

GENERAL STANDARD

FOR

BASIC DESIGN PACKAGE

AND

RECOMMENDED PRACTICE

FOR FRONT END ENGINEERING DESIGN

FIRST EDITION

MARCH 2016

FOREWORD

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

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

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

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

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

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GENERAL DEFINITIONS

Throughout this Standard the following definitions shall apply.

COMPANY :

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

PURCHASER :

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

VENDOR AND SUPPLIER:

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

CONTRACTOR:

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

EXECUTOR :

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

INSPECTOR :

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

SHALL:

Is used where a provision is mandatory.

SHOULD:

Is used where a provision is advisory only.

WILL:

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

MAY:

Is used where a provision is completely discretionary.

0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" is intended for convenience of use and 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 recommended practice for the project stages which can be distinguished in every Project:

Stage I:	Feasibility Study
Stage II:	Conceptual Design
Stage III:	Basic Design
Stage IV:	front end engineering design (FEED)
Stage V:	Detailed Design
Stage VI:	Procurement
Stage VII:	Construction and Installation
Stage IIX:	Pre Commissioning and Commissioning
Stage IX:	Operating and Maintenance

The process engineering standards of this group include the following 12 Standard Specifications:

IPS-E-PR-150	"Engineering Standard for Basic Design Package and Recommended Practice for Feasibility Studies"
IPS-E-PR-170	"Engineering Standard for Process Flow Diagram"
IPS-E-PR-190	"Engineering Standard for Layout and Spacing"
IPS-E-PR-200	"Engineering Standard for Basic Engineering Design Data"
IPS-E-PR-220	"Engineering Standard for Process Control"
IPS-E-PR-230	"Engineering Standard for Piping & Instrument Diagrams (P&IDs)"
IPS-E-PR-250	"Engineering Standard for Performance Guarantee"
IPS-E-PR-260	"Engineering Standard for Detailed Design, Engineering and Procurement"
IPS-E-PR-300	"Engineering Standard for Plant Technical and Equipment Manuals (Engineering Dossiers)"
IPS-E-PR-308	"Engineering Standard for Numbering System"
IPS-E-PR-280	"Engineering Standard for Start-Up Sequence and General Commissioning Procedures"
IPS-E-PR-290	"Engineering Standard for Plant Operating Manuals"

This Engineering Standard Specification covers:

"BASIC DESIGN PACKAGE"

BASIC DESIGN PACKAGE

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1. SCOPE

This Engineering Standard Specification defines the Company's minimum requirements for the basic design package which is to be prepared by the basic design Contractor, concerning the format of the package and contents. The purpose of this Project Engineering Standard is to define the technical requirements for common design, fabrication, construction, repair and replacement in industries. It is also including maintenance and modification of existing equipment and facilities, and new facilities and equipment.

Note 1:

This standard specification is reviewed and updated by the relevant technical committee on Oct. 2003. The approved modifications by T.C. were sent to IPS users as amendment No. 1 by circular No. 219 on Oct. 2003. These modifications are included in the present issue of IPS.

Note 2:

This is a revised version of this standard, which is issued as revision (1)-2016. Revision (0)-1997 of the said standard specification is withdrawn.

2. REFERENCES

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

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-170	"Engineering Standard for Process Flow Diagram"
IPS-E-PR-200	"Engineering Standard for Basic Engineering Design Data"
IPS-E-PR-230	"Engineering Standard for Piping & Instrumentation Diagrams (P&IDs)"
IPS-E-PR-280	"Engineering Standard for Start-Up Sequence & General Commissioning Procedures"
IPS-E-PR-290	"Engineering Standard for Plant Operating Manuals"
IPS-E-PR-810	"Engineering Standard for Process Design of Furnaces"

3. SYMBOLS AND ABBREVIATIONS

Symbols and abbreviations referred to in this Standard are as follows:

<u>SYMBOL/ABBREVIATION</u>	<u>DESCRIPTION</u>
APC	Advanced Process Control
API	American Petroleum Institute
BEDD	Basic Engineering Design Data

BOD₅	The 5 Day Biological Oxygen Demand at 20°C
COD	The Total Chemical Oxygen Demand
DCS	Distributed Control System
HVAC&R	Heating, Ventilation, Air Conditioning Cooling & Refrigeration
IPS	Iranian Petroleum Standards
NPSH	Net Positive Suction Head
PFD	Process Flow Diagram
P&IDs	Piping & Instrumentation Diagrams

4. UNITS

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

5. FORMAT

5.1 Covers and Size

The basic design package shall be presented in the form of a book of one or more volumes, the format of which shall essentially conform to the requirements stipulated in this Standard. The format of following items shall essentially specified by company requirement, but not limited to:

- 1) Size of covers
- 2) Size and type of back covers
- 3) Color of covers and back covers
- 4) Color of title in covers and back covers
- 5) Form of title character
- 6) Printing of character

5.2 Titles

The basic design package shall be called:

"Basic Design Package"

The titles shall include:

- 1) Country's name
- 2) Company's name and emblem
- 3) Project name of location
- 4) Project designation
- 5) Plant/Unit name and number
- 6) Volume number, if more than one volume
- 7) Date of issue
- 8) Contractor's name and mark

9) Licensor's name and mark, (if any).

The typical arrangement of titles for the front and bottom are shown on Figs. 1 & 2 respectively.

6. CONTENTS OF BASIC DESIGN PACKAGE

The basic design package shall be sufficiently comprehensive to allow a third-party Contractor to carry out the detail design engineering, procurement/supply of equipment and shall comprise of technical data and information as required.

The contents shall essentially consist of the following items, though some of them can be deleted in accordance with the scope of the project and Company's requirements. The contents listed in Table 1 shall be prepared as common for all Units, whereas, the contents required as per Table 2 shall be prepared for each Unit separately and independent of the other Units.

6.1 Common for All Units

The documents listed in Table 1 contain the items which are common for all Units throughout the complex/refinery.

This common information shall be provided in an individual package apart from the contents shown in Table 2.

However, this information can be combined in the same volume containing the individual items for each Unit if only basic design of one Unit is required. The contents of each document shall be as described below:

6.1.1 General design data

6.1.1.1 General information

This shall include the following items where required:

- Project document list;
- Numbering system;
- Basis of design including Units design and normal capacities, specifications and properties of feed, raw materials and products;
- Battery limit conditions for various incoming / outgoing streams;
- Set of design calculations (this information shall be prepared in a separate volume and be attached to the basic design package);
- Simulation native files and result;
- Material general specifications;
- Design criteria (all disciplines);
- Product and raw material storage capacity;
- Design philosophy:
 - Driver's selection philosophy;
 - Control philosophy;
 - Safety concept philosophy;
 - ESD philosophy;
 - Drainage and disposal philosophy;

- Cost estimation report philosophy;
- Product loading, storage and dispatch philosophy;
- Other miscellaneous general requirements;

6.1.1.2 Basic engineering design data

This shall provide the necessary basic information required for the basic design of the facilities and shall contain the following information; reference should be made to [IPS-E-PR-200](#) "Basic Engineering Design Data (BEDD)":

- Standards and codes for design;
- Utility information;
- Site condition information;
- Regulations concerning environmental pollution (air, water disposal, noise, etc.);
- Equipment including instrumentation and electrical general design information;
- Other requirements such as general design information for buildings, insulation, painting, fire proofing, etc.

6.1.1.3 Complex/Plant material balance

This shall provide the overall feed and products material balance in the complex/plant. The data shall also be shown on the block flow diagram which shall be prepared by the basic designer.

6.1.1.4 Utility summary tables

The maximum estimated utility requirements in summer and winter cases shall be tabulated for whole complex/refinery.

The utility services to be considered are electric power, steam, condensate, boiler feed water, potable (drinking) water, fire water, plant (service) water, raw water, cooling water, chilled water, sea water, fuel gas, hot oil, fuel oil, natural gas, instrument and plant air, inert gas, nitrogen, etc. Special requirements such as purging nitrogen, plant air for regeneration and decoking, etc. shall be provided. For typical utility summary tables, reference should be made to [IPS-E-PR-290](#), "Plant Operating Manuals".

6.1.1.5 Flare load summary tables

Design and engineering shall be prepared whole flare system including flare design loads (for each emergency condition, e.g. power failure, steam failure, fire and other utility failure and blocked in condition), flare header, knock out drum, flare stack, flare line, required pipe racks and pipe sleepers.

Note: To this purpose, OWNER shall allocate dedicate routing space later.

Gas and liquid flow rates to be routed to the flare or blow down system shall be tabulated for each failure and each safety relief valve. The table shall be provided and completed for the required data as shown in [IPS-E-PR-290](#).

6.1.1.6 Effluent summary tables

All gaseous and liquid effluents and solid waste showing quantities and qualities of impurities which are

object of control (sulfur, phenol, oil, BOD₅, COD, etc.) shall be tabulated to facilitate determining the environmental impact of the project.

Basic design inputs/outputs data and information shall be provided for treatment of PROCESS UNITS/UNIT effluents with due regard to type, quantity and composition of the effluents and waste disposal (which is to be prepared and included in the respective ENGINEERING DESIGN SPECIFICATION) considering specific requirements of OWNER, and as are necessary for design and operation of effluents and waste disposal system.

6.1.1.7 Winterizing & heat conservation and insulation data

Design basis for winterizing and heat conservation shall be provided and a table indicating the basis of selection of tracer size and number for various pipeline sizes and fluid temperatures in the required winterizing temperatures shall also be presented.

