دوره آموزشي PFD-P&ID

PFD-P&ID training course

تهيه كننده : محمد بهزادي Mohammad Behzadi

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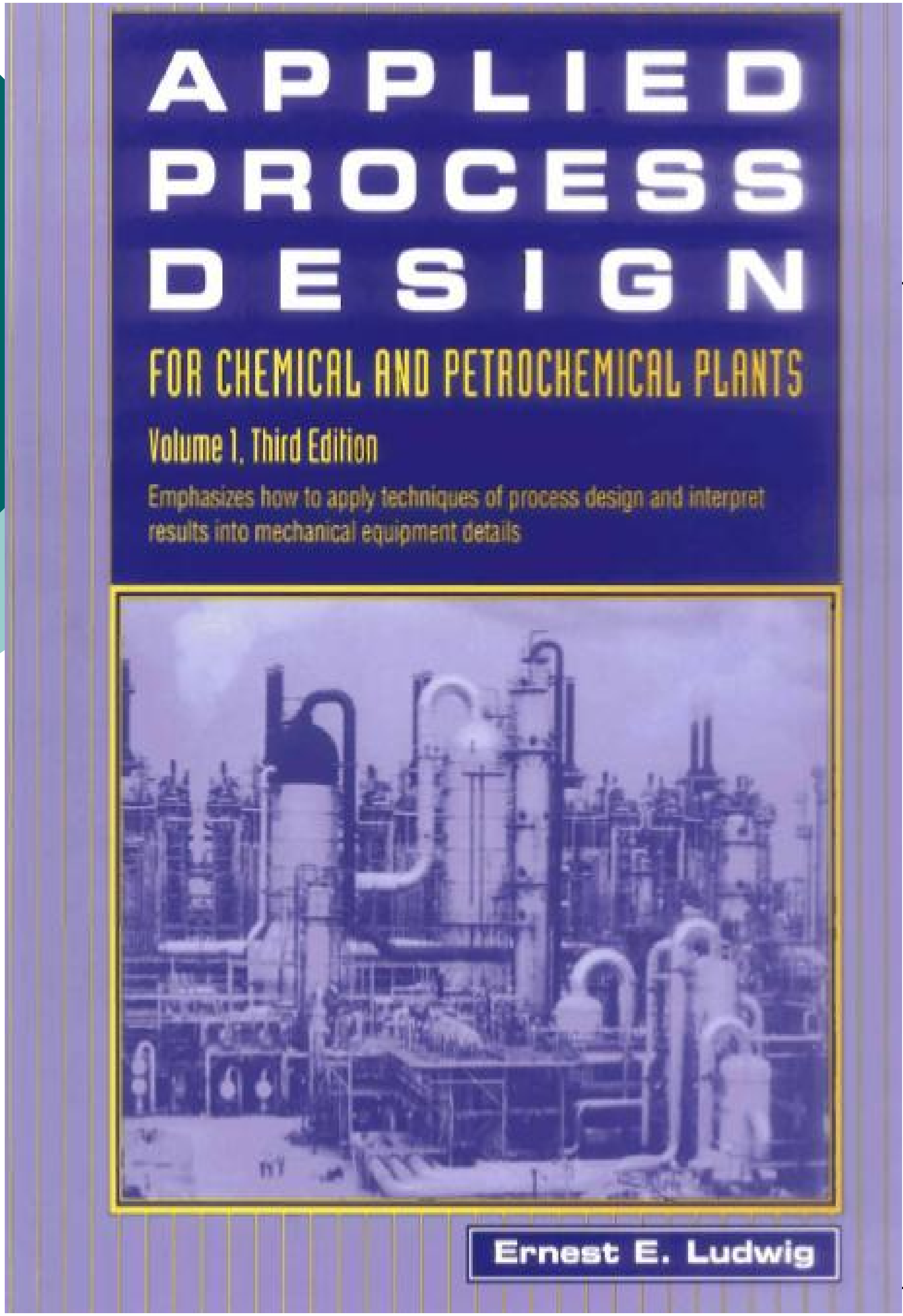
تقديم به برادرم سعيد رادپور كه با بخشش علمي بيدريغ خود استاد و قطب نماي علمي در مسير زندگيم بود

PFD-P&ID course
Piping course

Produced by:Mohammad Behzadi

تهیه کننده : محمد بهزادی

خرداد 1387



منابع مطالعاتی

Volume 1:
1. Process Planning, Scheduling, Flowsheet Design
2. Fluid Flow
3. Pumping of Liquids
4. Mechanical Separations
5. Mixing of Liquids
6. Ejectors
7. Process Safety and Pressure-Relieving Devices

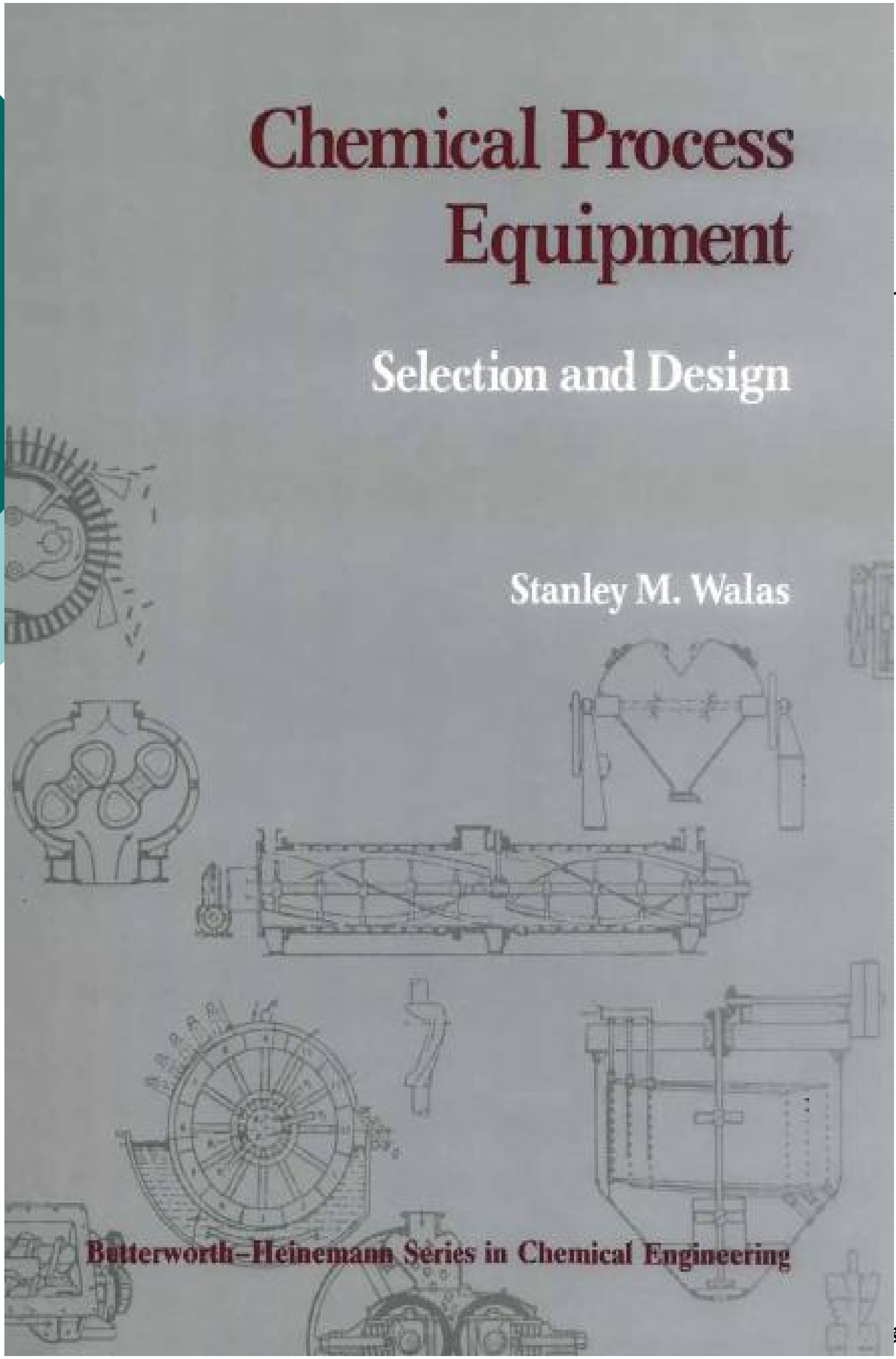
Appendix of Conversion Factors

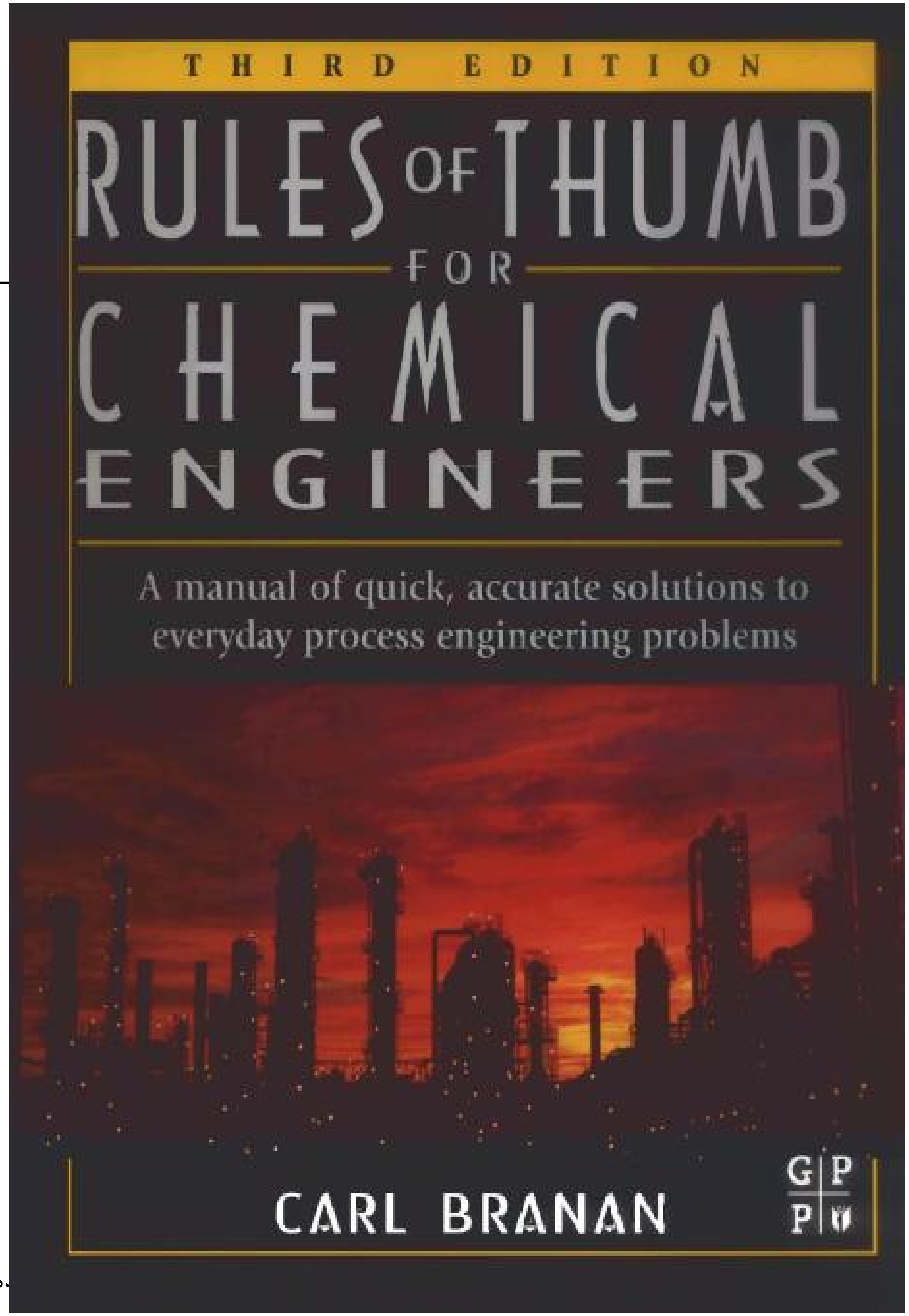
Volume 2:

8. Distillation
9. Packed Towers

Volume 3:

10. Heat Transfer
11. Refrigeration Systems
12. Compression Equipment (Including Fans)
13. Reciprocating Compression Surge Drums
14. Mechanical Drivers


Chemical Process Equipment
Selection and Design
Stanley M. Walas
Butterworth–Heinemann Series in Chemical Engineering


THIRD EDITION
RULES OF THUMB FOR CHEMICAL ENGINEERS
A manual of quick, accurate solutions to everyday process engineering problems
CARL BRANAN
GP
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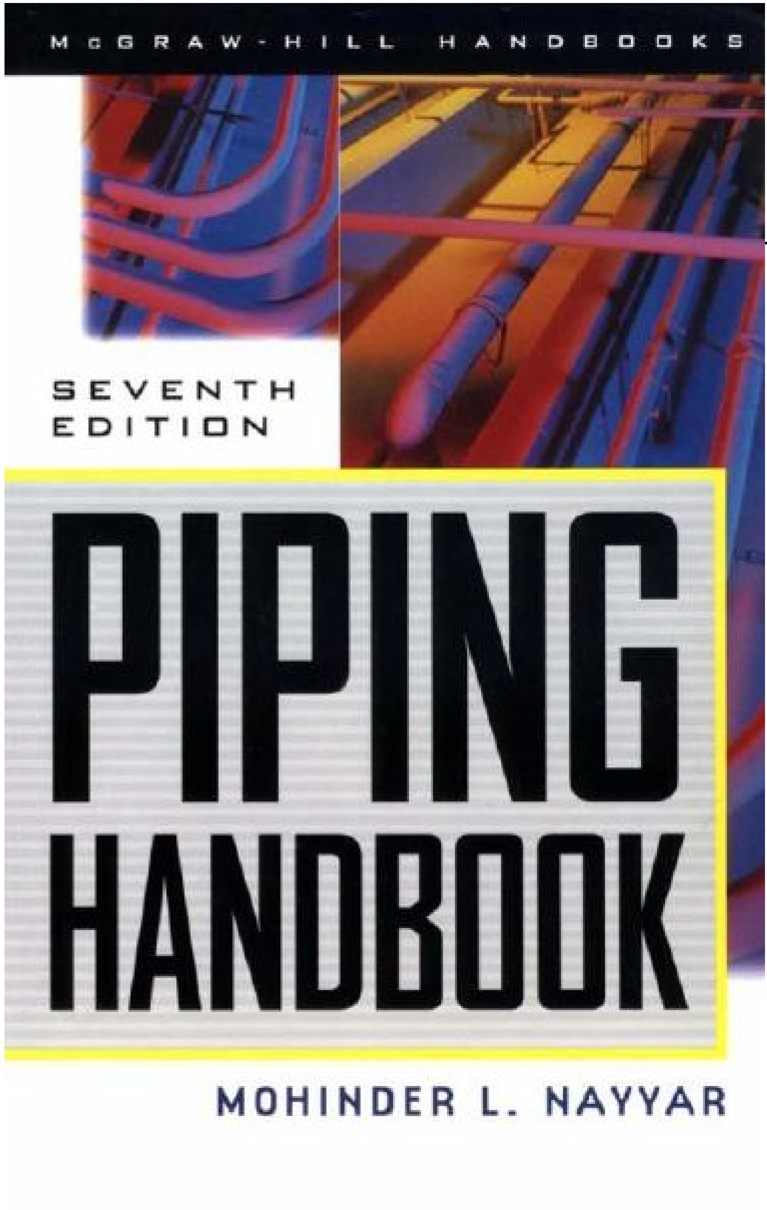
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SEVENTH EDITION
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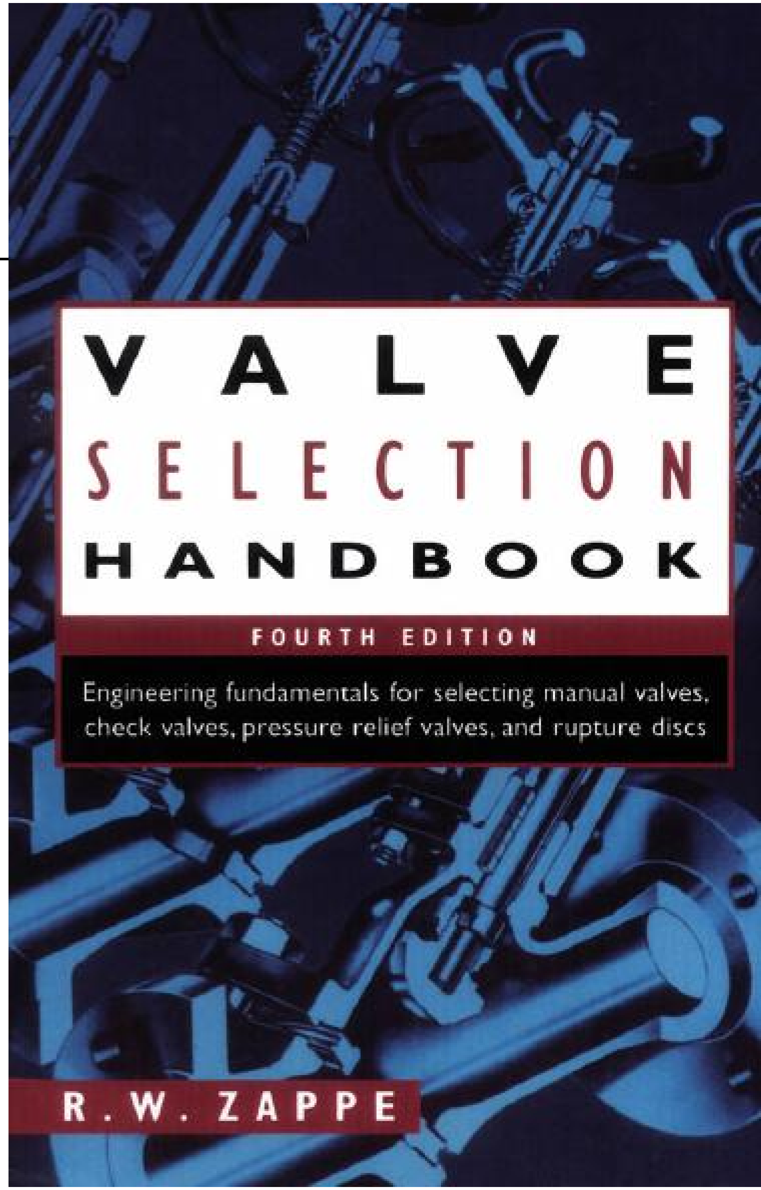
MOHINDER L. NAYYAR


VALVE
SELECTION
HANDBOOK
FOURTH EDITION
Engineering fundamentals for selecting manual valves, check valves, pressure relief valves, and rupture discs
R.W. ZAPPE

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ASME B31.3

Process Piping

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Subject Index

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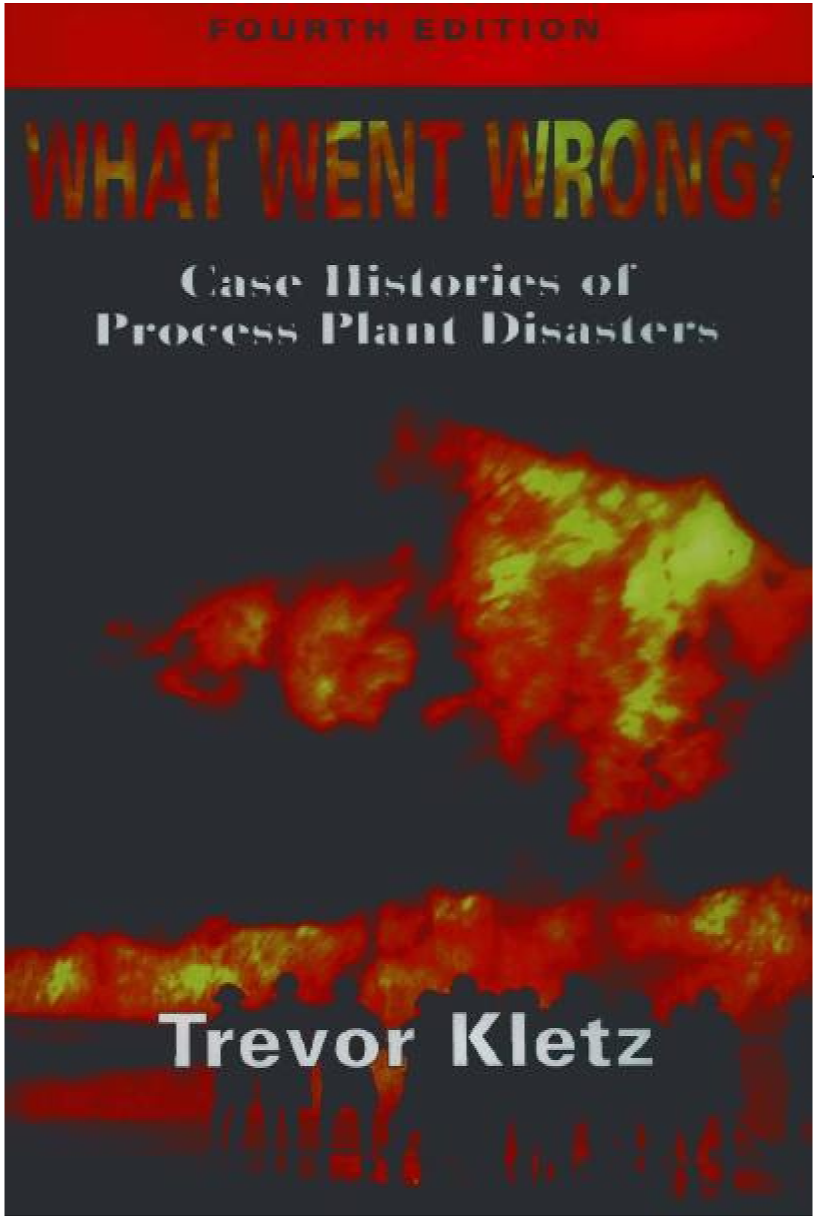
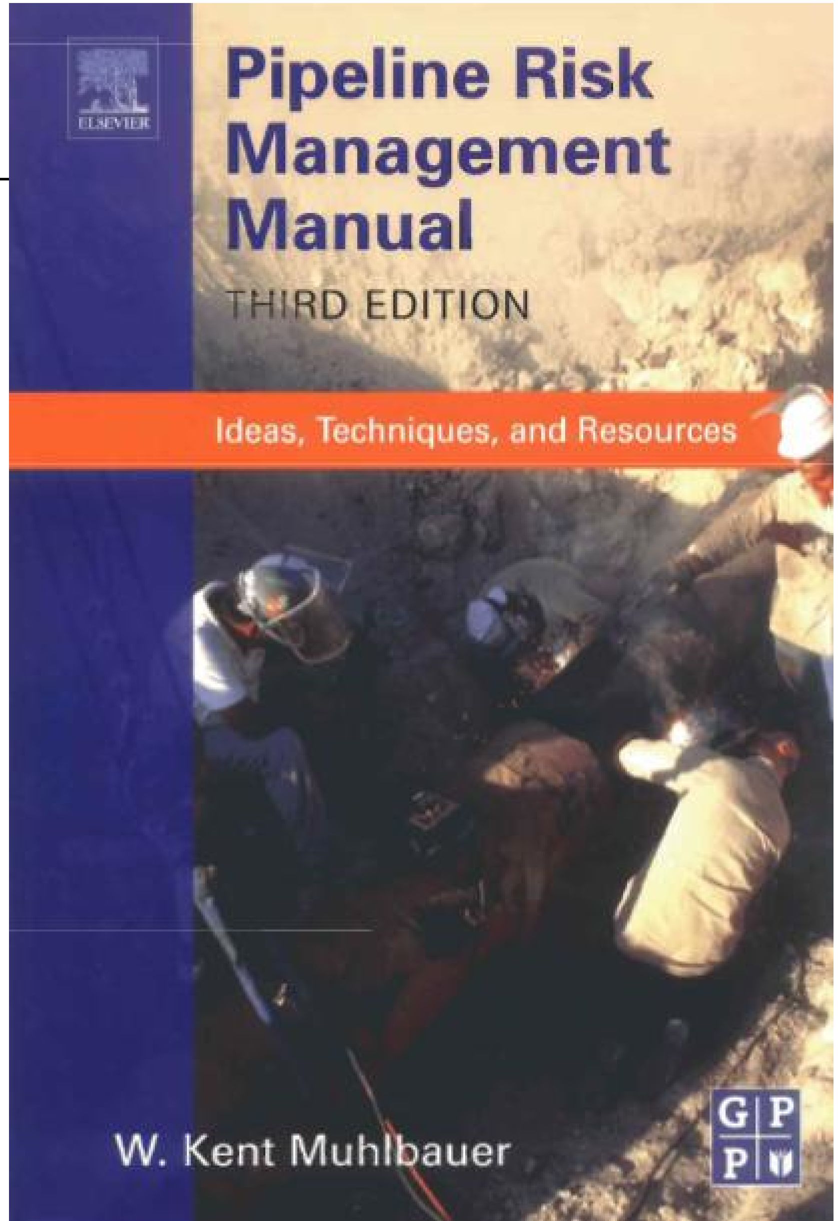

FOURTH EDITION
WHAT WENT WRONG?
Case Histories of
Process Plant Disasters
Trevor Kletz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Pipeline Risk
Management
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W. Kent Muhlbauer
GPP

Standards

Why do we apply standards?

- **Work Uniformity**
- **Increase of safety**
- **Improvement in qualification of design and operating condition**
- **Decrease of design and selection of material**

Standards

API

American Petroleum Institute

ASME

American Society of Mechanical Engineers

ANSI

American National Standard Institute

ASTM

American Society for Testing and Material

ISA

Instrumentation System and Automation Society

NACE

National Association of Corrosion Engineers

Standards

NFPA

National Fire Protection Association

TEMA

Tubular Exchanger Manufactures Association

DIN

Deutshes Institute fur Normung

BSI

British Standards Institution

ISO

International Organization for Standardization

AWWA

American Water Works Association

Standards

IPS

Iranian Petroleum Standard

IGS

IRANIAN GAS STANDARDS

NPCS

National Petrochemical Company Standard

API

API-RP-520: **Sizing, Selection, and Installation Of Pressure-Relieving Devices in Refinery**

API-RP-521: **Guide For Pressure-Relieving and Depressuring System**

API-RP-14E: **Recommend Practice for Design and Installation of Offshore Production Platform Piping System**

API-STD-2000: **Venting Atmospheric and Low-Pressure Storage Tanks**

API-STD-530: **Calculation of Heat-Tube Thickness in Petroleum**

IPS

IPS-E-PR-308: Engineering Standard For Process Design for Numbering System

IPS-E-PR-750: Engineering Standard For Process Design of Compressor

IPS-E-PR-330: Engineering Standard For Process Design of Compressor Air System

IPS-E-PR-440: Engineering Standard For Process Design of Piping System

IPS-E-PR-700: Engineering Standard For Process Design for Process Design of Crude Oil Electrostatic Desalter

NFPA

NFPA 20: **Standard for the Installation of Centrifugal Fire Pump**

NFPA 15: **Standard for Water Spray Fixed System for Fire Protection**

NFPA 11: **Foam Extinguishing System**

NFPA 12: **Standard on Carbon Dioxide Extinguishing System**

NFPA 13: **Standard for the Installation of Sprinkler System**

NFPA 72E: **Automatic Fire Detector**

استانداردهای معروف برای دیسیپلین های مختلف(پروسس)

DESIGN CODES, STANDARDS & REFERENCES

IPS E PR 230 Piping & Instrumentation Diagrams (P&IDs
API Spec 12J Specification for Oil and Gas Separator
IPS E PR 880 Engineering Standard for Process of Gas (Vapor) – Liquid Separators
IPS E PR 850 Engineering Standard for Process Requirements of Vessels, Reactors and Separators
API RP 520 Sizing, Selection and Installation of Pressure-Relieving Devices in Refineries (PSV)
API RP 521 Guide for Pressure-Relieving and Depressuring Systems (PSV)
API STD 2000 Venting Atmosphere and Low-Pressure Storage Tanks Non-Refrigerated and Refrigerated
IPS E PR 460 Engineering Standard for Process Design of Flare and Blow-down Systems
IPS E SF 860 Engineering Standard for Air Pollution Control

استانداردهای معروف برای دیسیپلین های مختلف

API STD 610	Centrifugal Pumps for General Refinery Services
API STD 674	Positive Displacement Pumps-Reciprocating
API STD 675	Positive Displacement Pumps-Controlled Volume
API STD 676	Positive Displacement Pumps-Rotary
API STD 681	Liquid Ring Vacuum Pumps and Compressors for Petroleum, Chemical and Gas Industry Services
API RP 50	Natural Gas Processing Plant Practices for Petroleum of the Environment
API RP 51	Onshore Oil and Gas Production Practices for Petroleum of the Environment
API RP 551	Process Measurement Instrumentation

استانداردهای معروف برای دیسیپلین های مختلف

API RP 14E	Recommended Practice for Design and Installation of Offshore Production Platform Piping Systems
API Spec 5L	Specification for Line Pipe
NACE RP 0169	Recommended Practice-Control of External Corrosion on Underground or Submerged Metallic Piping Systems
NACE RP 0175	Recommended Practice-Control of Internal Corrosion in Steel Pipelines and Piping Systems
NACE MR 0175	Material Requirement-Sulfide Stress Cracking Resistant Metallic Material for Oil Field Equipment

)

استانداردهای معروف برای دیسیپلین های مختلف

.Civil

The following codes and standards, which are listed in 5-2-1-2, are to be used for the civil Basic Design:

BS 8110	part 1 & 2	Structural use of concrete
BS 6031	Code of practice for earthworks	
BS 8004	Code of practice for foundations	
BS 6399 part 1	Loading for buildings	

Mechanical

API 610,	Centrifugal Pumps for General Refinery Service
API 671	Special Purpose Couplings
EN 292	Safety of Machinery
ASME Section IV	Heating boilers.
API 650	Welded Steel Tanks for Oil Storage
API 661	Air Cooled Heat Exchangers for General refinery service
NORSOK M-CR-501	Surface Protection and Protective Coating
NORSOK R-001	Mechanical Equipment
API Spec 5L:	Specification for Line Pipe, Forty-first Edition, April 1, 1995
IPS	Iranian Petroleum Standards
IPS-M-PI-110	Material and Equipment Standard for Valves
IPS-G-SF-900	General Standard for Noise Control and Vibration

استانداردهای معروف برای دیسیپلین های مختلف

Piping

ANSI B31.4	Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids Pipeline Transportation Systems for Liquid Hydrocarbons and other Liquids
ANSI B31.3	Process Piping
ANSI B16.34	Valves-Flanges, Threaded and Welding End Pipe Flanges and Flanged Fittings
ANSI B16.20	Metallic Gaskets
API 6D	Specification for Pipe Line Valves
ASME Section IX	Welding and Brazing Qualifications
NORSOK L-CR-003	Piping Details (except from chap. 5.5.)
API 5L	Specification of Line Pipe
API 1104	Standard for Field Welding of Pipelines
ANSI B16.5	Standard for Steel Pipe Flanges and Flanged Joints Painting Application Specification

استانداردهای معروف برای دیسیپلین های مختلف

IPS-E-PI-240	Engineering Standard for Plant Piping Systems
IPS-E-PI-200	Flexibility Analysis
IPS-G-PI-280	Pipe Supports
IPS-M-PI-110	Material and Equipment Standard for Valves
IPS-M-PI-150	Flanges & Fittings
IPS-E-PR-190	Layout & Spacing
IPS-E-PR-200	Basic Engineering Design Data
IPS-E-PR-230	Piping & Instrument Diagrams
IPS-E-PR-460	Process Design of Flare & Blowdown Systems
IPS-D-PI-102	Typical Unit Arrangement & Piperack Layout
IPS-D-PI-113	Y-Type Suction Strainer
IPS-D-PI-114	T-Type Suction Strainer
IPS-D-PI-122	Control Valve Piping Manifolds
IPS-D-PI-123	Relief Valve Installation and Relief System
IPS-D-PI-128	Utility Station, Hose Rack & Emergency Shower Details
IPS-D-PI-140	Sample Point Assembly for Piping

EPCC

Engineering

Procurement

Construction

Commissioning

ENGINEERING DISCIPLINES
دیسیپلینهای مهندسی

- Process
- HSE(Health,Safety,Environment)
- Piping
- Instrument
- Mechanic

☐ A .Fixed Equipments

-Vessel
-Tank
-Tower
-Exchanger
-...

☐ B. Rotary Machineries

-Pump
-Compressor
-Mixer
-Air Cooler

- Civil-Structure-Architecture
- Electrical

ENGINEERING COMPANY
دیسیپلینهای کلی یک شرکت

Management
Procurement
Projects
Estimating
Proposals
Budget-&-Control
Accounting
Construction – Supervision
Engineering
HR-Communication
Information – Technology
Support-Services

انواع مدارک PFD از لحاظ ارزش

First Issue (FI):
Release for proposal (Conclusion of estimate, study)
-Main equipment (Tagged)
-Main Process Lines
-Battery Limit
-Main control concept (control & switch)
-Package unit Limits

Issued For Information (IFI) : it is not used in constuction
Issued For Comment (IFC): between client and contractor and after that will be issued to owner(some kind of internal issue!!)

Issued For Approval (IFA):
Release for Basic Engineering In addition to contents 1.
-Important valve (isolation, manual control)
-Essential process shutdown circuits
-Important start up lines
-Definition of heat exchanger type

انواع مدارک PFD از لحاظ ارزش

Issued For Design (IFD):

Release for Basic Engineering Development (Conclusion of verification Phase and Basic Eng.)

-Content as 1. & 2. however adjusted to the contract conditions

Approved For Design (AFD):

Release for Detail Engineering (End of Basic Eng.)

-Crosscheck with P&ID, release detail engineering

انواع مدارک PFD از لحاظ ارزش

Approved For Construction (AFC):
Release for Construction phase (End of Detail Eng)
-Final issue of PFD in Detail phase

As Built (ASB):
End of construction
-Includes all of the changes in commissioning and construction phase

Issued For Construction (IFC):
Release for Detail Engineering Development
-Crosscheck with P&ID, release for purchase of bulk material

تفاوت کد و استاندارد

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Design factor

ایمنی(مثلا برای دبی 10 درصد)

اعضای تیم پروسس

- مدیر پروژهPM(Project manager)
- مدیر واحد مهندسیPEM(Project Enginnering manager)
- **Process team members**
  - Process Dept.Manager
    - کارشناس ارشد Process Senior Engineer
      - کارشناسProcess Engineer
  - نقشه کش
  - Process Senior Draftsman
    - Process Draftsman

PROCESS DEPARTMENT ACTIVITIES

Process Department's Activities in the following engineering stages:

1. Feasibility Study (FS)
2. Proposal Preparation (PP)
3. Basic Engineering (BE)
4. Detail Engineering (DE)

PFD, DEFINITION, PREPARATION SEQUENCE. ACCORDING TO IPS-E-PR-170

Feasibility Study
Process Design Basis
Conceptual Design

↓

Simplified Flow-Sheet

↓

Steady State
Process Simulation(HYSYS-ASPEN-CHEMCAD-PROII)

↓

PFD
Heat & Material Balance(H&M)

PROCESS DEPARTMENT ACTIVITIES

- **BFD**
- **Simulation**
- **PFD**
- **UFD**
- **Process Description**
- **Heat & Material Balance(H&M)**
- **P&ID**
- **Process Design Criteria**
- **Utility Consumption**
- **Chemical Consumptions**
- **Line List (For Piping Discipline)**
- **Instrument PROCESS Data Sheet (For Instrument Discipline)**
- **Equipment PROCESS Data Sheet (For mechanic Discipline)**
- **Process Data Sheet For Piping Special Item (For Piping Discipline)**

BFD

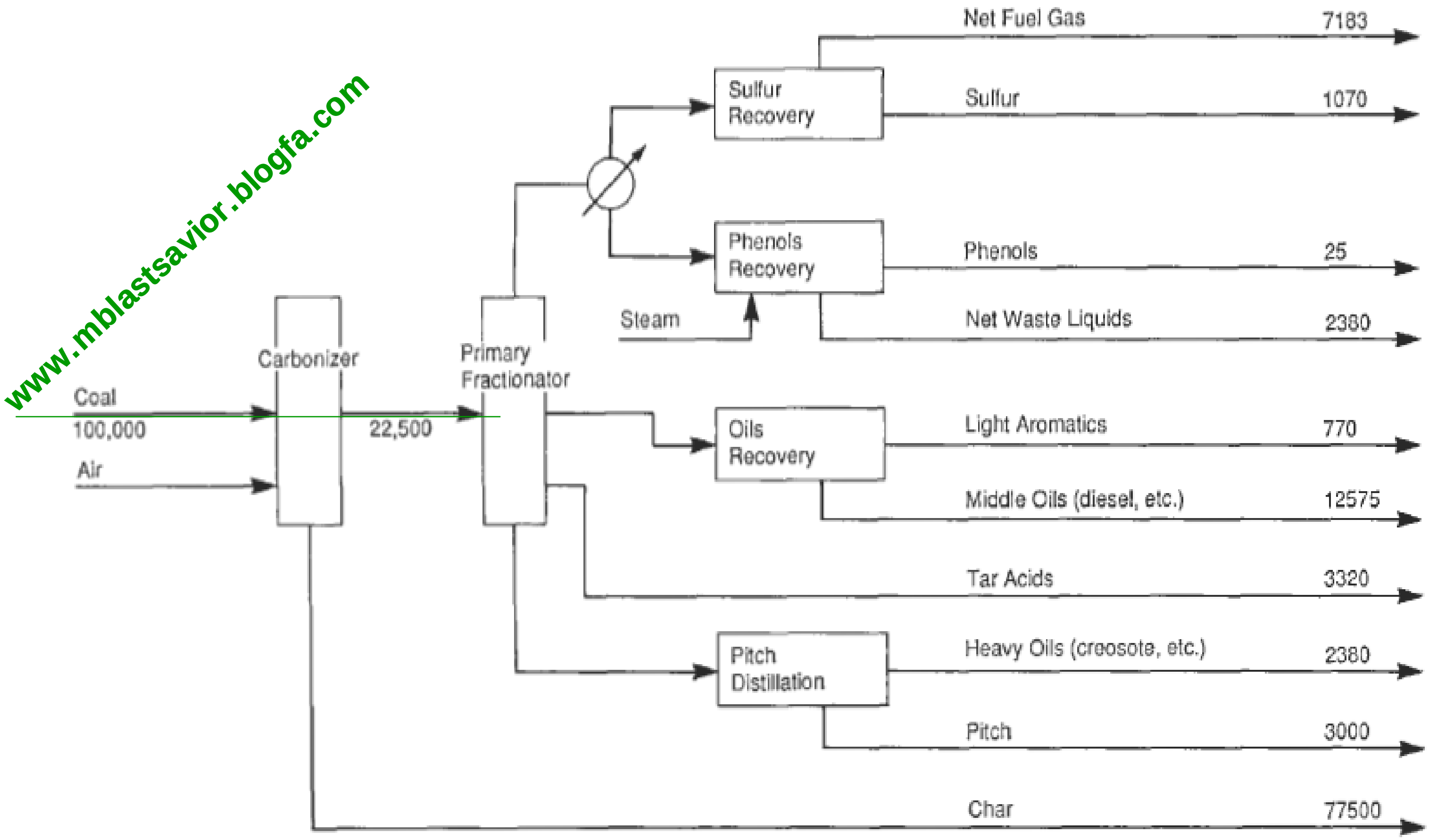
A BFD is a simple breakdown of a process into blocks or units of operations which represent major parts of of the process being depicted.

