the possibility of equipment being damaged due to runaway arising from exothermic reactions:  
Example: Hydrocracking Unit reactor and PVC polymerization reactor.
- b) Where it is necessary to urgently depressurize the Units due to the existence of a large quantity of high-pressure flammable gases:  
Example: Hydrocracking Unit.
- c) Where solidification occurs due to cooling:  
Example: Hot oil and liquid sulfur handling Unit.
- d) Where it is necessary to urgently transfer flammable materials.
- e) Fire fighting facilities (not onsite process Units).

**7.4.5.1.3** It is necessary to continue the supply of necessary utilities during the shut-down of plant operation.

#### **7.4.5.2 Method of preparing utility summary**

The types, consumption and time of consumption of utilities shall be listed on the onsite side. In this case, care shall be taken in the relevancy between each utility, in order to avoid the omission of necessary utilities. For example, should the cooling of the reaction system of the hydrocracking Unit be considered, the following items of equipment must be continuously supplied with necessary utilities.

- a)** Recycle gas compressor.
- b)** Cooler (AFC or water).
- c)** Cooling water, if the compressor driver is a condensing turbine.
- d)** Compressor, auxiliary equipment of turbine.
- e)** Cooling water for mechanical cooling.
- f)** Instrument air.

Items (d) through (f) are often overlooked. Care shall be taken in avoiding the omission of utilities to continue the operation of the utility facilities. For instance, if steam boilers must be kept in operation, it is necessary to keep FDFs, boiler feed water pumps, etc. operating.

#### **7.4.5.3 Measures**

**7.4.5.3.1** The following measures shall be taken into account according to the consumption and time of consumption of utilities.

- a)** Use of steam turbines or diesel engines as drivers.
- b)** Separation of cooling system or establishment of two systems.

**7.4.5.3.2** In the case of short time (max. 1 hour), necessary amount of cooling water shall be supplied by holders, basins, etc. (in order to know the details, thermal calculations shall be carried out). Where the time of utility consumption exceeds one hour, the installation of emergency generators, etc. shall be planned.

**7.4.5.3.3** The capacity of emergency generators (UPS or capacity of diesel engine) shall be determined by adding the power consumption of the utility facilities and safety-devices to the total power consumption necessary for emergency shut-down.

**7.4.5.3.4** Large-sized equipment and Units consuming utilities in large quantities shall be listed. Along with this, the equipment and Units to be shut-down as a result of shut-down of large-sized equipment and Units shall be picked up.

**7.4.5.3.5** Using the steam balance sheet in normal operation, each operational case shall be studied to see if the required capacity of the utility facilities can be fully covered.

#### **7.4.5.4 Precautions**

##### **7.4.5.4.1 Prevention of excessive design**

Special attention shall be made to the excessively cautions planning. In design of utility facilities, supply of all utilities extending over a long period of time shall be noted.

##### **7.4.5.4.2 Inert Gas / Nitrogen**

For inert gas/nitrogen gas purging, it is necessary to classify Units and items of equipment requiring prompt purging and those not requiring prompt purging. On the basis of such classification, the necessary consumption and time of consumption of inert and nitrogen gases shall be made clear. Thus, the capacity and flow rate of the inert gas/nitrogen supply systems can be determined.

## 7.5 Other Informations

In addition to the requirements based on each operating mode, the following information shall be prepared:

- a) - Classification of drivers which must be turbines.
  - Classification of drivers which must be preferably turbines.
  - Classification of drivers which may select motors or turbines.
- b) Selection of steam level of onsite steam generators.
- c) Equipment requiring boiler feed water or treated water having normal temperature (including required water quality, acceptability and/or mixture of chemicals).

## 7.6 Utility Summary

### 7.6.1 Preparation

**7.6.1.1** After obtaining the above information, a utility balance sheet which may become critical shall be prepared for each utility. Then, the capacity of each utility facility shall be determined.