Base data to select insulation thickness such as ambient temperature, wind velocity, insulation material and thermal conductivity, etc. shall be provided. Insulation thickness tables for selection of hot insulation, personnel safety, cold insulation and other purposes shall also be presented. Steam and electrical tracing shall be determined.

6.1.1.8 Health, safety and environmental

Minimum requirements shall be provided:

- a) Specifications, fire rating and identification of areas for fire proofing of steel structure, concrete structures, pipe racks and equipment.
- b) The H.S.E governmental (local) regulations, restricting items, codes & standards.
- c) Recommendation for fire-fighting facilities required for process Unit(s) and storage areas including rate of water/foam required, cooling system, deluge valve requirements and identification of the areas which require it.
- d) Recommendation for fire fighting facilities as well as provision of blast proof walls and/or roof for control room and substations.
- e) Recommendation for handling/storage of various chemicals, catalysts, hazardous materials etc.
- f) Number and location of safety showers, eye washes, fire hydrants, etc.
- g) Proposed methods of fire-fighting for different types of fires.
- h) Muster points location
- i) Risk assessment report
- j) HAZID study report
- k) Hazard source list
- l) HAZOP study report
- m) P&ID fire water supply system
- n) Major equipment data sheets
- o) Overall fire water network layout
- p) Hazardous area classification drawing
- q) Overall escape route and muster points location
- r) Any other specific HSE requirement.

6.1.1.9 Resins, chemicals, solvents and catalysts

a) The following information shall be prepared for each catalyst, packing and solid adsorbent employed in the process:

- Service;
- Name or designation;
- Acceptable suppliers;
- Volume required;
- Density;
- Pellet or grain size and shape;
- Design life;
- Regeneration characteristics;
- Hazardous, safety, disposal, warehousing.

b) The following information shall be provided for all resins, chemicals, additives, solvents and inhibitors employed in the process:

- Name or designation;
- Initial fill quantity;
- Annual consumption;
- Physical properties;
- Loading, unloading and make up procedures;
- Shelf life (if any);
- Any specific warehousing requirement.

6.1.1.10 Hazardous area classification

It shall indicate the sources of hazards and the extent of hazardous areas, providing area classifications (Fire Zone, Restricted Area, Impacted Area, Third Party Restricted Area) for the selection of electrical equipment.

6.1.1.11 Licensor's proprietary items

Sufficient process design data such as heat and material balance tables, required calculations and mechanical design data shall be supplied so as to perform detail design and procure the items from Licensor's approved manufacturers.

Licensor's standard engineering specifications and drawings for the detailed design of the specific Unit shall be provided. The Licensor shall supply these specifications and drawings as applicable to particular sections of the Unit. The specifications and drawings shall cover details or practices not given in the engineering procedures and specifications supplied by the Company.

6.1.2 Project specifications

Basic design package shall include all engineering standards and specifications and drawings applicable to the various parts of the project. The engineering standards/specifications shall be provided to define the basic requirements for basic design and engineering, Vendor selection, procurement, manufacturing, inspection and installation of the equipment and materials.

For the Licensed Units, the specific project engineering standards shall be provided by the Licensor together with the process design specifications.

Where required, specifications provided by the Licensor shall be adhered to the project general specifications by the basic engineering designer.

Contents of project specifications of each item are the process design basis & criteria including specifications, criteria, codes & standards, and standard drawings which shall be provided for the following items but not limited to these items:

- Fired heaters, including steam boilers, waste heat boilers, incinerators and all kinds of furnaces;
- Storage tanks, including all types of tanks, spheres, sumps and basins;
- Vessels, including all types of the vessels, towers, reactors, separators, and fractionators. The specifications for the internal parts of the vessels and towers such as trays, packings, distributors, etc. shall also be included in this section;
- Heat exchangers, including all types of the heat transfer equipment such as process to process heat exchangers, coolers, double pipe heat exchangers, reboilers, chillers, plate type heat exchangers, condensers, etc.;
- Machinery, including all types of compressors, turbines, blowers and pumps (e.g., rotary, reciprocating, centrifugal, etc.);
- Electrical, including all electric motors, cables, switches, transformers, generators, lighting, telecommunication, etc.;
- Instrument, including Distributed Control System (DCS), and all instrumentation systems and equipment such as alarms and shut-down systems, analyzers, transmitters, differential pressure elements, thermometers, thermocouples, level gages, pressure gages, control valves, measuring devices, cables, computer, etc.;
- Piping, including piping material, classification, lay-out, fittings, valves, etc.;
- Insulation, including project required insulation thickness tables and general specifications;
- Painting;
- Civil, including specifications for concrete, paving, stairs, platforms, structures, buildings, site preparations, rough gradings, foundations, etc.
- HVAC&R, including air conditioning and refrigeration general specifications and basic design data (e.g., room temperature, humidity, etc.);
- Miscellaneous, including all project specifications for package equipment, welding, buildings, safety, noise, etc. not included in the above mentioned specifications.

6.1.3 Manuals

Basic engineering designer should prepare the following preliminary manuals if required by the Company. Each manual shall be provided in an individual bound volume apart from the basic design package.

6.1.3.1 Operating manual

The operating manual shall include and outline of start-up, shut-down and alternative operations. It shall also indicate emergency procedures covering utility failures and major operating upsets. In addition, all safety procedures, catalyst regeneration instructions and process descriptions in the all operation modes shall be included. For further information on the contents of operating manual, reference should be made to [IPS-E-PR-290](#), "Plant Operating Manuals". This operating manual shall be reviewed and revised/completed at the end of detail design phase.

6.1.3.2 Laboratory manual

The laboratory manual shall include the following:

a) Laboratory equipment:

- Equipment list;
- Basic specifications.

b) Laboratory building:

- Building plot plan;
- Equipment location diagram;
- Utility distribution diagram.

c) Analytical method for:

- Raw materials;
- Chemicals;
- Process control;
- Products;
- Catalysts;
- Water impurities.

d) Instructions for sample taking and its frequency.

This laboratory manual shall be reviewed and revised/completed at the end of detail design phase.

6.1.3.3 Performance test run procedure

The manual shall include details of performance test runs and other aspects of commissioning such as:

- Operating data to be recorded by the Company in the log book;
- Sampling method;
- Analytical methods;
- Methods of calculations;
- Interpretation and measuring of parameters during the test;
- Methods of taking operating data;
- Methods of evaluating the Unit performance.

For further information, reference should be made to [IPS-E-PR-280](#), "Start-Up Sequence & General Commissioning Procedures".

6.1.4 Drawings

6.1.4.1 Flow diagram legend & general notes

Flow diagram legend and general notes shall be prepared to cover all legends / symbols to be used in the

engineering documents. If the legends and/or symbols cannot be integrated and indicated on one flow diagram, a specific project document shall be provided to cover all required legends, symbols and general notes. Reference is [IPS-E-PR-170](#) and [IPS-E-PR-230](#).

6.1.4.2 Complex/plant plot plan

A preliminary plot plan shall be provided to show layout of control room(s), process Unit(s), utility Unit(s) offsite facilities, tankage, loading and unloading facilities and other buildings, basins, etc. throughout the complex/plant. The plot plan shall be prepared in accordance with the safety, operation and maintenance requirements instructed by the Company's engineering standards and approved by the Company.

6.1.4.3 Block flow diagram

Overall simplified schematic diagram of the all Units showing all process Units, utility and offsite facilities shall be provided. The complex/refinery terminal material balances shall also be shown.

6.2 Individual Items for each Unit

Basic design package for each individual Unit shall contain the documents listed in Table 2. The subjects covered in the common items as described in Article 6.1 above should not be repeated in this Part. The contents of each document shall be in congruent with but not be limited to the following items:

6.2.1 General design data

6.2.1.1 General information

At least the following information shall be included:

- Brief description of the Unit different operation modes;
- Specifications and properties of feed, raw materials and products;
- Battery limit conditions for various incoming / outgoing streams;
- Other miscellaneous general requirements.

6.2.1.2 Unit design basis

Unit design basis shall include but not be limited to the following:

- Unit normal and design capacity and turn-down ratio and expected yields (SOR & EOR, where required) of the products;
- Test methods and procedures;
- Storage, handling and safety aspects;
- design calculations, where required by the Company;
- Other design requirements;
- Feed and product characteristic;
- Utility condition.

6.2.1.3 Material selection philosophy

The purpose of "Material selection philosophy" document is to specify minimum process requirements for

corrosion allowance and material selection.

The piping selection made during the EPC phase may include more stringent requirements for some media, and for fittings, valves etc.

The unit will be designed for the lifetime of equipments and piping is specified in this document.

This document shall be read in conjunction with the Material Selection Diagrams (MSD).

6.2.1.4 Equipment list

All equipment in the Unit shall be listed, together with item number, name, quantity, service material, unit and total weight, size/dimension referenced P&ID.

6.2.1.5 Heat & material balance tables

Heat & material balance table shall be provided to indicate the stream properties [such as flow rates, phase, composition, temperature, pressure, operating and standard relative densities (specific gravities) or densities, enthalpies, viscosities and molecular mass (weight) for gases and vapors] for each stream number shown on the PFD.

Individual heat & material balance tables shall be provided for each various case including different feed and operational mode, seasonal case and SOR/EOR case.

For typical heat & material balance table reference should be made to [IPS-E-PR-290](#), "Plant Operating Manuals".

6.2.1.6 Utility summary tables

The normal and maximum estimated utility requirements for each Unit including tankage and offsite facilities shall be tabulated. Such figures shall be consistent with a single operating case.