PFD

A PFD is a detailed breakdown of a process into symbols which represent all major equipment and pipelines which are part of a process as defined by the BFD.

A PFD consists of the following:

- Diagram Drawing
- Numbered Pipelines which indicate Flow Conditions
- Major Control Loops



Coal carbonization block flowsheet.

Quantities(MASS BALANCE) are in lb/hr

BFD (BLOCK FLOW DIAGRAM)

بلوکها معمولا از دایره و مربع

منابع تهیه BFD

- **BFD**
  - **Contract**
  - **Technical Proposal**
  - **Preliminary Eng. Study**

PROCESS DEPARTMENT ACTIVITIES

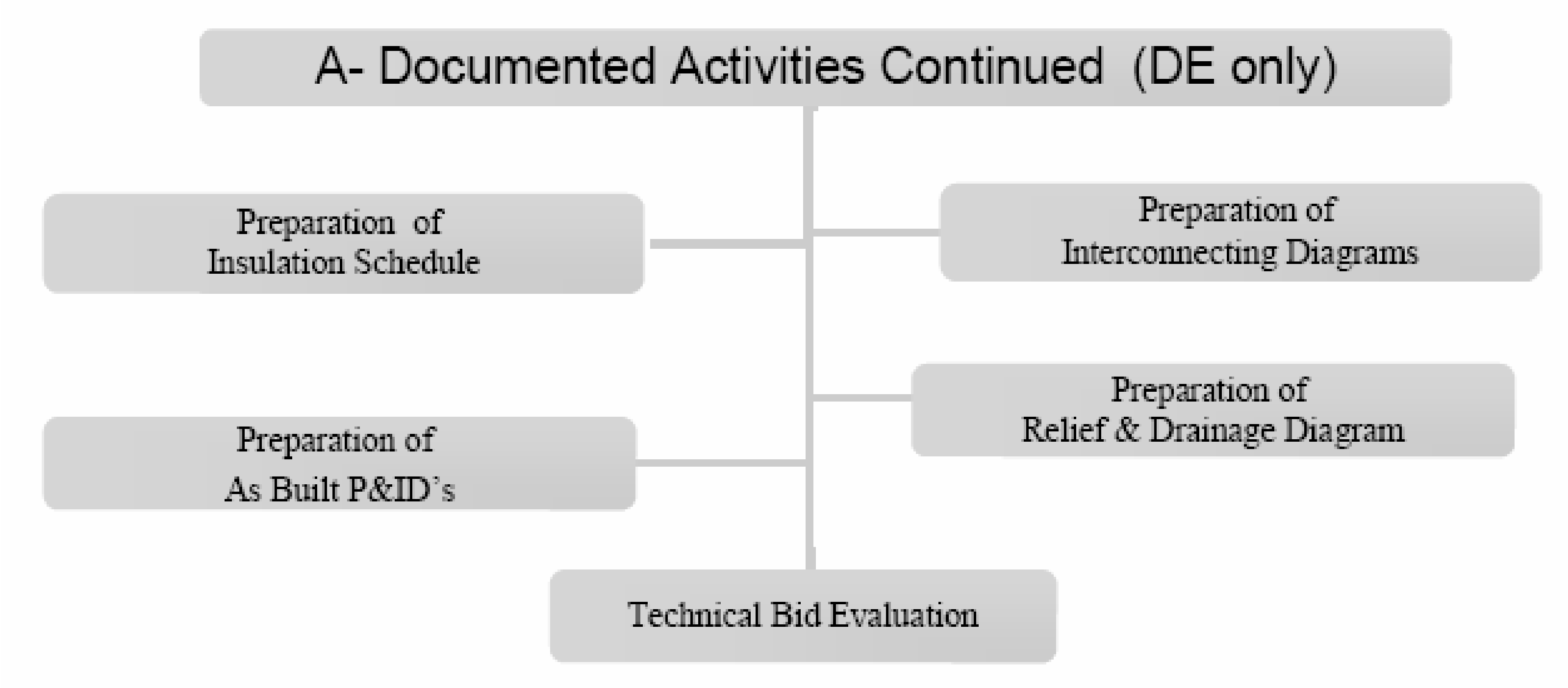
1. DOCUMENTED ACTIVITIES
2. NON-DOCUMENTED ACTIVITIES

PROCESS DEPARTMENT ACTIVITIES BASIC & DETAILED ENGINEERING

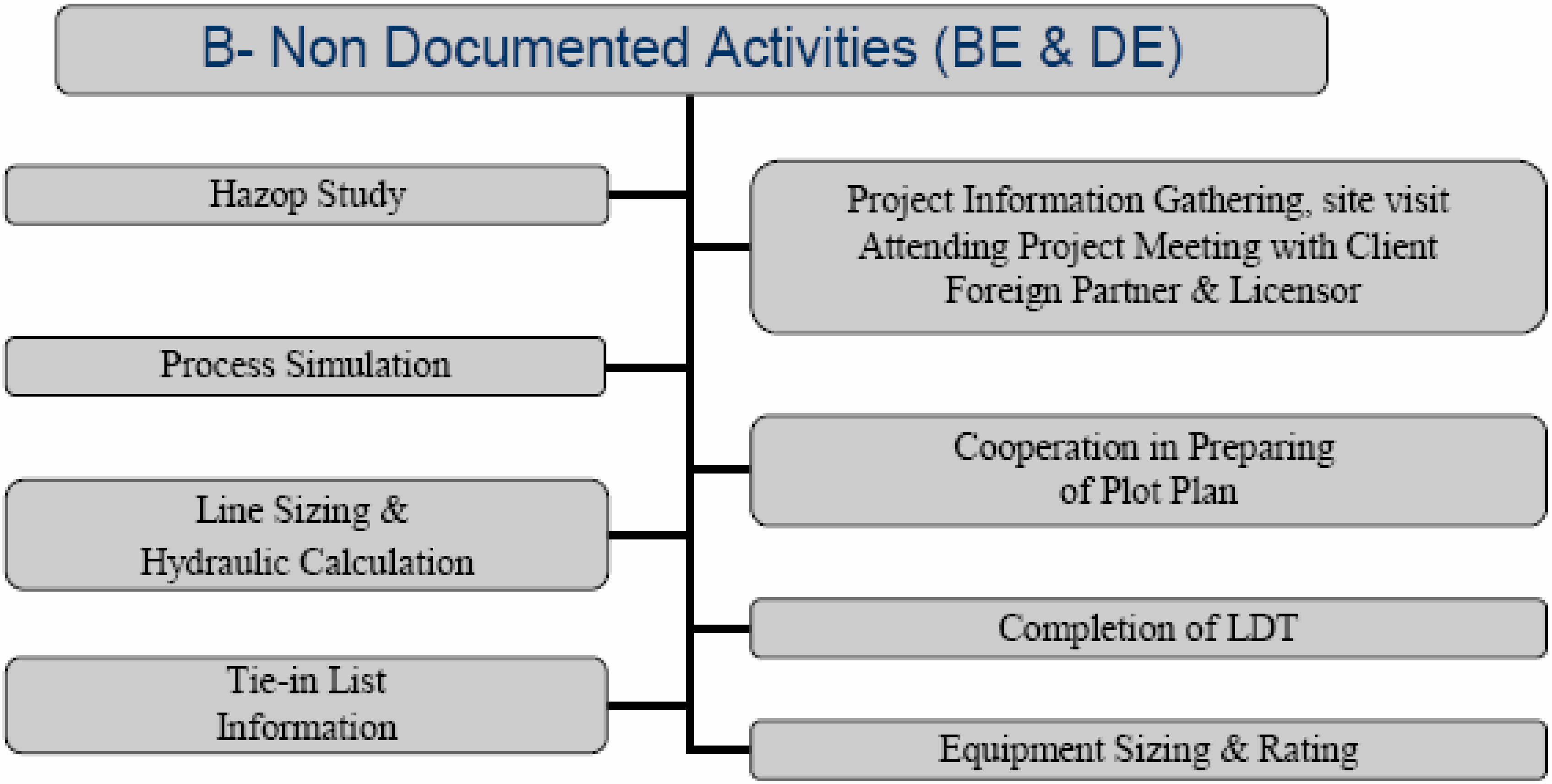
A- Documented Activities (BE & DE)

- Design Basis & Criteria
- Chemical & Utility Summary Table
- Electrical Load Summary Table
- Basic Design Package
- Preliminary Operating Manual
- Equipment Process D/S
  CV, BDV, PSV Process D/S
- Stream Process Condition List
- BFD,PFD, UFD
- P&ID
- Trip & Alarm Set Point
- Flare Load Summary Table
- Equipment List
- Control Philosophy
- ESD Concept / Block Diagram

PROCESS DEPARTMENT ACTIVITIES DETAILED ENGINEERING



PROCESS DEPARTMENT ACTIVITIES DETAILED ENGINEERING



PROCESS DEPARTMENT ACTIVITIES DETAILED ENGINEERING

B- Non Documented Activities Continued (DE only)

- Basic Package Endorsement
- Heat Tracing Calculation
- Vendor's Bid Evaluation Checking & Incorporating
- Model Review
- Completion of Equipment and Instrument D/S
- Cooperation with Inst. Dep. For DCS / PLC Design
- Cooperation with Piping Dep. For Tie-in List, Special Items, …
- Equipment Sizing & Rating

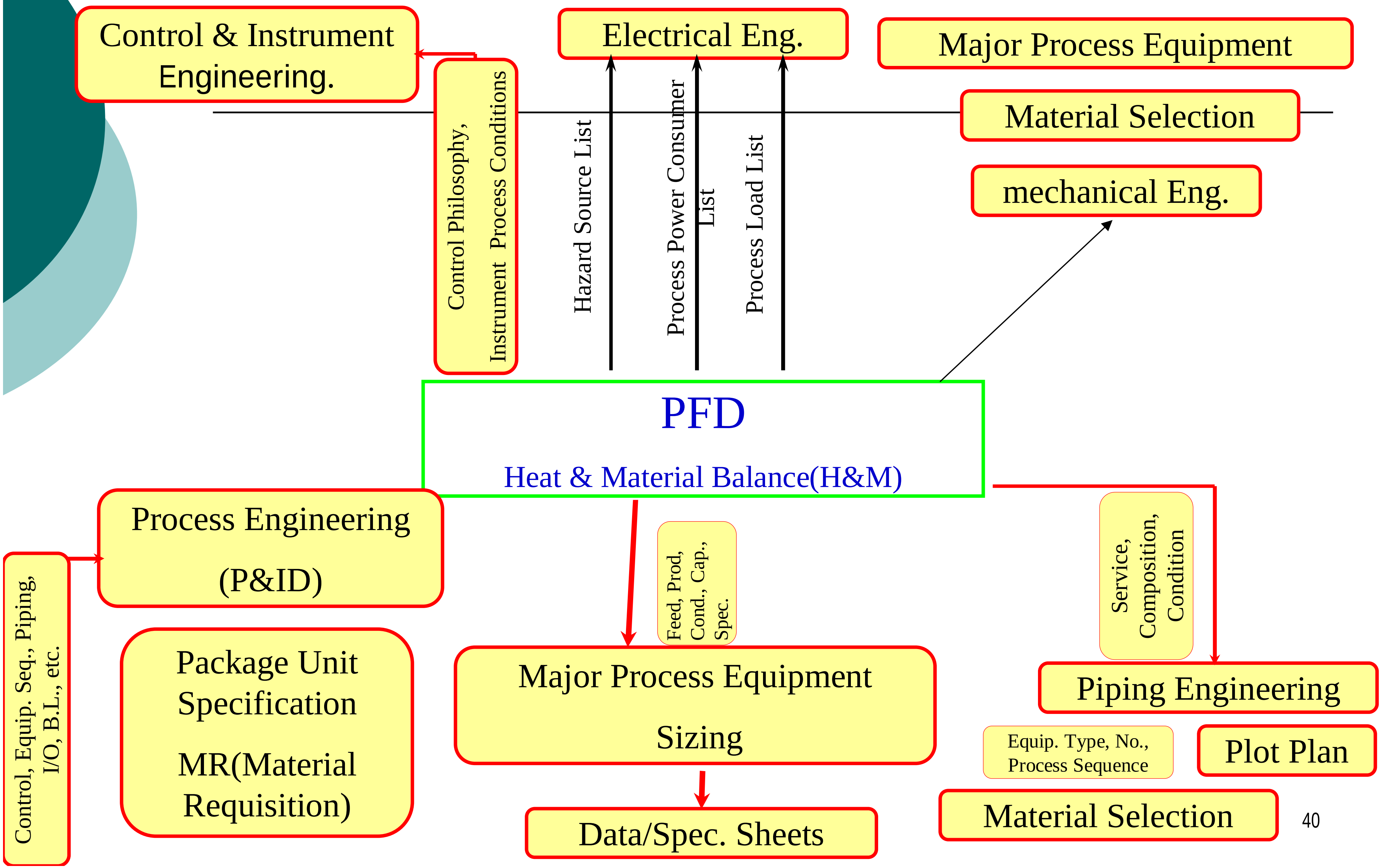
Flowsheets

Basic Design(BDP:BASIC DESIGN PACKAGE)
Detailed Design

Basic Design

BFD	**(BLOCK FLOW DIAGRAM)**
PFD	**(PROCESS FLOW DIAGRAM)**
P&ID	**(Piping & INSTRUMENTATION DIAGRAM)**
UFD	**(UTILITY FLOW DIAGRAM)**
UHD	**(UTILITY HEADER DIAGRAM)**
UDFD	**(UTILITY DISTRIBUTION FLOW DIGRAM)**

ارتباط مدرک PFD با سایر دیسیپلینها



SYMBOL AND LEGEND(SYMBOLOGY)

PFD

- DEFINITION
- ALL EQUIPMENTS
- H&M

P&ID

- VALVE
- LINE
- ALL EQUIPMENTS
- PROCESS CONTROL PARAMETER
- ADVANCE CONTROL SYSTEM

Scale

PFDs should not be drafted to scale. However, their size should be compatible with that of equipment drawings.

Flow Direction

As a rule, PFDs should be drawn from the left to the right in accordance with process flows.

Size

The size of PFD should normally be A1 (594 mm × 841 mm).

PFD (process flow diagram)

نقشه شماتيکي است که تعريف کلي از فرايند سيستم را توسط نمايش تجهيزات و خطوط اصلي فرايند همراه با مشخصات پروسسي اين خطوط ارائه ميدهد.اين مشخصات عموما شامل درجه حرارت و فشار کاري (عملياتي) ، دبي جريان ، دانسيته و ويسکوزيته ، ميزان و يا درصد عناصر مهم در خطوط مختلف ميباشد.

P&ID (piping and instrumentation diagram)

نقشه شماتيکي است که شامل کليه تجهيزات مکانيکي ، خطوط ارتباطي ، تجهيزات ابزار دقيق ، سيستمهاي کنترلي و اينترلاکها است . به عبارت ديگر کليه اقلام و تجهيزات مکانيکي ، لوله کشي و ابزار دقيق در اين نقشه به طور شماتيک نشان داده ميشوند ولي آندسته از اقلام لوله کشي که در طراحي piping layout (چيدمان لوله کشي) مورد نياز واقع ميشوند در نقشه P&ID ديده نميشوند از جمله زانوئي ها که دقيقا بستگي به طريقه چيدمان لوله کشي دارند.

UHD (utility header diagram)

نقشه‌هاي شماتيکي هستند که توزيع سيالات غير پرورسي (جانبي) را از خروجي واحد توليد کننده اين سيالات، تا مرز ورودي واحدهاي مصرف کننده (پروسسي) نشان ميدهد.
همچنين در داخل واحدهاي پروسسي نيز اين دياگرامها توزيع سيالات غير پرورسي (utility) در واحد را نمايش ميدهند.

نکات مهم در کنترل نحوه نقشه‌کشی نقشه PFD

ITEM	DESCRIPTION
01	IS LAY OUT ACCEPTABLE? آيا شكل نقشه از نظر ميزان پراكندگي تجهيزات و لوله‌كشي يكنواخت است
02	DIRECTION OF FLOWS? جهت جريانات زده شده باشد
03	THICKNESS AND TYPE OF LINES FOR INDICATION OF MAIN PROCESS,SECONDARY PROCESS ,UTILIYIES,SIGNALS,ETC. ARE CORRECT? ضخامت خطوط متناسب با نوع جريان انتخاب شده باشد (خطوط اصلي پررنگتر از خطوط فرعي بوده و جهت نشان دادن سيگنالهاي ابزاردقيق از خط متفاوتي استفاده شود
04	CROSSING ARE CORRECT? خطوطي ك هاز روي هم رد ميشوند با يكديگر برخورد نداشته باشند
05	BATTERY LIMITS , AND ADDRESSES ARE SHOWN CORRECTLY? مرز نقشه مشخص شده باشد و آدرس خطوط در ورود و خروج به واحد داده شده باشد.
06	LEGEND OF EQ. ARE CORRECT? شكل شماتيكي تجهيزات مطابق با LEGEND قراردادي انتخاب شده باشد
07	STRAM NOS ARE AS REQUIRED FOR MAKING BALANCE AROUND ALL EQ.? شماره جريانات كه با استفاده از آن در جدول MATERIAL BALANCE مشخصات پروسسي داده ميشود به تعداد كافي نشان داده شده باشد
08	TITLE BLOCK IS CORRECTLY COMPLETED? جدول عنوان نقشه به درستي تكميل شده باشد

الزامات موجود در PFD

TABLE 2.1. Checklist of Data Normally Included on a Process Flowsheet

1. Process lines, but including only those bypasses essential to an understanding of the process
2. All process equipment. Spares are indicated by letter symbols or notes
3. Major instrumentation essential to process control and to understanding of the flowsheet
4. Valves essential to an understanding of the flowsheet
5. Design basis, including stream factor
6. Temperatures, pressures, flow quantities
7. Weight and/or mol balance, showing compositions, amounts, and other properties of the principal streams
8. Utilities requirements summary
9. Data included for particular equipment
   a. Compressors: SCFM (60°F, 14.7 psia); ΔP psi; HHP; number of stages; details of stages if important
   b. Drives: type; connected HP; utilities such as kW, lb steam/hr, or Btu/hr
   c. Drums and tanks: ID or OD, seam to seam length, important internals
   d. Exchangers: Sqft, kBtu/hr, temperatures, and flow quantities in and out; shell side and tube side indicated
   e. Furnaces: kBtu/hr, temperatures in and out, fuel
   f. Pumps: GPM (60°F), ΔP psi, HHP, type, drive
   g. Towers: Number and type of plates or height and type of packing; identification of all plates at which streams enter or leave; ID or OD; seam to seam length; skirt height
   h. Other equipment: Sufficient data for identification of duty and size

الزامات موجود در PFD

Minimum Information Requirements For Equipments

حداقل اطلاعات لازم برای تجهیزات

- **1. Designated streams**
- **a) Stream numbers should be serially denoted by Decimal numbers.**
- **b) Fluid name.**
- **c) Total flow rate.**
- **d) Density and/or molecular mass (weight) if required.**
- **e) Operating pressure and temperature if required.**

الزامات موجود در PFD

Minimum Information Requirements For Equipments

حداقل اطلاعات لازم برای تجهیزات

- **2. Heat exchangers**
- **a) Identification number and service name.**
- **b) Operating heat duty.**
- **c) Inlet and outlet temperatures on both shell and tube sides.**

- **3. Furnaces**
- **a) Identification number and service name.**
- **b) Operating absorbed heat duty.**
- **c) Inlet and outlet operating temperatures on tube side.**

الزامات موجود در PFD

Minimum Information Requirements For Equipments

حداقل اطلاعات لازم برای تجهیزات

- **4. Reactors**
- **a) Identification number and service name.**
- **b) Inlet and outlet operation temperature.**
- **c) Inlet and/or outlet pressure.**

- **5. Columns**
- **a) Identification number and service name.**
- **b) Tray numbers, operating temperature and pressure for top and bottom trays**
- **and also for special trays such as feed and draw-off, etc.**
- **c) Trays shall be numbered from bottom to top.**

الزامات موجود در PFD

Minimum Information Requirements For Equipments

حداقل اطلاعات لازم برای تجهیزات

- **6. Drums**
- **a) Identification number and service name.**
- **b) Operating temperature.**
- **c) Operating pressure.**

- **7. Pumps**
- **a) Identification number and service name.**
- **b) Normal operating capacity and differential pressure.**

الزامات موجود در PFD

Minimum Information Requirements For Equipments

حداقل اطلاعات لازم برای تجهیزات

TYPE OF EQUIPMENT	REPRESENTATION OF INFORMATION ON PFD	REPRESENTATION OF INFORMATION ON P & ID
Pressure vessel / Tower	Item No.: Service: ID × TT: mm Operating Temp.: °C Operating Press.: Barg	Item No.: Service: ID × TT: mm Design Press.: Barg Design Temp.: °C
Package Unit	Item No.: Service: Capacity:	Item No.: Service: Capacity: Dimension or other related information
Pig Launcher /Receiver	Item No.: Service: Operating Press.: Barg Operating Temp.: °C	Item No.: Service: Dimension: Design Press.: Barg Design Temp.: °C

الزامات موجود در PFD

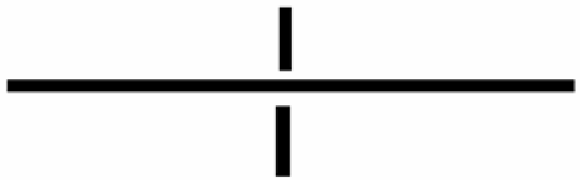
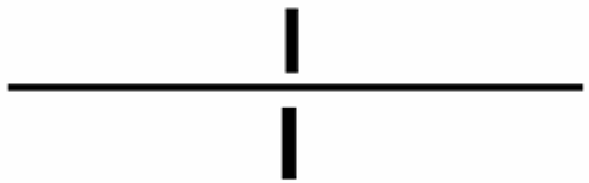
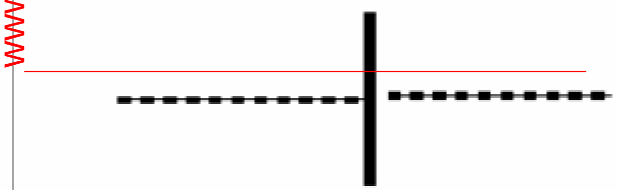
انواع خطوط و ضخامتهای استاندارد آنها KIND OF LINES

As a rule, Process lines, utility lines, and loop lines for instrument should be drawn according to IPS-E-PR-230 as follows:

a) Main process lines Thickness = 0.8 mm	
b) Secondary process lines and utility line Thickness = 0.5 mm	
c) All electrical, computerand instrument signals Thickness = 0.3 m	

الزامات موجود در PFD

گذر خطوط و نقاط تقاطع LINE CROSSOVER

a) Where two main process lines cross	
b) Where one main line crosses one secondary process and utility lines	
c) Where one main line crosses one loop line for an instrument	

الزامات موجود در PFD

TP(TIE IN POINT)نقاط تعیین کننده مرز پروژه

Denotation of Lines at Battery Limit Tie-In Points

a) Process lines

From Item No. and/
or Dwg. No.

To Item No. and/
or Dwg. No.

هدر (header , manifold)

لوله‌هايي كه جهت جمع‌آوري سيال از چند خط ،چند پمپ، و يا چند شير اطمينان (safety valve) و ....،وارسال اين سيال به يک يا چند خط بكار ميروند.

شير اطمينان (safety valve)

شير هايي كه روي خطوط لوله و يا مخازن تحت فشار نصب ميشوند و در صورت بروز پديده افزايش فشار بيش از ميزان تعيين شده (set point) باز شده و بخشي از سيال را از خط و يا مخزن تحت فشار تخليه كرده و فشار آن را به زير ميزان تعيين شده كاهش ميدهد.

شير كنترل (control valve)

شيرهاي اتوماتي هستند كه به منظور كنترل پارامترهايي مانند فشار، دبي،درجه حرارت و ... در خط تعبيه شده و بنا به نوع كنترلي كه دارند از pressure transmitter، temperature transmitter و يا ساير تجهيزات اندازه گيري با برنامه‌اي كه در DCS با عنوان logic diagram براي آنها تعريف ميشود پارامتر مورد نظر را كنترل مينمايند.عملگر اين شيرها عموما هواي ابزار دقيق ميباشد (pneumatic actuator)

Vent و drain

به ترتيب شير تخليه هوا كه در بالاترين نقطه خط نصب ميشود و جهت تخليه هوا از خط مورد استفاده قرار ميگيرد و شير تخليه مايع كه در پايين ترين نقطه خط نصب شده و جهت تخليه مايع استفاده ميشود.

انواع قدیمی دیگر PFD (منسوخ)

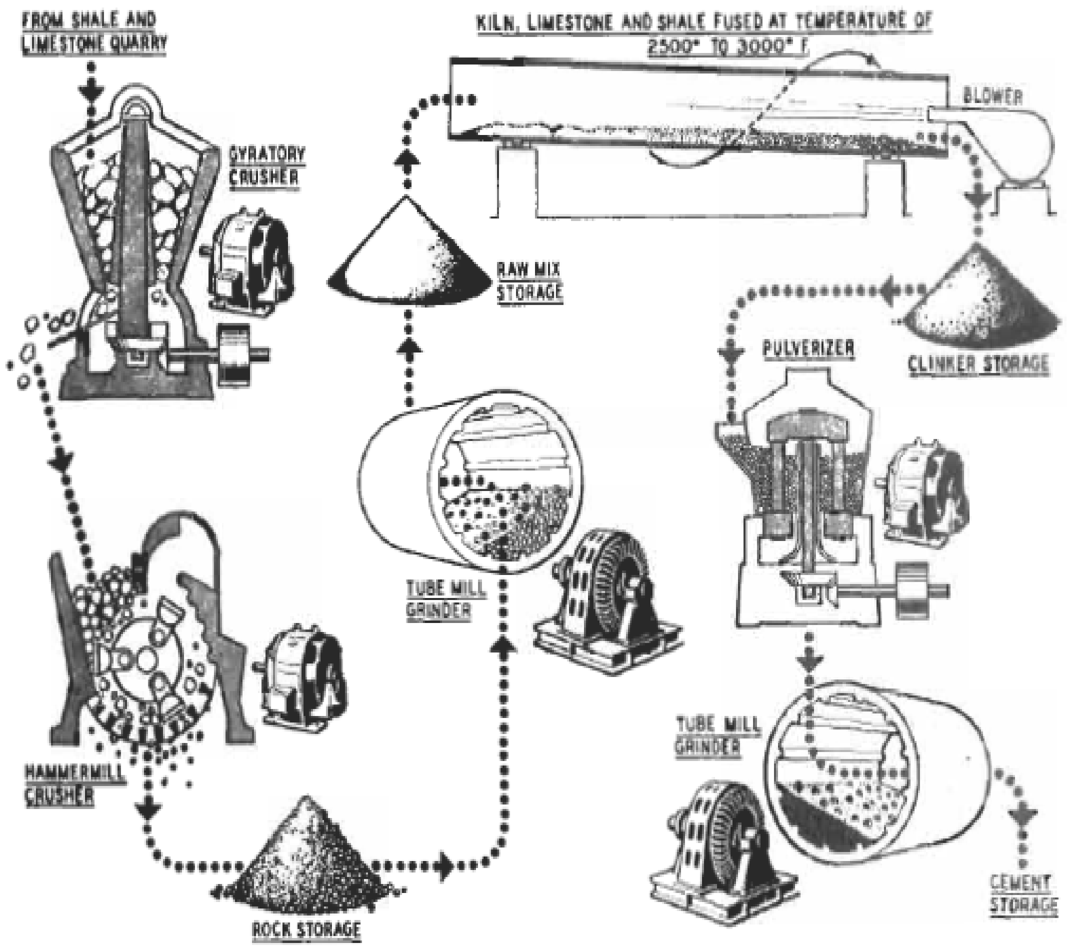


Figure 1-4. Pictorial flow diagram establishes key processing steps: Cement manufacture. By permission, E-M Synchronizer, Electric Machinery Mfg. Co.

انواع قدیمی دیگر PFD (منسوخ)

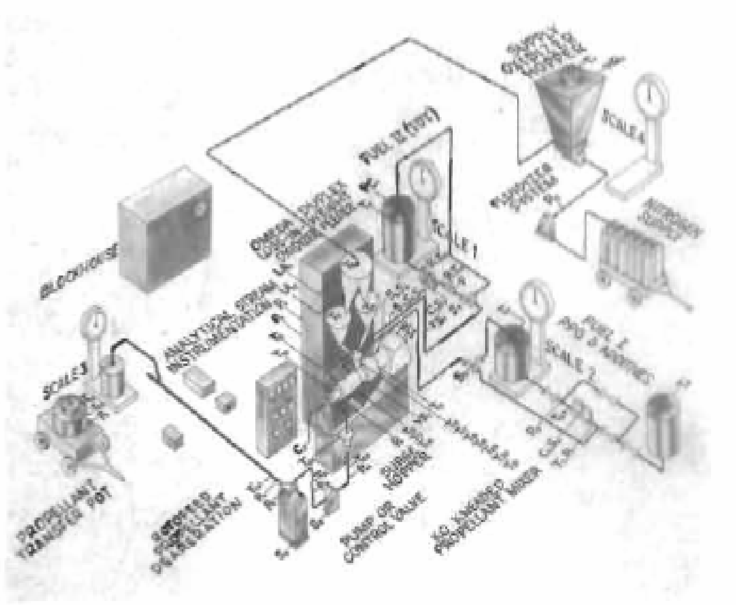
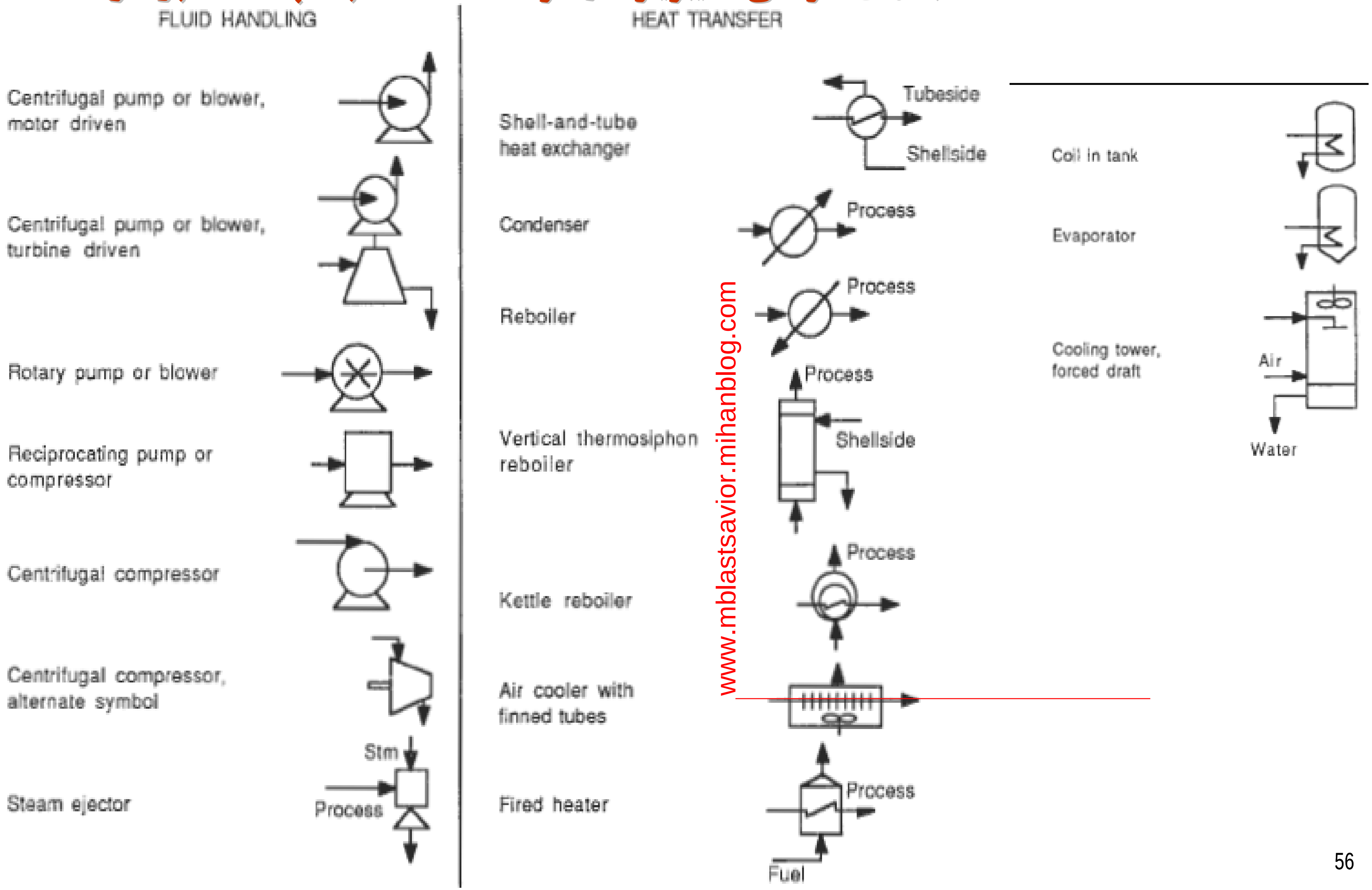


Figure 1-5B. Isometric pictorial flow diagram. By permission, J. W. Keating and R. D. Geckler, Aerojet General Corp.

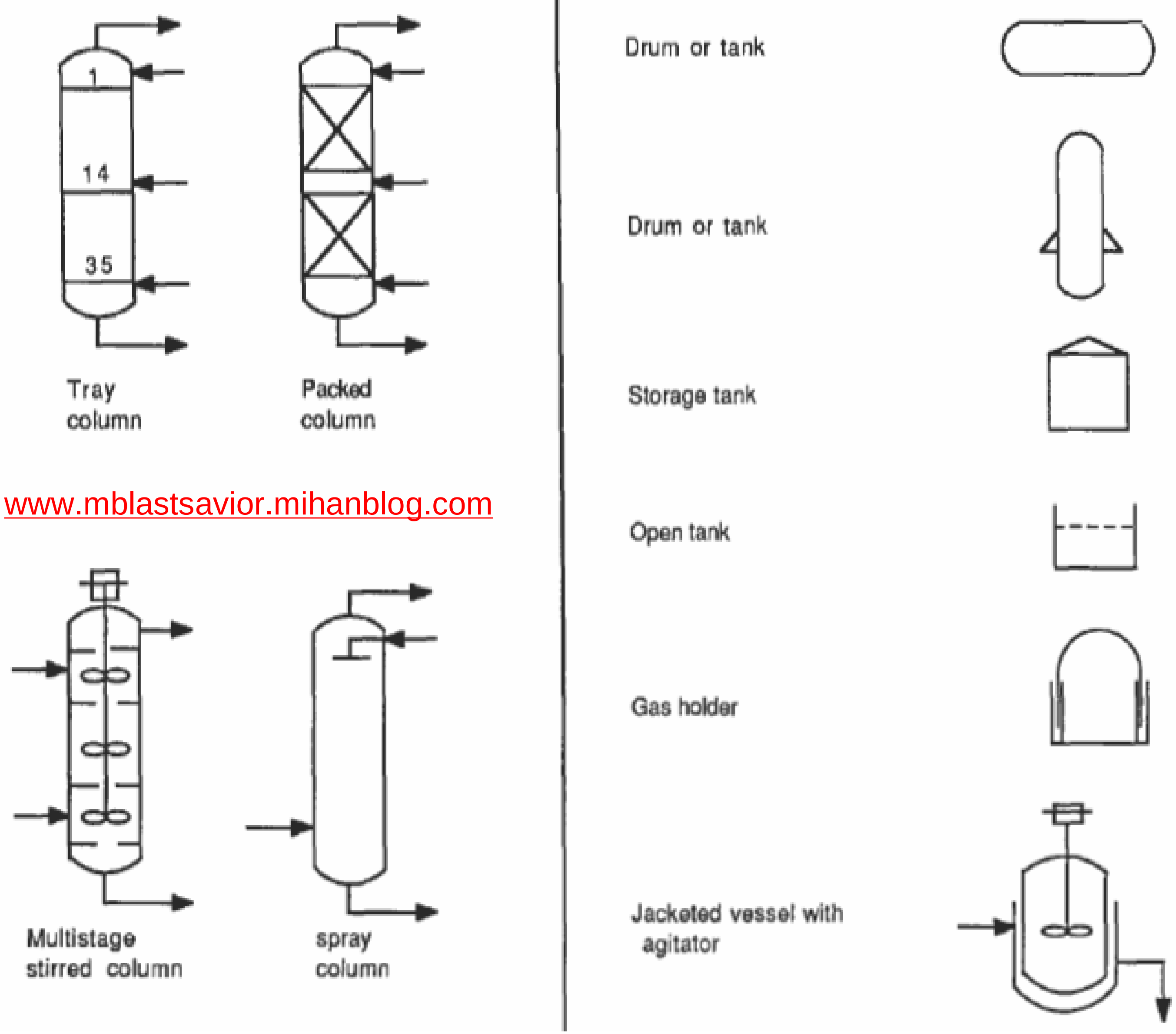
الگوهای مختلف مورد استفاده در رسم نمودار جریان

پمپ و کمپرسور — مبدلهای حرارتی ، ریبویلرها و کوره ها — مخازن



الگوهای مختلف مورد استفاده در رسم نمودار جریان

برجها   درامها



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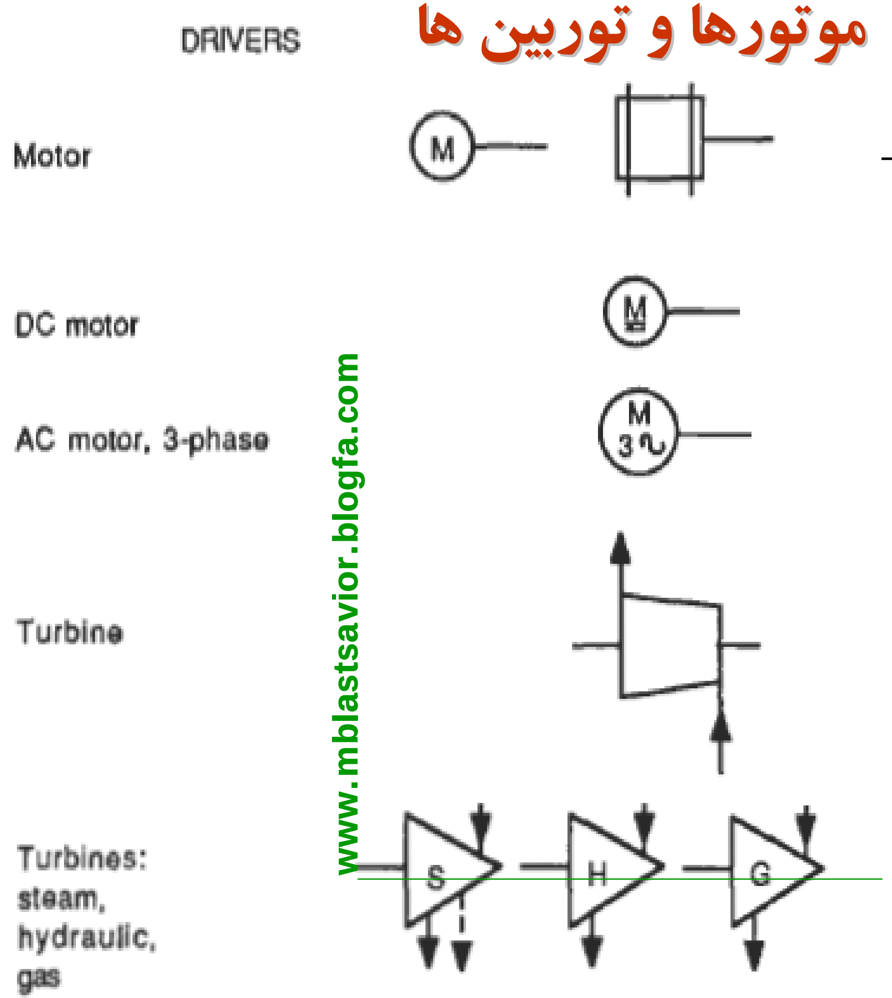
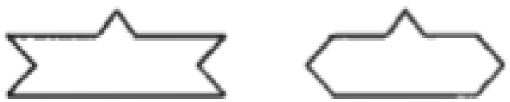
الگوهای مختلف مورد استفاده در رسم نمودار جریان

موتورها و توربین ها



الگوهای مختلف مورد استفاده در رسم نمودار جریان

TABLE 2.3. Flowsheet Flags of Operating Conditions in Typical Units

Mass flow rate, lbs/hr	13,028
Molal flow rate, lbmols/hr	217
Temperature, °F	510
Pressure, psig (or indicate if psia or Torr or bar)	155 psia
Volumetric liquid flow rate, gal/min.	65.3
Volumetric liquid flow rate, bbls/day	8,500
Kilo Btu/hr, at heat transfer equipment	9,700
Enthalpy, Btu/lb	953
Others	

مهم

1. VISBREAKER OPERATION

Visbreaking is a mild thermal pyrolysis of heavy petroleum fractions whose object is to reduce fuel production in a refinery and to make some gasoline.