**7.6.1.2** In order to avoid a change in the capacity of each utility facility during the progress of job execution, the reliability of utility consumption data and particularly large-scale users shall be fully checked.

**7.6.1.3** In addition, after studying the steam balance of the entire plant, the necessary change of the waste heat recovery system (e.g., use of air preheaters, etc. instead of steam generators) or the necessity of change of driver specifications (change in the type of turbines from back pressure turbines to condensing turbines, etc.) shall be studied.

### 7.6.2 Change

It is inevitable to change utility summary to a certain extent. However, in order to reduce man-hours necessary for preparing and modifying utility balance sheets, changes shall be made simultaneously where necessary.

## 8. DATA PREPARATION OF EFFLUENTS

### 8.1 General

**8.1.1** Since air and water pollution controls are strictly required by the legislations of the country or its local regulations, the discharging amount of such pollutants shall be confirmed in advance of the public application of a plant.

Should such amount exceed the specified values, appropriate treating facilities shall be planned and the approval thereof by the governmental authorities concerned shall be obtained duly in advance.

For that purpose, the effluents summary sheet is considered as important.

**8.1.2** The discharging amounts of all the pollutants which will pollute environment shall be calculated prior to the preparation of the effluents.

### 8.2 Units of Measuring

The following units shall be applied:

- a) Pollutants in gaseous effluents: (mg/Nm<sup>3</sup>) or (vol ppm);
- b) Pollutants in liquid effluents: (g/m<sup>3</sup>) or (mg/kg) i.e., (mass ppm).

### 8.3 Gaseous Effluents

Regarding the gaseous effluents to be discharged to the atmosphere such as fired heater flue gas, boiler flue gas, vent gas and etc., the discharging amounts of the pollutants described below shall be calculated per source.

- a)  $\text{SO}_x$ .
- b)  $\text{NO}_x$ .
- c) Solid Particles.
- d)  $\text{H}_2\text{S}$ ,  $\text{NH}_3$ ,  $\text{HCl}$ ,  $\text{HF}$ , etc..
- e)  $\text{Cl}_2$ ,  $\text{F}_2$ .
- f)  $\text{CO}$ .
- g) Hydrocarbons.
- h) Metal and its compounds; Hg, Cu, As, Pb, Cd, etc.

### 8.4 Liquid Effluents

Regarding the liquid effluents to be discharged from processes such as process waste water, boiler blow-down water, cooling water, cooling tower blow-down water, ballast water, waste water from research laboratory and etc., the discharging amounts of the pollutants described below shall be calculated per source.

- a) pH.
- b) Oil (1).
- c) COD (2), BOD.
- d) Total Suspended Solids.
- e) Total Hardness.
- f) Metals; Cd, Cr, Cu, Pb, Hg, Ni, Zn, Ag, etc..
- g)  $\text{HCN}$ ,  $\text{H}_2\text{S}$ ,  $\text{HCl}$ ,  $\text{NH}_3$ , etc..
- h) Phenol.

#### Notes:

- 1) State clearly the analytical method.
- 2) State clearly whether the COD means Mn or Cr.

## 9. DATA PREPARATION OF CATALYSTS AND CHEMICALS

### 9.1 General

**9.1.1** Regarding all catalysts and chemicals required for the plant operation, the quantity required for the initial filling and consumption thereof shall be calculated, and such catalysts and chemicals shall be summarized under their types.

**9.1.2** All requirements shall be stipulated in their net value, and in the case where these catalysts and chemicals are actually purchased, orders shall be placed for the same in the gross value taking into account some allowances (including their filling loss and others).

**9.1.3** All catalysts and chemicals required for the licensed Units shall be in accordance with the Licensor's instructions.

## 9.2 Catalysts and Packings

The following catalysts and packings shall be specified:

- a) Catalyst.
- b) Adsorbent , molecular sieves.
- c) Desiccant.
- d) Sand and rock salt for dehydrator.
- e) Iron-exchange resin.
- f) Ceramic balls for catalyst supporting and holding.