The services to be considered are fuel (all types), electrical power, steam and condensate (all levels), boiler feed water, water (all services), cooling water, air (instrument and plant), nitrogen, inert gas, etc. where required. For typical utility summary tables, reference should be made to [IPS-E-PR-290](#).

6.2.1.7 Flare load summary tables

See Article 6.1.1.5 above.

6.2.1.8 Effluent summary tables

See Article 6.1.1.6 above.

6.2.1.9 Health, safety and environmental

See Article 6.1.1.8 above.

6.2.1.10 Resins, chemicals, solvents and catalysts

See Article 6.1.1.9 above.

6.2.1.11 Hazardous area classification

See Article 6.1.1.10 above.

6.2.1.12 List of detail design document to be review by basic designer/licensor after detail design

This shall include review and approval by Licensor or basic engineering designer for critical equipment detailed design data, information and drawings and critical piping detailed design with respect to the Licensor's basic design. The equipment and facilities to be reviewed by the Licensor/basic designer shall be clearly described for all services in this section.

6.2.2 Specifications & data sheets

Specification sheets indicating all process and mechanical basic design data required for designing the equipment shall be provided. Further specific design information shall be inclusively provided together with the data sheets where required.

The blank forms of the equipment data sheets shall be prepared in accordance with the data sheets and requirements stipulated in the project specifications and/or standards attached to the basic design package.

All blank forms of the equipment data sheets shall be approved by the Company.

The units of measurement used in the data sheets shall be based on International System of Units, (SI) except where otherwise specified.

Equipment data sheets shall include the following general requirements in additions to the items specified for each individual equipment data sheet as described herein below:

- Equipment item number;
- Type;
- Quantity;
- Applicable standards and codes;
- Service;
- Material table;
- Corrosion allowances where required;
- Site conditions;
- Capacity/dimensions;
- Nozzles identification table including rating, size and quantity for each nozzle;
- Fluid service and physical properties.

6.2.2.1 Fired heaters

a) Furnaces and non-reaction type heaters

API type data sheets (see [IPS-E-PR-810](#)) shall be used for non-reaction type heaters.

The following information is required and included in the basic design package:

- Type of heater and coil arrangement;
- Vaporization curves;
- Fluid flow rates;

-
- Operating and design temperatures and pressures at inlet and outlet;
 - Heat duty and physical properties at inlet and outlet conditions;
 - SOR & EOR design and allowable pressure drop and allowable differential temperature;
 - Maximum turn-down ratio of heater and burner considering its effect on the Unit performance;
 - Fuel characteristics such as type, composition, viscosities, impurities, etc.;
 - Minimum efficiency;
 - Limiting fluid peak temperatures;
 - Limiting transfer rates or velocities;
 - Heat flux density (maximum allowable);
 - Control specifications;
 - Specific design and fabrication requirements;
 - Whether air preheat system envisaged with forced draft fans and ducting is required;
 - Whether induced draft fan is required;
 - Material of construction for tubes;
 - Corrosion allowances;
 - Maximum allowable excess air for any type of fuel;
 - Type of terminal fittings;
 - Whether coil temperature and pressure profile is required from Vendor;
 - Whether steam-air decoking is required;
 - Burner arrangement;
 - Maximum allowable flue gas temperature;
 - Refractory type;
 - Environmental and safety aspect.

b) Reaction type heaters

For this type of heater involving a thermal or catalytic reaction in addition above item, the following information shall be included:

- Conceptual furnace design;
- Capacity and dimensions;
- Inlet and outlet design and operating conditions and design parameters;
- Radiant tube maximum allowable diameter and material of construction;
- Heat flux (maximum allowable and normal);
- Heat transfer coefficient;
- Duty for each operating case;
- Number of cells;
- Specific mechanical design where required;
- Description of kinetics involved;
- Any other requirements.

6.2.2.2 Storage tanks

The data sheet shall include but not be limited to the following items:

- Type (e.g., floating roof, fixed roof, double roof, spherical, etc.);
- Dimension and nominal capacity;
- Operating and design temperature and pressure;
- Maximum operating temperature and pressure;
- Fluid properties;
- Internal facilities such as air Sparger, steam heater, mixers and other requirements;
- Requirements of insulation;
- Any special surface finish requirement including painting, sandblast (internal and external surfaces);
- Stress relieving & post weld heat treating requirement;
- Instrumentation requirements;
- A simplified storage tank sketch showing all internals and nozzles and instrumentation;
- Loading and unloading rates;
- Inspection requirement;
- Type of walkway;
- Ladder and stairway;
- Fire fighting requirement.

6.2.2.3 Towers, reactors and vessels

Outline sketches for towers, reactors and vessels and filters shall be prepared, including the following data as minimum requirement:

- Diameter and height or length;
- Number, type and spacing of trays (for columns);
- Type and spacing of internals for reactors;
- Operating and design temperature and pressure;
- Materials and corrosion allowances;
- Liquid levels and/or interface levels;
- Insulation requirement;
- Basic information of internals such as seal pans, distributors, spray nozzles, packing, demisters, chimney tray, etc.;
- Lining or cladding requirements;
- Special performance requirements for other process equipment such as coalesces, cyclones and separators, etc.;
- Space velocity (normal and design), conversion per pass (normal and design), reactor pressure drop (SOR & EOR), recycling (normal and design), reactor inlet and outlet conditions (normal and design), reactor bed temperature profile (normal and design) for reactors;
- Bed arrangement in reactors catalyst (type and detail);

- Vapor/liquid loading for towers;
- Foaming characteristics; July 1997 IPS-E-PR-150
- Stress relieving requirement;
- Requirements of mist eliminators, supports, mesh or packing, etc.;
- Nozzles identification table including quantity, rating and size of all nozzles (e.g. process, instruments, manholes, etc.);
- Nozzles elevations excluding elevations of level gauge, transmitter and switch;
- Instrumentation requirements;
- Skirt or leg requirement;
- Fire proof requirements.

6.2.2.4 Heat exchangers

The data sheets for shell and tube type heat exchangers, chillers, coolers, condensers, process heat exchangers, air coolers and special type heat exchangers shall be prepared, including the following data as minimum requirement. The rating of heat exchangers shall be included in the detail engineering phase in the Contractor's or Vendor's scope of work:

- Temperature control system;
- Duty (normal and design);
- Hot and cold side detail;
- Flow rates for liquid/vapor phases separately;
- Physical properties of the fluid such as specific heat, boiling temperature, viscosities, densities, thermal conductivities, etc.;
- Surface intention;
- Inlet and outlet temperature and pressure;
- Maximum allowable and normal operating pressure drop;
- Fouling resistances;
- Condensing or vaporization curve (if necessary);
- Type of TEMA design;
- Mechanical design conditions;
- Materials and corrosion allowances;
- Limiting transfer rates and velocities where applicable;
- Restrictions on combining air fin services;
- Tube and baffle arrangement;
- Alternative specifications for specific services;
- Tube layout and arrangement;
- Baffle arrangement;
- Driver load, shaft power, number of bay, number of unit;
- Fan detail, tube arrangement, adjustable device for fan detail, induce force specification for air coolers;
- A simplified sketch showing nozzles and general configuration for kettle type exchangers, the

sketch shall also include vapor space, surge volume required, high/normal/low liquid levels and instrumentation.

6.2.2.5 Machinery

The data sheets shall be provided for pumps, compressors, blowers, expanders and turbines, etc., including the following data as minimum requirement:

- Type;
- Minimum, normal and maximum flow rates required considering all modes of operations;
- Material of construction and corrosion allowances;
- Special mechanical/process features required;
- Operating and design temperatures and pressures at suction and discharge;
- Surge system and control requirements (noise control, speed control, mode of control requirements, etc);
- Physical properties of the fluid at suction and discharge conditions;
- Basic recommendations for spares;
- Break horsepower and shaft power;
- Sealing and lubrication requirements;
- Cooling (if any) basic requirements; (type of cooling water and its requirements);
- Adiabatic and polytropic efficiency, performance curve and characteristic if available;
- NPSHA;
- Alternative specifications if necessary for specific services;
- Spare philosophy of machinery;
- Spare part requirements;
- Flushing requirements;
- Speed (rpm);
- Filter and strainer size and type for auxiliary;
- Number of stages of turbine, compressor and pump;
- Noise limit and environmental data;
- Safety devices;
- Governor type for turbines and expander;
- Turndown ratio for machinery;
- Any other requirement.

6.2.2.6 Electrical

The following specifications and/or data sheets shall be provided if not included in the common specifications as described in Article 6.1 above.