The oil of 7.2 API and 700°F is supplied from beyond the battery limits to a surge drum F-1. From there it is pumped with J-1A&B to parallel furnaces B-1A&B from which it comes out at 890°F and 200 psig. Each of the split streams enters at the bottom of its own evaporator T-1A&B that has five trays. Overheads from the evaporators combine and enter at the bottom of a 30-tray fractionator T-2. A portion of the bottoms from the fractionator is fed to the top trays of T-1A&B; the remainder goes through exchanger E-5 and is pumped with J-2A&B back to the furnaces B-1A&B. The bottoms of the evaporators are pumped with J-4A&B through exchangers E-5, E-3A (on crude), and E-3B (on cooling water) before proceeding to storage as the fuel product.

A side stream is withdrawn at the tenth tray from the top of T-2 and proceeds to steam stripper T-3 equipped with five trays. Steam is fed below the bottom tray. The combined steam and oil vapors return to T-2 at the eighth tray. Stripper bottoms are pumped with J-6 through E-2A (on crude) and E-2B (on cooling water) and to storage as "heavy gasoline."

Overhead of the fractionator T-2 is partially condensed in E-1A (on crude) and E-1B (on cooling water). A gas product is withdrawn overhead of the reflux drum which operates at 15 psig. The "light gasoline" is pumped with J-5 to storage and as reflux.

Oil feed is 122,480 pph, gas is 3370, light gasoline is 5470, heavy gasoline is 9940, and fuel oil is 103,700 pph.

Include suitable control equipment for the main fractionator T-2.

Example

PFD وP&ID آن را به طور کامل رسم کنید

(از چپ به راست با حفظ تقارن!!)

ترسیم با AutoCAD

UFD-UHDمدارک لازم برای تهیه

Project design criteria
PFD
P&ID
Plot Plan
symbology

UTILITY FLOWSHEETS

UFD (UTILITY FLOW DIAGRAM)

UHD (UTILITY HEADER DIAGRAM)

UDFD (UTILITY DISTRIBUTION FLOW DIGRAM)

These are UFD diagrams(LIKE P&ID) for individual utilities such as

steam condensate (HPS,MPS,LPS)

cooling water(CWS,CWR,RWA,DWA(demin water))

NIT(NITROGEN) inert blanketing gases or purging or catalyst regeneration,

P&ID

Instrument

P&ID

A P&ID is a document which is developed and used by Engineers,Technicians, Technologists, Maintenance and Operations personnel to define a manufacturing system. It's intent is to communicate in detail the controls, instruments, piping, and equipment used to implement that system.

P&ID

A P&ID consists of the following:

- **Diagram Drawing**
- **Equipment List information**
- **Piping Equipment List information**
- **Pipeline List Information**
- **Instrument List information (both local and DCS I PLC)**
- **Notes and Details**
- **Line slope and Flow direction**

"P&ID" INPUT DATA	
اطلاعات مورد نیاز جهت طراحی P&ID	
ITEM	DESCRIPTION
01	PROJECT DESIGN CRITERIA ضوابط طراحي پروژه
02	PROCESS FLOW DIAGRAM (PFD) فلوشيت پروسسي
03	PIPING MATERIAL SPEC. مشخصات فني لولهكشي
04	PROCESS DATA SHEET
05	EQUIPMENT PROCESS DATA
06	INSTRUMENT DATA
07	ENG. PRACTICE CODE AND STANDARD استانداردهاي مورد نياز همراه با تجربيات و دستورالعملها
08	LEGEND AND SYMBOLS

P&ID Symbols:

- **P&ID Equipment Symbols**
- **P&ID General Symbols**
- **P&ID Instrument Symbols (Typical Hook-Up)**
- **P&ID Instrument Symbols (Valve Symbol)**

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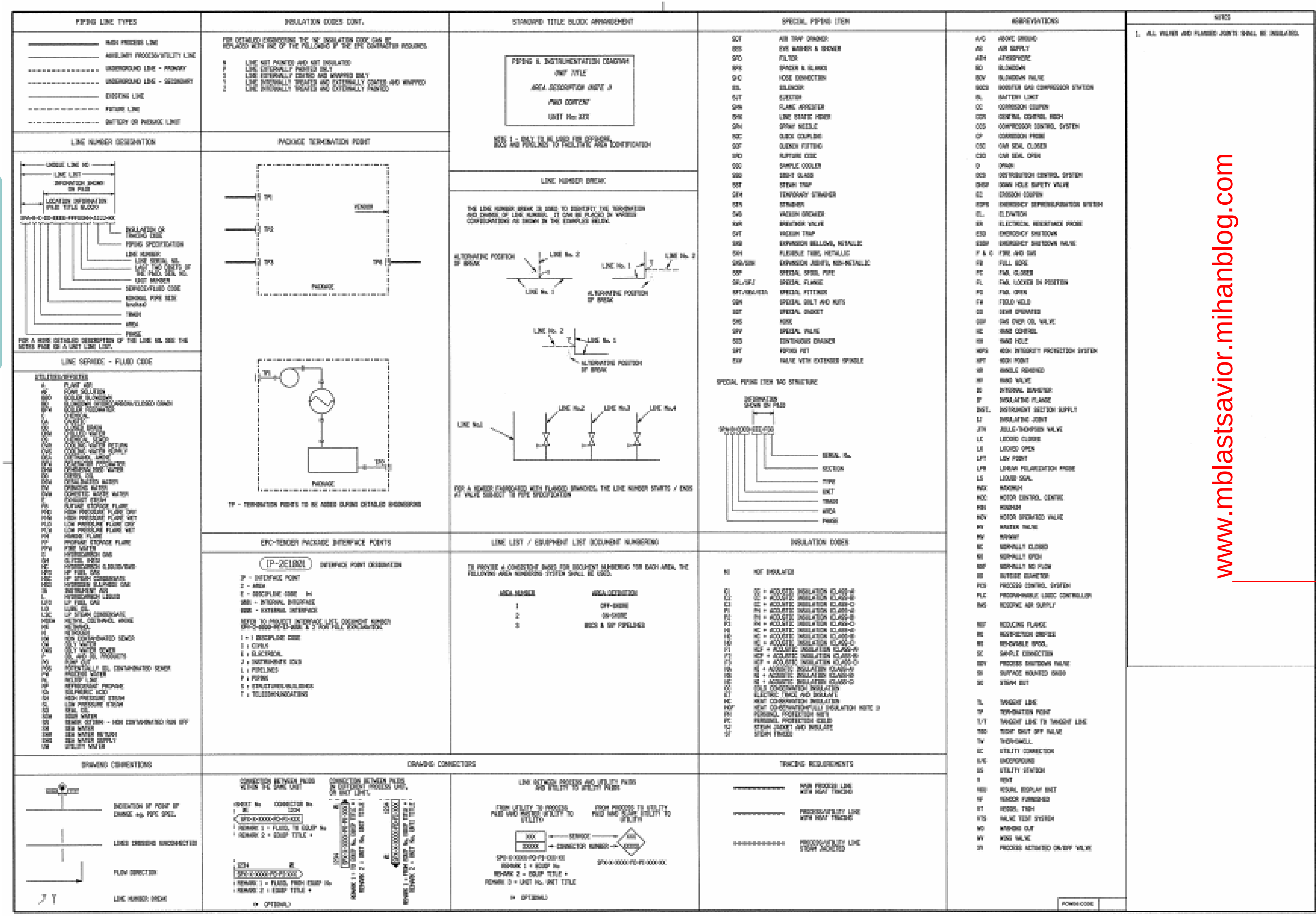

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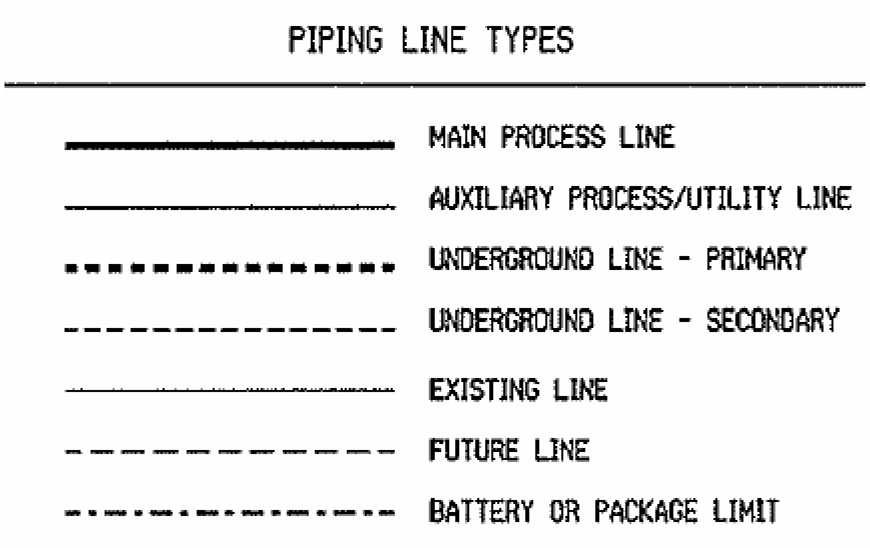

صفحه اول

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مدارک Legend و Symbology یک پروژه

UTILITIES/OFFSITES

A	PLANT AIR
AF	FOAM SOLUTION
BBD	BOILER BLOWDOWN
BD	BLOWDOWN (HYDROCARBON)/CLOSED DRAIN
BFW	BOILER FEEDWATER
C	CHEMICAL
CA	CAUSTIC
CD	CLOSED DRAIN
CHW	CHILLED WATER
CS	CHEMICAL SEWER
CWR	COOLING WATER RETURN
CWS	COOLING WATER SUPPLY
DEA	DIETHANOL AMINE
DFW	DEAERATOR FEEDWATER
DMW	DEMINERALISED WATER
DO	DIESEL OIL
DSW	DESALINATED WATER
DW	DRINKING WATER
DWW	DOMESTIC WASTE WATER
E	EXHAUST STEAM
FB	BUTANE STORAGE FLARE
FHD	HIGH PRESSURE FLARE DRY
FHW	HIGH PRESSURE FLARE WET
FLD	LOW PRESSURE FLARE DRY
FLW	LOW PRESSURE FLARE WET
FM	MARINE FLARE
FP	PROPANE STORAGE FLARE
FFW	FIRE WATER
G	HYDROCARBON GAS
GM	GLYCOL (MEG)
HC	HYDROCARBON (LIQUID/GAS)
HFG	HP FUEL GAS
HSC	HP STEAM CONDENSATE
HSG	HYDROGEN SULPHIDE GAS
IA	INSTRUMENT AIR
L	HYDROCARBON LIQUID
LFG	LP FUEL GAS
LO	LUBE OIL
LSC	LP STEAM CONDENSATE
MDEA	METHYL DIETHANOL AMINE
ME	METHANOL
N	NITROGEN

NW	NON CONTAMINATED SEWER
OW	OILY WATER
OWS	OILY WATER SEWER
P	OIL AND OIL PRODUCTS
PO	PUMP OUT
POS	POTENTIALLY OIL CONTAMINATED SEWER
PW	PROCESS WATER
RL	RELIEF LINE
RP	REFRIGERANT PROPANE
SA	SULPHURIC ACID
SH	HIGH PRESSURE STEAM
SL	LOW PRESSURE STEAM
SO	SEAL OIL
SOW	SOUR WATER
SR	SEWER (STORM) - NON CONTAMINATED RUN OFF
SW	SEA WATER
SWR	SEA WATER RETURN
SWS	SEA WATER SUPPLY
UW	UTILITY WATER

صفحه اول

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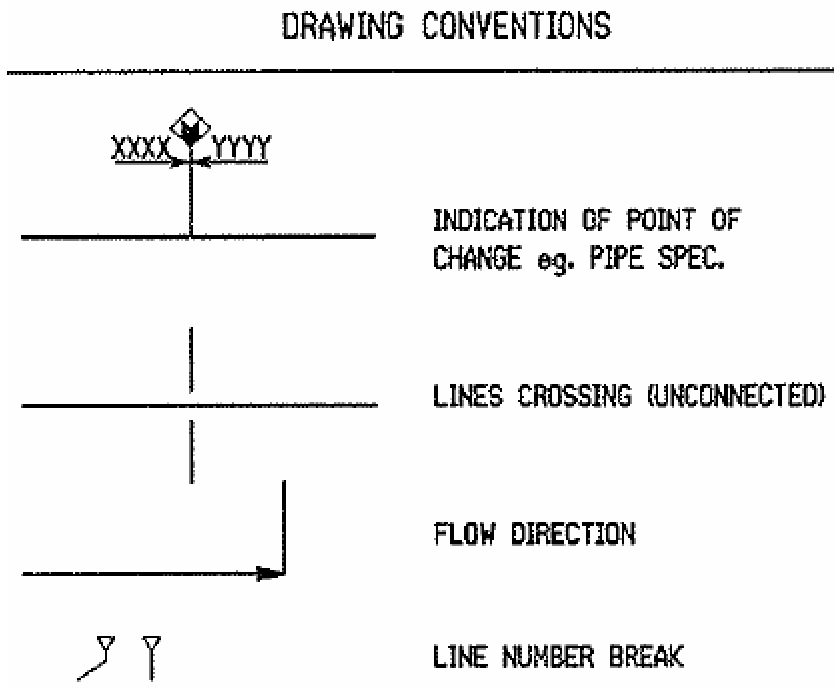
مدارک Legend و Symbology یک پروژه



صفحه اول

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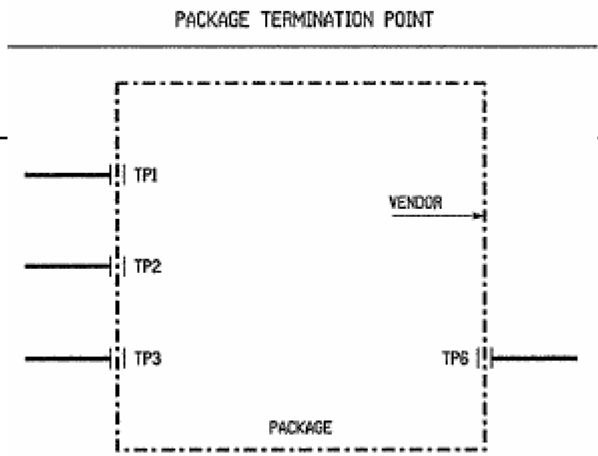

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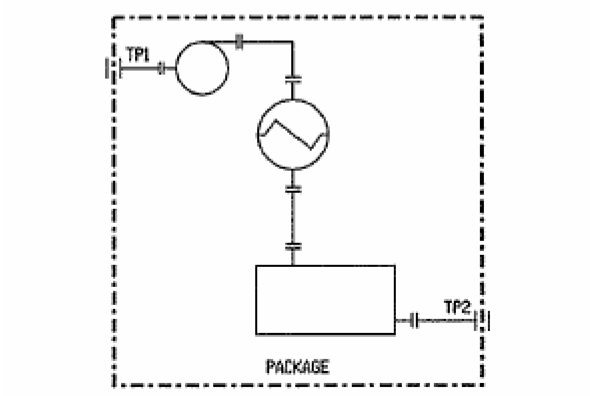

TP - TERMINATION POINTS TO BE ADDED DURING DETAILED ENGINEERING

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مدارک Legend و Symbology یک پروژه

STANDARD TITLE BLOCK ARRANGEMENT

PIPING & INSTRUMENTATION DIAGRAM

UNIT TITLE

AREA DESCRIPTION (NOTE 1)

P&ID CONTENT

UNIT No: *XXX*

NOTE 1 - ONLY TO BE USED FOR OFFSHORE, BGCS AND PIPELINES TO FACILITATE AREA IDENTIFICATION

صفحه اول

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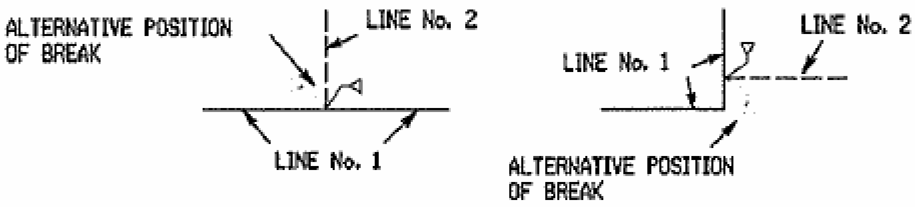
مدارک Legend و Symbology یک پروژه

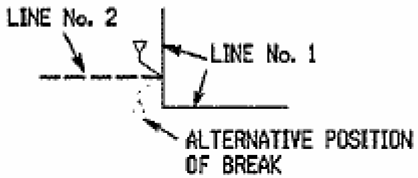
LINE NUMBER BREAK

THE LINE NUMBER BREAK IS USED TO IDENTIFIY THE TERMINATION AND CHANGE OF LINE NUMBER. IT CAN BE PLACED IN VARIOUS CONFIGURATIONS AS SHOWN IN THE EXAMPLES BELOW.



طرق مختلف نمایش تغییر شماره خط

صفحه اول



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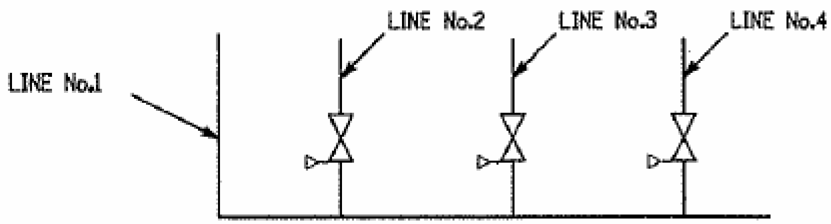

FOR A HEADER FABRICATED WITH FLANGED BRANCHES, THE LINE NUMBER STARTS / ENDS AT VALVE SUBJECT TO PIPE SPECIFICATION

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صفحه اول

LINE LIST / EQUIPMENT LIST DOCUMENT NUMBERING

TO PROVIDE A CONSISTENT BASIS FOR DOCUMENT NUMBERING FOR EACH AREA, THE FOLLOWING AREA NUMBERING SYSTEM SHALL BE USED.

AREA NUMBER	AREA DEFINITION
1	OFF-SHORE
2	ON-SHORE
3	BGCS & 56' PIPELINES

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مدارک Legend و Symbology یک پروژه

SPECIAL PIPING ITEM

SDT	AIR TRAP DRAINER
SES	EYE WASHER & SHOWER
SFD	FILTER
SFS	SPACER & BLANKS
SHC	HOSE CONNECTION
SIL	SILENCER
SJT	EJECTOR
SMA	FLAME ARRESTER
SMX	LINE STATIC MIXER
SPN	SPRAY NOZZLE
SQC	QUICK COUPLING
SQF	QUENCH FITTING
SRD	RUPTURE DISC
SSC	SAMPLE COOLER
SSG	SIGHT GLASS
SST	STEAM TRAP
STM	TEMPORARY STRAINER
STR	STRAINER
SVB	VACUUM BREAKER
SVR	BREATHER VALVE
SVT	VACUUM TRAP
SXB	EXPANSION BELLOWS, METALLIC
SXH	FLEXIBLE TUBE, METALLIC
SXB/SXH	EXPANSION JOINTS, NON-METALLIC
SSP	SPECIAL SPOOL PIPE
SFL/SFJ	SPECIAL FLANGE
SFT/SEA/STA	SPECIAL FITTINGS
SBN	SPECIAL BOLT AND NUTS
SGT	SPECIAL GASKET
SHS	HOSE
SPV	SPECIAL VALVE
SCD	CONTINUOUS DRAINER

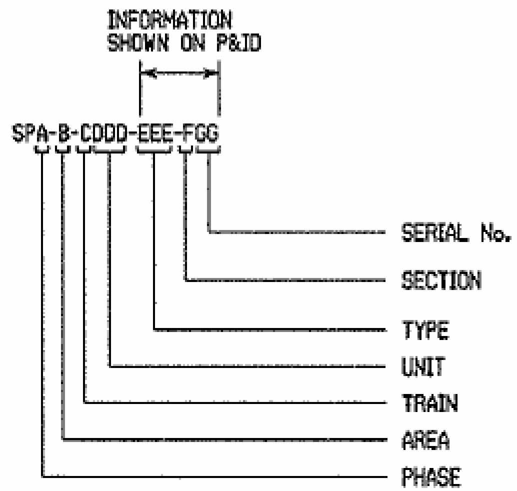
اختصارات مختلف پایپینگ

صفحه اول

مدارک Legend و Symbology یک پروژه

SPT	PIPING POT
EXV	VALVE WITH EXTENDED SPINDLE

SPECIAL PIPING ITEM TAG STRUCTURE



صفحه اول

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مدارک Legend و Symbology یک پروژه

اختصارات عایقها

INSULATION CODES CONT.

FOR DETAILED ENGINEERING THE 'NI' INSULATION CODE CAN BE REPLACED WITH ONE OF THE FOLLOWING IF THE EPC CONTRACTOR REQUIRES.

N	LINE NOT PAINTED AND NOT INSULATED
P	LINE EXTERNALLY PAINTED ONLY
X	LINE EXTERNALLY COATED AND WRAPPED ONLY
Y	LINE INTERNALLY TREATED AND EXTERNALLY COATED AND WRAPPED
Z	LINE INTERNALLY TREATED AND EXTERNALLY PAINTED

INSULATION CODES

NI	NOT INSULATED
C1	CC + ACOUSTIC INSULATION (CLASS-A)
C2	CC + ACOUSTIC INSULATION (CLASS-B)
C3	CC + ACOUSTIC INSULATION (CLASS-C)
P1	PH + ACOUSTIC INSULATION (CLASS-A)
P2	PH + ACOUSTIC INSULATION (CLASS-B)
P3	PH + ACOUSTIC INSULATION (CLASS-C)
H1	HC + ACOUSTIC INSULATION (CLASS-A)
H2	HC + ACOUSTIC INSULATION (CLASS-B)
H3	HC + ACOUSTIC INSULATION (CLASS-C)
F1	HCF + ACOUSTIC INSULATION (CLASS-A)
F2	HCF + ACOUSTIC INSULATION (CLASS-B)
F3	HCF + ACOUSTIC INSULATION (CLASS-C)
NA	NI + ACOUSTIC INSULATION (CLASS-A)
NB	NI + ACOUSTIC INSULATION (CLASS-B)
NC	NI + ACOUSTIC INSULATION (CLASS-C)
CC	COLD CONSERVATION INSULATION
ET	ELECTRIC TRACE AND INSULATE
HC	HEAT CONSERVATION INSULATION
HCF	HEAT CONSERVATION(FULL) INSULATION (NOTE 1)
PH	PERSONEL PROTECTION (HOT)
PC	PERSONEL PROTECTION (COLD)
SJ	STEAM JACKET AND INSULATE
ST	STEAM TRACED

صفحه اول

NOTES

1. ALL VALVES AND FLANGED JOINTS SHALL BE INSULATED.

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مدارک Legend و Symbology یک پروژه

اختصارات مختلف

صفحه اول

ABBREVIATIONS

A/G	ABOVE GROUND
AS	AIR SUPPLY
ATM	ATMOSPHERE
BD	BLOWDOWN
BDV	BLOWDOWN VALVE
BGCS	BOOSTER GAS COMPRESSOR STATION
BL	BATTERY LIMIT
CC	CORROSION COUPON
CCR	CENTRAL CONTROL ROOM
CCS	COMPRESSOR CONTROL SYSTEM
CP	CORROSION PROBE
CSC	CAR SEAL CLOSED
CSO	CAR SEAL OPEN
D	DRAIN
DCS	DISTRIBUTION CONTROL SYSTEM
DHSV	DOWN HOLE SAFETY VALVE
EC	EROSION COUPON
EDPS	EMERGENCY DEPRESSURISATION SYSTEM
EL.	ELEVATION
ER	ELECTRICAL RESISTANCE PROBE
ESD	EMERGENCY SHUTDOWN
ESDV	EMERGENCY SHUTDOWN VALVE
F & G	FIRE AND GAS
FB	FULL BORE
FC	FAIL CLOSED
FL	FAIL LOCKED IN POSITION
FO	FAIL OPEN
FW	FIELD WELD
GO	GEAR OPERATED

GOV	GAS OVER OIL VALVE
HC	HAND CONTROL
HH	HAND HOLE
HIPS	HIGH INTEGRITY PROTECTION SYSTEM
HPT	HIGH POINT
HR	HANDLE REMOVED
HV	HAND VALVE
ID	INTERNAL DIAMETER
IF	INSULATING FLANGE
INST.	INSTRUMENT SECTION SUPPLY
IJ	INSULATING JOINT
JTV	JOULE-THOMPSON VALVE
LC	LOCKED CLOSED
LO	LOCKED OPEN
LPT	LOW POINT
LPR	LINEAR POLARIZATION PROBE
LS	LIQUID SEAL
MAX	MAXIMUM
MCC	MOTOR CONTROL CENTRE
MIN	MINIMUM
MOV	MOTOR OPERATED VALVE
MV	MASTER VALVE
MW	MANWAY
NC	NORMALLY CLOSED
NO	NORMALLY OPEN
NNF	NORMALLY NO FLOW
OD	OUTSIDE DIAMETER
PCS	PROCESS CONTROL SYSTEM
PLC	PROGRAMMABLE LOGIC CONTROLLER
RAS	RESERVE AIR SUPPLY

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مدارک Legend و Symbology یک پروژه

اختصارات مختلف

صفحه اول

RDF	REDUCING FLANGE
RO	RESTRICTION ORIFICE
RS	REMOVABLE SPOOL
SC	SAMPLE CONNECTION
SDV	PROCESS SHUTDOWN VALVE
SK	SURFACE MOUNTED (SKIN)
SO	STEAM OUT
TL	TANGENT LINE
TP	TERMINATION POINT
T/T	TANGENT LINE TO TANGENT LINE
TSO	TIGHT SHUT OFF VALVE
TW	THERMOWELL
UC	UTILITY CONNECTION
U/G	UNDERGROUND
US	UTILITY STATION
V	VENT
VDU	VISUAL DISPLAY UNIT
VF	VENDOR FURNISHED
VT	VESSEL TRIM
VTS	VALVE TEST SYSTEM
WO	WASHING OUT
WV	WING VALVE
XV	PROCESS ACTUATED ON/OFF VALVE

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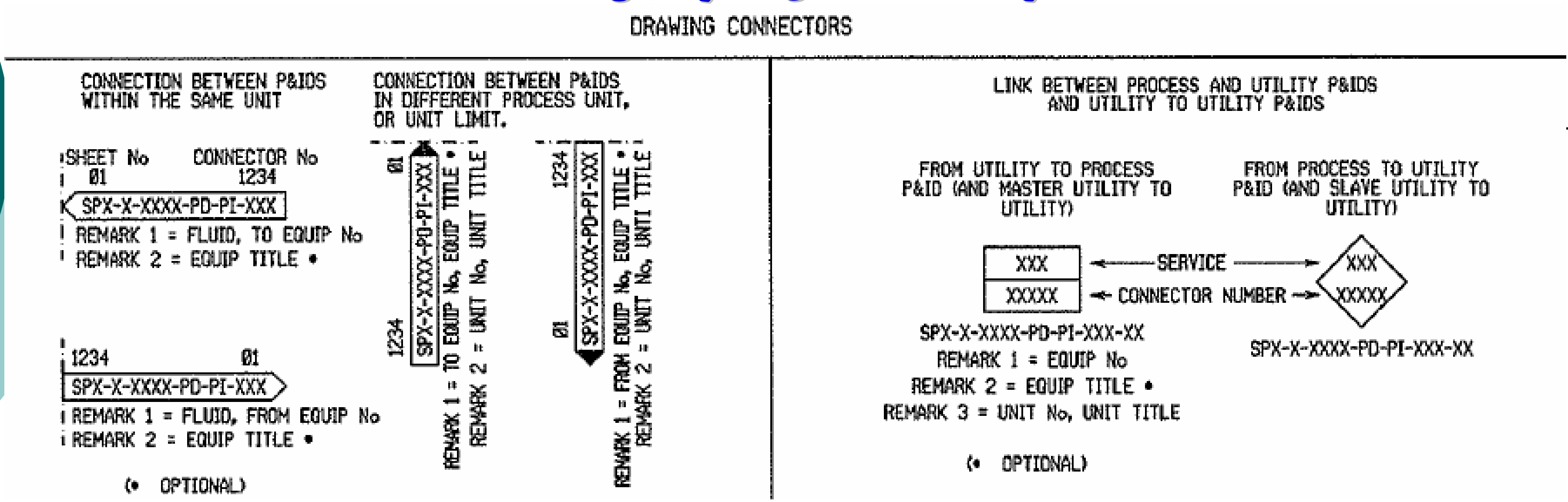
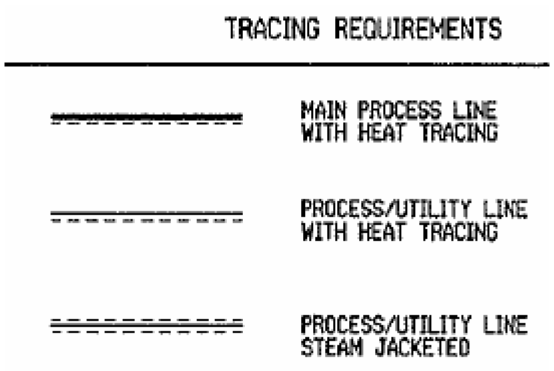
مدارک Legend و Symbology یک پروژه

طرق مختلف اتصال خطوط بین مدارک

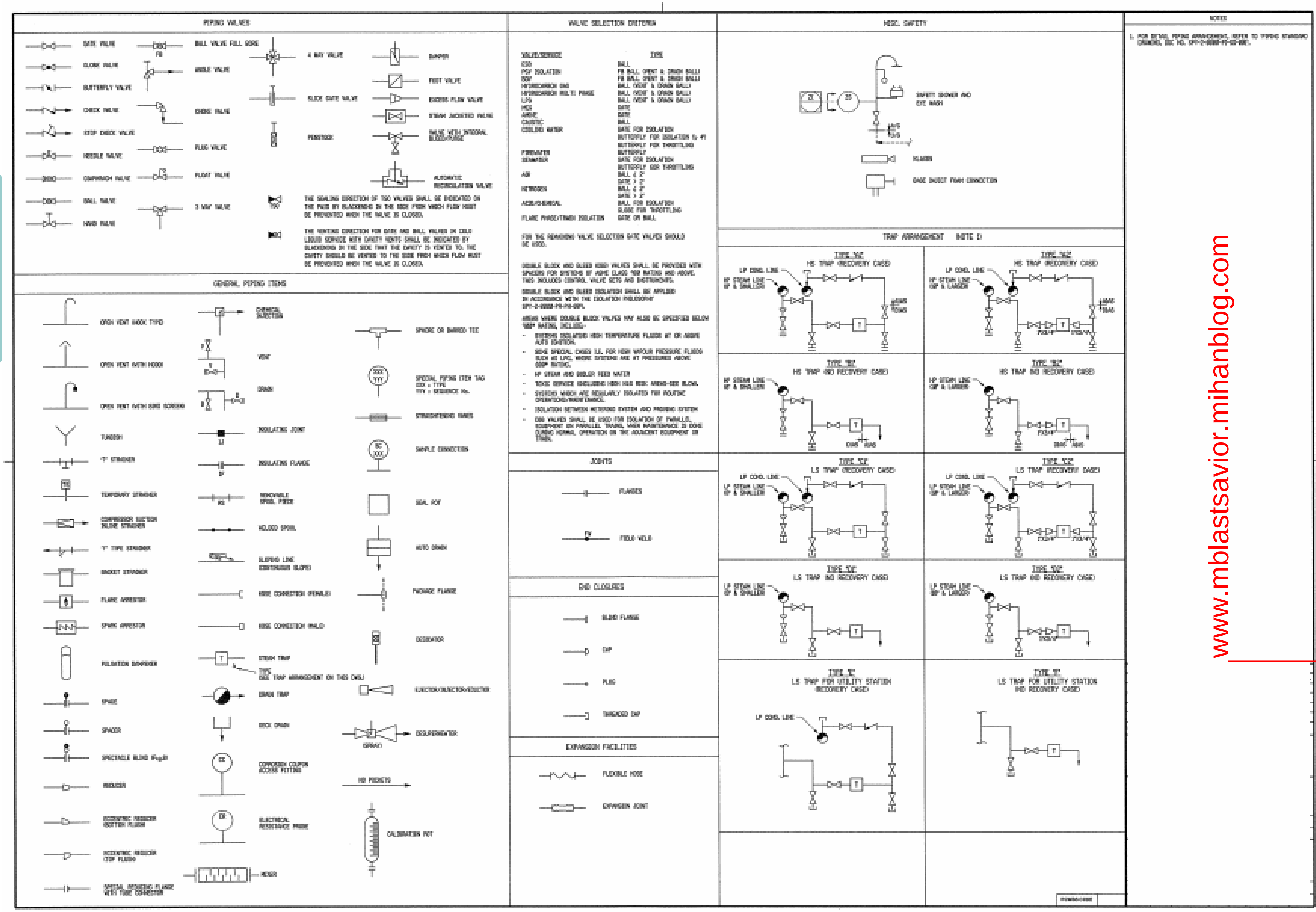


صفحه اول



طرق مختلف نمایش خطوط تریس

مدارک Legend و Symbology یک پروژه

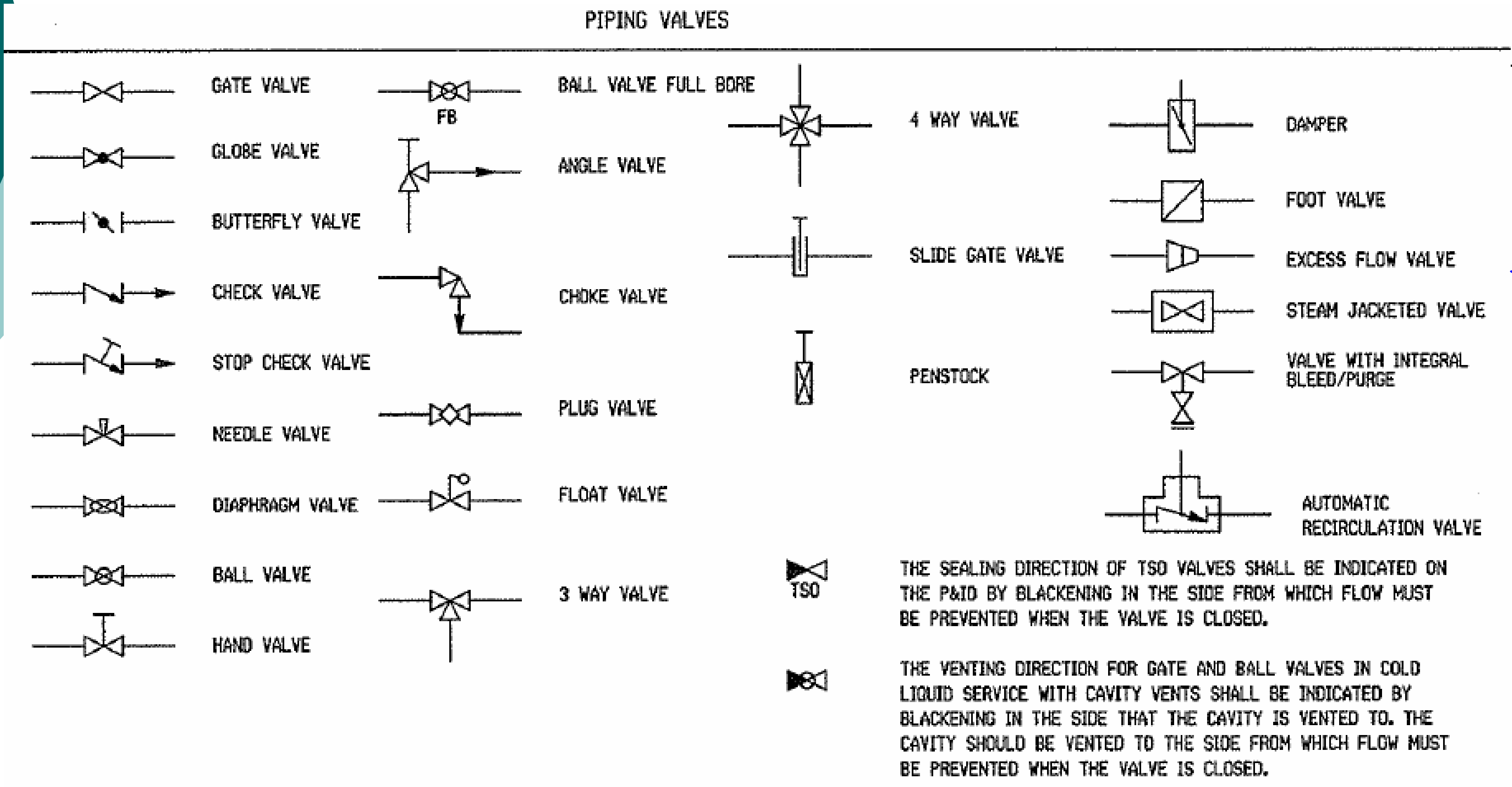


تهیه کننده:محمد بهزادی

صفحه دوم

مدارک Legend و Symbology یک پروژه

شکلهای شیرهای مختلف



صفحه دوم

مدارک Legend و Symbology یک پروژه

شرایط انتخاب شیرهای مختلف

DOUBLE BLOCK AND BLEED (DBB) VALVES SHALL BE PROVIDED WITH SPACERS FOR SYSTEMS OF ASME CLASS 900 RATING AND ABOVE. THIS INCLUDES CONTROL VALVE SETS AND INSTRUMENTS.