## 9.3 Chemicals and Additives

The following chemicals shall be stipulated:

- a) Solvents such as Furfural, etc..
- b) NaOH, H<sub>2</sub>SO<sub>4</sub>, HCl, etc..
- c) Inhibitors for corrosion, fouling, polymerization, etc..
- d) Antifoamer.
- e) Additives for lube oil, finished products, BFW, etc..
- f) Amines such as MEA, DEA, DGA, etc..
- g) Glycol, methanol, etc..
- h) Refrigerant;
- i) Emulsion breaker, filter aids, etc.;
- j) pH control agent;
- k) Flocculant and coagulant.

## 9.4 Others

Lube oil and seal oil required for the operation of rotary machineries or similar equipment shall be summarized later by project engineer or rotary machinery engineer.

**APPENDICES**

**APPENDIX A**

**TABLE A.1 - STEAM**

**UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS**

(4) SYSTEM IDENTIFICATION	PROCESS AND UTILITY BATTERY LIMIT CONDITIONS				EQUIPMENT MECHANICAL DESIGN CONDITIONS					
	PRODUCER BATTERY LIMIT		CONSUMER BATTERY LIMIT		PIPING		VESSELS AND EXCHANGERS		TURBINES	
	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C
Turbine Generator					....	....	....	....	....	....
Utility	.... (min.)	.... (min.)	.... (min.)	.... (min.)	....	....	....	....	....	....
HPS Area	.... (max.)	.... (max.)	.... (max.)	.... (max.)	....	....	....	....	....	....
Process	.... (min.)	.... (min.)	.... (min.)	.... (min.)	....	....	....	....	....	....
Area	.... (max.)	.... (max.)	.... (max.)	.... (max.)	....	....	....	....	....	....
MPS (5)	.... (min.)	.... (min.)	.... (min.)	.... (min.)	....	....	....	....	....	....
	.... (max.)	.... (max.)	.... (max.)	.... (max.)	....	....	....	....	....	....
LPS (5), (2)	.... (min.)	.... (min.)	.... (min.)	.... (min.)	....	....	....	....	....	....
	.... (max.)	.... (max.)	.... (max.)	.... (max.)	....	....	....	....	....	....
LLPS (3)	....	....	....	....	....	....	....	....	....	....

**Notes:**

1) System safety valve set pressure.

2) Exhaust from MPS inlet - LPS outlet turbines and make-up steam from LPS. Pressure control station will not be desuperheated.

3) LLPS is low pressure recovered steam from condensate flash drums and shall be condensed by means of air cooler(s). Location of air cooler(s) will be determined based on the economical point of view.

4) For turbine inlet conditions reference shall be made to steam Table A.2 of Appendix A.

5) Operating temperature for reboilers process design shall be:

MPS :---- °C

LPS :---- °C

(to be continued)



## APPENDIX A (continued)

**TABLE A.2 - STEAM**  
**TURBINE INLET CONDITIONS FOR HPS AND MPS**

OPERATING / DESIGN CONDITIONS	HPS				MPS			
	PRESSURE bar (ga)		TEMPERATURE °C		PRESSURE bar (ga)		TEMPERATURE °C	
	UTILITY	PROCESS	UTILITY	PROCESS	UTILITY	PROCESS	UTILITY	PROCESS
Minimum	.....	.....	.....	.....	.....	.....	.....	.....
Normal	.....	.....	.....	.....	.....	.....	.....	.....
Maximum	.....	.....	.....	.....	.....	.....	.....	.....
Mechanical (Design)	.....	.....	.....	.....	.....	.....	.....	.....