- a) Specifications of power supply system and electrical installation.
- b) Specifications of emergency power supply.
- c) Single line diagram.
- d) Requirement of information for:
 - Interlocking method with instrumentation system;

- Fire alarm system;
 - Lighting system;
 - Consumers requiring emergency power and duration of it;
 - Any other electrical equipment/system.
- e)** Information for motor controls (local, central, etc.) with reference to measurement required for Units as follows:
- Control, indication, metering and annunciation philosophy of various drivers with basic logic diagrams;
 - Data on control requirements like remote start-up, auto start-stop for motors.
- f)** High, medium and low voltage requirements for each Unit.
- g)** Implications of power failure and recommended Unit's emergency supply scheme for all types of electrical loads which require emergency power.
- h)** List of drives requiring emergency power feed along with their power consumption.
- i)** Specifications of critical drives/variable speed drives and their controls.
- j)** Requirements of Uninterrupted Power Supply (UPS) system such as:
- Total load;
 - Rated voltage and permissible variation. Duration for which UPS system shall be designed;
 - Maximum change-over time allowed;
 - Step load/permissible voltage dip;
 - In-rush current in worst case;
 - Load power factor;
 - Redundancy, if needed.
- k)** Electrical Load List.
- l)** Electric motor driver's data sheets.
- m)** Main Cable Schedule.
- n)** Typical Diagrams
- Typical diagram shall consist of protection, measuring, schematic, interlocking and intertripping concepts at least as follows:
- All protections;
 - Location of their actions (open, close, permission, information, alarm, etc).
- o)** Load Shedding Study.
- p)** Motor Starting Study.
- q)** Sizing of Electrical Equipment.
- r)** Load flow and short circuit calculation.
- s)** Dynamic stability study.
- t)** Governor and AVR Models and transfer function block diagrams.
- u)** Voltage level selection.
- v)** NEUTRAL GROUNDINGX) CABLE SIZING CALCULATION NOTESY) EARTHING GRID SIZING NOTE.
- w)** LIGHTNING PROTECTION STUDYA) SUBSTATIOIN LOCATION DRAWINGS AND MAIN CABLE ROUTINGS.
- x)** SUBSTATION ARRANGEMENT LAYOUT.
- y)** For more information see IPS-E-EL-100.

6.2.2.7 Instrument

The following information, drawings, specifications and/or data sheets shall be included in this section. The following specifications should not be duplicated in case of inclusion in common part as described in Article 6.1 above.

- a) Information for alarm signal and interlocking system.
- b) List and specification for special control and measuring system.
- c) Preliminary layout for physical arrangement of operator stations in the central control room/ control rooms including reference to the requirements regarding ventilation, air-conditioning, UPS, etc.
- d) Recommendation on transmission system of instruments.
- e) Special requirements for Process Control System (PCS), Emergency Shutdown (ESD) and Unlimited Safety System (USS) not included in the general specification for each individual process Unit.
- f) Requirements for Advanced Process Control (APC) and Optimization.
- g) Calculation and sizing of all flow measuring devices.
- h) List and basic specifications of instruments.
- i) The specification/data sheets shall include the following items as minimum requirements:
 - Tag number;
 - Name and service;
 - Quantity;
 - Unit and Location;
 - P&ID number;
 - Area classification requirement;
 - Applicable standards/codes;
 - Basic design data;
 - Process design data;
 - Materials of construction;
 - Instrument operating range;
 - Alternate operation modes (if any).
- j) Specification/data sheets shall be provided for but not be limited to the following equipment:
 - Alarms;
 - Interlocks;
 - Analyzers;
 - Flow instruments;
 - Pressure instruments;
 - Level instruments;
 - Level switches;
 - Tank gauging;
 - Transmitters;
 - Temperature instruments;
 - Orifice plates, orifice flanges and other primary flow elements;
 - Control valves;
 - Fire and gas detectors;
 - Safety relief valves;
 - Motor operating valve (MOV), BDV and ESD valve;

- Junction boxes;
 - Solenoid valves;
 - Converters.
- k) CV calculated and estimated valve size as per the Manufacturer Catalogue (competent manufacturers), flow rates and operating range, operating conditions, applicable physical properties of process and utility streams, action of the measured variable, flashing status of the fluid and position in case of air failure shall be provided in the specification sheets for all types of control valves.
- l) Flow rates, set pressure, operating conditions, relieving conditions with applicable physical properties of the emergency stream for each emergency case and type of the valve and selected and calculated orifice size shall be provided in the specification sheets for all types of safety relief valves.
- m) The estimated required layout for physical arrangement of control panels in the central control room/ control rooms/technical rooms including sizing of ventilation, air conditioning, UPS, computers room and other facilities required described elsewhere, etc. shall be provided.
- n) Requirement / information for:
- Paging system;
 - Telecommunication system
 - Telephone system PABX
 - Telephone system PMBX
 - Closed Circuit Television System (CCTV)

6.2.2.8 Piping/Pipeline

The following information, drawings, specifications and/or data sheets shall be included for piping/pipeline. The following specifications should not be duplicated in case of inclusion in common part as described in Article 6.1 above.

- a) GEOLOGICAL & GEOTECHNICAL STUDIES REPORT
- b) piping/pipeline ROUTE diagrams, Analysis and Plans
- c) CROSS SECTION DRAWING VOLUMETRIC
- d) VOLUMETRIC EARTH CALCULATION and ANALYSIS REPORT
- e) Steady and dynamic states/HYDRAULIC CALCULATION (flow assurance study)
- f) PIGGING REQUIREMENT STUDY
- g) DEPRESSURIZING AND BLOWDOWN TIME CALCULATION STUDY
- h) PIPING DIAGRAMS and modeling
- i) Stress Analysis and Thickness Calculation
- j) Specification for Insulation, Painting, Coating, Heat Tracing
- k) LINE LIST, Valve list, etc.
- l) Specification and Requirement for Under Ground/ Above Ground
- m) Specification for Pipe Racks and Sleeper
- n) TIE IN point/LIST
- o) STANDARD DRAWING LIST
- p) DATA SHEETS AND SPECIFICATION FOR CASING AND CASING MATERIAL

- q) DATA SHEETS AND SPECIFICATION FOR BOLTS & NUTS
- r) DATA SHEETS AND SPECIFICATION FOR GASKETS
- s) DATA SHEETS AND SPECIFICATION FOR FLANGES
- t) DATA SHEETS AND SPECIFICATION FOR FITTINGS
- u) DATA SHEETS AND SPECIFICATION FOR PIG LAUNCHER & RECEIVER TRAP
- v) DATA SHEETS AND SPECIFICATION FOR ANCHOR FLANGES
- w) DATA SHEETS AND SPECIFICATION FOR INSULATING JOINT
- x) DATA SHEETS AND SPECIFICATION FOR VALVES
- y) DATA SHEETS AND SPECIFICATION FOR PIPES
- z) SPECIFICATION FOR FIELD HYDROSTATIC TEST
- aa) PRELIMINARY MATERIAL TAKE OFF
- bb) CATHODIC PROTECTION BASIS & CRITERIA
- cc) CATHODIC PROTECTION MATERIAL TAKE OFF

6.2.2.9 Miscellaneous

Specifications and data sheets shall be provided for the miscellaneous equipment not included in other equipment category items. Complete duty specification to be provided for each item including all process and mechanical design data as required for the equipment basic design and operation in different modes.

6.2.3 Drawings

6.2.3.1 MSD (Material Selection Diagram)

This document provides corrosion allowance and materials of equipments and the main lines in a unit based on process fluid properties and design condition.

6.2.3.2 Preliminary unit plot plan

The plot plan in the basic design shall be based on the preliminary equipment dimensions and shall include preliminary layout of control room(s), buildings, equipment and other required facilities in the Unit. For Licensed Units, the plot plan should be prepared based on the Licensor's information and requirements for normal and emergency operation, HSE requirement and maintenance.

The Unit plot plan shall be prepared with due consideration to the overall plot plan layout of the entire plant and interrelations of the Unit with other Units.

6.2.3.3 Process flow diagram (PFD)

PFD shall be provided in accordance with the requirements stipulated in [IPS-E-PR-170](#) for each Unit separately.

6.2.3.4 Piping & instrumentation diagrams (P&IDs)

P&IDs shall be prepared in accordance with the requirements outlined in [IPS-E-PR-230](#). P&IDs shall be

provided for each Unit separately and shall include all facilities, piping and equipment and interconnections between the Unit and adjacent facilities. Interconnection P&IDs shall also be prepared to clarify piping connection points and their tie-in between the new plant and other adjacent Units.

6.2.3.5 Utility distribution flow diagrams (UFD)

UFD shall be provided for each Unit separately and shall include all equipment item numbers which are utility consumer or producer with all required pipelines and interrelations between headers/sub headers and all utility users.

6.2.3.6 Emergency shut-down block diagram and/or logic diagram.

6.2.3.7 Cause & effect tables/diagrams.

6.2.3.8 Single line diagrams.

7. ARRANGEMENT

Contents of the basic design package shall be arranged in sequence as shown in Tables 1 and 2 with partition papers with titles inserted for each section.

TABLE 1 - CONTENTS OF BASIC DESIGN PACKAGE (COMMON FOR ALL UNITS)**1. GENERAL DESIGN DATA**

- 1.1 General Information
- 1.2 Basic Engineering Design Data
- 1.3 Complex/Plant Material Balance
- 1.4 Utility Summary Tables
- 1.5 Flare Load Summary Tables
- 1.6 Effluent Summary Tables
- 1.7 Winterizing & Heat Conservation and Insulation Data
- 1.8 Health, Safety and environmental
- 1.9 Resins, Chemicals, Solvents and Catalysts
- 1.10 Hazardous Area Classification
- 1.11 Licensor's Proprietary Items

2. PROJECT SPECIFICATIONS

- 2.1 Fired Heaters
- 2.2 Storage Tanks
- 2.3 Towers, Reactors and Vessels
- 2.4 Heat Exchangers
- 2.5 Machinery
- 2.6 Electrical
- 2.7 Instrument
- 2.8 Piping
- 2.9 Insulation
- 2.10 Painting
- 2.11 Civil
- 2.12 HVAC&R (Heating, Ventilation, Air Conditioning Cooling & Refrigeration)
- 2.13 Miscellaneous

3. MANUALS**4. DRAWINGS**

- 4.1 Flow Diagram Legend & General Notes
- 4.2 Complex/Refinery Plot Plan
- 4.3 Block Flow Diagram