DOUBLE BLOCK AND BLEED ISOLATION SHALL BE APPLIED IN ACCORDANCE WITH THE ISOLATION PHILOSOPHY SPY-2-0000-PR-PH-009.

AREAS WHERE DOUBLE BLOCK VALVES MAY ALSO BE SPECIFIED BELOW 900* RATING, INCLUDE:-

- SYSTEMS ISOLATING HIGH TEMPERATURE FLUIDS AT OR ABOVE AUTO IGNITION.
- SOME SPECIAL CASES I.E. FOR HIGH VAPOUR PRESSURE FLUIDS SUCH AS LPG, WHERE SYSTEMS ARE AT PRESSURES ABOVE 600* RATING.
- HP STEAM AND BOILER FEED WATER
- TOXIC SERVICE (INCLUDING HIGH H_2S RISK AREAS-SEE BLOW).
- SYSTEMS WHICH ARE REGULARLY ISOLATED FOR ROUTINE OPERATIONS/MAINTENANCE.
- ISOLATION BETWEEN METERING SYSTEM AND PROVING SYSTEM
- DBB VALVES SHALL BE USED FOR ISOLATION OF PARALLEL EQUIPMENT ON PARALLEL TRAINS, WHEN MAINTENANCE IS DONE DURING NORMAL OPERATION ON THE ADJACENT EQUIPMENT OR TRAIN.

VALVE SELECTION CRITERIA

VALVE/SERVICE	TYPE
ESD	BALL
PSV ISOLATION	FB BALL (VENT & DRAIN BALL)
BDV	FB BALL (VENT & DRAIN BALL)
HYDROCARBON GAS	BALL (VENT & DRAIN BALL)
HYDROCARBON MULTI PHASE	BALL (VENT & DRAIN BALL)
LPG	BALL (VENT & DRAIN BALL)
MEG	GATE
AMINE	GATE
CAUSTIC	BALL
COOLING WATER	GATE FOR ISOLATION BUTTERFLY FOR ISOLATION (> 4") BUTTERFLY FOR THROTTLING
FIREWATER	BUTTERFLY
SEAWATER	GATE FOR ISOLATION BUTTERFLY GOR THROTTLING
AIR	BALL ≤ 2" GATE > 2"
NITROGEN	BALL ≤ 2" GATE > 2"
ACID/CHEMICAL	BALL FOR ISOLATION GLOBE FOR THROTTLING
FLARE PHASE/TRAIN ISOLATION	GATE OR BALL

FOR THE REMAINING VALVE SELECTION GATE VALVES SHOULD BE USED.

END CLOSURES


BLIND FLANGE


CAP


PLUG


THREADED CAP

صفحه دوم

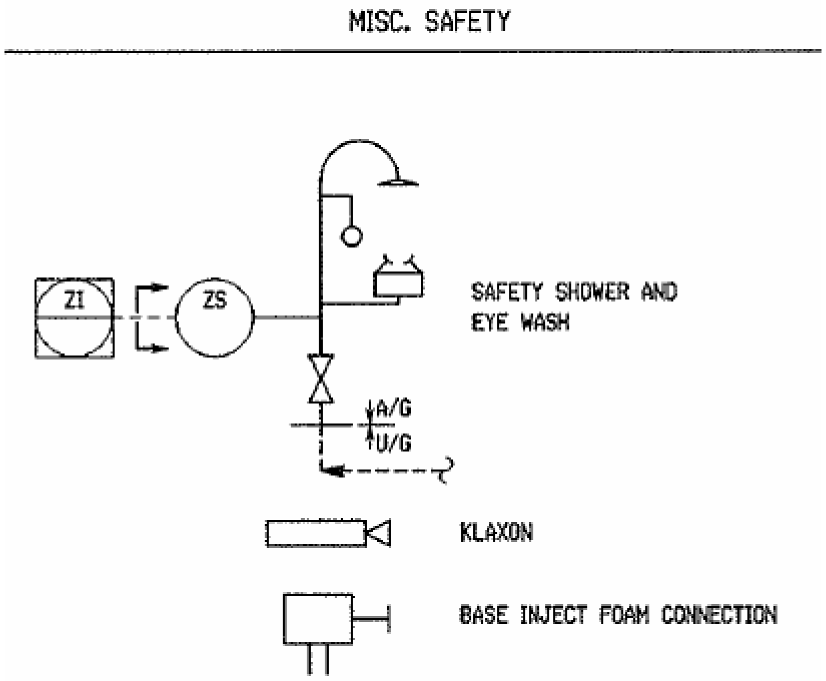
EXPANSION FACILITIES


FLEXIBLE HOSE


EXPANSION JOINT

تهیه کننده:محمد بهزادی

طریقه نمایش حوضچه شستشو



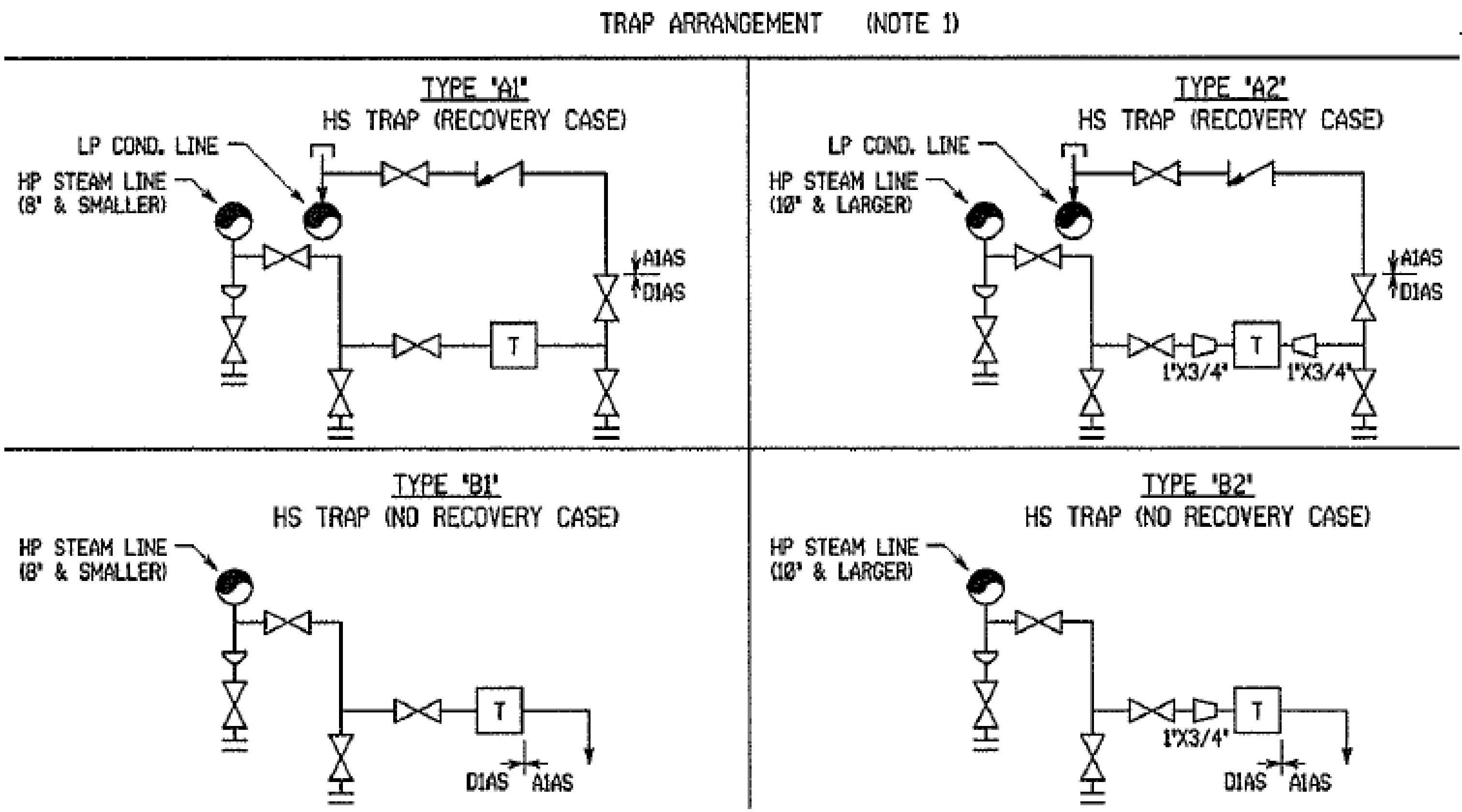
صفحه دوم

مدارک Legend و Symbology یک پروژه

شکلهای مختلف سیستمهای تله بخار

فشار بالا

با ریکاوری



بدون ریکاوری

صفحه دوم

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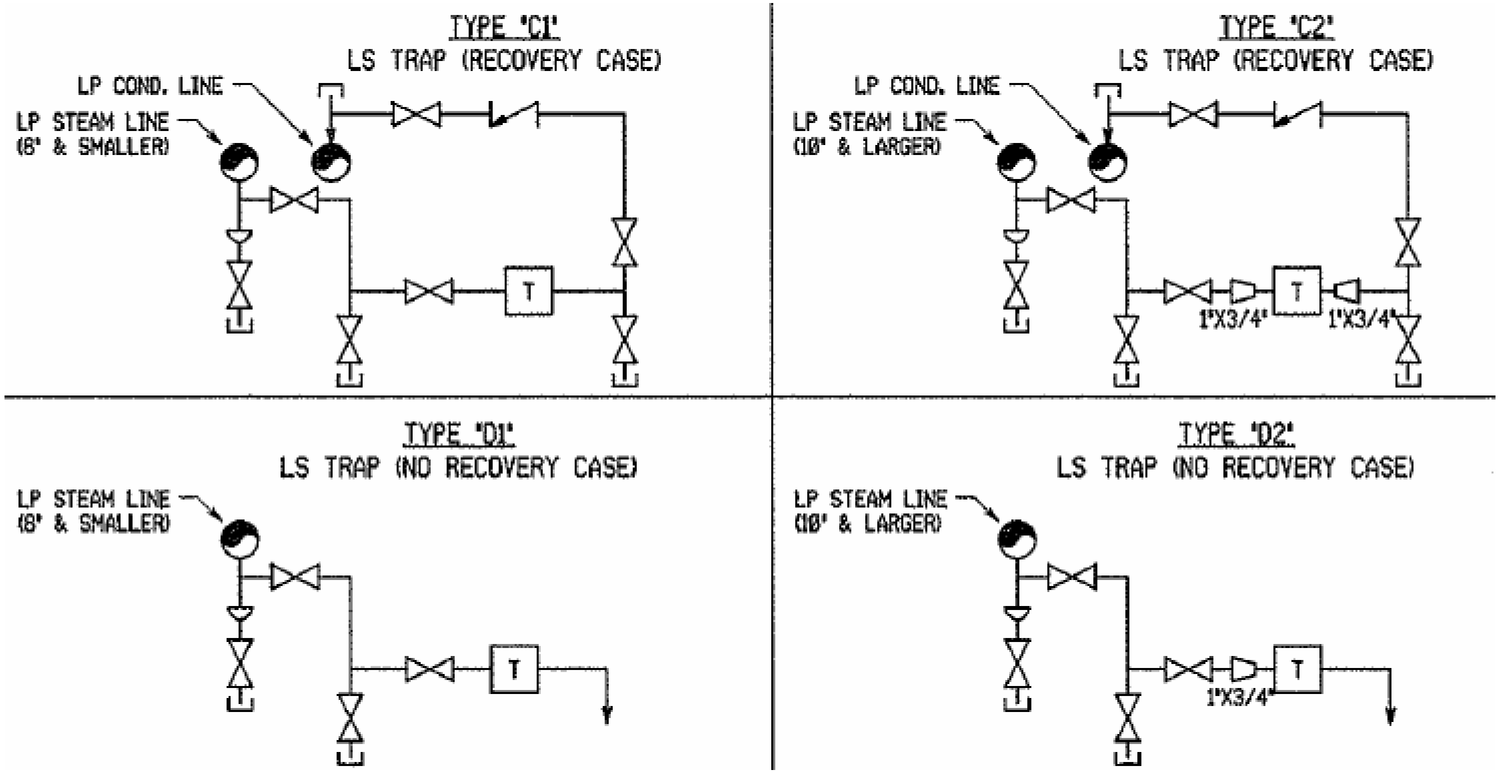
مدارک Legend و Symbology یک پروژه

شکلهای مختلف سیستمهای تله بخار

فشار پایین



صفحه دوم

بدون ریکاوری

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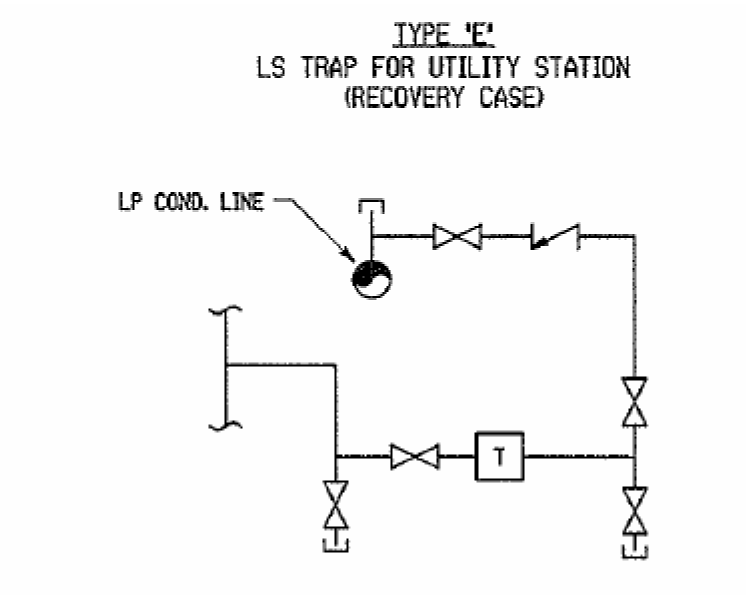
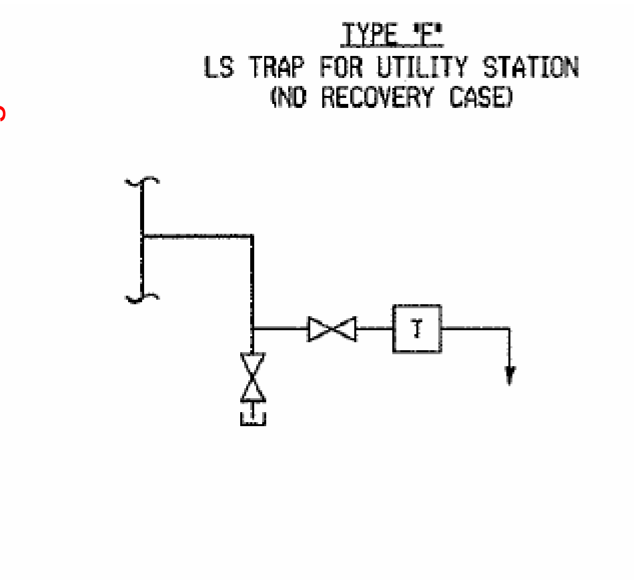
مدارک Legend و Symbology یک پروژه

شکلهای مختلف سیستمهای تله بخار





صفحه دوم

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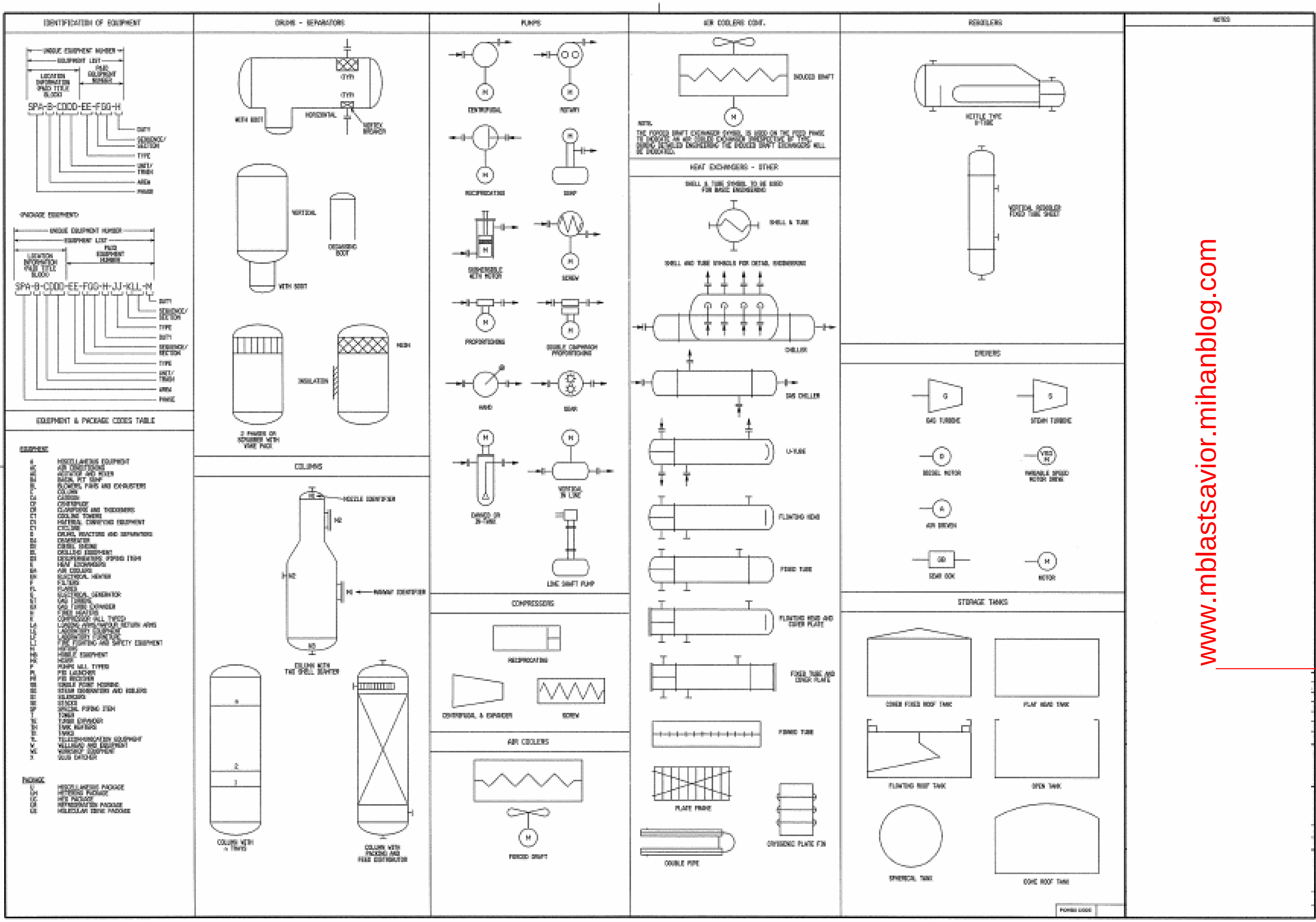
مدارک Legend و Symbology یک پروژه



صفحه سوم

تهیه کننده:محمد بهزادی

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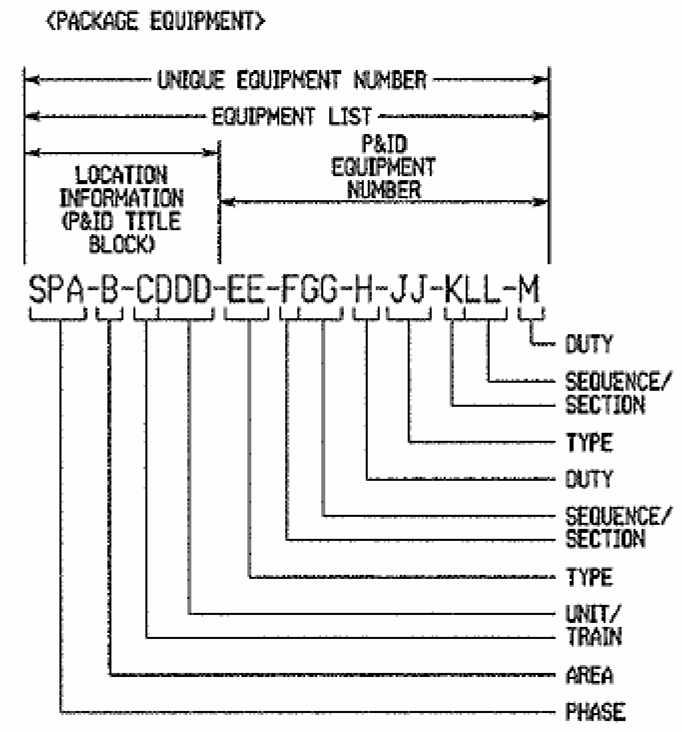
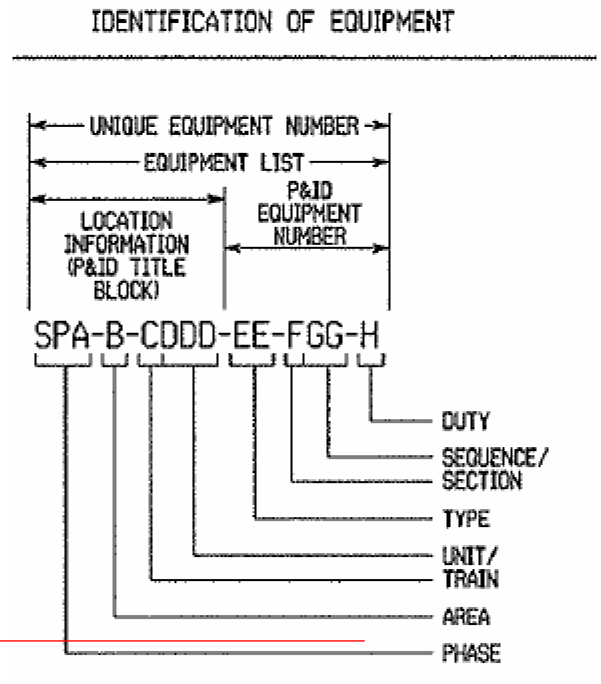
مدارک Legend و Symbology یک پروژه

شماره گذاری پکیج



شماره گذاری تجهیزات



صفحه سوم

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مدارک Legend و Symbology یک پروژه

EQUIPMENT & PACKAGE CODES TABLE

اختصارات تجهیزات

EQUIPMENT

A	MISCELLANEOUS EQUIPMENT
AC	AIR CONDITIONING
AG	AGITATOR AND MIXER
BA	BASIN, PIT SUMP
BL	BLOWERS, FANS AND EXHAUSTERS
C	COLUMN
CA	CAISSON
CE	CENTRIFUGE
CR	CLARIFIERS AND THICKENERS
CT	COOLING TOWERS
CV	MATERIAL CONVEYING EQUIPMENT
CY	CYCLONE
D	DRUMS, REACTORS AND SEPARATORS
DA	DEAEREATOR
DE	DIESEL ENGINE
DL	DRILLING EQUIPMENT
DS	DESUPERHEATERS (PIPING ITEM)
E	HEAT EXCHANGERS
EA	AIR COOLERS
EH	ELECTRICAL HEATER
F	FILTERS
FL	FLARES
G	ELECTRICAL GENERATOR
GT	GAS TURBINE
GX	GAS TURBO EXPANDER
H	FIRED HEATERS
K	COMPRESSOR (ALL TYPES)
LA	LOADING ARMS/VAPOUR RETURN ARMS
LE	LABORATORY EQUIPMENT
LF	LABORATORY FURNITURE
LZ	FIRE FIGHTING AND SAFETY EQUIPMENT
M	MOTORS
MB	MOBILE EQUIPMENT
MX	MIXER
P	PUMPS (ALL TYPES)
PL	PIG LAUNCHER
PR	PIG RECEIVER
SB	SINGLE POINT MOORING
SG	STEAM GENERATORS AND BOILERS
SI	SILENCERS
SK	STACKS
SP	SPECIAL PIPING ITEM
T	TOWER
TE	TURBO EXPANDER
TH	TANK HEATERS
TK	TANKS
TL	TELECOMMUNICATION EQUIPMENT
W	WELLHEAD AND EQUIPMENT
WE	WORKSHOP EQUIPMENT
X	SLUG CATCHER

PACKAGE

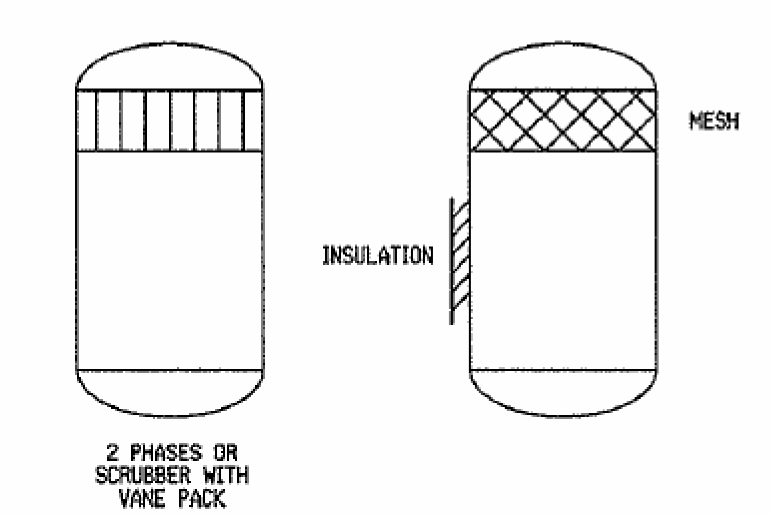
U	MISCELLANEOUS PACKAGE
UM	METERING PACKAGE
UG	MEG PACKAGE
UR	REFRIGERATION PACKAGE
US	MOLECULAR SIEVE PACKAGE

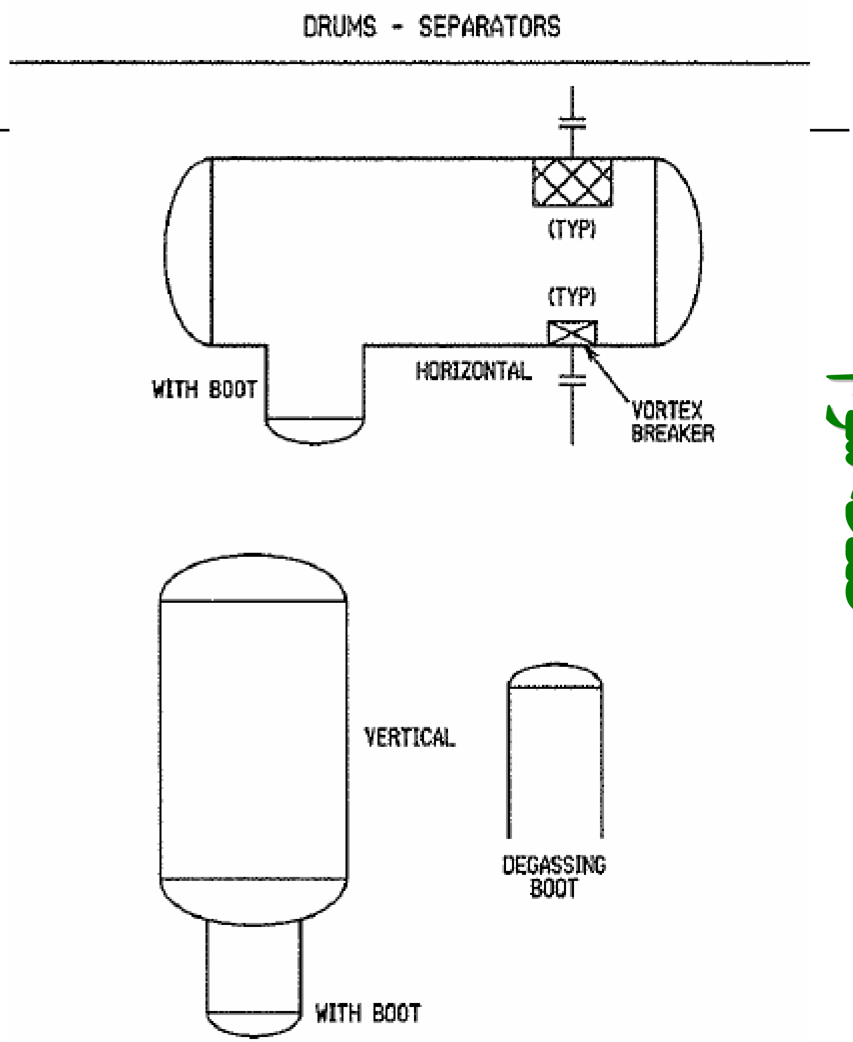
صفحه سوم

تهیه کننده:محمد بهزادی

مدارک Legend و Symbology یک پروژه

شکلهای مختلف درام





صفحه سوم

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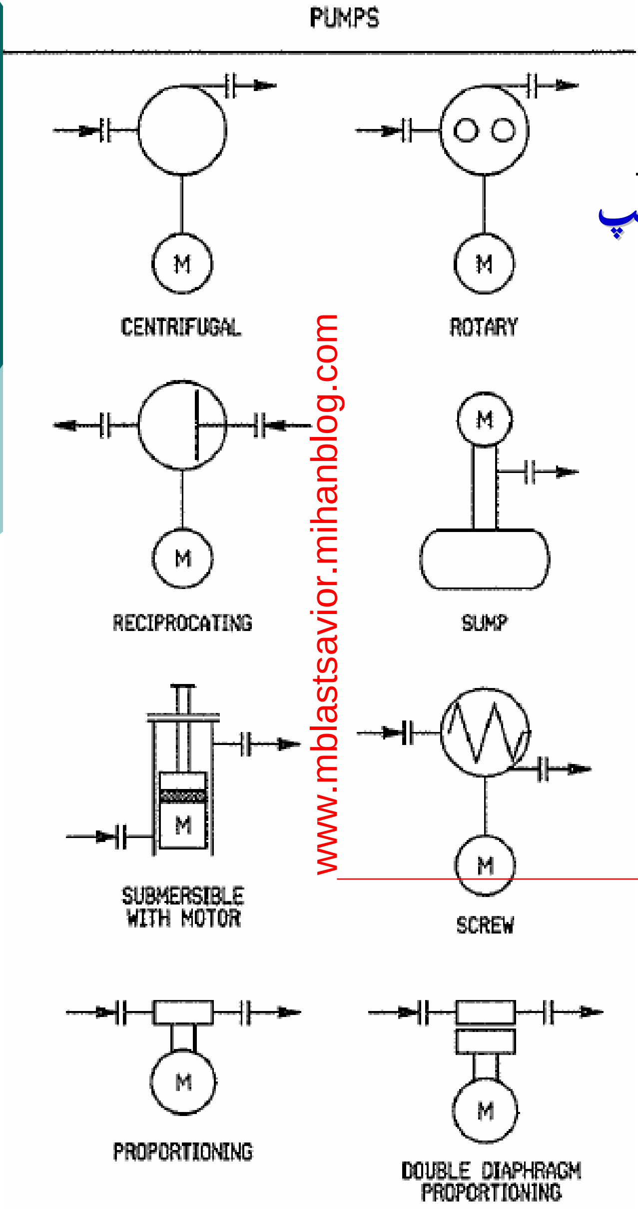
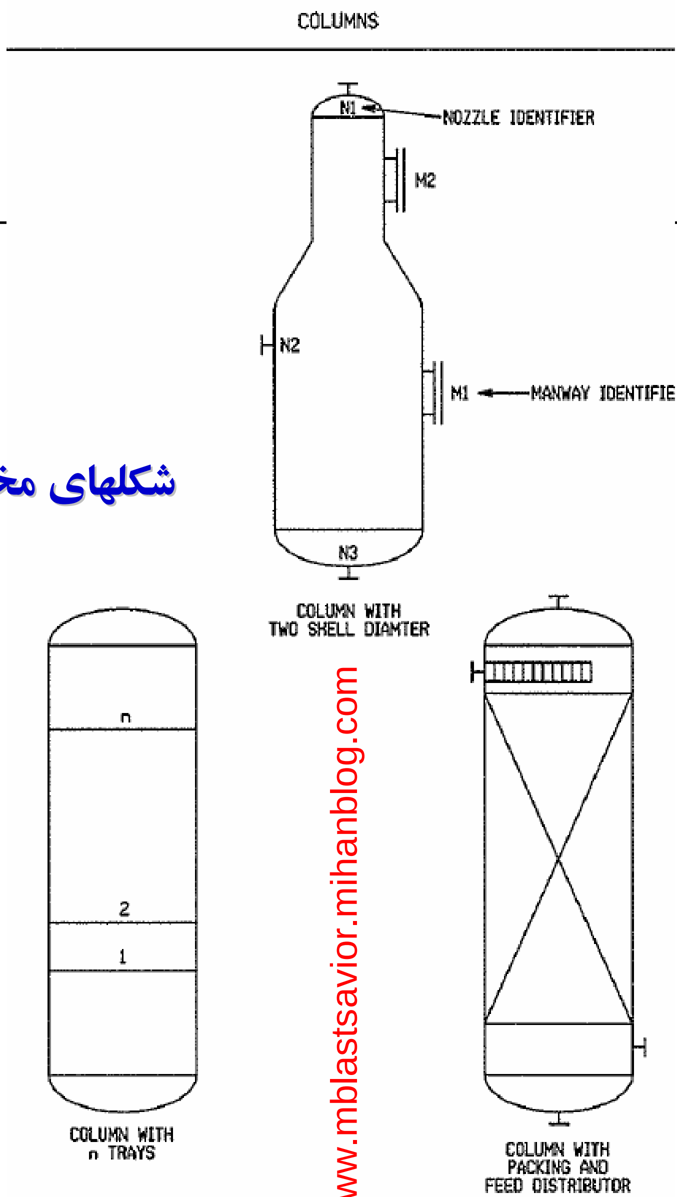
مدارک Legend و Symbology یک پروژه

شکلهای مختلف پمپ



شکلهای مختلف برج



صفحه سوم

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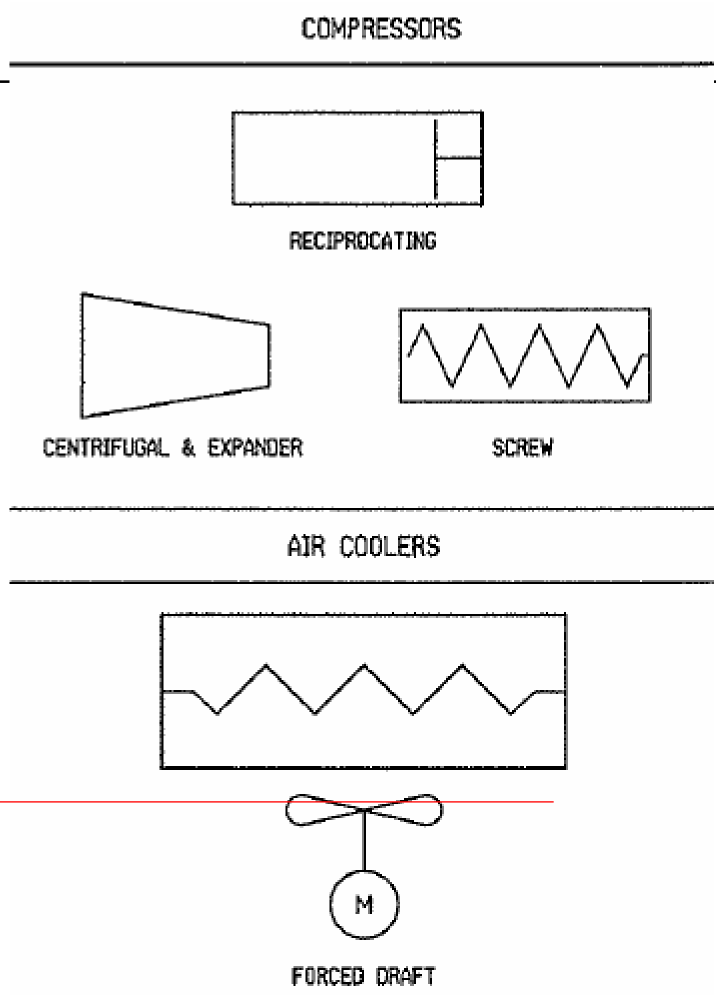
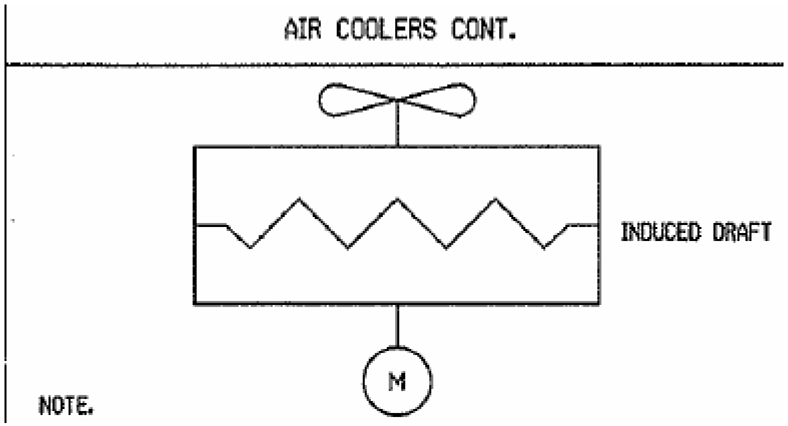
مدارک Legend و Symbology یک پروژه