(to be continued)

**APPENDIX A (continued)**

**TABLE A.3 - WATER**

**UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS**

SYSTEM IDENTIFICATION	PROCESS / UTILITY BATTERY LIMIT CONDITIONS				EQUIPMENT MECHANICAL DESIGN CONDITIONS					
	PRODUCER BATTERY LIMIT		CONSUMER BATTERY LIMIT		PIPING		VESSELS AND EXCHANGERS		TURBINES	
	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C
HP Boiler Feed W.	....	....	....	....	....	....				
MP Boiler Feed W.	....	....	....	....	....	....				
Cooling W. Supply	....	....	.... (2)	....	....	....	....	....	....	....
Cooling W. Return	....	....	....	....	....	....	....	....	....	....
Raw W.	....	....	.... (min.)	....	....	....	....	....		
Plant W.	....	....	.... (min.)	....	....	....	....	....		
Drinking W.	....	....	.... (min.)	....	....	....	....	....		
Fire W.	....	....	.... (min.) (1)	....	....	....	....	....		
Demineralized W.	....	....	....	....	....	....	....	....		
Desalinated W.	....	....	....	....	....	....	....	....		

**Notes:**

- 1) At most remote hydrant.
- 2) Allowable pressure drop shall be less than .... bar, for cooler, condenser and machine cooling equipment.
- 3) Cooling tower is designed based on cooling water return temperature of ... °C.

(to be continued)

**APPENDIX A (continued)**

**TABLE A.4 - WATER  
WATER SPECIFICATION**

DESCRIPTION	SERVICE			
	CIRCULATING COOLING WATER	COOLING TOWER MAKE - UP	RAW WATER	TREATED WATER (BFW)
- Availability over use (dm <sup>3</sup> /s) - Value (CENT/1,000 dm <sup>3</sup> ) - pH - Total hardness as CaCO <sub>3</sub> (mg/kg) - CALCIUM as CaCO <sub>3</sub> (mg/kg) - MAGNESIUM as CaCO <sub>3</sub> (mg/kg) - Total ALKALINITY as CaCO <sub>3</sub> (mg/kg) - SODIUM as CaCO <sub>3</sub> - POTASSIUM as CaCO <sub>3</sub> (mg/kg) - SULFATE as CaCO <sub>3</sub> (mg/kg) - CHLORIDE as CaCO <sub>3</sub> (mg/kg) - NITRATE as CaCO <sub>3</sub> (mg/kg) - SILICA as SiO <sub>2</sub> - Total IRON (mg/kg) - Suspended SOLIDS (mg/kg) - Dissolved SOLIDS (mg/kg) - COD (mg/kg) - Others				

**(to be continued)**

## APPENDIX A (continued)

TABLE A.5 - CONDENSATE

UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS

SYSTEM IDENTIFICATION	PROCESS / UTILITY BATTERY LIMIT CONDITIONS				EQUIPMENT MECHANICAL DESIGN CONDITIONS					
	PRODUCER BATTERY LIMIT		CONSUMER BATTERY LIMIT		PIPING		VESSELS AND EXCHANGERS		TURBINES	
	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C
HP Hot condensate										
LP Hot condensate										
Cold condensate										
Pump flashed condensate										

(to be continued)

**APPENDIX A (continued)**

**TABLE A.6 - ELECTRICAL POWER**

**A.6.1 ELECTRICAL SYSTEM VOLTAGE LEVELS**

<b>SYSTEM</b>	<b>VOLTAGE (volt)</b>
<ul style="list-style-type: none"> <li>- Generation</li> <li>- Power receiving from national grid</li> <li>- Distribution</li> <li>- Power (medium voltage)</li> <li>- Power (low voltage)</li> <li>- Lighting</li> <li>- Instrumentation                             <ul style="list-style-type: none"> <li>- Instrumentation (Shut-Down)</li> <li>- Control power for all</li> <li>- Switchgears</li> </ul> </li> </ul>	

**A.6.2 VOLTAGES TO THE MOTORS**

<b>MOTOR SIZE</b>	<b>VOLTAGE</b>	<b>PHASE</b>
<ul style="list-style-type: none"> <li>- Less than 0.4 kW</li> <li>- 0.4 kW and up to 150 kW</li> <li>- 151 kW and above</li> </ul>		