TABLE 2 - CONTENTS OF BASIC DESIGN PACKAGE (INDIVIDUAL ITEMS FOR EACH UNIT)**1. GENERAL DESIGN DATA**

- 1.1 General Information
- 1.2 Unit Design Basis
- 1.3 Material selection philosophy
- 1.4 Equipment Item Index
- 1.5 Heat & Material Balance Tables
- 1.6 Utility Summary Tables
- 1.7 Flare Load Summary Tables
- 1.8 Effluent Summary Tables
- 1.9 Health, Safety and environmental
- 1.10 Resins, Chemicals, Solvents and Catalysts
- 1.11 Hazardous Area Classification
- 1.12 List of detail design document to be review by basic designer/licensor after detail design

2. SPECIFICATIONS & DATA SHEETS

- 2.1 Fired Heaters
- 2.2 Storage Tanks
- 2.3 Towers, Reactors and Vessels
- 2.4 Heat Exchangers
- 2.5 Machinery
- 2.6 Electrical
- 2.7 Instrument
- 2.8 Piping
- 2.9 Miscellaneous

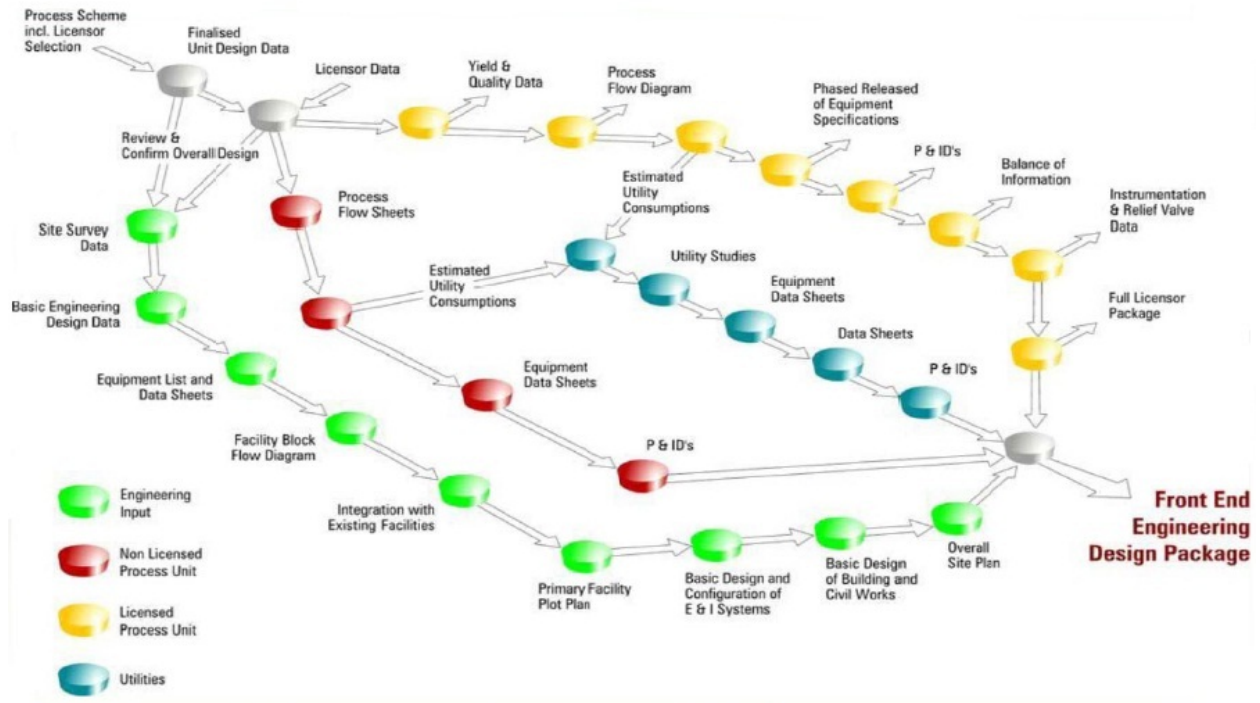
3. DRAWINGS

- 3.1 Preliminary Unit Plot Plan
- 3.2 Material selection diagram (MSD)
- 3.3 Process Flow Diagram (PFD)

- 3.4 Piping & Instrumentation Diagrams (P&IDs)
- 3.5 Utility Distribution Flow Diagrams (UDFDs)
- 3.6 Emergency shut-down block diagram and/or logic diagram
- 3.7 Cause & effect tables/diagrams
- 3.8 Single line diagrams

APPENDICES

APPENDIX A
BASIC DESIGN AND FEED PACKAGE



Islamic Republic Of Iran

Ministry Of Petroleum



National Iranian Oil Company

REFINERIES ENGINEERING AND CONSTRUCTION

ARAK REFINERY

BASIC DESIGN

COMMON

MARCH 1991

 **JGC CORPORATION** **TPL** SpA

TYPICAL ARRANGEMENT OF TITLE FOR FRONT COVER

Fig. 1

Islamic Republic Of Iran

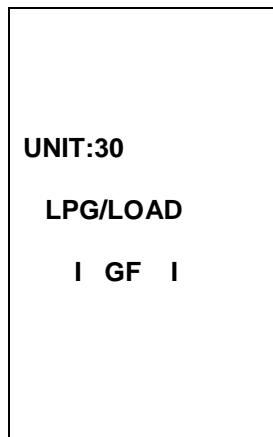
Ministry Of Petroleum



National Iranian Oil Company

REFINERIES ENGINEERING AND CONSTRUCTION

**ARAK REFINERY
BASIC DESIGN PACKAGE**



MARCH 1991

TYPICAL ARRANGEMENT OF TITLE FOR BOTTOM COVER

Fig. 2

PART TWO

RECOMMENDED PRACTICE FOR FRONT END ENGINEERING DESIGN

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0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for Front End Engineering Design Stage (FEED Stage)" is intended for convenience of use and pattern of follow-up and also guidance. These Standard Engineering Practice Manuals also indicate the check points to be considered by the process engineers for assurance of fulfillment of pre-requisitions at any stage in the implementation of process plant projects and engineering phases.

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 General and Recommended Practice FEED Requirement phases which should be distinguished in every Project.

Any project must be cost-effectively delivered on ever-tighter schedules by firms and their project teams dealing with an increasing shortfall in the number of highly skilled engineers available to tackle these challenges. The ability to secure, in a timely fashion, materials and labor to deliver projects or carry out maintenance is critical to business success and requires effective information sharing among the multi-disciplinary firms typically involved in these efforts.

1. SCOPE

This Engineering Standard Specification defines the Company's minimum requirements for the "Front End Engineering Design Stage (FEED Stage)" Package which is to be prepared by the Front End Engineering Design team or Contractor, concerning the format of the package and its contents. But prior of the preparation of this Package a Basic Engineering Design should be carried out according to procedure presented as per part one of this standard.

2. REFERENCE

- Teaching Front End Engineering Design (FEED),Richard Devon & Kathryn Jablokow, Penn State University
- Best Practices in Front-End Design,A Bentley White Paper,Arvind Patel,Business Development Manager, Conceptual Design and FEED Application
- Engineering Design Integrity Work flow,Article & Design Practice ,amec,2011
- Petrofac Training Manual, Process Engineering, GET - Process , 05-Mar-2009
- Approaching to Front End Engineering Design ,Arvind G.N.Patel.Bentley Uk.,Hydrocarbon Engineering ,Jan-2008
- General Process Specification,GS ECP 105,Total Engineering & Practice-Rev.02-2003

3. SYMBOLS AND ABBREVIATIONS

Symbols and abbreviations referred to in this Standard are as follows:

Symbol/Abbreviation	Description
FEED/FEL :	Front End Engineering Design/ Front End Loading
EPC:	Engineering Procurement Construction
HSE :	Healthy, safety, environmental
C&I	Control and Instrument
FAT :	Factory Acceptance Test
SAT:	Site Acceptance Test
PAT :	Performance Acceptance Test
H&MB:	Heat and Material Balance
HAZID :	Hazard Identification
HAZOP:	Hazard and Operability Study
AFD/AFC :	Approve for Design/Construction
IDC :	Internal Discipline Check
TDR :	Technical Document Register
PPR :	Pre-Project Planning
ROA :	Return of Asset
FPSO:	Floating production storage and offloading
SDV/ESDV :	Shut-Down Valve/Emergency Shut Down Valve
APC	Advanced Process Control
API	American Petroleum Institute
BEDD	Basic Engineering Design Data
DCS	Distributed Control System
IPS	Iranian Petroleum Standards
NPSH	Net Positive Suction Head
PFD	Process Flow Diagram
P&ID	Piping & Instrumentation Diagrams
CAPEX	Capital Expenditure
OPEX	Operating Expenditure/Expense
HMI:	Human-Machine Interface
IEC:	International Electrotechnical
MAC:	Main Automation Contractor
OTS:	Operator Training Simulator

4. UNITS

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

5. FORMAT

5.1 Covers and Size

The Conceptual Design Package shall be presented in the form of a book of one or more volumes, the format of which shall essentially conform to the require following format shall be applied for the basic design package

- **Size of covers**
230 mm × 300 mm (bound on the 300 mm side)

- **Size and type of back covers**
70 mm max. Thickness and integral with covers

- **Color of covers and back covers**
Bluesteel, without window

- **Color of title in covers and back covers**
Golden

- **Form of title character**
Block letters

- **Printing of character**
Silk screen process.