شکلهای مختلف کمپرسور



صفحه سوم



شکلهای مختلف مبدلهای هواخنک

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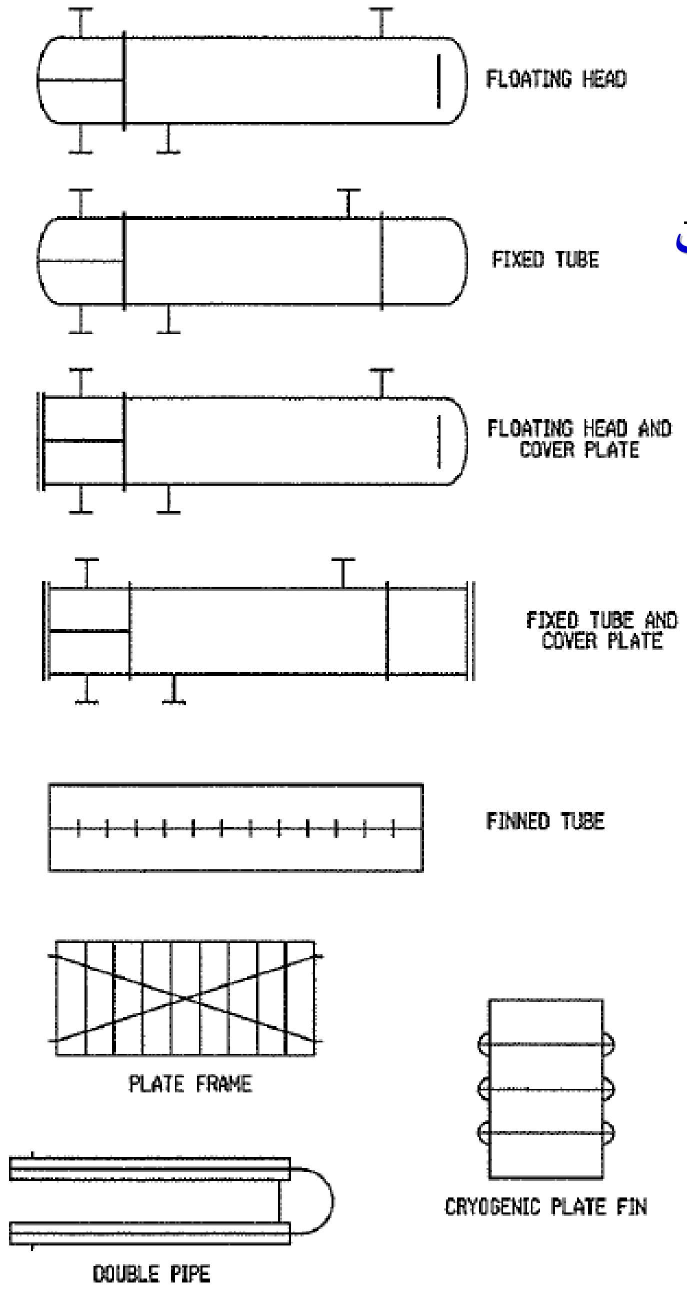
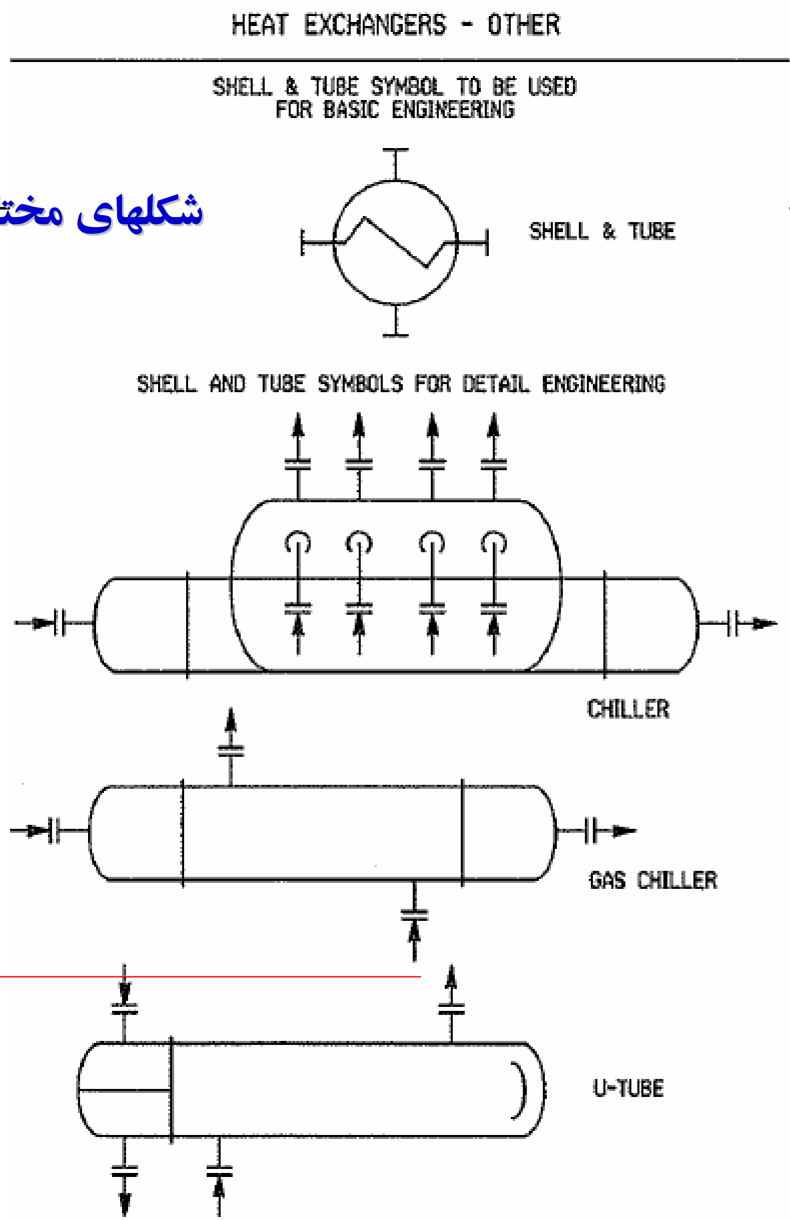
مدارک Legend و Symbology یک پروژه



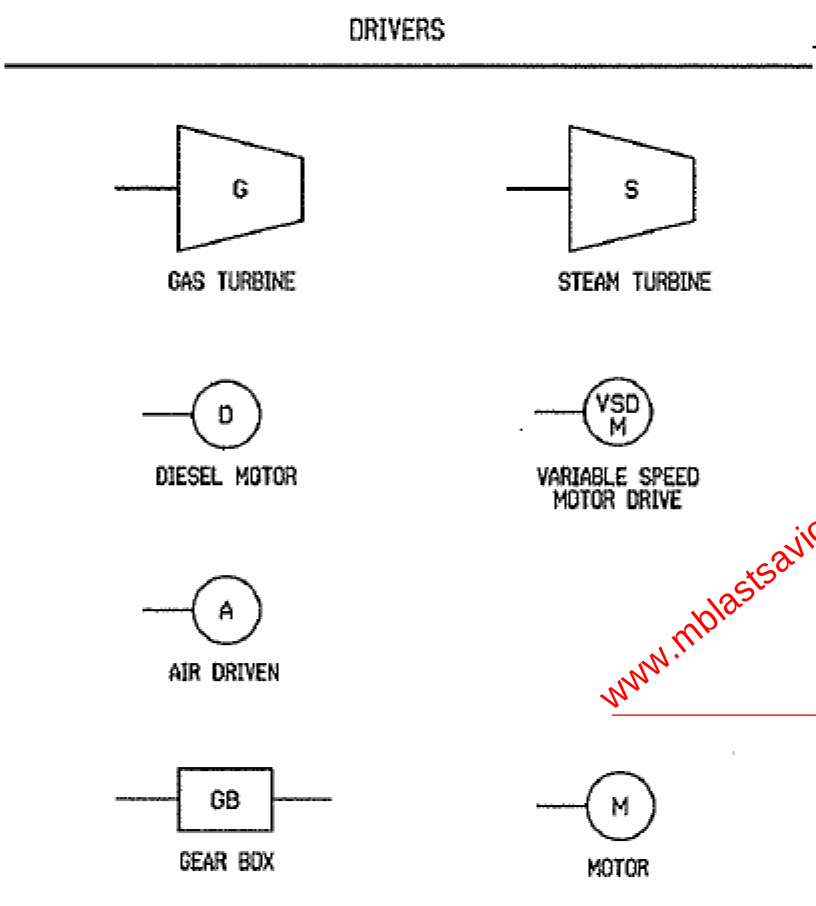
شکلهای مختلف مبدلهای حرارتی

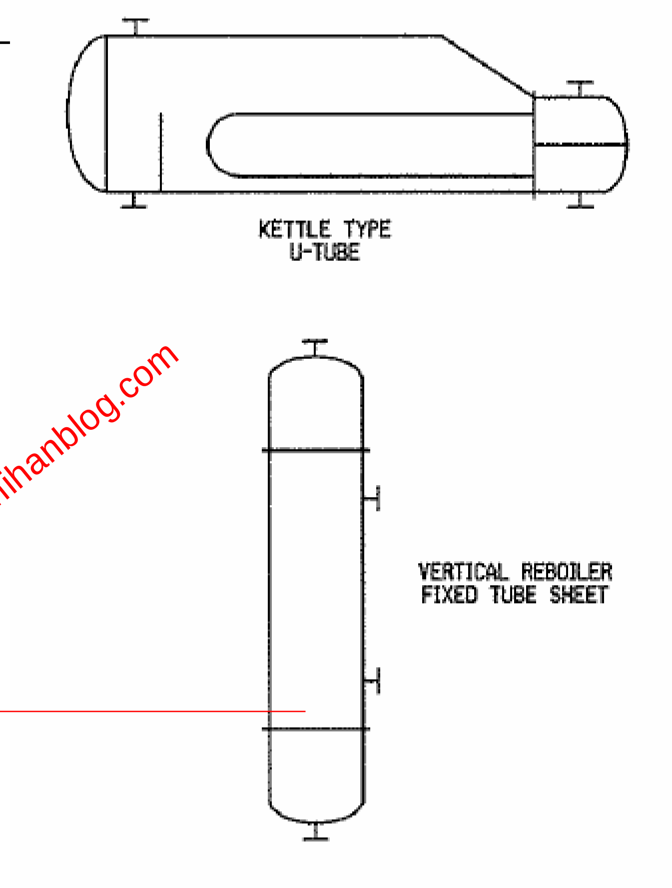


صفحه سوم

مدارک Legend و Symbology یک پروژه

شکلهای مختلف منابع انرژی





صفحه سوم

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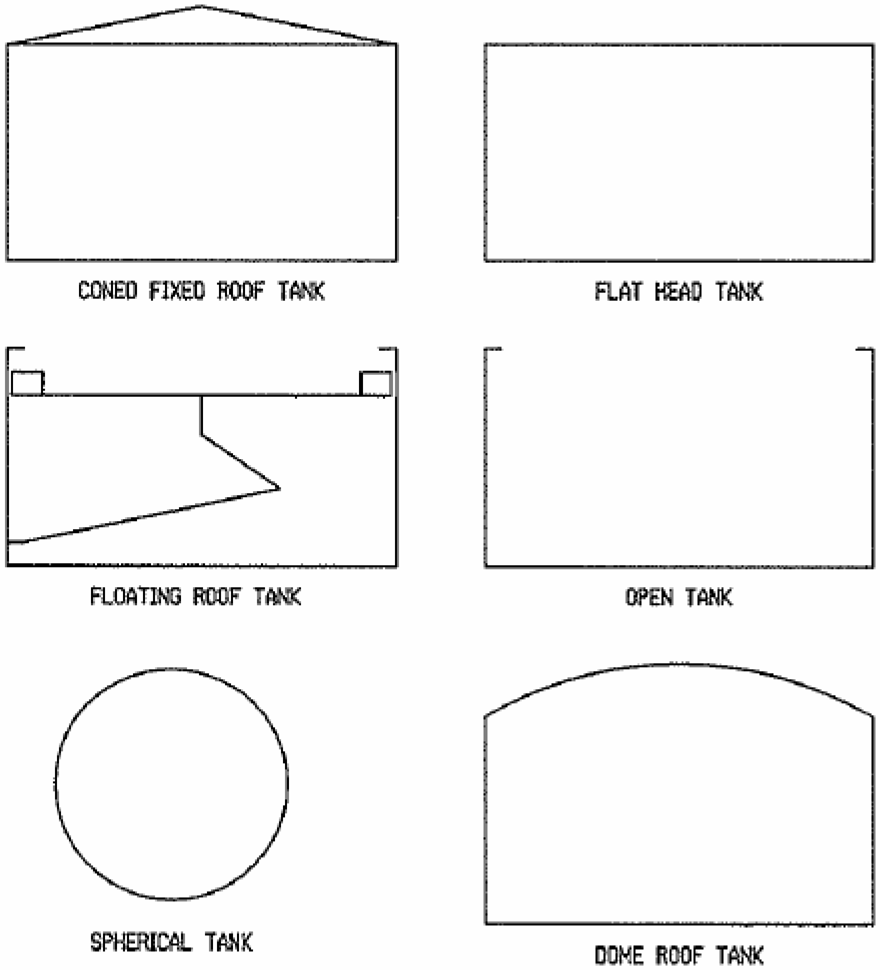
مدارک Legend و Symbology یک پروژه

شکلهای مختلف مخازن ذخیره

STORAGE TANKS



صفحه سوم

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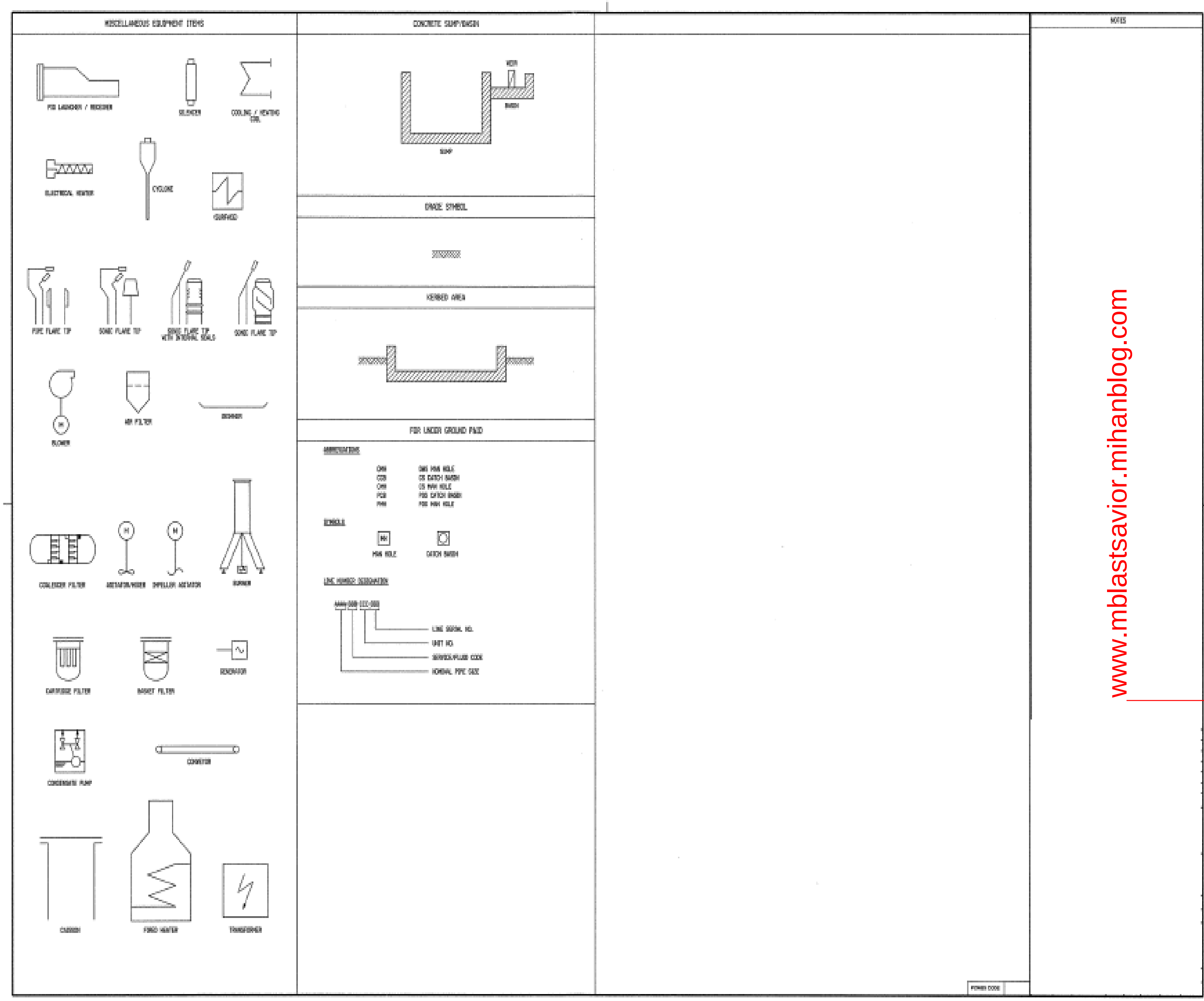

صفحه چهارم

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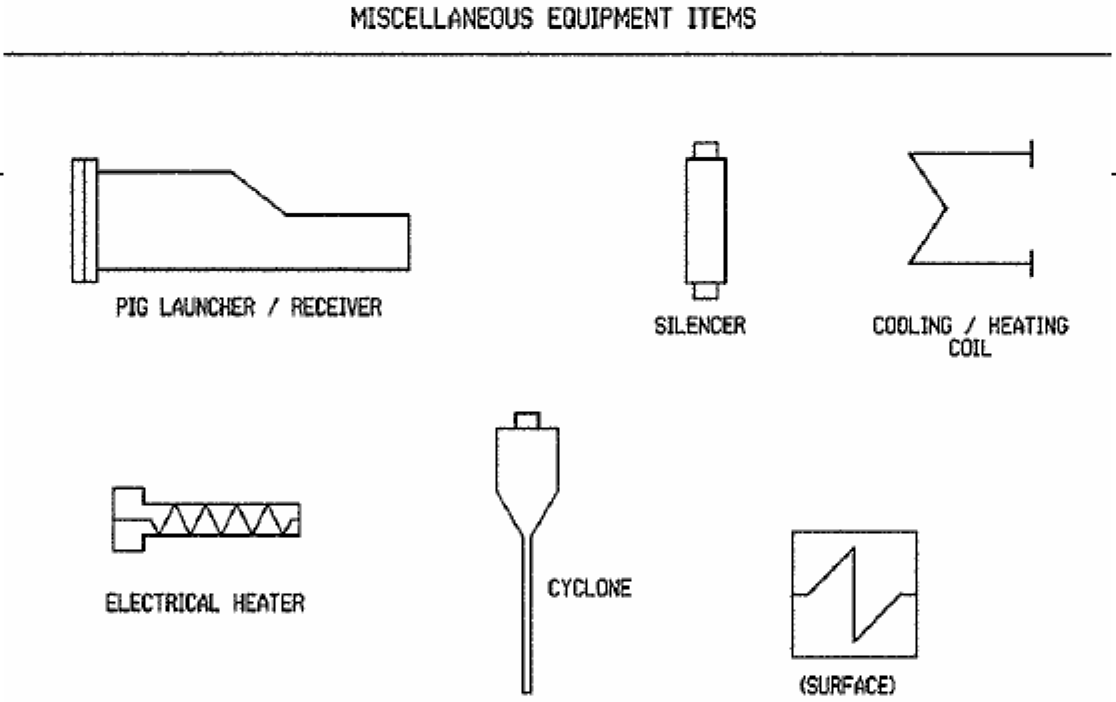
مدارک Legend و Symbology یک پروژه



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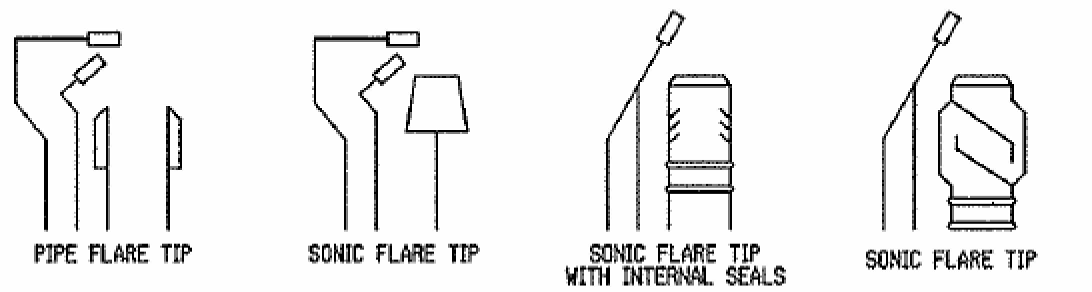

صفحه چهارم

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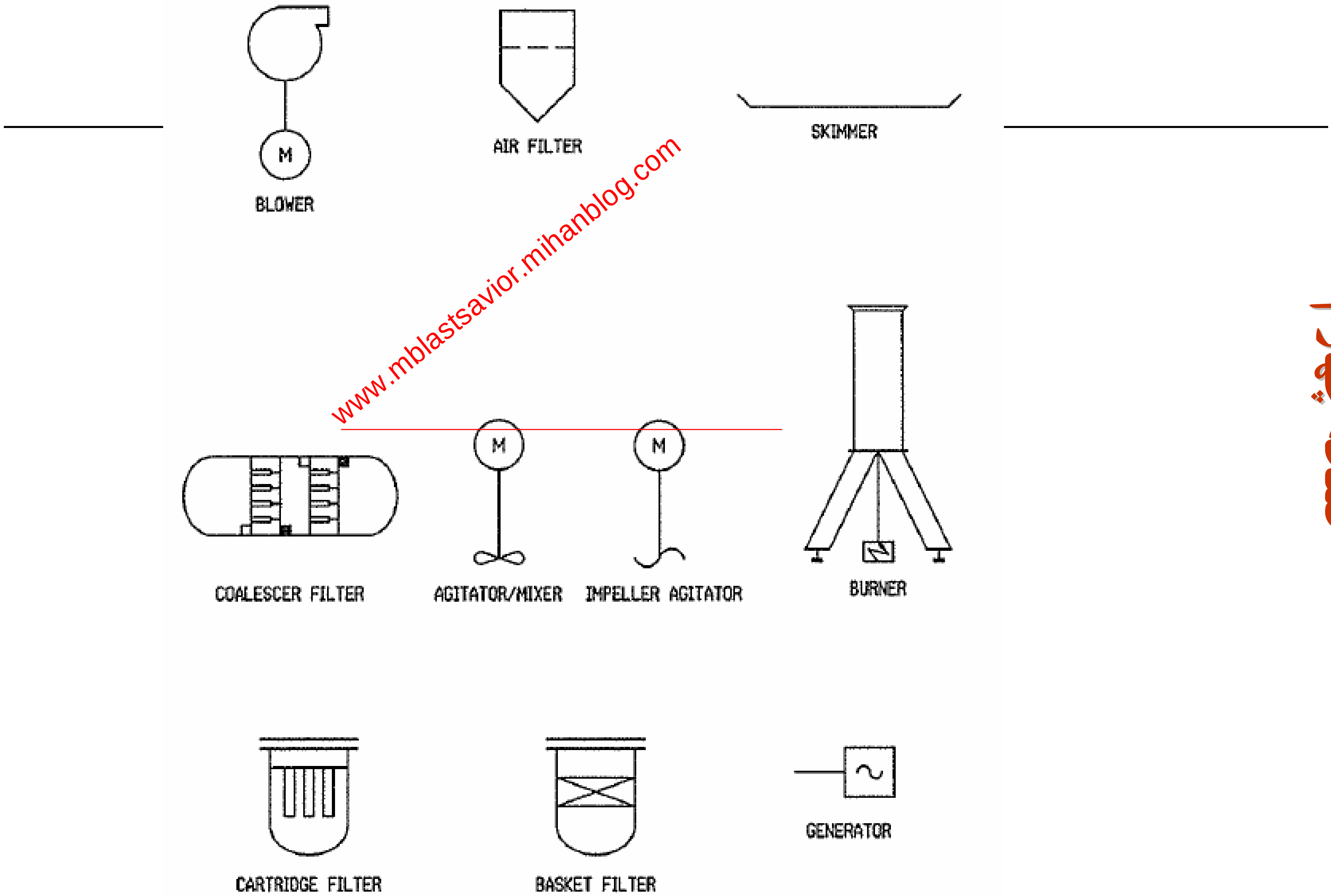
مدارک Legend و Symbology یک پروژه



صفحه چهارم

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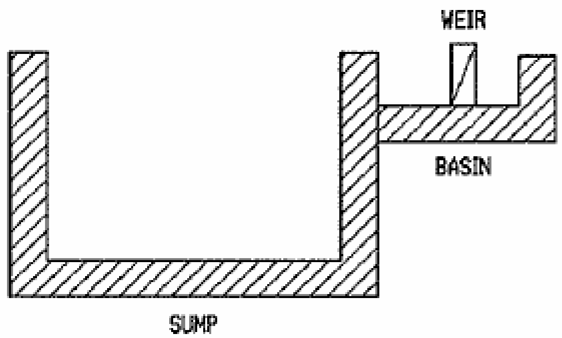
مدارک Legend و Symbology یک پروژه

CONCRETE SUMP/BASIN



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GRADE SYMBOL

صفحه چهارم

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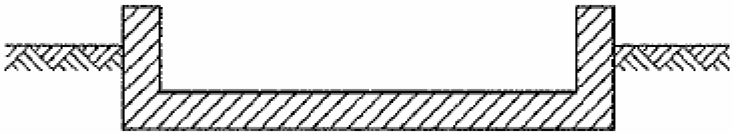
مدارک Legend و Symbology یک پروژه

KERBED AREA



صفحه چهارم

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مدارک Legend و Symbology یک پروژه

صفحه پنجم

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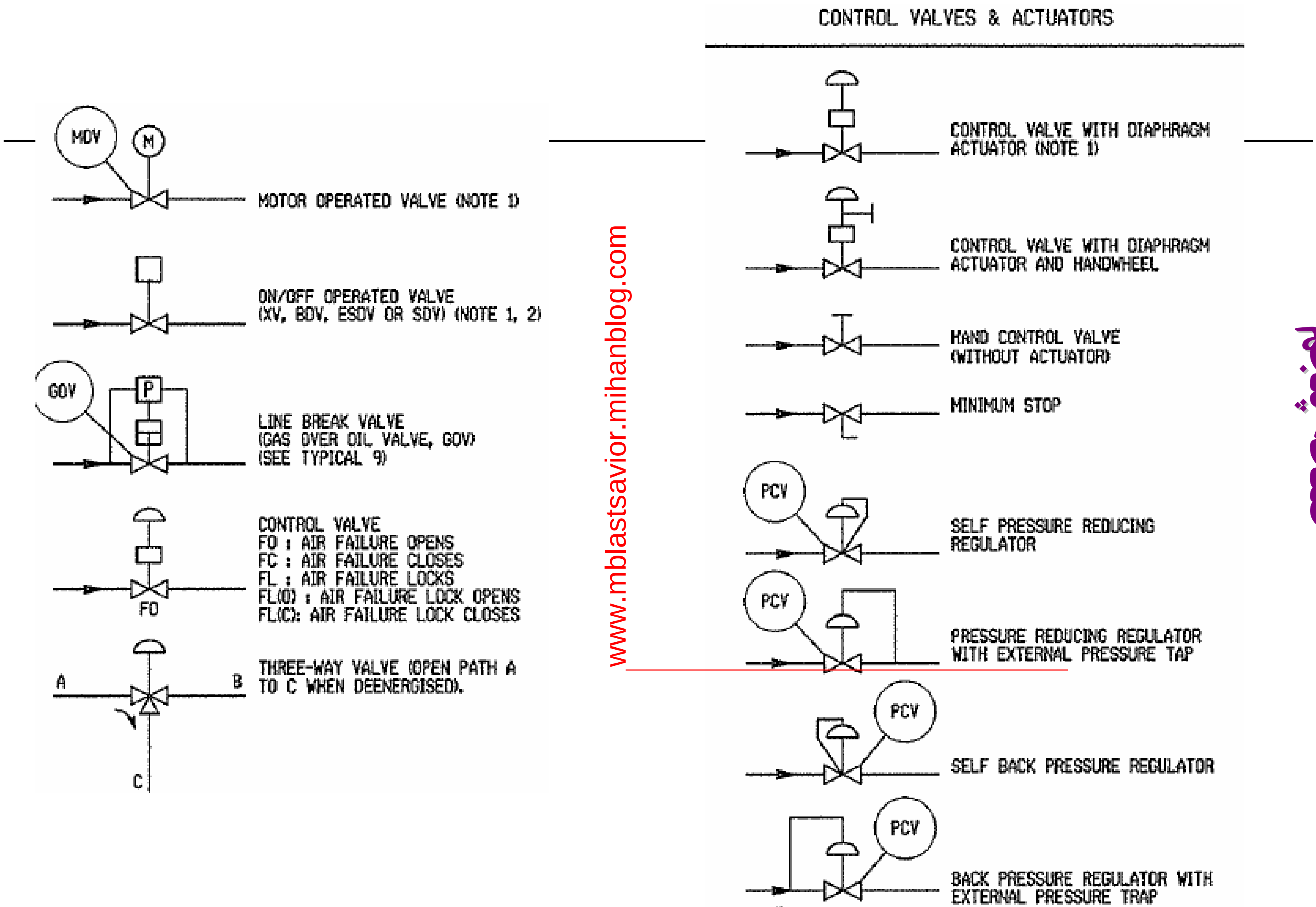
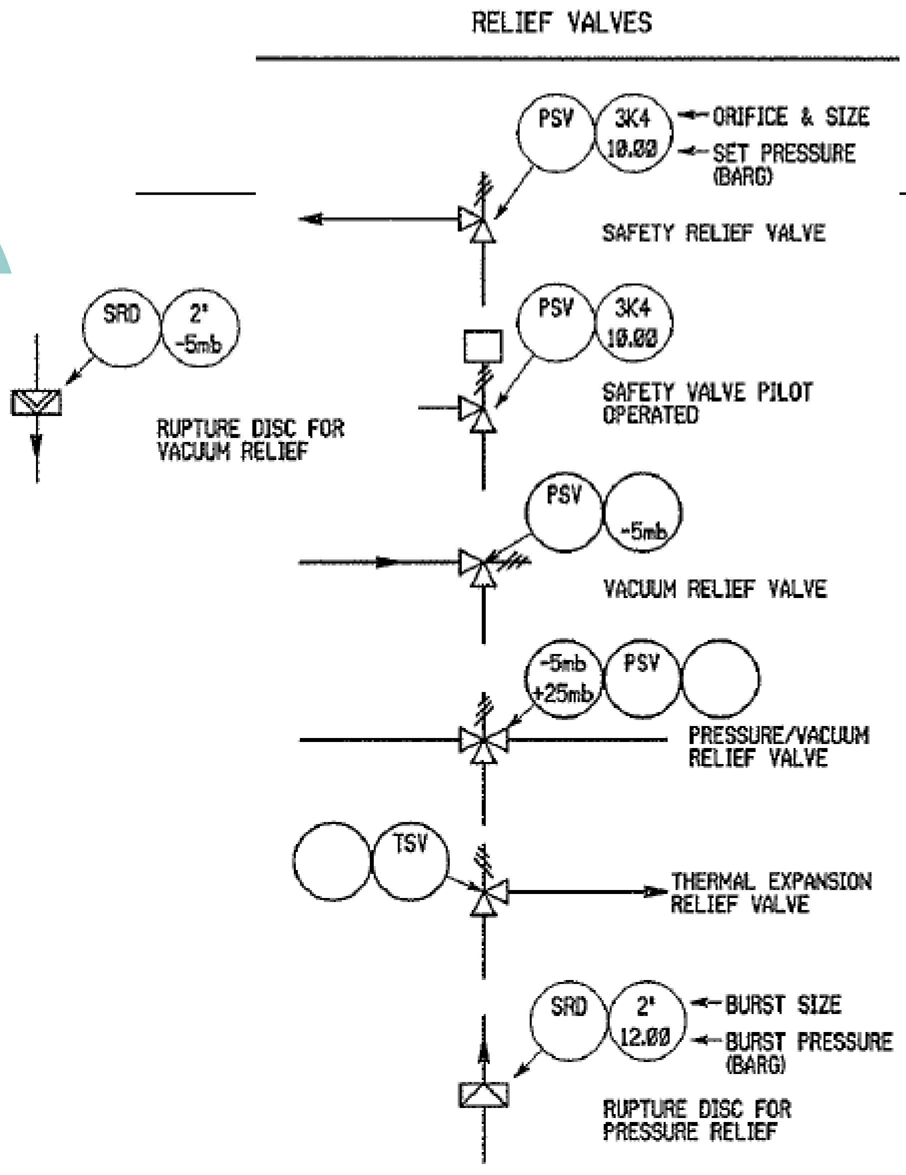
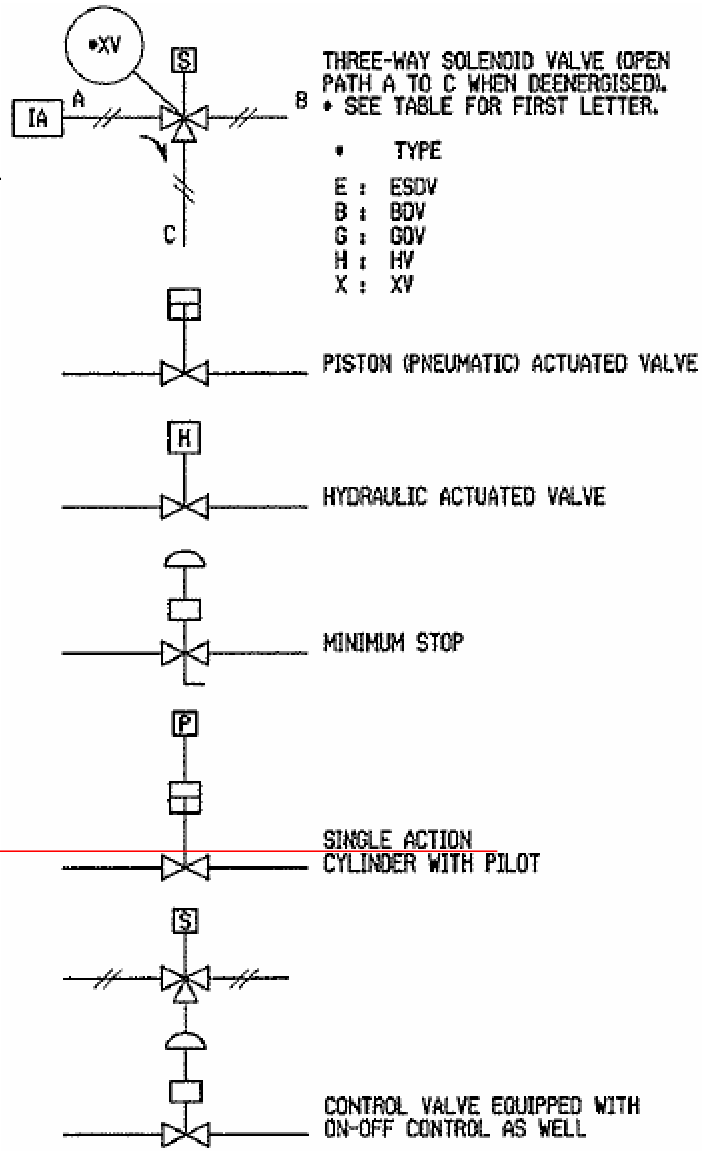
مدارک Legend و Symbology یک پروژه