**(to be continued)**

**APPENDIX A (continued)**

**TABLE A.7 - FUEL  
FUEL SPECIFICATION**

DESCRIPTION	TYPE					
	OIL			GAS		
	FUEL OIL	NAPHTHA	START-UP OIL	FUEL GAS min. LHV	FUEL GAS max. LHV	NATURAL GAS
<ul style="list-style-type: none"> <li>- API gravity</li> <li>- Relative density at 15.6°C</li> <li>- Viscosity at 100°C (Pa.s)</li> <li>- Viscosity at the Burner (Pa.s)</li> <li>- Temperature at the Burner (°C)</li> <li>- Lower heating value for liquid fuels (kJ/kg)</li> <li>- Lower heating value for gas fuels (MJ/Nm³)</li> <li>- Availability over use (m³h)</li> <li>- VANADIUM / NICKEL (mg/kg)</li> <li>- SODIUM (mg/kg)</li> <li>- SULFUR (mg/kg)</li> <li>- ASH content (mg/kg)</li> <li>- Flash point (°C)</li> <li>- H<sub>2</sub>S (mg/kg)</li> <li>- Header pressure, normal [bar(ga)]</li> <li>- Header temperature (°C)</li> </ul>						

(to be continued)

**APPENDIX A (continued)**

**TABLE A.8 - FUEL**

**UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS**

SYSTEM IDENTIFICATION	PROCESS / UTILITY BATTERY LIMIT CONDITIONS				EQUIPMENT MECHANICAL DESIGN CONDITIONS			
	PRODUCER BATTERY LIMIT		CONSUMER BATTERY LIMIT		PIPING		VESSELS AND EXCHANGERS	
	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C
Fuel oil Supply								
Fuel oil Return								
Fuel gas								
Natural gas								
Naphtha								

**Note:**

The fuel system shall be designed in accordance with the requirements stipulated in "IPS-E-PR-340", "PROCESS DESIGN OF FUEL SYSTEMS".

**TABLE A.9 - AIR**

**UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS**

SYSTEM IDENTIFICATION	PROCESS / UTILITY BATTERY LIMIT CONDITIONS				EQUIPMENT MECHANICAL DESIGN CONDITIONS			
	PRODUCER BATTERY LIMIT		CONSUMER BATTERY LIMIT		PIPING		VESSELS AND EXCHANGERS	
	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C	bar (ga)	°C
Plant air								
Instrument air								
Regeneration air								

(to be continued)

**APPENDIX A (continued)**

**TABLE A.10 - AIR  
AIR SYSTEM SPECIFICATIONS**

DESCRIPTION	SERVICE	
	PLANT AIR	INSTRUMENT AIR
Availability, Nm <sup>3</sup> /h Driver type of compressors Furnished dry air dew point Will system furnish oil-free air? Total number of compressors		

**TABLE A.11 - INSTRUMENTS  
EXTENT OF METERING FOR UTILITY MEASUREMENT AS UNIT TOTALS**

STREAM	FLOW ELEMENT	RECORDER/INDICATOR (IN CONTROL ROOM)	NOTHING REQUIRED
Steam	Yes	Yes	
Feed water	Yes	Yes	
Condensate produced	—	—	×
Plant water	—	—	×
Cold condensate	Yes	—	
Cooling water supply	Yes	Yes	
Cooling water return	Yes	Yes	
Fuel oil supply	Yes	Yes	
Fuel oil return	Yes	Yes	
Fuel gas/natural gas	Yes	Yes	
Instrument air	Yes	—	
Electric power	Yes		



## APPENDIX B

### NOZZLES IDENTIFICATION

The following symbols will be used for identification of the nozzles.