5.2 Titles

The FEED package shall be called: "Fundamental Requirements for the Front End Engineering Design Package"

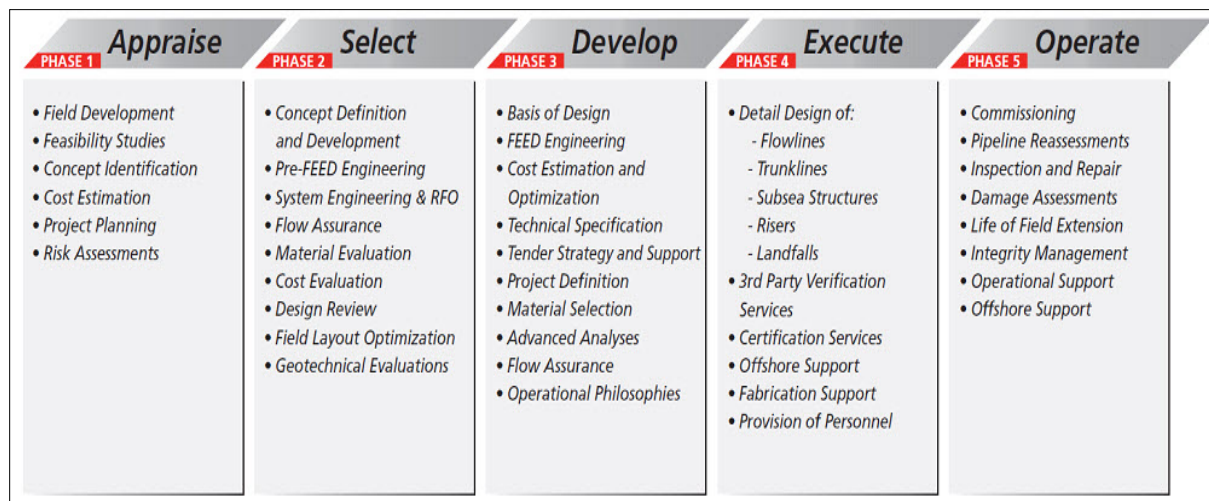
The titles shall include:

- 1) Country's name
- 2) Company's name and emblem
- 3) Refinery/plant name or location
- 4) Project designation
- 5) Plant/Unit name and number
- 6) Volume number, if more than one volume
- 7) Date of issue
- 8) Contractor's name, and mark
- 9) Licensor's name and mark, (if any).
- 10) The typical arrangement of titles IPS-E-PR-200.

6. DEFINITION STAGES OF OIL AND GAS ENGINEERING, EXECUTION PLAN OR PHASES

Process industries can improve project performance by adopting a multi-disciplinary, concurrent workflow that ensures all engineering decisions made during the conceptual design, Basic and front-end engineering phases of a project are based on the best design practices. Ever more design decisions, such as material selection and plant layout that are typically made at the detailed design phase, are now made at the front-end engineering and design (FEED) phase. In fact, detailed P&IDs and 3D plant models (30, 60 and 90 percent) at the FEED phase are developed much earlier so that informed decisions based on cost implications can be made.

It should be noted that major maintenance or constructability issues would be arisen during the engineering/procurement/construction (EPC) phase. Below chart shows phase of engineering activity during each oil, gas and petrochemical project as a typical guideline:



PHASE OF ENGINEERING ACTIVITY DURING OIL, GAS AND PETROCHEMICAL PROJECTS

Fig. 1

For more information see IPS-E-PR-150.

7. FEED PHASE

The FEED phase bridges the gap between the design concept and the detailed design phase. In this task, the overall system configuration is defined, and schematics, diagrams, and layouts of the project will provide early project configuration. During detailed design and optimization, the parameters of the part being created will change, but the FEED focuses on creating the general framework to build the project.

7.1 Front-End Engineering Primary Definitions

Front-end engineering is the first step in engineering design. It defines requirements and covers the preparation of the engineering data that is needed to start detail design. This phase typically parallels the preparation of piping and instrumentation diagrams (P&IDs) and the completion of hazard analysis for all processes. The hazard analysis is an essential part of the design FEED activities.

In general, the following documents should be completed during the front-end engineering phase and finalized before the start of detailed design:

- The P&IDs,
- The control system definition (which may include a preliminary instrument index), and
- The logic diagrams

On some projects, two additional documents may be required:

- Scope-of-work preparation for the engineering contractor that will do the detailed engineering),
and
- Scope-of-work preparation for the supplier of packaged equipment, such as water treatment facilities, boilers, compressors, and so on.

7.2 A good FEED will reflect all of the client's project-specific requirements and avoid significant changes during the execution phase. During the FEED phase there is close communication between Project Owners and Operators and the Engineering Contractor to work up the project-specific requirements.

7.3 The following project specifications are thoroughly extracted and would be developed in detail design phase:

- Process Flow Diagrams, Piping and Instrument Diagram
- Project Organization Chart
- Project Scope
- Defined Civil, Mechanical and Chemical Engineering
- HAZOP, safety and ergonomic studies
- 2D & 3D Preliminary Models
- Equipment layout and installation plan
- Engineering design and development of packages equipment
- Automation strategy
- Project timeline
- Major equipment list
- Long-lead quotation

7.4 The accuracy of cost estimation study in FEED stage should be ± 10 percent of total project cost.

7.5 During FEED phases the Engineering Services consultancy team can potentially provide world class solutions to positively progress the project forward both technically and commercially. The team executes work for both new and existing developments. (See fig. 2)

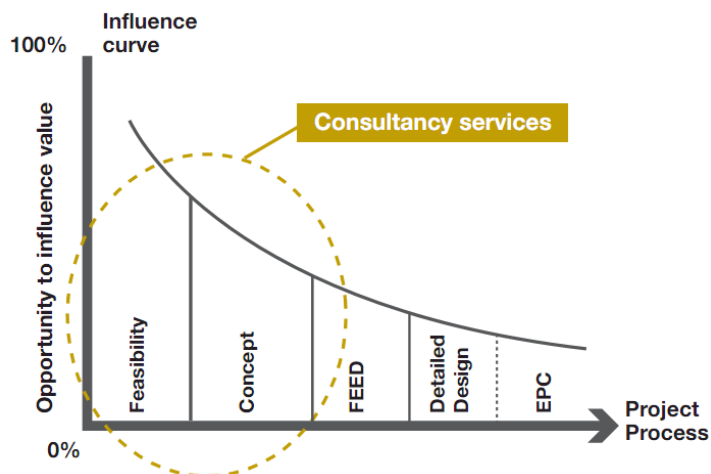


Fig. 2

8. PROCESS ENGINEERING ACTIVITY AND ROLE DURING FEED STAGE

8.1 For any typical process related Especially FEED project, the process engineer begins by gathering all the Basic data / information, can about the process and the physical & chemical information of the substances involved in the process. The initial goal of the Preliminary Process Study is to obtain an Economic Evaluation of the process, with the minimum expenditure of time and money. During this stage, all information necessary to obtain a reasonably accurate cost estimate for building and operating the plant is determined.

8.2 In the design and evaluation of a process, the process engineer takes the following activities. These are the selection of a site, the writing of the scope (definition of project), the choosing of the process steps and Basic Endorsement, the calculation of material and energy balances, the listing of all major equipment with its specifications, the development of the physical layout of the plant, the instrumentation of the plant, the development of a cost estimate; and finally the economic evaluation of the process.

8.3 Process engineer must be conversant to carry out the following activities.

- Prepare Heat and Material Balance (H&MB) studies for a proposed process, with and without use of software applications.
- Prepare rough cost economics, including preliminary sizing and important details of equipment, factor to an order of magnitude capital cost estimate, prepare a production cost estimate, and work with economic evaluation representatives to establish a payout and the financial economics of the proposed process.
- Participate in layout planning for the proposed plant.
- Prepare operating, control and safeguarding philosophies of the plant.
- Prepare and supervise drafting of process flow diagrams (PFD).
- Prepare and supervise drafting of piping and instrumentation diagram (P&ID), with necessary preliminary sizing of all piping, equipment and representation of all instrumentation for plant monitoring, automation and protection.
- Prepare detailed sizing of all process equipment and utility systems, with and without use of software applications.
- Prepare process datasheet for all equipment and package systems. This is used by mechanical engineers to prepare a detailed equipment specification.
- Determine size and specifications for all safety relief valves.
- Select piping specifications from existing company standards for the fluids and their operating conditions for incorporation in P&ID.

- Select from company insulation standards the insulation codes to be applied to each hot or cold pipe or equipment as applicable.
- Prepare line schedule, equipment summary schedules, summary schedules for safety relief valves and rupture disks.
- Perform technical evaluation of bids and recommendation of qualified vendors.
- Prepare process manuals, philosophies, procedures and other studies related to plant (Operation Manual & Commissioning, Start Up and Shutdown Procedure, etc.....)