صفحه پنجم

مدارک Legend و Symbology یک پروژه



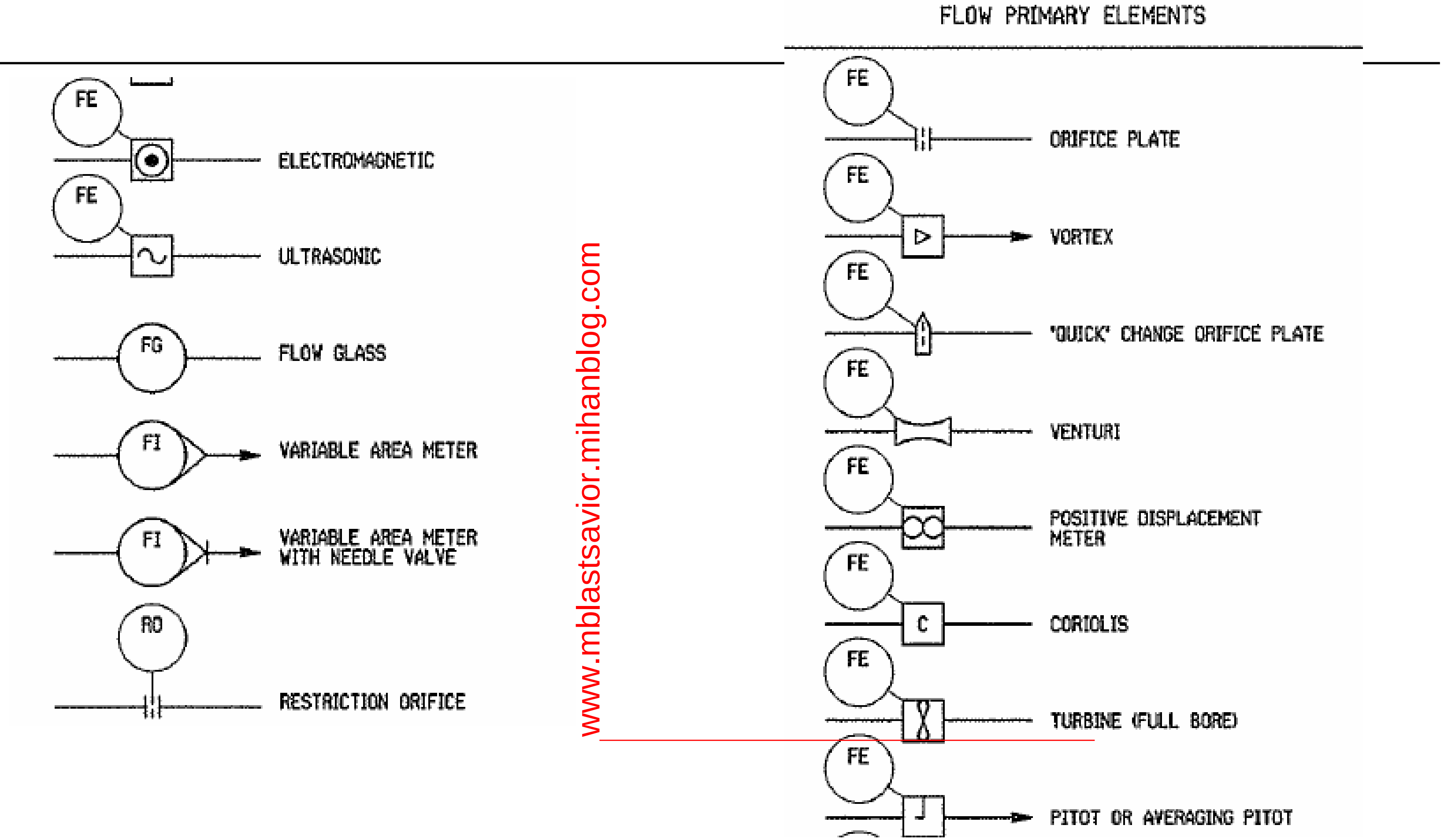


صفحه پنجم

105

مدارک Legend و Symbology یک پروژه

طرق مختلف اندازه گیری دبی



صفحه پنجم

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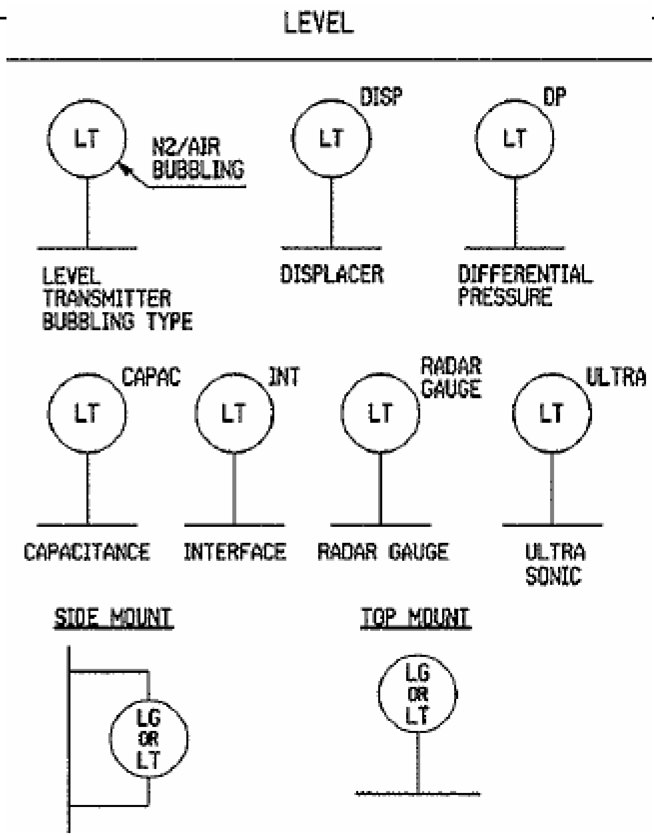
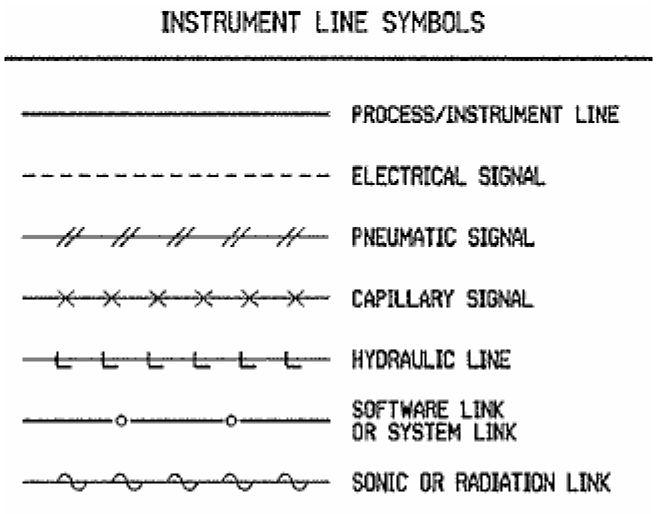
مدارک Legend و Symbology یک پروژه

طرق مختلف اندازه گیری سطح مایع



خطوط ابزار دقیق



صفحه پنجم

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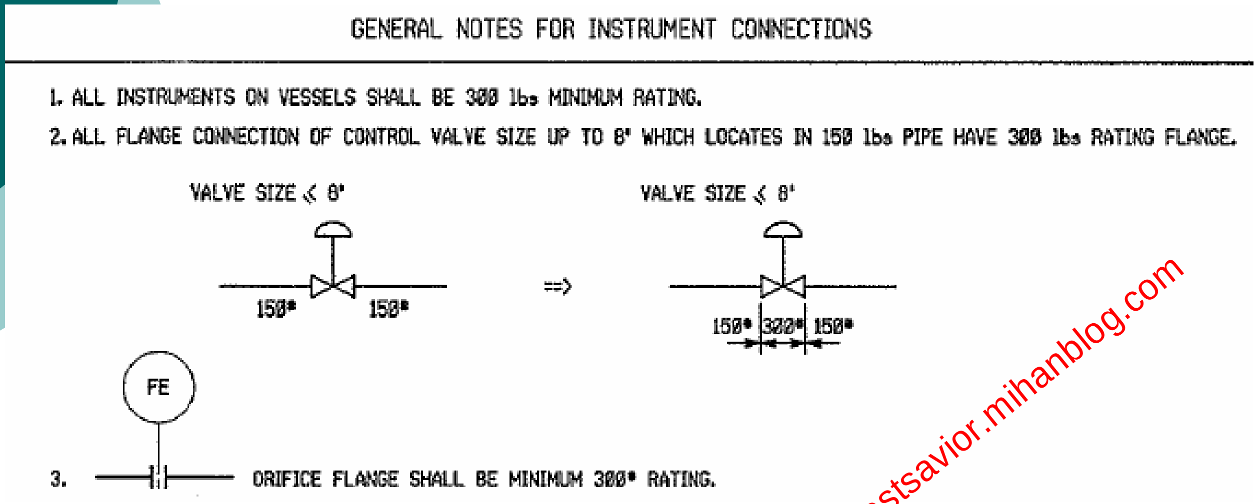
مدارک Legend و Symbology یک پروژه

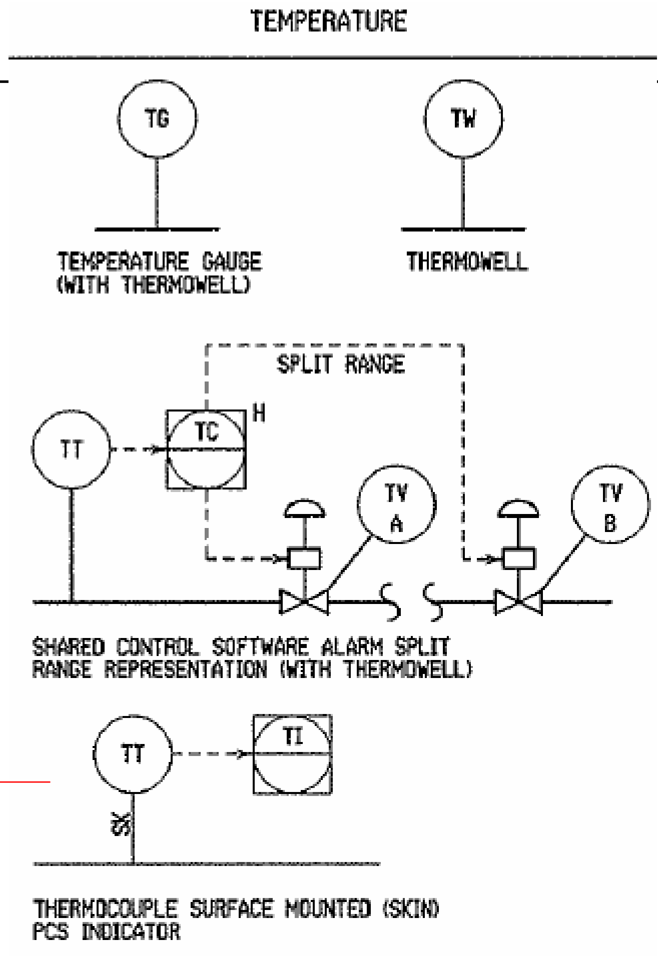
طرق مختلف اندازه گیری دما

کلاس فشاری ابزار دقیق


GENERAL NOTES FOR INSTRUMENT CONNECTIONS

1. ALL INSTRUMENTS ON VESSELS SHALL BE 300 lbs MINIMUM RATING.
2. ALL FLANGE CONNECTION OF CONTROL VALVE SIZE UP TO 8" WHICH LOCATES IN 150 lbs PIPE HAVE 300 lbs RATING FLANGE.

3. ORIFICE FLANGE SHALL BE MINIMUM 300# RATING.



صفحه پنجم

تهیه کننده:محمد بهزادی

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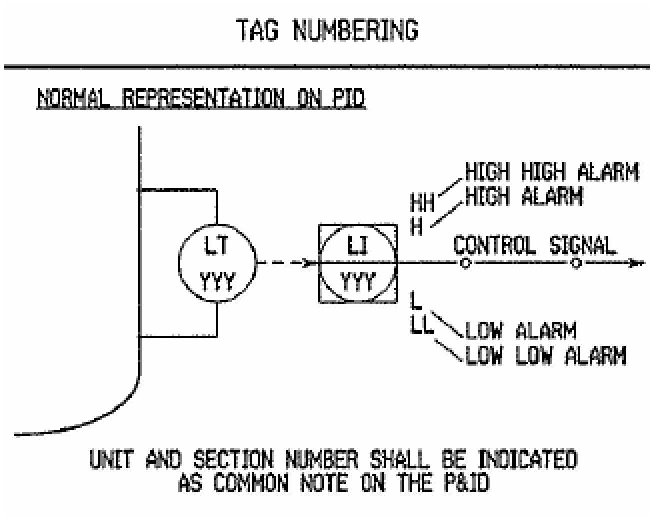
مدارک Legend و Symbology یک پروژه

شماره گذاری ابزار دقیق



صفحه چهارم

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مدارک Legend و Symbology یک پروژه

اندازه نازل ابزار دقیق

LEVEL GAUGE	2"	-	-	FLANGE: 2" INST: 3/4"	3/4" NPT
LEVEL SWITCH	2"	-	2"	FLANGE: 2" INST: 1"	3/4" NPT
LEVEL SWITCH (TOP)	4"	-	4"	4"	-
DIRECT MOUNTED TRANSMITTER	3"	-	3"	-	DRIP RING
FLOW D/P CELL	-	1/2"	-	1/2" NPT	1/4"

ALL CONNECTIONS LISTED BELOW ARE FLANGED UNLESS OTHERWISE STATED.

	CONNECTION TO EQUIPMENT			INSTRUMENT CONNECTION	VENT & DRAIN
	VESSELS	PIPE	TANK		
THEMOWELLS	2"	2"	2"	-	-
PRESSURE GAUGES	2"	1"	2"	1/2" NPT	1/4" NPT
PRESSURE TRANS.	2"	1"	2"	1/2" NPT	1/4" NPT
D/P CELL (PRESSURE)	2"	1"	2"	1/2" NPT	1/4" NPT
DIAPHRAGM TYPE PRESSURE GAUGES	2"	1"	2"	1"	-
DIAPHRAGM TYPE PRESSURE TRANS.	2"	2"	2"	2"	-
DIAPHRAGM TYPE PRESSURE DIFF. TRANS.	3"	3"	3"	3"	-
DIAPHRAGM TYPE LEVEL TRANS.	3"	-	3"	3"	-
LEVEL DISPLACERS	2"	-	-	2"	3/4" NPT
LEVEL DISPLACERS (TOP)	4"	-	-	4"	-
D/P CELL (LEVEL)	2"	-	2"	1/2" NPT	1/4" NPT

صفحه پنجم

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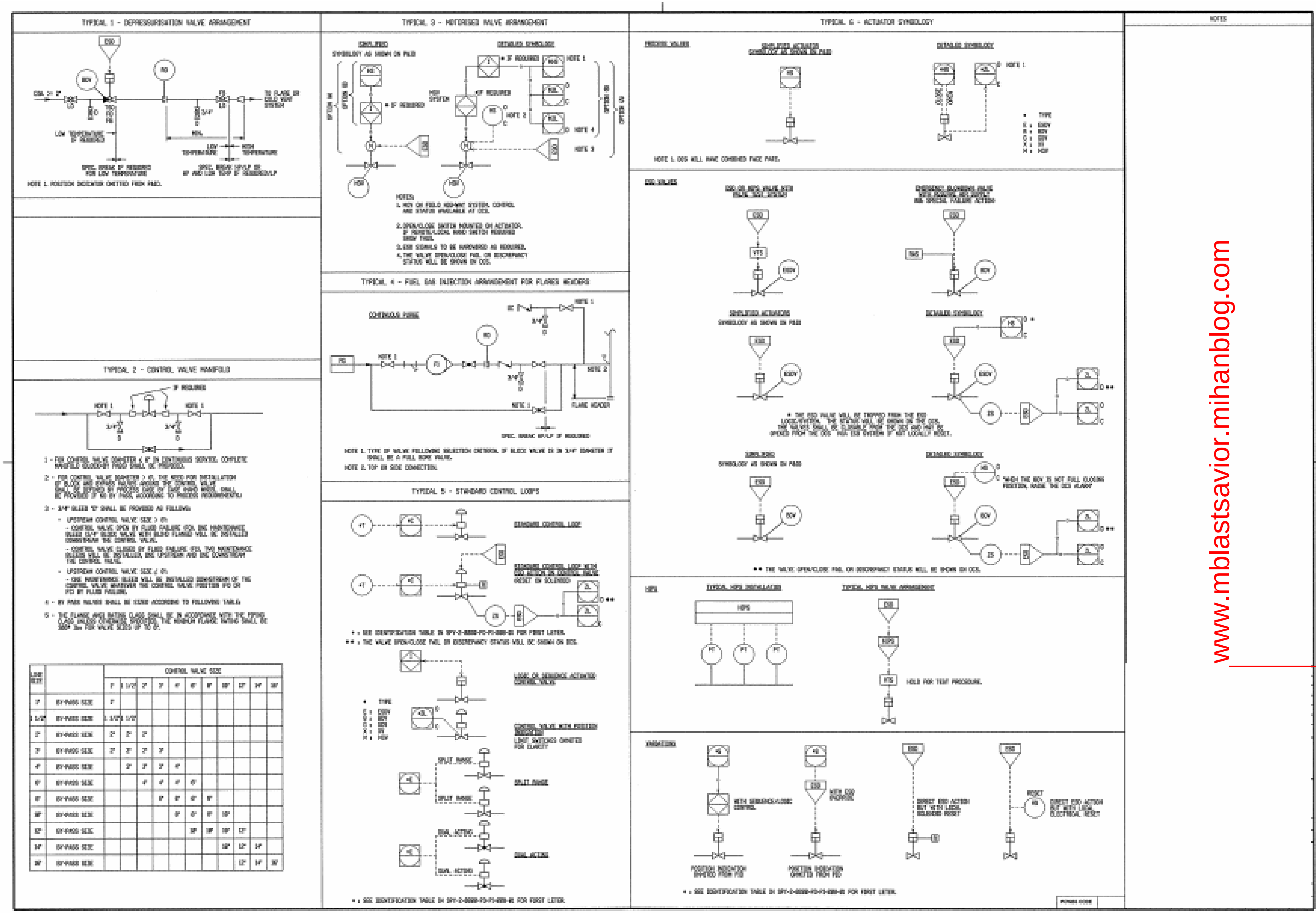
مدارک Legend و Symbology یک پروژه



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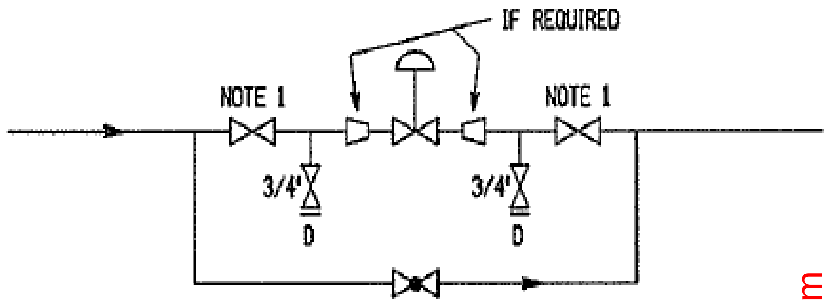
صفحه ششم

مدارک Legend و Symbology یک پروژه

TYPICAL 2 - CONTROL VALVE MANIFOLD



1 - FOR CONTROL VALVE DIAMETER ≤ 6" IN CONTINUOUS SERVICE. COMPLETE MANIFOLD (BLOCK+BY PASS) SHALL BE PROVIDED.

2 - FOR CONTROL VALVE DIAMETER > 6", THE NEED FOR INSTALLATION OF BLOCK AND BYPASS VALVES AROUND THE CONTROL VALVE SHALL BE DEFINED BY PROCESS CASE BY CASE (HAND WHEEL SHALL BE PROVIDED IF NO BY PASS, ACCORDING TO PROCESS REQUIREMENTS.)

3 - 3/4" BLEED "D" SHALL BE PROVIDED AS FOLLOWS:

- UPSTREAM CONTROL VALVE SIZE > 6":
  - CONTROL VALVE OPEN BY FLUID FAILURE (FO). ONE MAINTENANCE BLEED (3/4" BLOCK VALVE WITH BLIND FLANGE) WILL BE INSTALLED DOWNSTREAM THE CONTROL VALVE.
  - CONTROL VALVE CLOSED BY FLUID FAILURE (FC). TWO MAINTENANCE BLEEDS WILL BE INSTALLED, ONE UPSTREAM AND ONE DOWNSTREAM THE CONTROL VALVE.
- UPSTREAM CONTROL VALVE SIZE ≤ 6":
  - ONE MAINTENANCE BLEED WILL BE INSTALLED DOWNSTREAM OF THE CONTROL VALVE WHATEVER THE CONTROL VALVE POSITION (FO OR FC) BY FLUID FAILURE.

4 - BY PASS VALVES SHALL BE SIZED ACCORDING TO FOLLOWING TABLE:

5 - THE FLANGE ANSI RATING CLASS SHALL BE IN ACCORDANCE WITH THE PIPING CLASS UNLESS OTHERWISE SPECIFIED. THE MINIMUM FLANGE RATING SHALL BE 300# lbs FOR VALVE SIZES UP TO 8".

صفحه ششم

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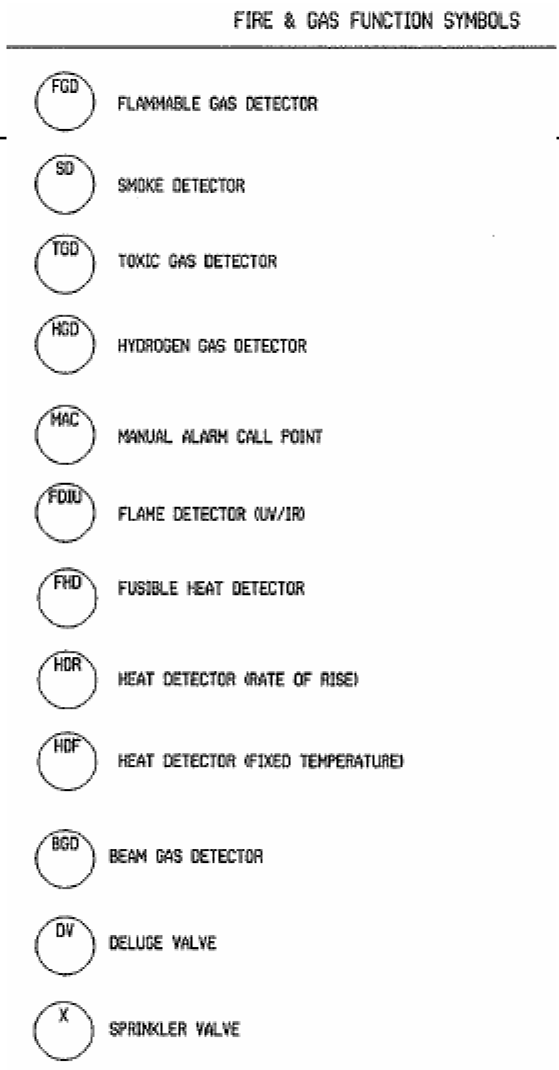
مدارک Legend و Symbology یک پروژه

VARIABLE	PRIMARY ELEMENT	INDICATION	LOCAL	CONTROLLER	TRANSM.	CONTROL VALVE	SOLENOID VALVE	SWITCH	ALARM	STATUS	TOTALISING	FUNCTION BLOCK
ANALYSIS (*)	AE	AI	-	AC	AT		AX	AS	AA		AQ	AY
BURNER FLAME	BE	BI	-	-	-			BS	BA	BL		
CURRENT	IE	II	-	IC	IT			IS	IA			
FLOW (****)	FE	FI	FG	FC	FT	FV	FX	FS	FA		FQ	FY
LEVEL (**)	-	LI	LG	LC	LT	LV	LX	LS	LA			LY
MANUALLY OPERATED				HC		HV	HX	HS				HY
MOTOR OPERATED VALVE						MOV						
MULTI VARIABLE				UC		UV	UX		UA		UQ	UY
OTHER	XE	XI	-	XC	XT	XV		XS XS	XA XA	XL		XY
POSITION (***)		ZI			ZT			ZSO ZSC	ZA	ZLO ZLC		
POWER	JE	JI			JT						JQ	
PRESSURE	-	PI	PG	PC	PT	PV	PX	PS	PA			PY
PRESSURE DIFFERENTIAL	-	PDI	PDG	PDC	PDT	PDV	PDX	PDS	PDA			
SPEED	SE	SI	-	SC	ST			SS	SA		SQ	
TEMPERATURE	TE	TI	TG	TC	TT	TV	TX	TS	TA			TY
VIBRATION	VE	VI			VT			VS	VA			
VOLTAGE	EE	EI	-	EC	ET			ES	EA			
WEIGHT	WE	WI							WA			

صفحه ششم

113

مدارک Legend و Symbology یک پروژه



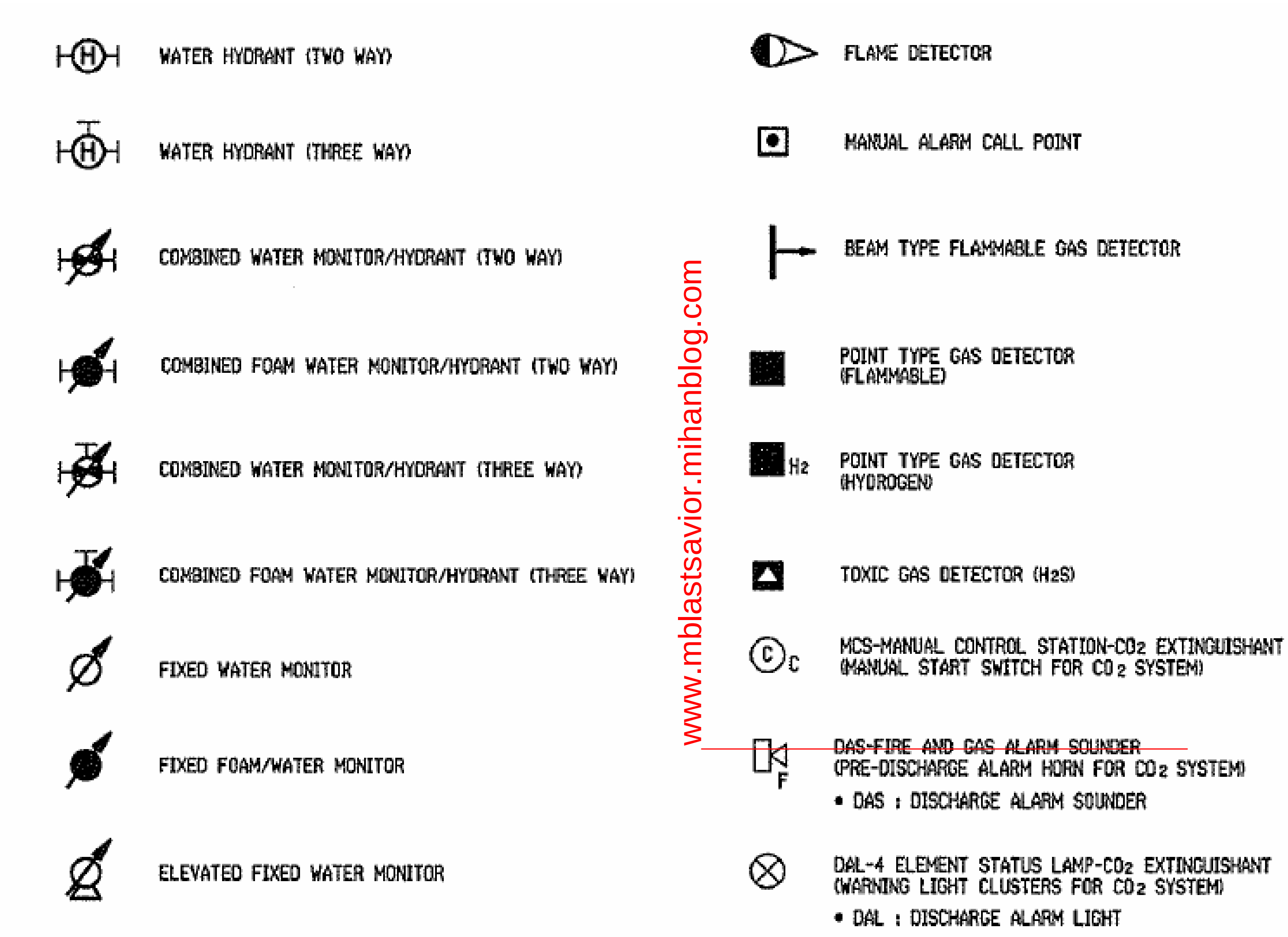
FIRE & GAS FUNCTION SYMBOLS

Symbol	Description
FGD	FLAMMABLE GAS DETECTOR
SD	SMOKE DETECTOR
TGD	TOXIC GAS DETECTOR
HGD	HYDROGEN GAS DETECTOR
MAC	MANUAL ALARM CALL POINT
FDIU	FLAME DETECTOR (UV/IR)
FHD	FUSIBLE HEAT DETECTOR
HDR	HEAT DETECTOR (RATE OF RISE)
HDF	HEAT DETECTOR (FIXED TEMPERATURE)
BGD	BEAM GAS DETECTOR
DV	DELUGE VALVE
X	SPRINKLER VALVE

صفحه ششم

114

مدارک Legend و Symbology یک پروژه



صفحه ششم

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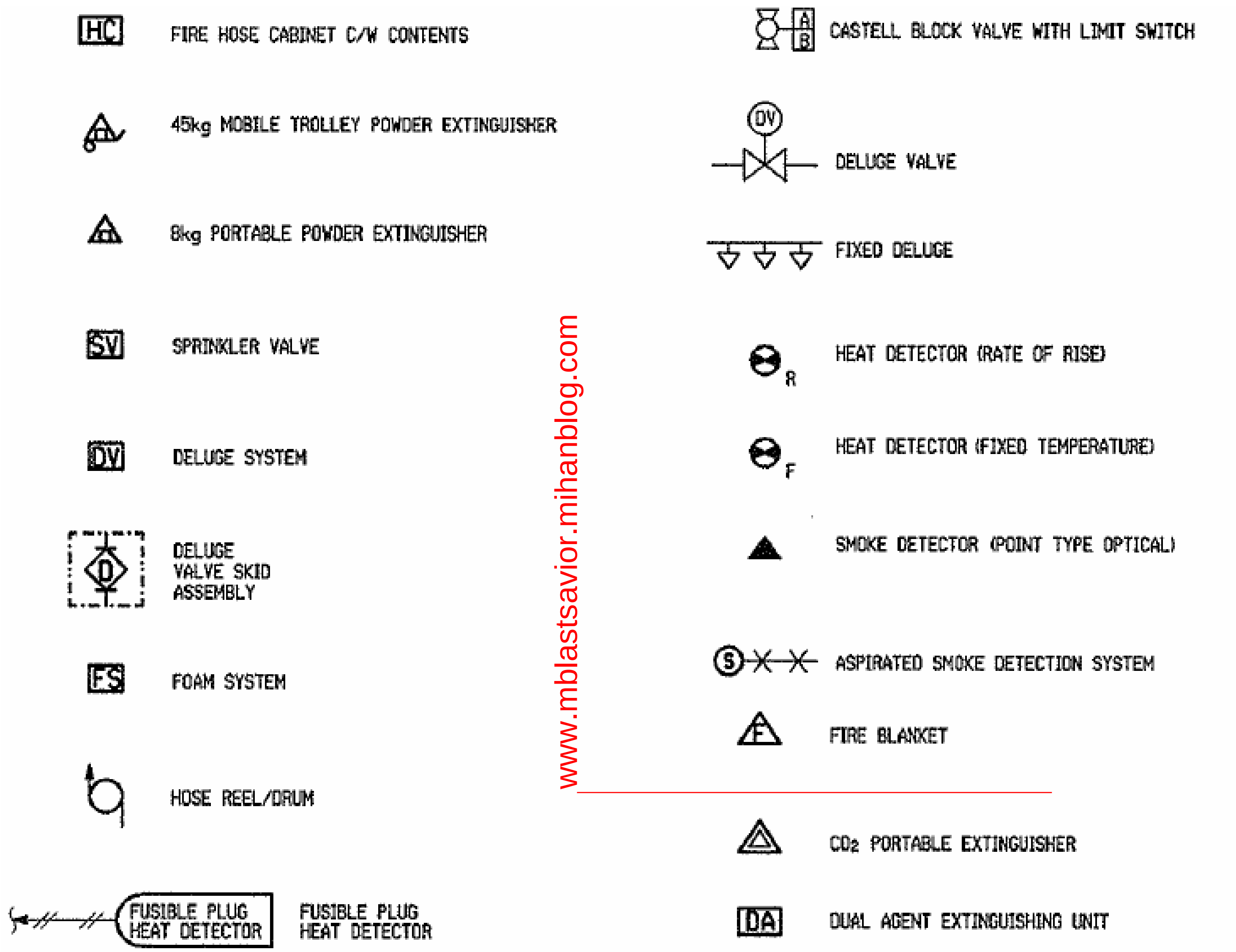
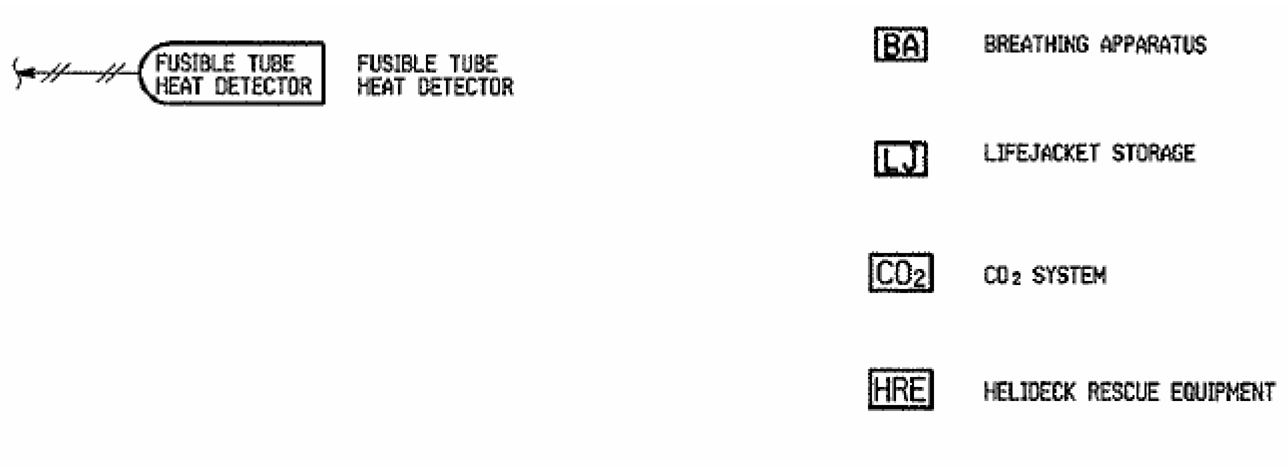
مدارک Legend و Symbology یک پروژه



صفحه ششم

مدارک Legend و Symbology یک پروژه



صفحه ششم

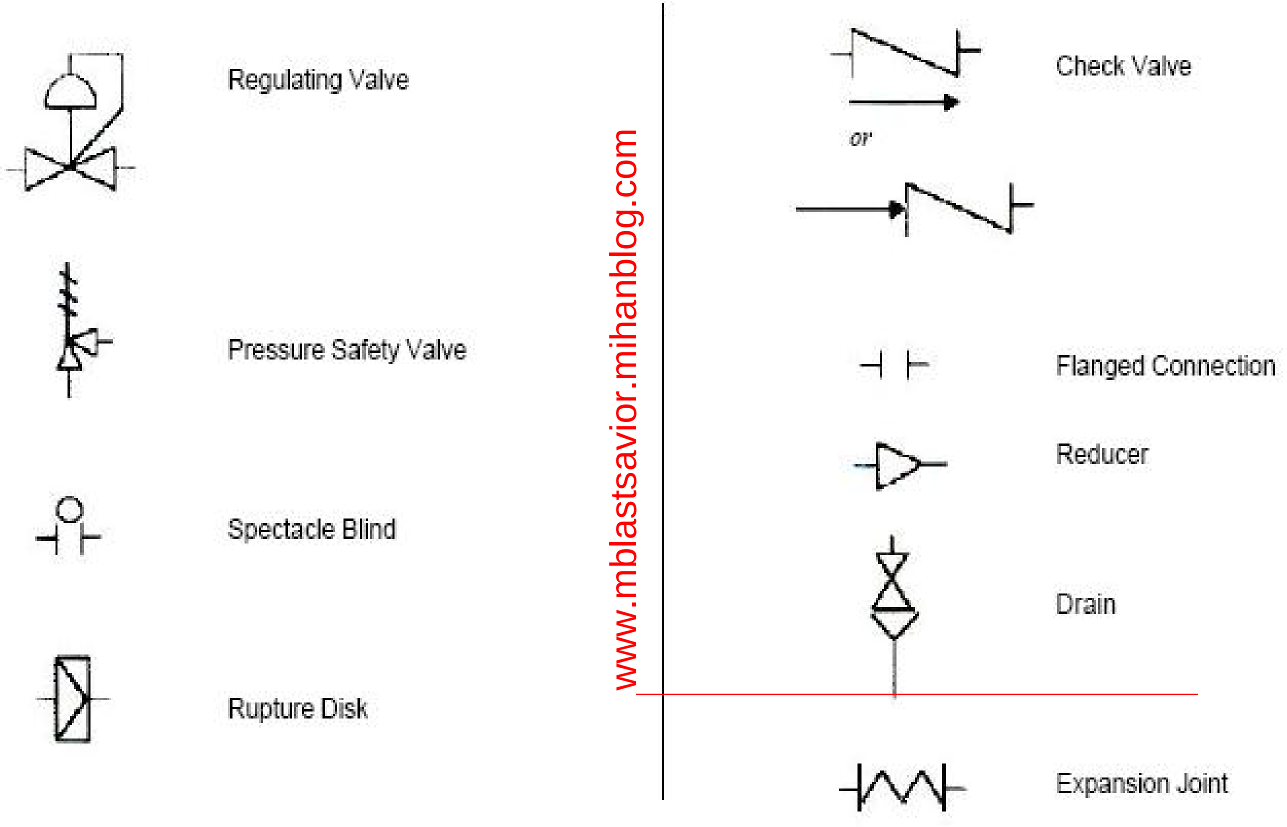
117

P&ID Symbols from Aspen-Icarus

ENGINEERING FLOWSHEET OR ENGINEERING LINE DIAGRAM

BS1646

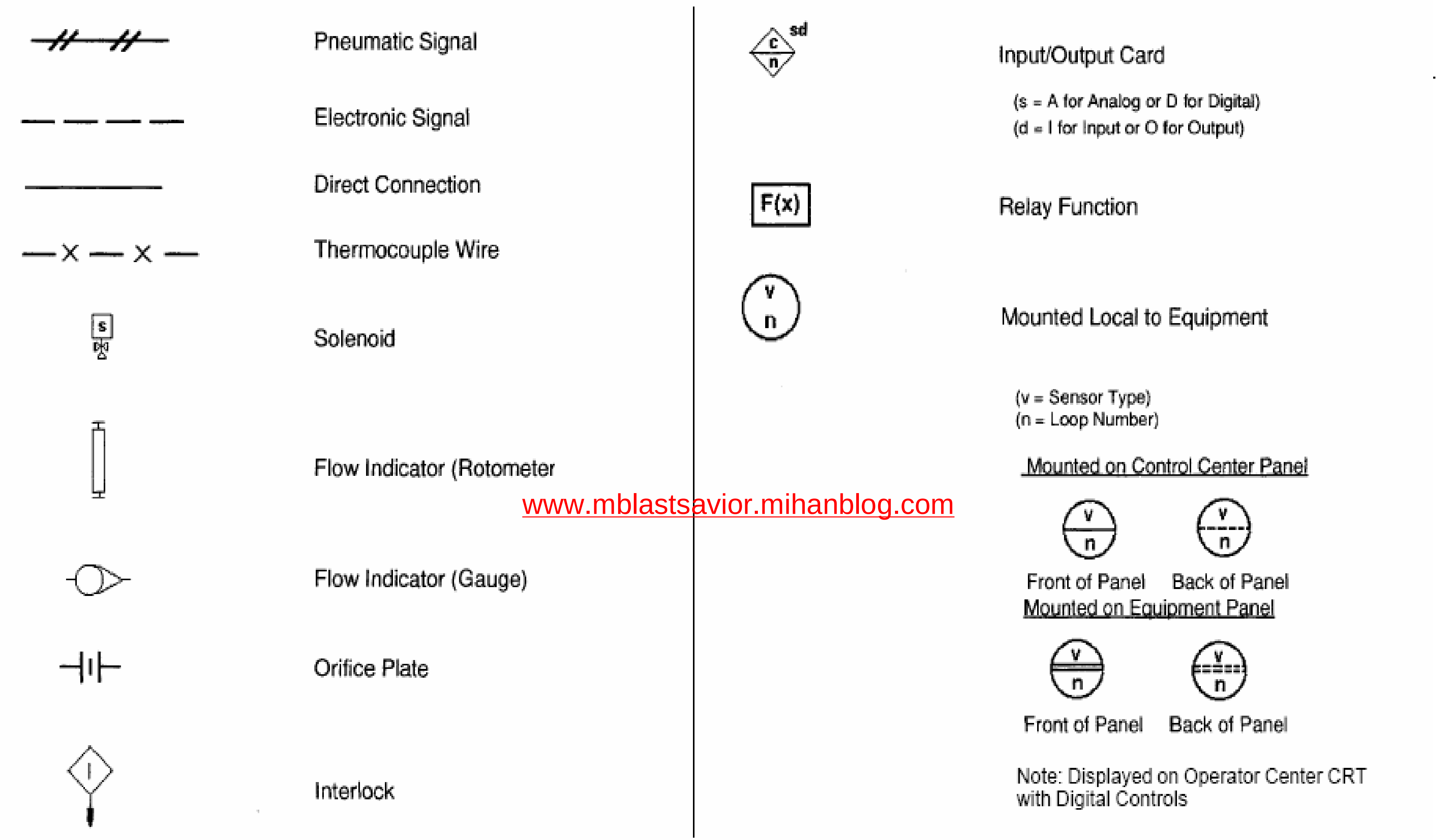
Piping Symbols



P&ID Symbols from Aspen-Icarus manual

ENGINEERING FLOWSHEET OR ENGINEERING LINE DIAGRAM

Instrument Symbols



Pneumatic Signal

Electronic Signal

Direct Connection

Thermocouple Wire

Solenoid

Flow Indicator (Rotometer

Flow Indicator (Gauge)

Orifice Plate

Interlock

Input/Output Card

(s = A for Analog or D for Digital)
(d = I for Input or O for Output)

Relay Function

Mounted Local to Equipment

(v = Sensor Type)
(n = Loop Number)

Mounted on Control Center Panel

Front of Panel   Back of Panel

Mounted on Equipment Panel

Front of Panel   Back of Panel

Note: Displayed on Operator Center CRT with Digital Controls

P&ID Symbols from Aspen-Icarus manual

ENGINEERING FLOWSHEET OR ENGINEERING LINE DIAGRAM

Instrument Identification

Process Variable (first position of name)

Symbol	Description
C	Consistency
F	Flow
T	Temperature
P	Pressure
dP	Differenctial Pressure
L	Level
S	Speed
PN	Position
PH	pH Analysis
XM	Axial Motion

Device (second position of name; MODE: F=field, P=panel)

Symbol	Mode	Description
R	R,P	Recorder
I	F,P	Indicator
C	F,P	Controller
RC	F,P	Recording Controller
IT	F	Indicating Transmitter
S	F	Switch
E	F	Element
A	O	Alarm (F-O-P)
Y	P	Relay (B-O-P)
EY	F	Solenoid

Qualifiers (last position)

Symbol	Description
H	High
L	Low
HH	High High
LL	Low Low

Special

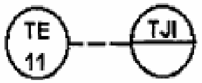
TW	Thermowell
S.P.	Set Point
ESD	Emergency Shut-Down

P&ID Samples from walas book

Examples:

Local flow indicating transmitter, pneumatic; Loop No. 3.