<b><u>NOZZLE</u></b>	<b><u>IDENTIFICATION SYMBOL</u></b>
A, A2	Inlets
B	Outlet
C	Condensate
D	Drain or Draw-off
E*	
F	Feed
G	Level Gage or Gage Glass
H	Handhole
J	Pumpout
K*	
L	Level Instrument (also LT, LI)
M	Manhole
N	Reboiler Connection
P	Pressure Connection (also PT, PI)
R	Reflux
S	Steam or Sample Connection
T	Temperature Connection (also TI, TE, TW)
V	Vapor or Vent
W	Relief Valve Connection (Oversize unless actual size known)
*	Use E or K when none of the other symbols apply. Do not use I, O, Q, U, X, Y or Z.

APPENDIX C  
UTILITY SUMMARY TABLES

CONTRACTOR'S NAME	M I O C ARAK REFINERY PROJECT		CRUDE / VACUUM UNIT  UTILITY SUMMARY		OPERATION MODE [ ] NORMAL OPE [ ] PEAK OPE [ ] BLACK OPE [ ] START-UP [ ] EMERGENCY [ ] SHUT DOWN [ ] REDUCED OPE		NIOC No. DS. No. 01. 031		CON. PROJ. No.		UNIT No. 1		REV.						
	UNIT NAME CBU/VDU						NIOC PROJ. No. 2219		CONCEPT No.		SI								
	LOAD BHP (kW)	ELEC. POWER (kW)	STEAM, CONDENSATE, BFW, PURE WATER AND LOSS (1000 kg/h)																
			STEAM			COND. WASTE			COOLING WATER					FUEL (L/H)					
ITEM No.	SERVICE			MS	LPS	LLPS	COLD	HP	LP	3PM	PURE WATER	DEAL WATER	LOSS	TEMP WATER (m <sup>3</sup> /h)	FRESH WATER (m <sup>3</sup> /h)	TEMP. RISE (°C)	OIL (1000 (L/h)	GAS (1000 (L/h)	
E-173A/B	VACUUM COL. SLOP GAS DEL. COOLER														304.0				
E-173A/C	VACUUM TAR COOLER														645.0				
	TOTAL																		

Notes:

- + Indicates quantity generated.
- Indicates quantity consumed.
- ( ) Indicates spare or intermittent use. Not included in totals.
- [ ] Indicates auto-starting equipment.

(to be continued)

**APPENDIX C (continued)**  
**UTILITY SUMMARY TABLES**

CONTRACTOR'S NAME مهندس محمد علي		N I O C ABAK REFINERY PROJECT		UNIT NAME LPG RECOVERY		OPERATION MODE										NIOC No. 06-29-25-000		REV.	
																CON. PROJ. No.		UNIT No.	
																CON. SPEC. NO.		SIL OF	
ITEM No.	SERVICE	NITROGEN (Nm <sup>3</sup> /h)	AIR (Nm <sup>3</sup> /h) INST.	PLANT WATER (m <sup>3</sup> /h)	POT. WATER (m <sup>3</sup> /h)	INERT GAS (m <sup>3</sup> /h)	NAT. GAS (m <sup>3</sup> /h)												
	UTILITY STATIONS			138	137														
	INSTRUMENTATION		41																
F-SHLLA	FIRST STAGE CAUSTIC CIRCULATION			41															
F-SHLLB	FIRST STAGE CAUSTIC CIRCULATION			41															
F-SHLLA	SECOND STAGE CAUSTIC CIRCULATION			41															
F-SHLLB	SECOND STAGE CAUSTIC CIRCULATION			41															
	TOTAL		40	42															
NOTES: - INDICATED QUANTITY MADE. - INDICATED QUANTITY USED. R INDICATES SPARE OR INTERMITTENT USE. NOT INCLUDED IN TOTALS		5																	
		4																	
		3																	
		2																	
		1																	
		0																	
REV.	ISSUED FOR APPROVAL		DATE		BY		APPR.		REV.		DATE		BY		APPR.				