9. Feed Stage Phase & Basic Design Endorsement

Most Oil & Gas projects pass through the Front-End Engineering and Design (FEED) phase before going to detailed engineering. FEED phase scope generally covers the basic design and engineering of the facilities, development of the layout, vendor inputs for major packages, HSE impact assessment and refines the cost estimates of the conceptual design. The engineering activity during feed stage is according to below, but not limited to:

- Review Concept or Basic Design endorsement & Report and Basis of Design
- Review applicable codes, standards & legislation
- Develop Process Design (H&MB, PFD, and Equipment List)
- Detailed Flow Assurance Evaluation
- Perform Process Studies and selection of technologies
- Develop Process Philosophies
- Major Equipment sizing, selection and datasheets.
- Develop P&ID and perform sizing of major piping.
- Develop Material Selection Report
- Develop Plot Plan
- HAZID & HAZOP Documents Preparation
- Perform HAZOP review & issue HAZOP report
- Develop Mechanical datasheets and specifications for major equipment.
- Develop engineering process data & design for Pipeline, Piping, Civil, Electrical, HSE, C&I, Telecom etc.
- Produce MTOs (Piping, Structural, Civil, Electrical, Instrument etc.)
- Issue Request for Budget quotations for major equipment.
- Generate Requisitions & issue RFQs for long lead items.
- Perform Technical & Commercial Bid Evaluations of vendor quotes and provide recommendations.
- Develop Procurement Plan, Preferred Suppliers list, Logistics study.
- Generate Cost Estimate ($\pm 10\%$ ~ 20% accurate)
- Define Project Execution Plan
- Update Basis of Design
- Generate Invitation to Tender for Engineering, Procurement & Construction (EPC) Contract for proposal engineering

9.1 In some project for long lead items procurement data, spec and purchase order may be done in FEED stage depending the client approval and request.

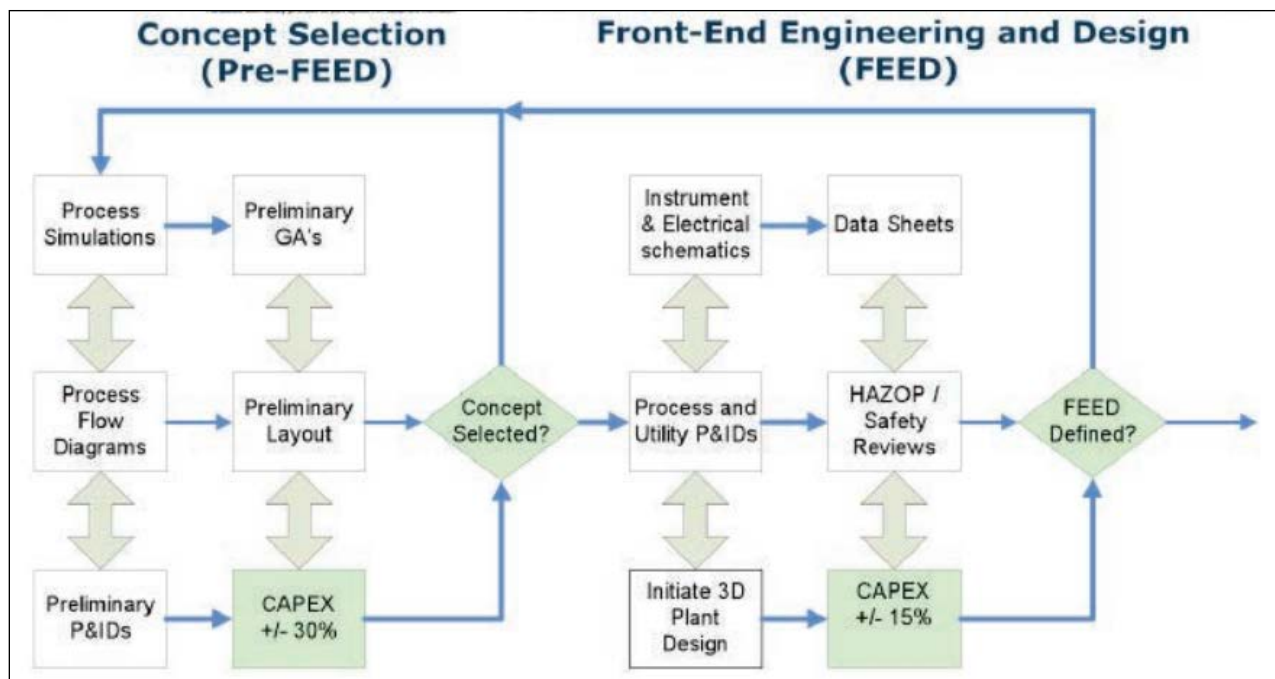
9.2 The FEED cost estimates are used to obtain required management approvals and also serve as basis to review the proposal of the Engineering, Procurement & Construction (EPC) contractors. The FEED dossier, which is a compilation of basic design and engineering documents, is provided to the EPC contractor to serve as input data for further detailing during the EPC phase and forms a part of contract documentation.

9.3 For EPC phase it is mandatory to endorse feed document and approval, with the emergence of the FEED endorsement concept, a single point responsibility is passed on to the EPC Contractor to be fully responsible for the delivery of the project, meeting all requirements and without any involvement of the FEED contractor. EPC contractors are required to endorse the FEED at the time of bidding and take full responsibility of the project including process guarantees, in addition to the normal warranties / guarantees associated with usual EPC project scope. This concept is quite advantageous in terms of Owner's project execution strategy.

The FEED Endorsement requires understanding of the complete design concept and complete verification of design without any face to face interaction with Owner or the FEED contractor. It is worth noting that FEED endorsement requires significant efforts for design verification and includes redoing many basic design activities within a short period. (See fig. 3)

FEED is broken into six phases:

- Scope Definition and Engineering Execution Strategy
- Commencement of FEED Design
- Initial FEED Development and Hazard Identification
- Initial Design Review & Audit
- FEED Design Approval (AFD)
- Final Reviews and Feed Report Compilation



TYPICAL WORKFLOW IN FRONT-END DESIGN PROJECTS

Fig. 3

10. FEED – PROCESS ENGINEERING SCOPE WORK AND DELIVERABLE DOC & REPORT

10.1 Inputs:

- Basis of Design
- Concept Engineering Report
- Preliminary Process Design (H&MB, PFD, Equipment List)
- Preliminary Equipment Datasheets and Plot Plan
- Preliminary Engineering Philosophies (HSE, Electrical, C&I, Civil)

10.2 Process Activities

- Process Selection
- Process Simulation
- Flow Assurance Evaluation
- Develop Process Philosophies (Operating & Control, Isolation, Shutdown, Blowdown, Sparring, Insulation & Winterization etc.)
- Selection & Sizing of major Equipment
- Sizing of major piping
- Evaluation of relief scenarios and relief valve sizing
- Process Studies (Optimization, Energy conservation, Flare & Blowdown study etc.)
- Inter-department Inputs (Material Selection, Plot plans, HAZID, HAZOP & SIL studies etc.)

10.3 Process Deliverables

- Updated Basis of Design
- Process Design Philosophies
- Process Study Reports
- H&MB - PFD, UFD - P&ID
- Equipment List
- Process Datasheets (Equipment, Instrument)
- Cause & Effect Diagram
- Utility Summary
- Line List
- Input to Design Manual, Pre-Commissioning & Commissioning Procedures, Operating & Maintenance Manual.

11. PROCESS INTERFACE WITH OTHER DISCIPLINE ENGINEERS DURING FEED STAGE

Once the project begins to take shape with initial inputs from process engineers, the design work by helping to other engineering disciplines begin with evaluating the process engineering documents and drawings. Additional design information and details are provided by them to bring the project to a complete shape. The role of process engineering discipline in the project design cycle is detailed below:

11.1 Mechanical Engineering:

Preparation of process data for equipment (static, rotating, packages) specification or mechanical datasheets based on process datasheets.

The Mechanical data such as design data, protective coating & insulation, scope of supply, material of construction, nozzles data, equipment sketch, shall be included and specified the requirements of client technical specifications and applicable international codes and standards

11.2 Piping / Pipeline Engineering:

- Identifies site area & boundary limits and prepare plant layout.
- Identifies pipeline source/sink destination and route options.
- Prepares primary plot plan, equipment layout and performs accessibility study.
- Prepares pipeline numbering system and valve data /point.
- Prepares piping material specification.
- Prepares tie-in connection.

11.3 Electrical Engineering:

- Primary evaluates the electrical & power availability, generation, distribution and consumption for the plant.
- Performs electrical process power requirement system and load study, motor power study.

11.4 Civil & Structural Engineering:

- Soil data or seabed conditions for site grading & foundation requirements, together with survey, seismic data & met-ocean data for offshore structures.

11.5 Instrumentation Engineering:

- Review of control system & instrument philosophy.
- Review of Identifies type of control systems required.
- Review metering philosophy, operation and shutdown manual ,etc.
- Review control system specification (DCS/ESD/FGS etc)
- Conducts SIL review.
- Review control valve specification and Review control valve sizing
- Review and filling process data for field instrument data sheets & specifications.
- Review I/O list (DCS/ESD/F&G etc)

11.6 HSE Engineering:

- Identifies gaseous emissions & produced water disposal quantities.
- Review HSE Design Philosophy, Safety concept, Fire protection Philosophy
- Review Safety and Fire fighting equipment layout.
- Review Emergency Escape route layout.

- Review Hazardous area classification schedule / layout.
- Review Fire and Gas detection system and Fire Suppression system.
- Review HSE Review (HAZID, HAZOP, SIL) of the project.
- Review out risk assessment studies (QRA, SIMOPS, and FERA etc).
- Review Availability / Reliability Analysis.
- Review out Environmental Studies (EIA, ENVID etc).
- Prepares HSE material take-off (MTO).

12. FINAL REVIEWS AND FEED REPORT COMPILATION

To ensure all final design deliverables are completed and that client and statutory obligations are satisfactorily resolved. Collate all discipline inputs and finalize study report.