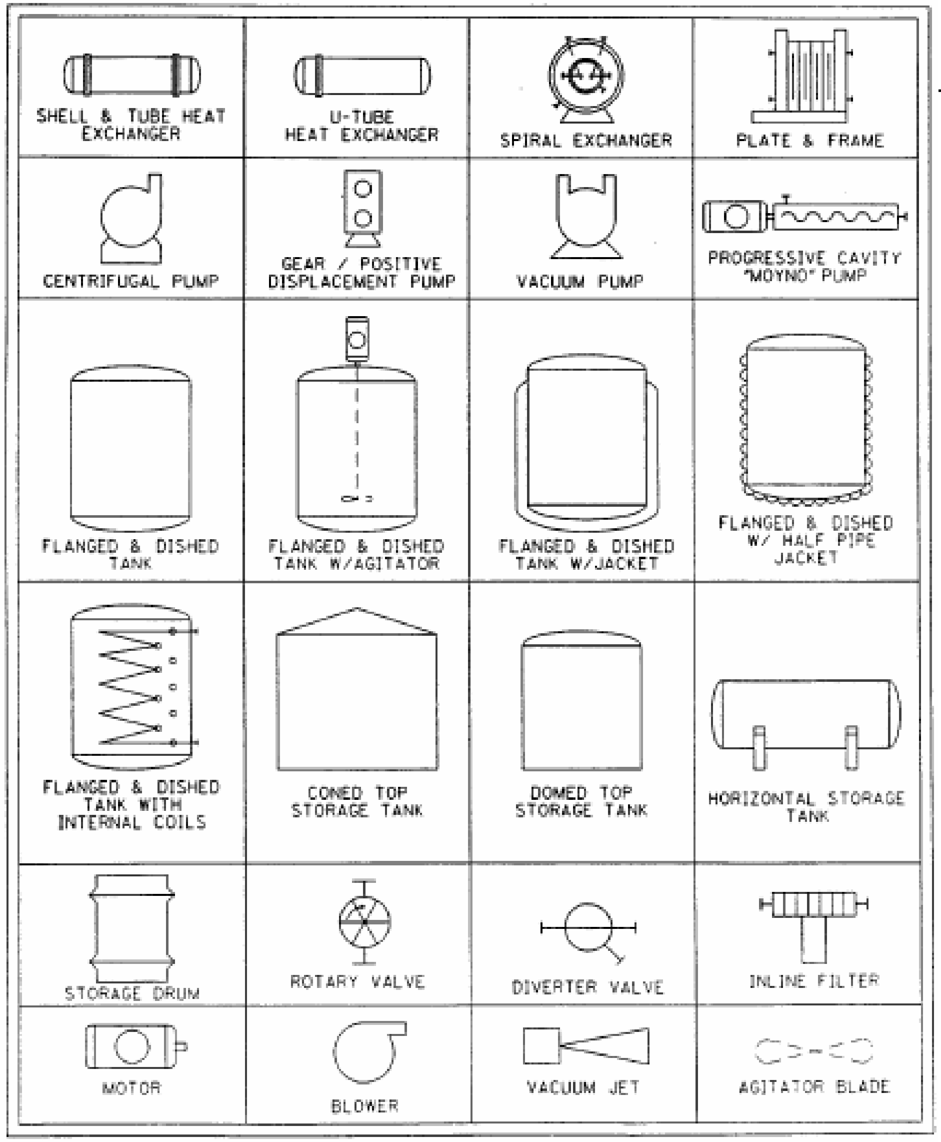
Pressure recording controller, electronic, mounted on panel; displayed, if digital at Loop No. 2.

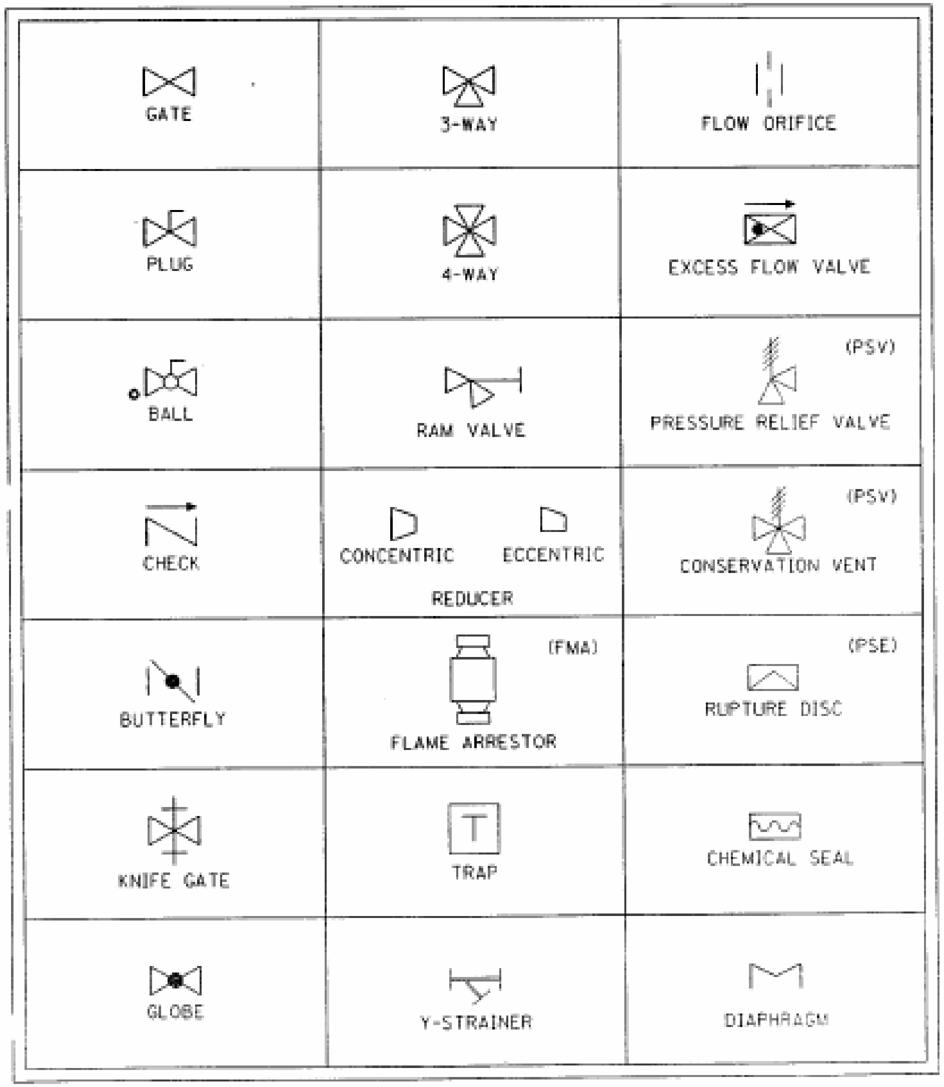


Thermocouple element, local to equipment, connected via thermocouple wire to multipoint temperature indicator mounted on panel; displayed, if digital at Loop No. 11.

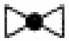
چند مثال

AC	AT	Analysis (composition) controller, transmitter
DPC	DPT	Differential pressure controller, transmitter
FC	FT	Flow rate controller, transmitter
LC	LT	Liquid level controller, transmitter
PC	PT	Pressure controller, transmitter
TC	TT	Temperature controller, transmitter

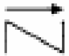

SHELL & TUBE HEAT EXCHANGER
U-TUBE HEAT EXCHANGER
SPIRAL EXCHANGER
PLATE & FRAME
CENTRIFUGAL PUMP
GEAR / POSITIVE DISPLACEMENT PUMP
VACUUM PUMP
PROGRESSIVE CAVITY "MOYNO" PUMP
FLANGED & DISHED TANK
FLANGED & DISHED TANK W/AGITATOR
FLANGED & DISHED TANK W/JACKET
FLANGED & DISHED W/ HALF PIPE JACKET
FLANGED & DISHED TANK WITH INTERNAL COILS
CONED TOP STORAGE TANK
DOMED TOP STORAGE TANK
HORIZONTAL STORAGE TANK
STORAGE DRUM
ROTARY VALVE
DIVERTER VALVE
INLINE FILTER
MOTOR
BLOWER
VACUUM JET
AGITATOR BLADE


GATE
3-WAY
FLOW ORIFICE
PLUG
4-WAY
EXCESS FLOW VALVE
BALL
RAM VALVE
(PSV)
PRESSURE RELIEF VALVE
CHECK
CONCENTRIC
ECCENTRIC
REDUCER
(PSV)
CONSERVATION VENT
BUTTERFLY
(FMA)
FLAME ARRESTOR
(PSE)
RUPTURE DISC
KNIFE GATE
TRAP
CHEMICAL SEAL
GLOBE
Y-STRAINER
DIAPHRAGM

GATE VALVE - USE TO BLOCK FLOW. DOES NOT PROVIDE TIGHT SHUT-OFF AND IS UNRELIABLE.

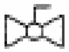


GLOBE VALVE - USE TO THROTTLE FLOW. PROVIDES TIGHT SHUT-OFF AND IS RELIABLE.

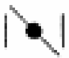


CHECK VALVE - USE TO PREVENT OR CONTROL BACK-FLOW. DOES NOT PROVIDE TIGHT SHUT-OFF.

PLUG VALVE - USE TO BLOCK FLOW AND PROVIDE TIGHT SHUT-OFF.



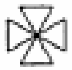
BALL VALVE - USE TO BLOCK FLOW AND PROVIDE TIGHT SHUT-OFF.



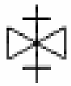
BUTTERFLY VALVE - USE TO SHUT-OFF AND TO THROTTLE FLOW. CAN PROVIDE GOOD SHUT-OFF, BUT IS A POOR THROTTLER OF FLOW.

RAM VALVE - USE WHERE SERVICE TENDS TO PLUG THE OPENING. PROVIDES GOOD SHUT-OFF.

THREE-WAY VALVE - USE WHERE FLOW NEEDS TO BE DIVERTED BETWEEN TWO PATHS.

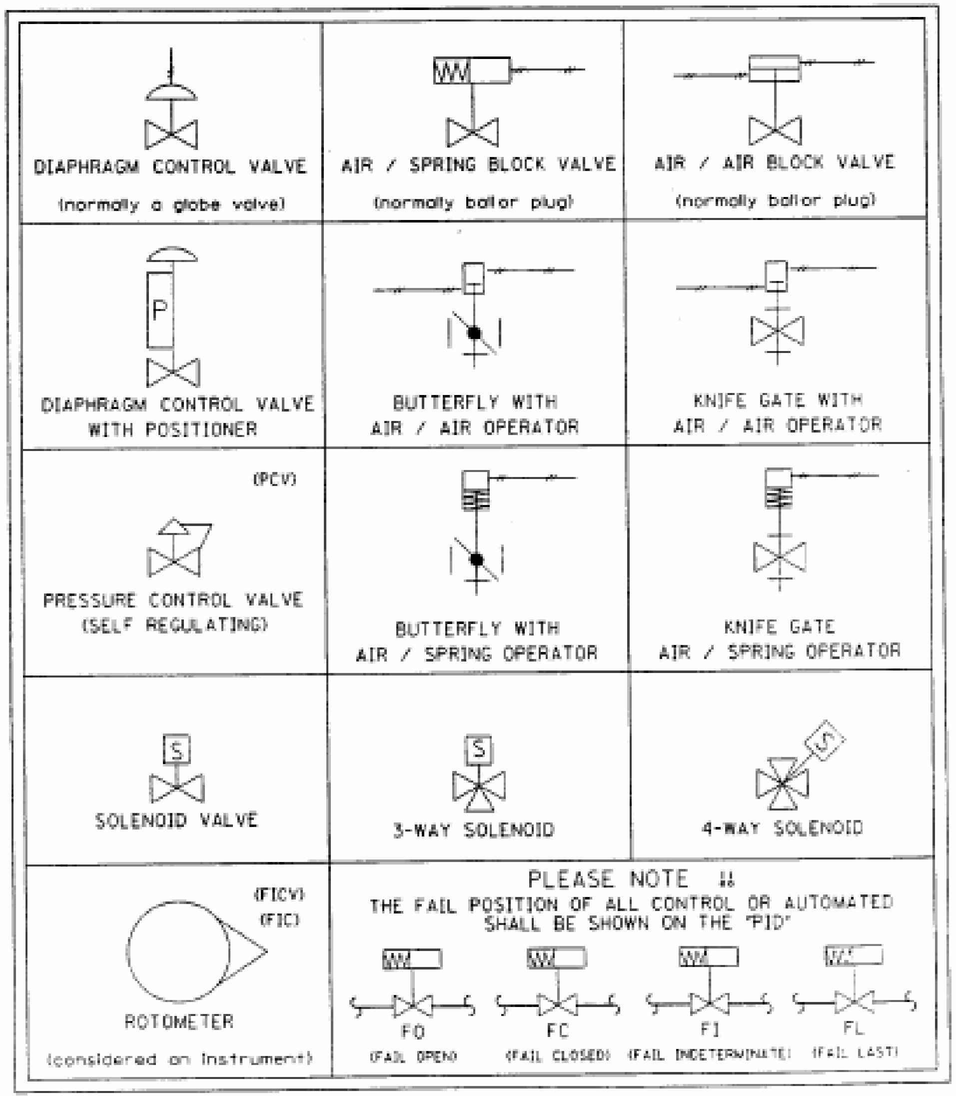


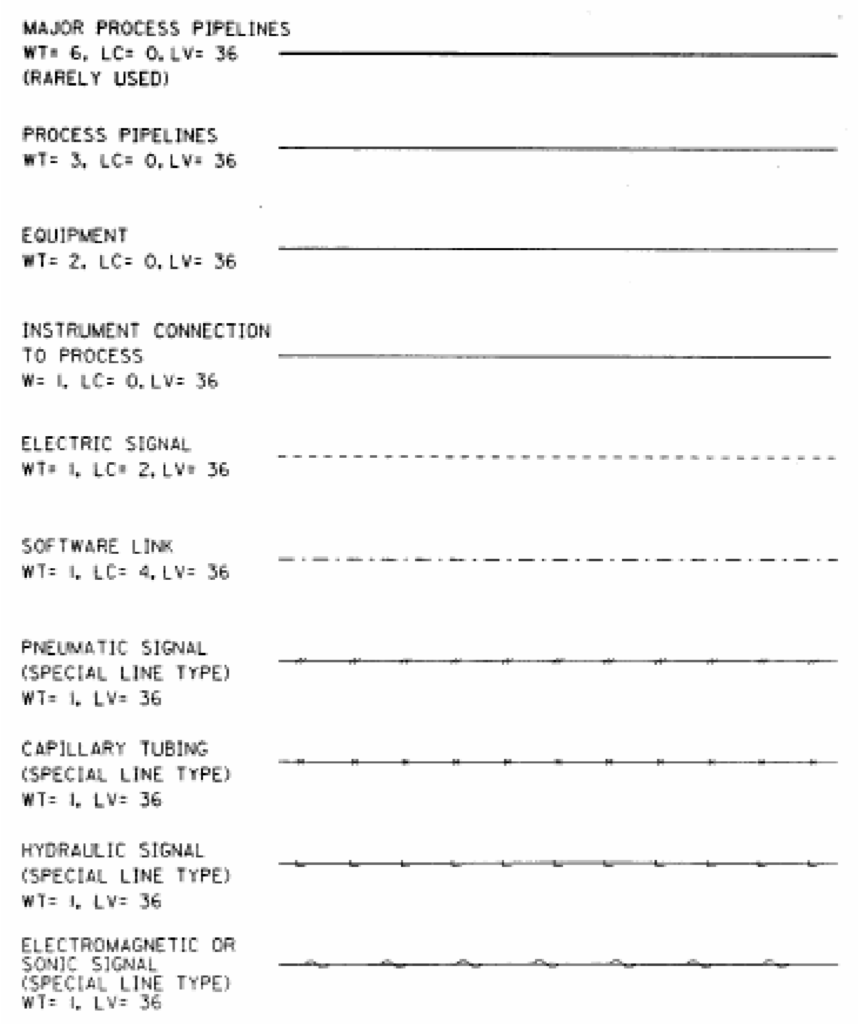
FOUR-WAY VALVE - USE WHERE FLOW NEEDS TO BE DIVERTED BETWEEN TWO PATHS AND FLOW PATHS REVERSED.

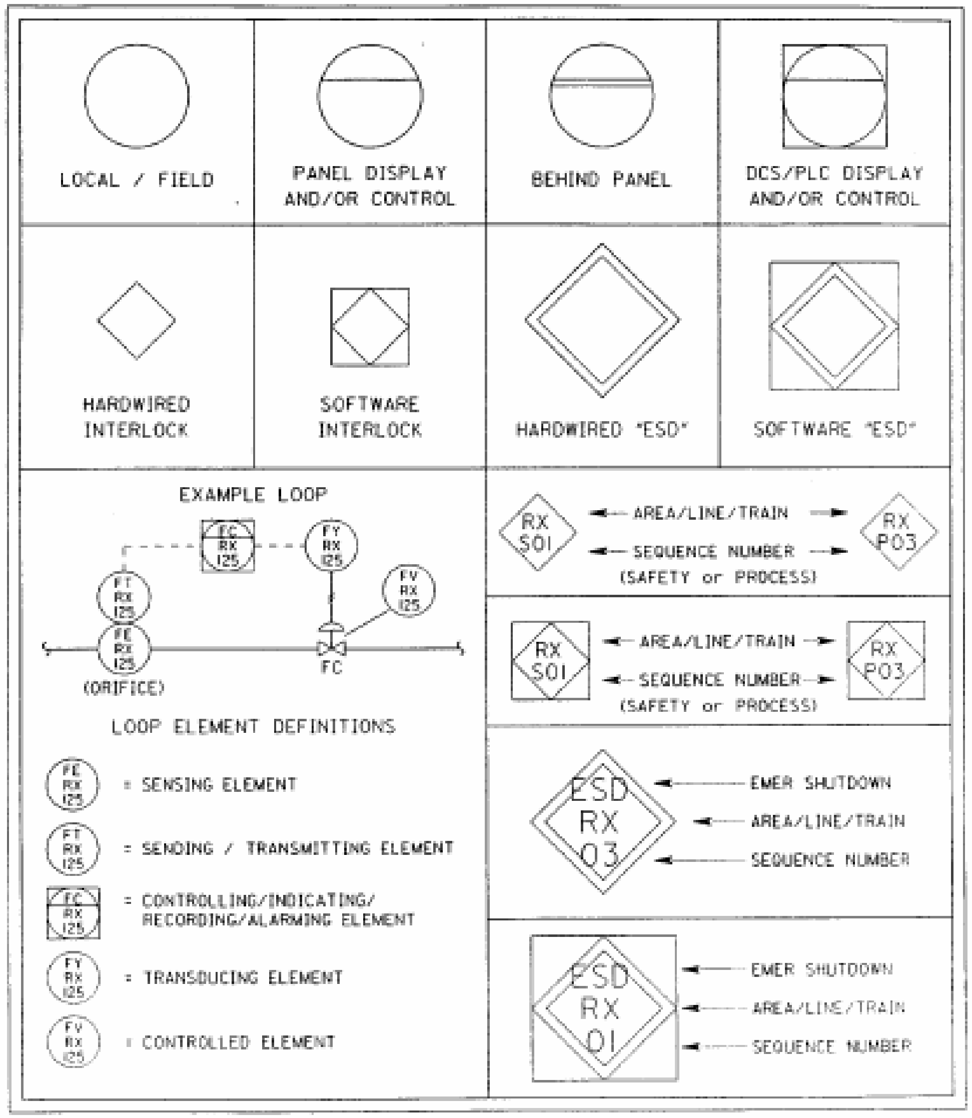


KNIFE GATE VALVE - USE FOR SOLIDS FLOW SHUT-OFF. USE WITH PELLETS AND / OR GRANULATED MATERIALS.

DIAPHRAGM VALVE - USE THIS TYPE PINCH VALVE TO BLOCK OR THROTTLE SLURRY FLUIDS OR THOSE WITH SOME SOLIDS WHICH MIGHT BLOCK SMALL ORIFICES SUCH AS GLOBE VALVE PASSAGES. GENERALLY NOT SUITED TO ABRASIVES SERVICE.


DIAPHRAGM CONTROL VALVE
(normally a globe valve)
AIR / SPRING BLOCK VALVE
(normally ball or plug)
AIR / AIR BLOCK VALVE
(normally ball or plug)
P
DIAPHRAGM CONTROL VALVE WITH POSITIONER
BUTTERFLY WITH AIR / AIR OPERATOR
KNIFE GATE WITH AIR / AIR OPERATOR
(PCV)
PRESSURE CONTROL VALVE (SELF REGULATING)
BUTTERFLY WITH AIR / SPRING OPERATOR
KNIFE GATE AIR / SPRING OPERATOR
S
SOLENOID VALVE
3-WAY SOLENOID
4-WAY SOLENOID
(FICV)
(FIC)
ROTOMETER
(considered an instrument)
PLEASE NOTE !!
THE FAIL POSITION OF ALL CONTROL OR AUTOMATED SHALL BE SHOWN ON THE "PID"
FO
(FAIL OPEN)
FC
(FAIL CLOSED)
FI
(FAIL INDETERMINATE)
FL
(FAIL LAST)

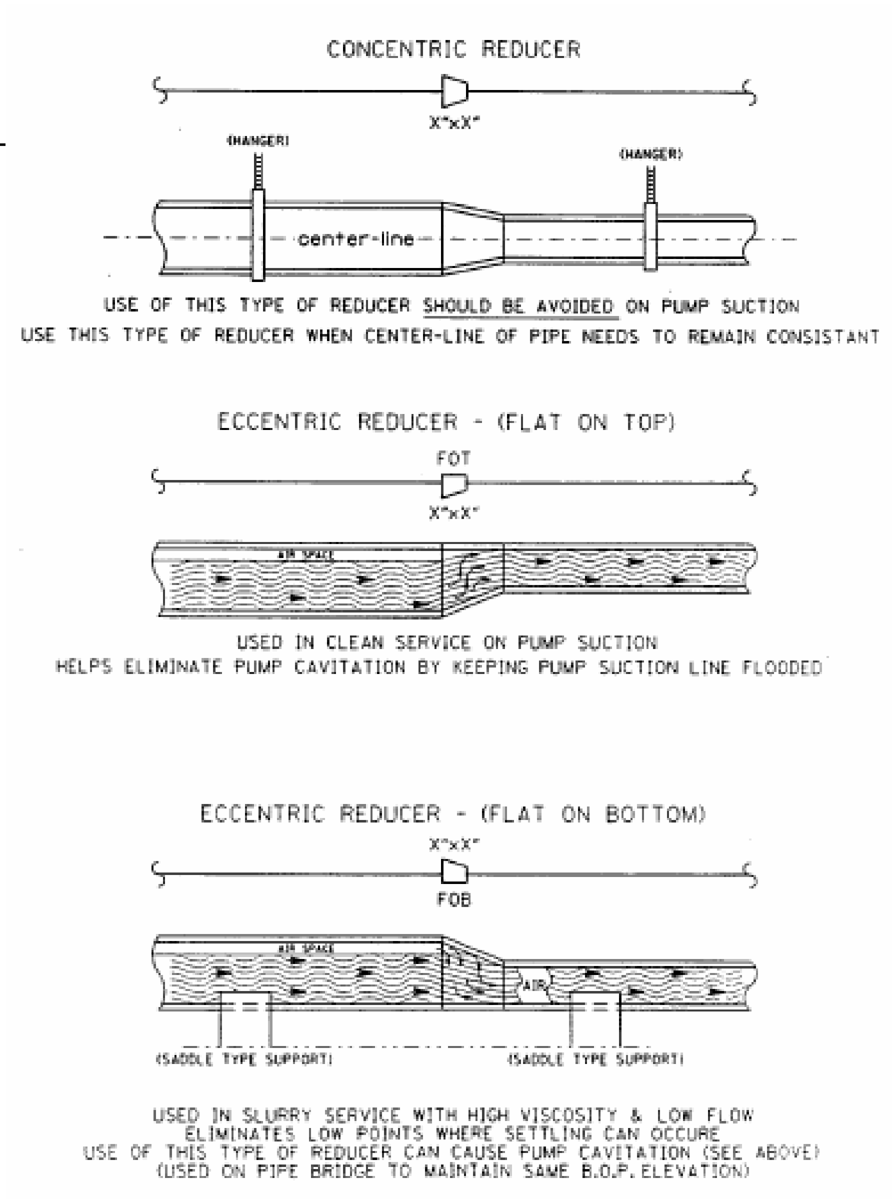

MAJOR PROCESS PIPELINES
WT= 6, LC= 0, LV= 36
(RARELY USED)
PROCESS PIPELINES
WT= 3, LC= 0, LV= 36
EQUIPMENT
WT= 2, LC= 0, LV= 36
INSTRUMENT CONNECTION
TO PROCESS
W= 1, LC= 0, LV= 36
ELECTRIC SIGNAL
WT= 1, LC= 2, LV= 36
SOFTWARE LINK
WT= 1, LC= 4, LV= 36
PNEUMATIC SIGNAL
(SPECIAL LINE TYPE)
WT= 1, LV= 36
CAPILLARY TUBING
(SPECIAL LINE TYPE)
WT= 1, LV= 36
HYDRAULIC SIGNAL
(SPECIAL LINE TYPE)
WT= 1, LV= 36
ELECTROMAGNETIC OR
SONIC SIGNAL
(SPECIAL LINE TYPE)
WT= 1, LV= 36


LOCAL / FIELD
PANEL DISPLAY AND/OR CONTROL
BEHIND PANEL
DCS/PLC DISPLAY AND/OR CONTROL
HARDWIRED INTERLOCK
SOFTWARE INTERLOCK
HARDWIRED "ESD"
SOFTWARE "ESD"
EXAMPLE LOOP
FC RX 125
FY RX 125
FT RX 125
FV RX 125
FE RX 125
FC
(ORIFICE)
LOOP ELEMENT DEFINITIONS
= SENSING ELEMENT
= SENDING / TRANSMITTING ELEMENT
= CONTROLLING/INDICATING/ RECORDING/ALARMING ELEMENT
= TRANSDUCING ELEMENT
= CONTROLLED ELEMENT
RX S01
AREA/LINE/TRAIN
SEQUENCE NUMBER
(SAFETY or PROCESS)
RX P03
ESD RX 03
EMER SHUTDOWN
AREA/LINE/TRAIN
SEQUENCE NUMBER
ESD RX 01

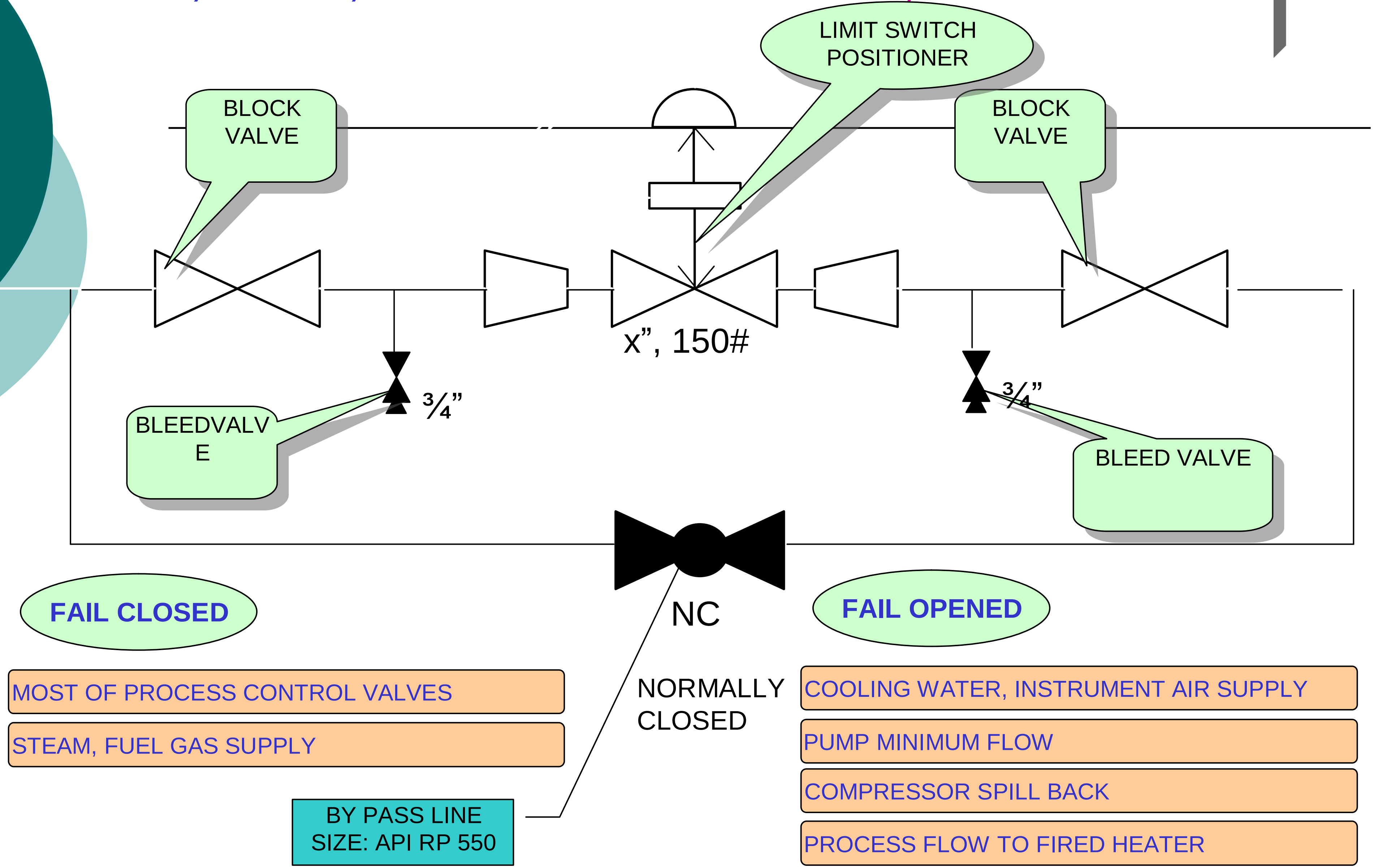
IDENTIFICATION LETTERS

	FIRST-LETTER (4)		SUCCEEDING-LETTERS (3)		
	MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A	Analysis(5,19)		Alarm		
B	Burner, Combustion		User's Choice(1)	User's Choice(1)	User's Choice(1)
C	User's Choice(1)			Control(13)	
D	User's Choice(1)	Differential(4)			
E	Voltage		Sensor (Primary Element)		
F	Flow Rate	Ratio (Fraction)(4)			
G	User's Choice(1)		Glass, Viewing Device(9)		
H	Hand				High(7,15,16)
I	Current (Electrical)		Indicate(10)		
J	Power	Scan(7)			
K	Time, Time Schedule	Time Rate of Change(4,21)		Control Station (22)	
L	Level		Light(11)		Low(7,15,16)
M	User's Choice(1)	Momentary(4)			Middle, Intermediate(7,15)
N	User's Choice(1)		User's Choice(1)	User's Choice(1)	User's Choice(1)
O	User's Choice(1)		Orifice, Restriction		
P	Pressure, Vacuum		Point (Test) Connection		
Q	Quantity	Integrate, Totalize(4)			
R	Radiation		Record(17)		
S	Speed, Frequency	Safety(8)		Switch(13)	
T	Temperature			Transmit(18)	
U	Multivariable(6)		Multifunction(12)	Multifunction(12)	Multifunction(12)
V	Vibration, Mechanical Analysis(19)			Valve, Damper, Louver(13)	
W	Weight, Force		Well		
X	Unclassified(2)	X Axis	Unclassified(2)	Unclassified(2)	Unclassified(2)
Y	Event, State or Presence(20)	Y Axis		Relay, Compute, Convert(13,14,18)	
Z	Position, Dimension	Z Axis		Driver, Actuator, Unclassified Final Control Element	

Note: Numbers in parentheses refer to specific explanatory notes on pages 15 and 16


CONCENTRIC REDUCER
X"xX"
(HANGER)
(HANGER)
center-line
USE OF THIS TYPE OF REDUCER SHOULD BE AVOIDED ON PUMP SUCTION
USE THIS TYPE OF REDUCER WHEN CENTER-LINE OF PIPE NEEDS TO REMAIN CONSISTANT
ECCENTRIC REDUCER - (FLAT ON TOP)
FOT
X"xX"
AIR SPACE
USED IN CLEAN SERVICE ON PUMP SUCTION
HELPS ELIMINATE PUMP CAVITATION BY KEEPING PUMP SUCTION LINE FLOODED
ECCENTRIC REDUCER - (FLAT ON BOTTOM)
X"xX"
FOB
AIR SPACE
AIR
(SADDLE TYPE SUPPORT)
(SADDLE TYPE SUPPORT)
USED IN SLURRY SERVICE WITH HIGH VISCOSITY & LOW FLOW
ELIMINATES LOW POINTS WHERE SETTLING CAN OCCURE
USE OF THIS TYPE OF REDUCER CAN CAUSE PUMP CAVITATION (SEE ABOVE)
(USED ON PIPE BRIDGE TO MAINTAIN SAME B.O.P. ELEVATION)

P&ID, VALVES, CONTROL VALVE. IPS-E-PR-230, IPS-E-PR-830



Fail Open / Closed (Control Valve): The safe position of a valve which will shift to upon loss of the power medium.

Normal Position (Valve): The position of a valve in Normal Condition of the process (N.O. , N.C.)

- **Plant Shutdown:** The shutting in of all process stations of a Plant Production process and all support equipment for the process.
- **Process Shutdown:** The isolation of a given process station from the process by closing appropriate SDVs to shut-in flow to the process station or divert flow to another process station.
- **Shutdown Valve (SDV):** An automatically operated Normally Closed valve used for isolating a process station.
- **Emergency Shutdown System (ESD):** A system of stations which when activated initiate plant shutdown.

- **Pressure Safety Valve (PSV):** A pressure relief device designed to open and relieve excess pressure and to reclose and prevent the further flow of fluid after normal conditions have been restored.

- **Depressurization**: When metal exposed to fire on one side with vapor on the other side, the metal temp. may reach a level at which metal rupture due to stress may occur, even though the pressure does not exceed the allowable overpressure. An emergency depressurization (blow down) system is provided to avoid such an occurrence.

P&ID Symbols from walas

مثالی از روشهای مختلف کنترل

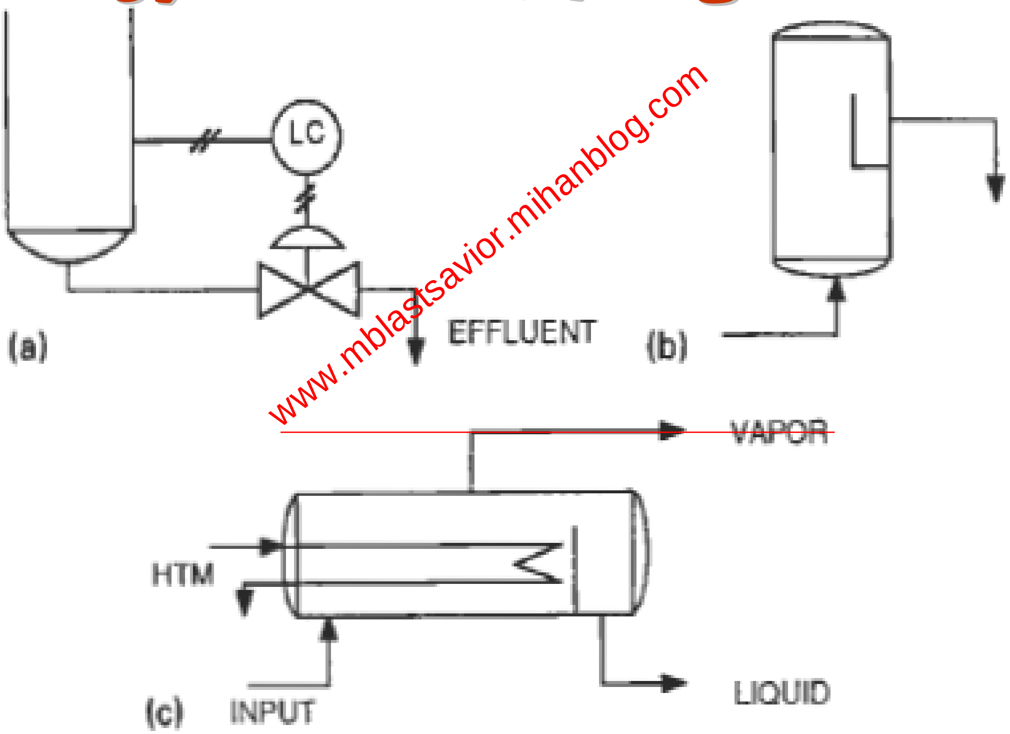


Figure 3.6. Some modes of control of liquid level. (a) Level control by regulation of the effluent flow rate. This mode is externally adjustable. (b) Level control with built in overflow weir. The weir may be adjustable, but usually only during shutdown of the equipment. (c) Overflow weir in a horizontal kettle reboiler. The weir setting usually is permanent.