13. RELIABILITY CENTERED DESIGN ANALYSIS AND FRONT END ENGINEERING AND DESIGN

Reliability Centered Design Analysis is a process, which is integrated into project management stages i.e. Front End Engineering and Design (FEED). Typical project management & commitment consists of independent stages. Funding for Reliability Centered Design Analysis is included in project. (See figures 4, 5, 6, 7)

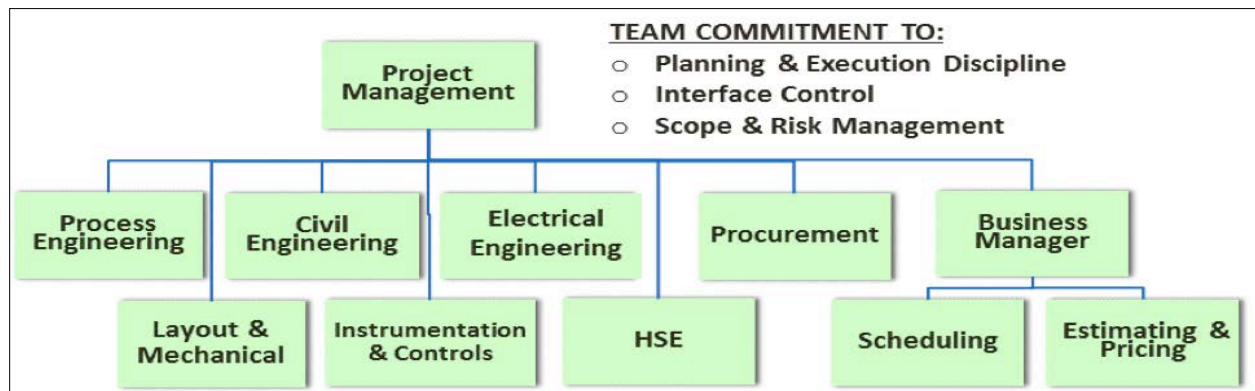


Fig. 4

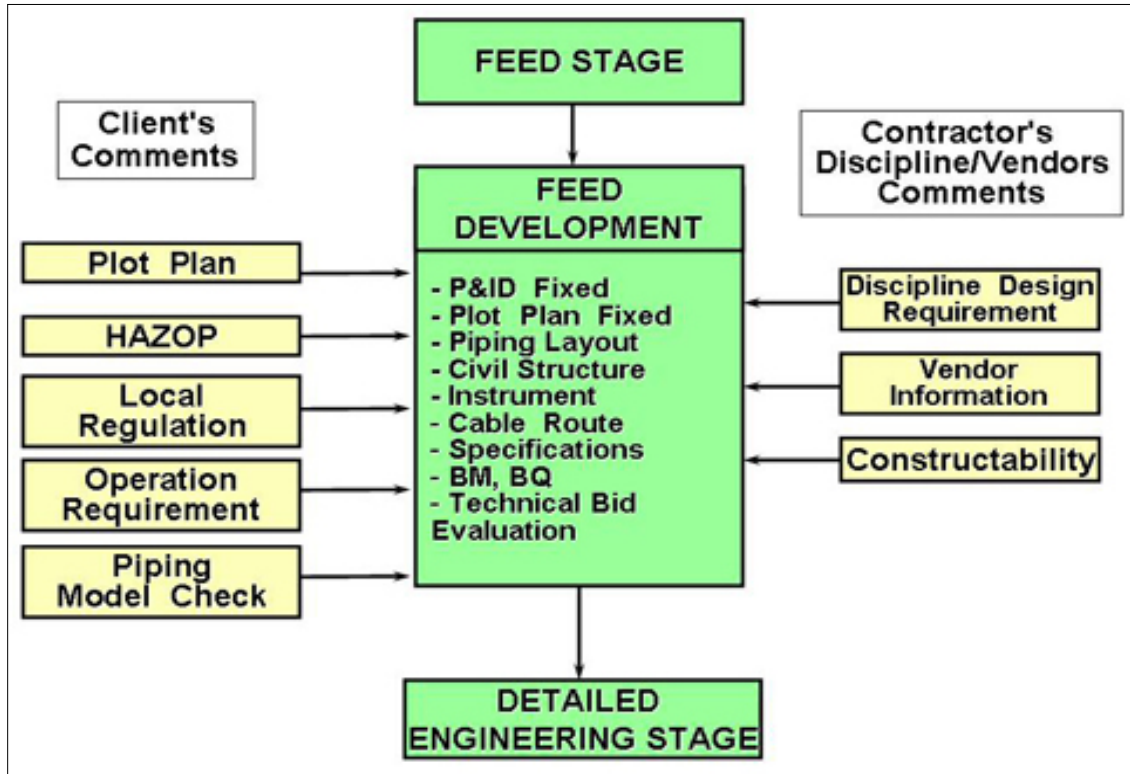


Fig. 5

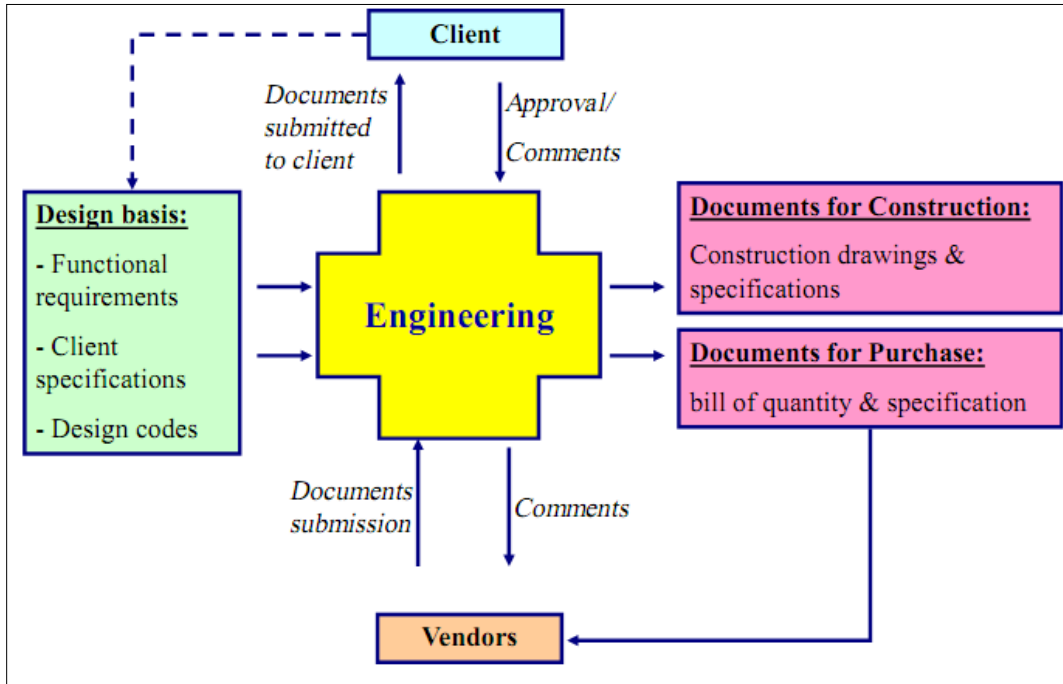


Fig. 6

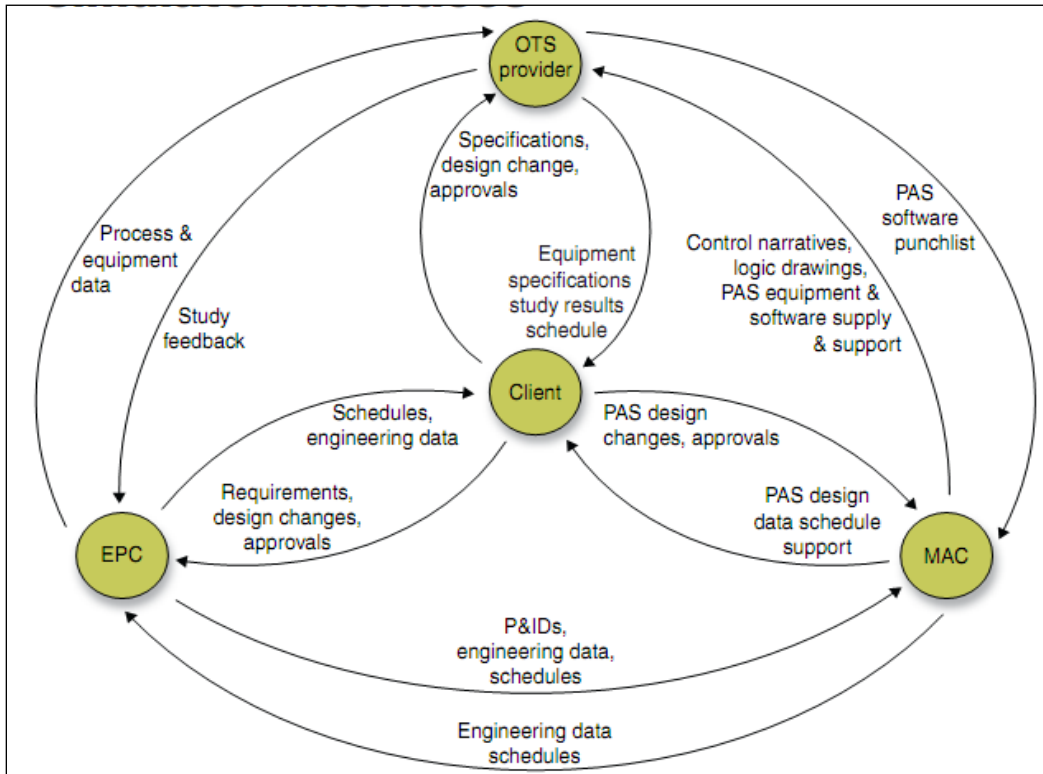


Fig. 7

Information of Control Engineering