مدارک پایپینگ

بسیار حائز اهمیت است که هر کدام از شاخه ها از هدف کاری که توسط شاخه های دیگر در حوزه تخصصی آنها انجام می گیرد آگاه باشند و همکاری و همگامی با شاخه های دیگر داشته باشند.

از فلوشیت مکانیکال تجهیزات یا پایپینگ و نقشه های ابزار دقیق تهیه شده، اطلاعات لازم برای تهیه، خریداری یا ساخت تجهیزات و ماشین آلات لازم به دست می اید.

(plot Plant)

جانمایی سایت، محدوده های جغرافیایی زمینی که کارخانه قرار می گیرد را تعریف می کند.

نقشه های مخازن و تجهیزات

این نقشه ها برای نمایش پیرامون تجهیزات به همراه حداقل احتیاجات نازل تهیه می شوند و ممکن است شامل جزئیات ساخت در جاهایی که مورد نیاز است شود.

نقشه های ایزومتریک

مدارک پایپینگ

این نقشه ها برای دستیابی به اهداف ذیل تهیه می شوند:

- ایزومتریکهای سیستم برای نشان دادن پایپینگ کامل سیستم(شامل زانویی ها)
- ایزومتریکهای تنش اولیه- برای تخمین تنش اولیه لوله ها (توسط نرم افزار سزار)
- ایزومتریکهای تنش نهایی- لوله های ایزومتریک تهیه شده براساس آنالیز تنش تکمیلی
- نقشه های ایزومتریک از برشهای **(Spool)**-نقشه های اسپول سیستم که برای ساخت یا مونتاژ قبل از نصب مناسب هستند.

مدارك پايپينگ

لیست تجهیزات(Equipment list)

لیست تجهیزات برای هر سیستم به طور جداگانه تهیه می شودو و تعداد هر یک از تجهیزات و همچنین اندازه ، محل و موقعیت آنها را شرح می دهد.

لیست شیرها (valve list)

لیست شیرها برای هر سیستم از اطلاعاتی که از **P&ID** استخراج می شود، تهیه می گردد.

لیست خطوط (line list)

لیست خطوط بایستی با استفاده از اطلاعاتی که از **P&ID** به دست می آید تهیه می شود. هدف از تهیه این لیست، شماره بندی خطوط در ارتباط با چیدمان کلی پایپینگ و نقشه ه ای مختلف ایزومتریک می باشد.

جدول آویزها (Hanger schedule)

جداولی که در ارتباط با سیستمهای پایپینگ تهیه می شوند تا امکان تهیه متریال اولیه لازم جهت ساپورت گذاری لوله کشی فراهم شود.

مدارك پايپينگ

نقشه های ازبیلت(As built)

نقشه های ازبیلت کپی هایی از نقشه های قرارداد هستند که تغییراتی که در حین ساخت در پروژه انجام گرفته در آنها اعمال می شود.

نقشه های گزارشی(Report drawings)

برای نمایش آیتمهای خاص که در گزارشها به آنها اشاره شده به کار می روند. جزئیات بایستی حداقل باشند و وضوح و کیفیت نمایش متریال مورد نظر مد نظر قرار گیرند.

نقشه های خارجی(Foreign drawings)

نقشه ها ی ا اسناد دیگری هستند که توسط پیمانکاران ی ا فروشندگان و تامین کنندگان خارج از شرکت تهیه شده اند تا جزئیات کار، پروژه ی ا دستگاهی که توسط آنها تامین می شوند را ارائه می دهند.

IPS

بخش

PFD –P&ID

Process Flow Diagram

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

Phase I: Basic Design Stages (containing seven Standards)

Phase II: Detailed Design, Engineering and Procurement Stages (containing two Standards)

Phase III: Start-Up Sequence and General Commissioning Procedures (containing two Standards)

منابع IPS برای این بخش

Phase I: Basic Design Stages (containing 7 Standards)

STANDARD CODE	STANDARD TITLE
I) Manuals of Phase I (Numbers 1 - 7)	
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-230	"Piping & Instrumentation Diagrams (P&IDs)"
IPS-E-PR-250	"Performance Guarantee"
IPS-E-PR-308	"Numbering System"

منابع IPS برای این بخش

Phase II: Detailed Design, Engineering and Procurement Stages (containing 2 Standards)

I) Manuals of Phase II (Numbers 8&9)

IPS-E-PR-260 "Detailed Design, Engineering and Procurement"

IPS-E-PR-300 "Plant Technical and Equipment Manuals (Engineering Dossiers)“

Phase III: Start-Up Sequence and General Commissioning Procedures (containing two Standards)

III) Manuals of Phase III (Numbers10&11)

IPS-E-PR-280 "Start-Up Sequence and General Commissioning Procedures"

IPS-E-PR-290 "Plant Operating Manuals"

هدف IPS برای این بخش

Scope

This Standard is also intended to establish uniform symbols for equipment, piping and instrumentation on P&IDs and UDFDs throughout the Oil, Gas and Petrochemical (OGP) projects.

تعاریف IPS برای این بخش
Nomenclature or Terminology
Flowsheets

the Piping and Instrumentation Diagrams (P&IDs)

Utility Distribution Flow Diagrams (UDFDs,UHD,UFD)

Process flow diagram(PFD)

REFERENCES

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME Code.

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI B 16.1 "Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800"

1st. Ed., 1989

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-E-PR-200 "Basic Engineering Design Data"

IPS-E-PR-308 "Numbering System"

IPS-E-PR-725 "Process Design of Plant Waste Sewer Systems"

IPS-G-IN-160 "Control Valves"

IPS-D-AR-010 "Abbreviations & Symbols for HVAC&R Drawings"

IPS-D-AR-011 "General Notes for HVAC & R System"

REFERENCES

ISA (INSTRUMENT SOCIETY OF AMERICA)

ISA-S5.1	**"Instrumentation Symbols and Identification" 1st. Ed., 1984**
ISA-S5.2	**"Binary Logic Diagrams for Process Operations" 2nd. Ed., 1981 (Reaffirmed 1992)**
ISA-S5.3	**"Graphic symbols for distributed control / shared display instrumentation, logic and computer systems "Ed.,1983**
ISA-S5.4	**"Instrument Loop Diagrams" Ed., 1991**
ISA-S5.5	**"Graphic Symbols for Process Displays" 1st. Ed., 1985**
ISA-S18.1	**"Annunciator Sequences and Specifications" 1st. Ed., 1979 (Reaffirmed 1992)**
ISA-S50.1	**"Compatibility of analogue signals for electronic industrial process instruments" 1st. Ed., 1975 (Reaffirmed 1995)**
ISA-S51.1	**"Process Instrumentation Terminology" 1st. Ed., 1979**

REFERENCES

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

ISO 3098: Part 1 "Technical Drawings-Lettering, Part 1: Currently Used Characters"

1st. Ed. 1974

ISO 3511: Part 1 & Part 4 "Process measurement control functions and instrumentation-symbolic representation-Part 1: Basic requirements, 1st.Ed. 1977;Part 4: Basic symbols for process computer, Interface, and shared display/control functions" Ed. 1985

1st. Ed., 1984

ISO 6708 "Pipe component definition of nominal size" Ed., 1995.

API (AMERICAN PETROLEUM INSTITUTE)

API Standard 602 "Compact steel gate valves-flanged, threaded, welding and extended body ends “nine Ed., 1995

GPSA (Gas Process System Analysis)

TERMINOLOGY:

Company or Employer / Owner :

affiliated companies of the Iranian ministry of petroleum :

National Iranian Oil Company (NIOC)

National Iranian Gas Company (NIGC)

National Petrochemical Company (NPC)

SYMBOLS AND ABBREVIATIONS

IMORTANTS AND COMMONS IN RED

قرمزها حفظ گردد

Drain / Sewer Symbols

AMN	Amine Drains (MEA,MDEA)
AY	Amine Drain Funnel (MEA,MDEA)
CAU	Caustic Sewer(NAOH)
CDB	Concrete Drain Box
CSW	Chemical Sewer
CY	Chemical Drain Pit
DC	Drain Connection
DWW	Desalter Waste Water
NSW	Non Oily Water Sewer
OPD	Open Drain
OSW	Oily Water Sewer
SSW	Sanitary Water Sewer
SWA	Stripped Sour Water
TY	Toxic Drain Funnel
Y	Drain Funnel (General)

Letters at Individual Valves Designations

B	Monel Valve (grease sealed seat and packing)
BV	Ball Valve
CAO	Close-Automatic-Open
CC	Cable Control
CO	Chain Operated
CHV	Check Valve
D	Drain
FB	Full Bore
FC	Fail Close (closes on minimum signal to valve actuator)
FO	Fail Open (opens on minimum signal to valve actuator)
FD	Flex Disc Valve (Diapheragm Valve)

Monelآلیاژی از نیکل و کبالت که در برابر خوردگی مقاوم است

Flexخم شو

Letters at Individual Valves Designations

MOV	Motorized Valve(motor operated valve)
NC	Normally Closed(like by-pass valve for control valves)
NO	Normally Open
NV	Needle Valve (Plug valve)
OV	Operating Valve
PIVA	Post Indicator Valve(if it is Closed or open)
PSE	Rupture Disk Assembly (Pressure Safety Equipment)
PSV	Pressure Safety Relief Valve
P	Plugged
SR	Split Range
SSV	Stainless Steel Valve
T	Trap
V	Vent
WP(J)	Jacketed Plug Valve
XCV	Steam Trap with Integral Strainer

Piping Abbreviations

CS	Carbon Steel
DN	Diameter Nominal
FF	Flat Face
FS	Forged Steel
LJ	Lap Joint
MI	Mallable Iron
PN	Pressure Nominal
RF	Raised Face
RS	Removable Spool
SF	Socket Weld Line Blind with Flexitallic Gaskets
SB	Spectacle Blind
SO	Slip on
SS	Stainless Steel
ST(H)	Steam Trap (Heat Conservation)
SW	Socket Weld
WN	Weld Neck

Miscellaneous Designations

AG	Above Ground
BL	Battery Limit
DCS	Distributed Control System
HCB	Hydrocarbon
HCH	Hydrocarbon with Hydrogen
HHLL	High High Liquid Level
HLL	High Liquid Level
LG	Level Gage
LLL	Low Liquid Level
LLLL	Low Low Liquid Level
MW	Manway
NLL	Normal Liquid Level
P	Pressure
PB	Push Bottom
PFD	Process Flow Diagram
PG	Pressure Gage
PI	Pressure Indicator

Miscellaneous Designations

P&ID	Piping & Instrumentation Diagram
PO	Pump Out
PT	Pressure Test Connection
RES	Residue
RG	Refrigerant Gas
RL	Refrigerant Liquid
RTD	Resistance Temperature Detector
RVP	Reid Vapor Pressure
SC	Sample Connection
SCL	Sample Cooler
SG	Sight Glass
SP	Set Point
SP.GR.	Relative Mass Density (Specific Gravity)
STO	Steam Out
TI	Temperature Indicator
T/T	Tangent to Tangent
UFD	Utility Flow Diagram
UG	Under Ground
VB	Vortex Breaker

Utility Services Abbreviations

BFW	Boiler Feed Water
CLW	Chlorinated Water
CW	Cooling Water
CWR	Cooling Water Return
CWS	Cooling Water Supply
DMW	Demineralized Water
DSW	Desalinated Water
DWA	Drinking Water
FLG	Fuel Gas
FLR	Flare Discharge
FOR	Fuel Oil Return
FOS	Fuel Oil Supply
FWA	Fire Water
HBW	High Pressure Boiler Feed Water
HPC	High Pressure Condensate
HPS	High Pressure Steam

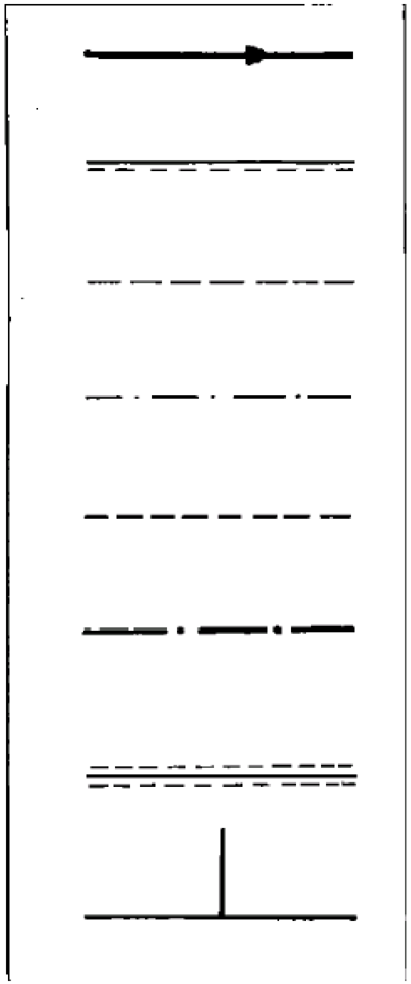
Utility Services Abbreviations

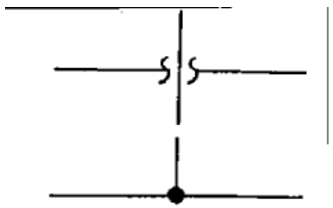
ISA	Instrument Air
LLPS	Low Low Pressure Steam
LPC	Low Pressure Condensate
LPS	Low Pressure Steam
MBW	Medium Pressure Boiler Feed Water
MPC	Medium Pressure Condensate
MPS	Medium Pressure Steam
NG	Natural Gas
NIT	Nitrogen
PLA	Plant Air
PWA	Plant Water(service water)
RFO	Refinery Fuel Oil
RFW	Refrigerated water
RWA	Raw Water
SWA	Sour Water
TWA	Treated Water
WAT	Water

power supply

AS		Air Supply
	ISA	Instrument Air
	PLA	Plant Air
ES		Electric Supply
GS		Gas Supply
HS		Hydraulic Supply(Water)
NS		Nitrogen Supply
SS		Steam Supply

انواع خطوط

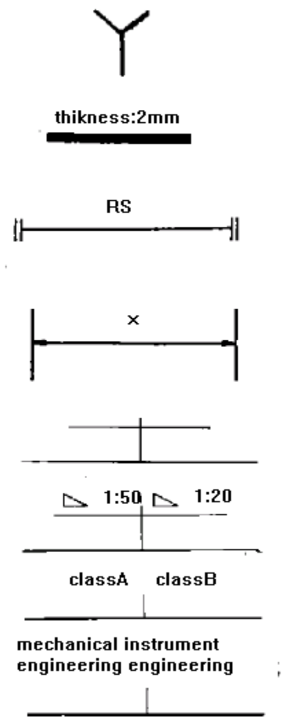
SYMBOL	DESCRIPTION
	Main process line (arrow of 30indicates Direction of fluid flow) Heat traced pipe line Underground pipeline Existing line Future line Vendor package Jackated or double containment pipeline Line crossing (connected)



Line crossing (nconnected)

Lines junction

www.mblastsavior.mihanblog.com



Dripe funnel

Platform

Removable spoolpice

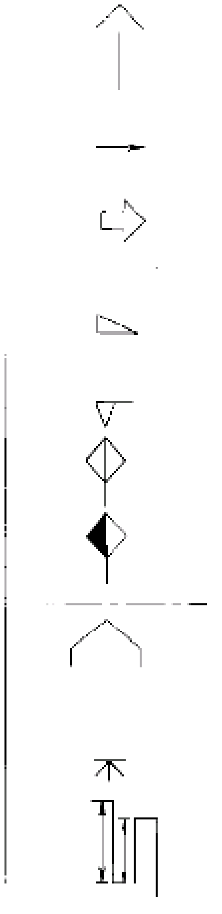
Minimum distance

Indication of point of change:

a)change in sloop

b) change in piping class

c)change in responsibility



Outlet to the atmosphere for steam / gas

Flow / motion in diraction of arrow

Arrow for inlet or outlet of essential substances

Slope

Level reference

Limit , general

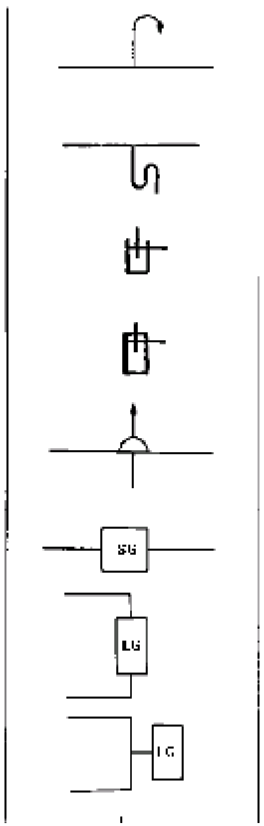
Contractor/ vendor

Battery limit

Hood , general (Furnace)

Distribution device for fluids , spray nozzle

Siphon with dip length



Open vent

Syphon drain(seal leg)

Liquid seal, oen

Liquid seal ,closed

Butsting disc

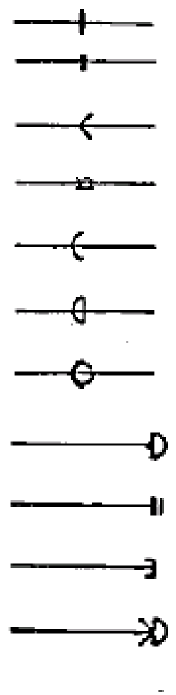
Sight glass

Level gage

Level gage on standpipe (vertical pipe)

Interlock logic symbols

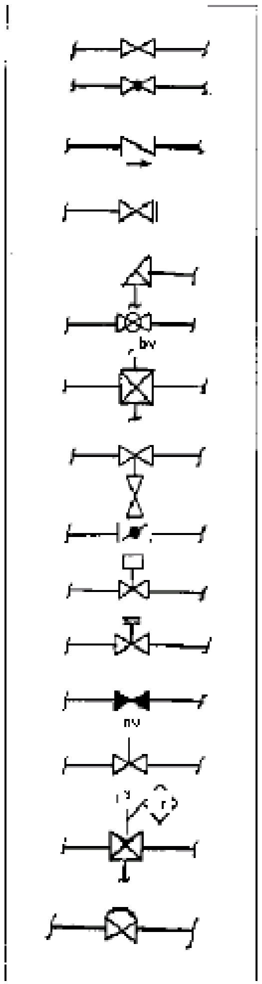
symbol	description
or — or	output exists if one or more input exists
and — and	output exists if and only if all the input exists
nut — not	no output exists if one and only one input exists
td —	time delay output exists after preset time
xor — exclusive	output exists if one and only one input exists
▷ —	sequential logic control connection



Butt welded joint
Flanged joint
Screwed joint (arrow : 90)
Socket welded joint
Socket and spigot joint
Compression joint
Swivel joint
End cap ,but welded
End flanged and bolted
End cap ,fillet welded (socket)
End cap ,screwed (arrow:90)

Symbols for manually operated and miscellaneous valves and monitors

مهم!!



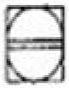
Gate valve (basic symbol)
Globe valve
Check valve (general)
Gate valve behind off
Angle valve
Ball valve
Fourway valve

Gate valve with body bleed
Butterfly valve
Hydraulic control (water force)
Metering cock
Needle valve
Plug valve

S=solenoid valve
R= Manual reset when indicated

Diaphragm valve

Distributed control/shared display symbols

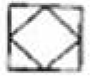
symbol	description
	field mounted instrument (not normally accessible to operator)
	indicator/controller/alarm (normally accessible to operator)
	auxiliary oparetors interface device

اشکال مختلف ابزار دقیق برای سیستم DCS

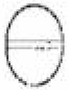
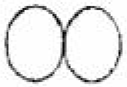
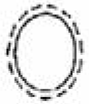
اشکال مختلف ابزار دقیق برای سیستم PLC

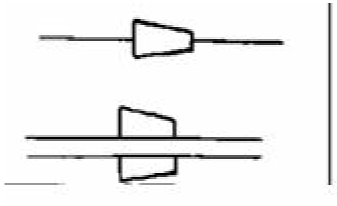
APPENDIX A (continued)

Programmable logic controller (PLC) function symbols

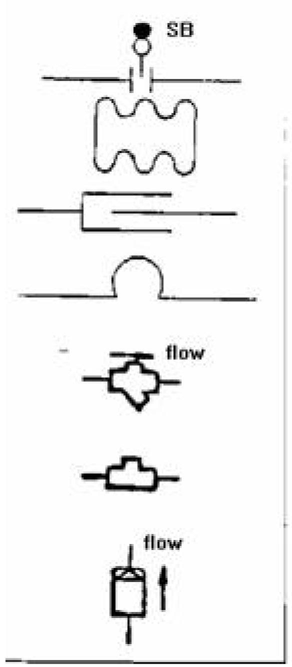
symbol	description
	field mounted PLC integral to DCS not normally accessible to operator
	control mounted PLC integral to DCS not normally accessible to operator
	control board mounted axuiliary location normally accessible to operator
	behind of control board not normally accessible to operator
	behind of control board axuiliary location not normally accessible to operator

General instrument or function symbols

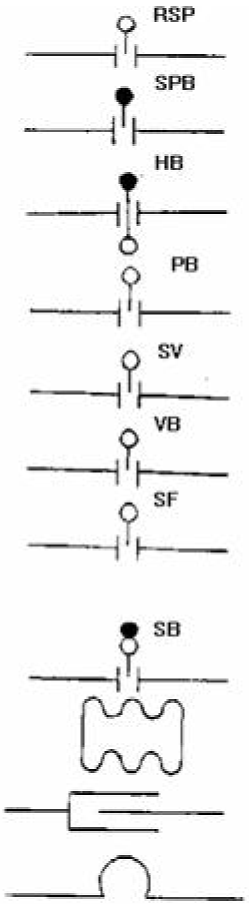
SYMBOL	DESCRIPTION
	field mounted instrument
	panel mounted instrument
	inrtrument mounted behind control panel incontrol room
	local panel mounted insrument
	instrument mounted behind local panel
	instrument sharing common housing with two function
	steam traced instrument
	electeric traced instrument
	light (color R=RED G=GREEN)
	valve position indicasting lamps



Concentric reducer	کاهنده متقارن
Eccentric reducer (flush bottom)	کاهنده نامتقارن
Eccentric reducer (flush top)	



spectacle blind (normally open)	صفحه عینکی
expansion bellow	
sleeve extension	
expansion loop	
steam trap with built-in strainer (thermostatic or thermodynamic type)	تله بخار با صافی
steam trap without built-in strainer (thermostatic or thermodynamic type)	تله بخار بدون صافی
steam trap with integral check valve (bucket type)	تله بخار با شیر یک طرفه



Ring spacer

Spade blind

Hammer blind

Pressure blind in welded line

Standard socket weld line blind union W/viton gaskets

6 mm thick blind to blank off equipment (vapor blind)

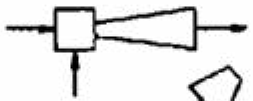
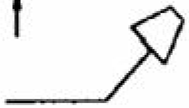
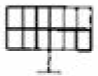
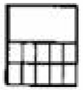
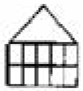
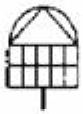
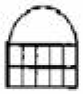
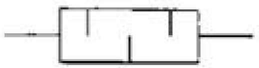
standard socket weld line blind union W/flexitallic gaskets

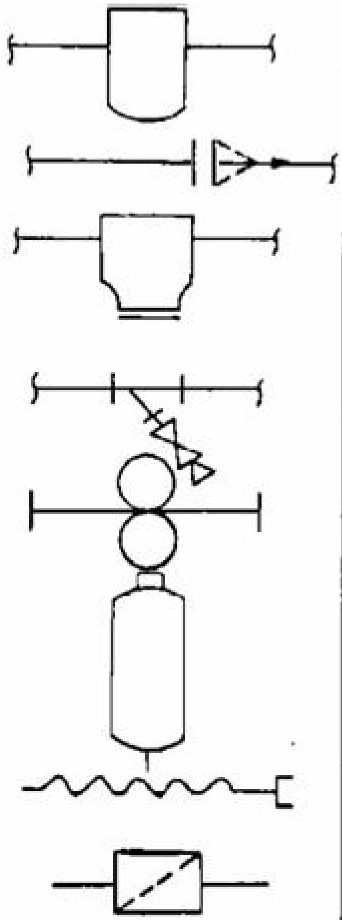
spectacle blind (normally open)

expansion bellow

sleeve extension

expansion loop

	Ejector
	Jet mixer
	Ring header
	Flame arrestor (general)
	Explosion-proof flame arrestor (explosion comes From the side of the rectangular)
	Detonation –proof flame arrestor
	Fire –resistant detonation –proof flame arrestor with Outlet to the atmosphere
	Fire_ resistance flame arrestor
	Silencer



Bucket (basket)type strainer

Temporary strainer (cone type)

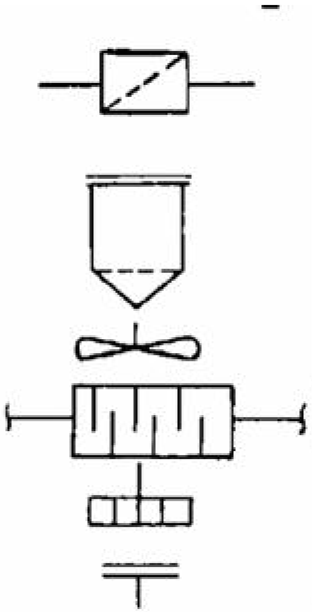
T-type strainer

Y- type strainer (with valved drain)

Duplex strainer

Pulsation dampener

Flexible hose with quick coupling



Flexible hose with quick coupling

Filter (general)

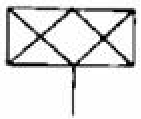
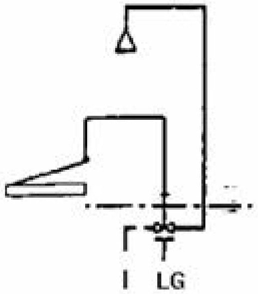
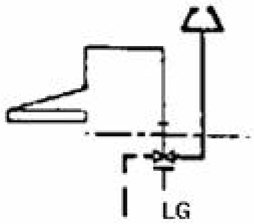
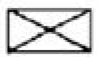
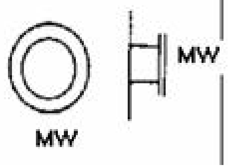
Cartridge type filter

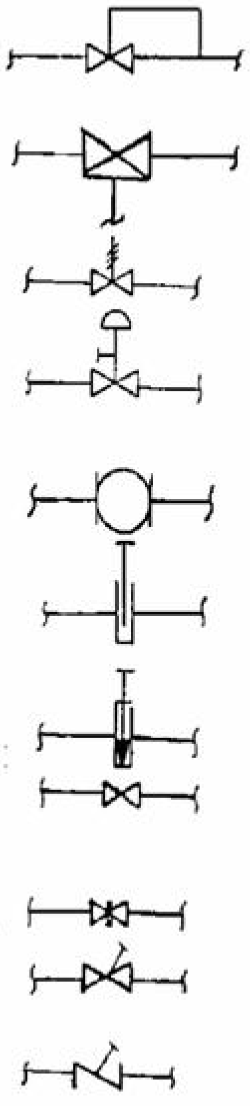
Propeller mixer

In –line mixer (static)

Turbine mixer

Nozzle (blinded off)

	Breather
	Emergency (safety) shower equipped with no freezing drain valve
	Eyewasher equiped with no freezing drain valve
	Vortexx breaker
	Manway



Self contained regulator

Treeway valve

Spring loading valve

Control valve with handweel

Rotary valve

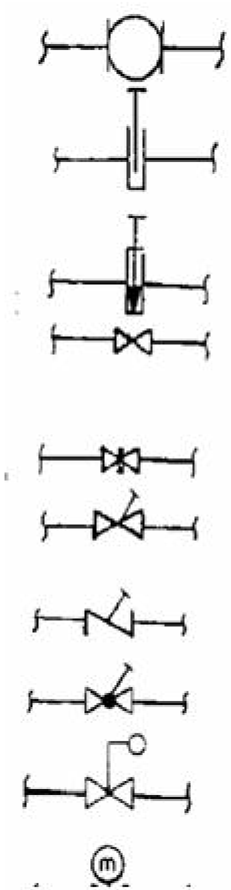
Slide valve

Knife valve

Post indicator valve

Piston valve

Y- type below down valve



Rotary valve

Slide valve

Knife valve

Post indicator valve

Piston valve

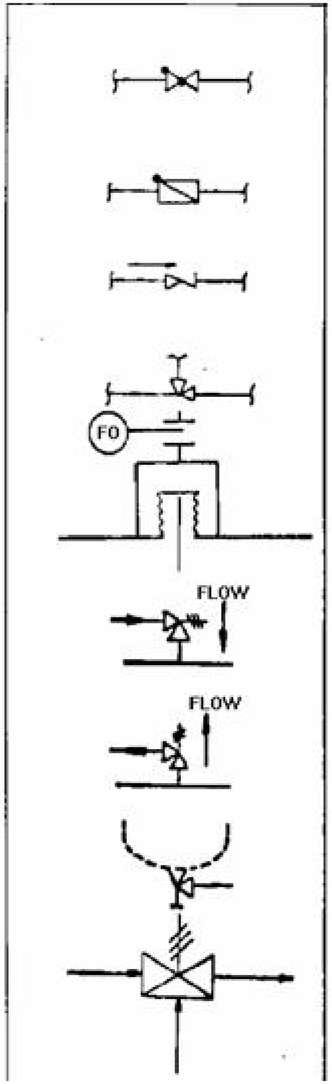
Y- type below down valve

Y-type stop check valve

Y-type globe valve

Float valve

Motor operated valve



Lift check valve

Swing check valve

Stop check

Stop check , non -return valve

Trip valve (low lube oil ppressure)

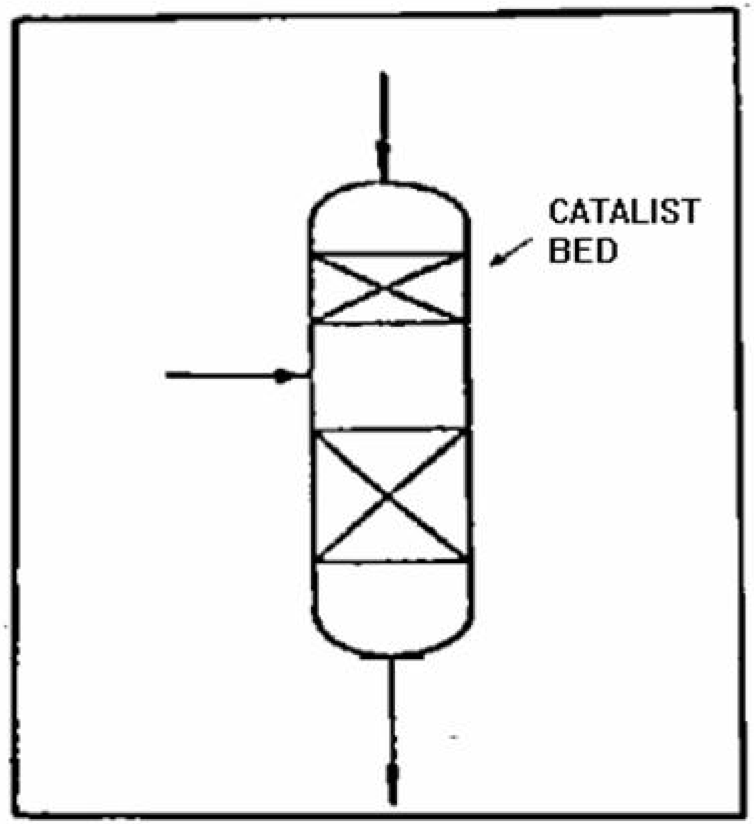
Relief valve (angle ,vaccum)

Relief valve (angle ,pressure)

Flush bottom valve

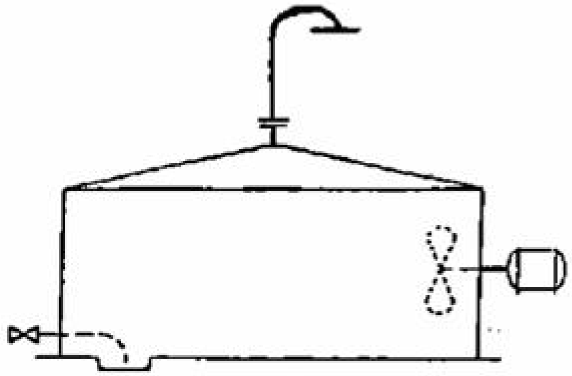
Pressure/ vacum valve

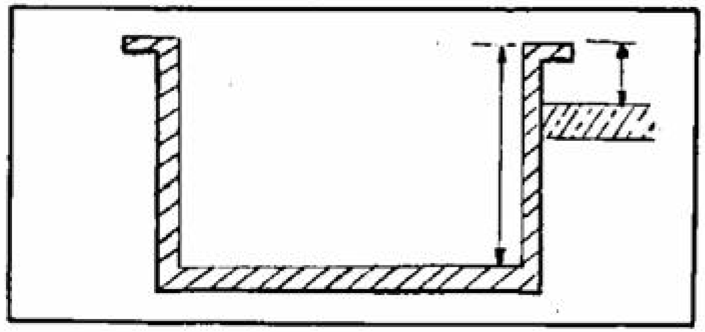
Foot valve with strainer



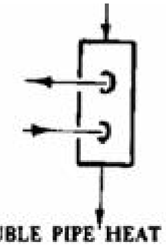
REACTOR

OPEN VENT WITH SCREEN

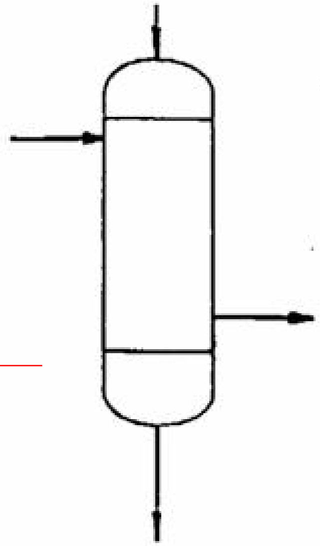




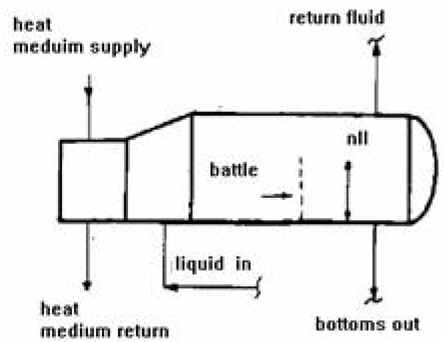
CONCRETE SUMP



DOUBLE PIPE HEAT EXCHANGER

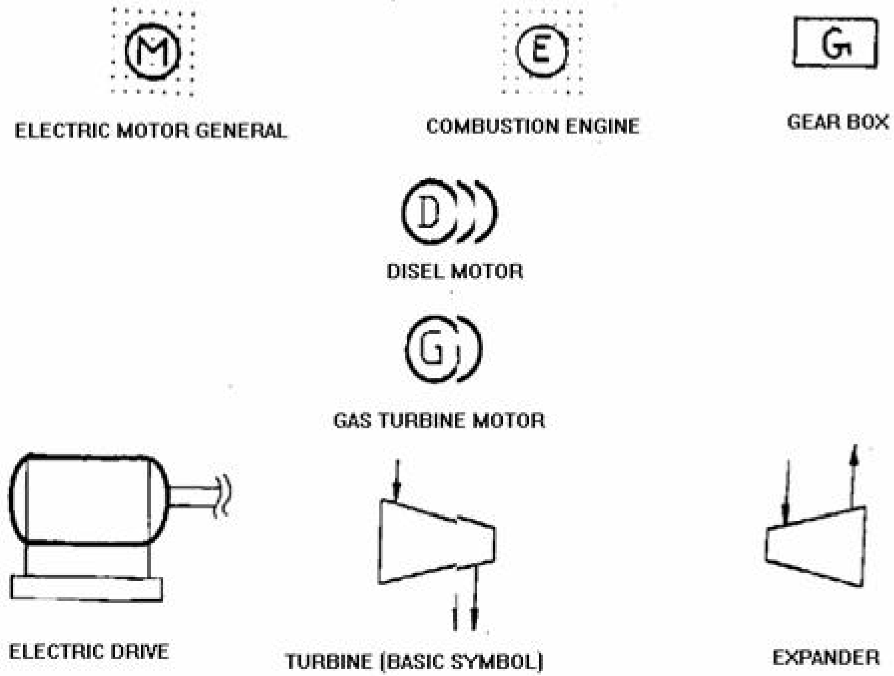


vertical shell _tube heat exchanger (general)

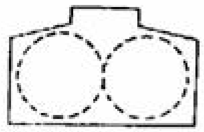


kettle type reboiler u tube type (general configuration)

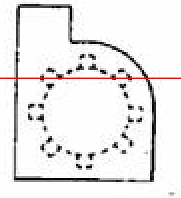
A.2.3.4.3 GENERAL SYMBOLS FOR DRIVERS



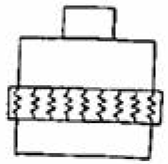
Crusher



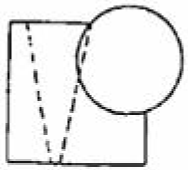
ROLL CRUSHER



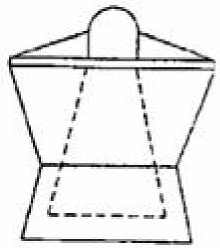
HAMMERMILL CRUSHER



CONE CRUSHER

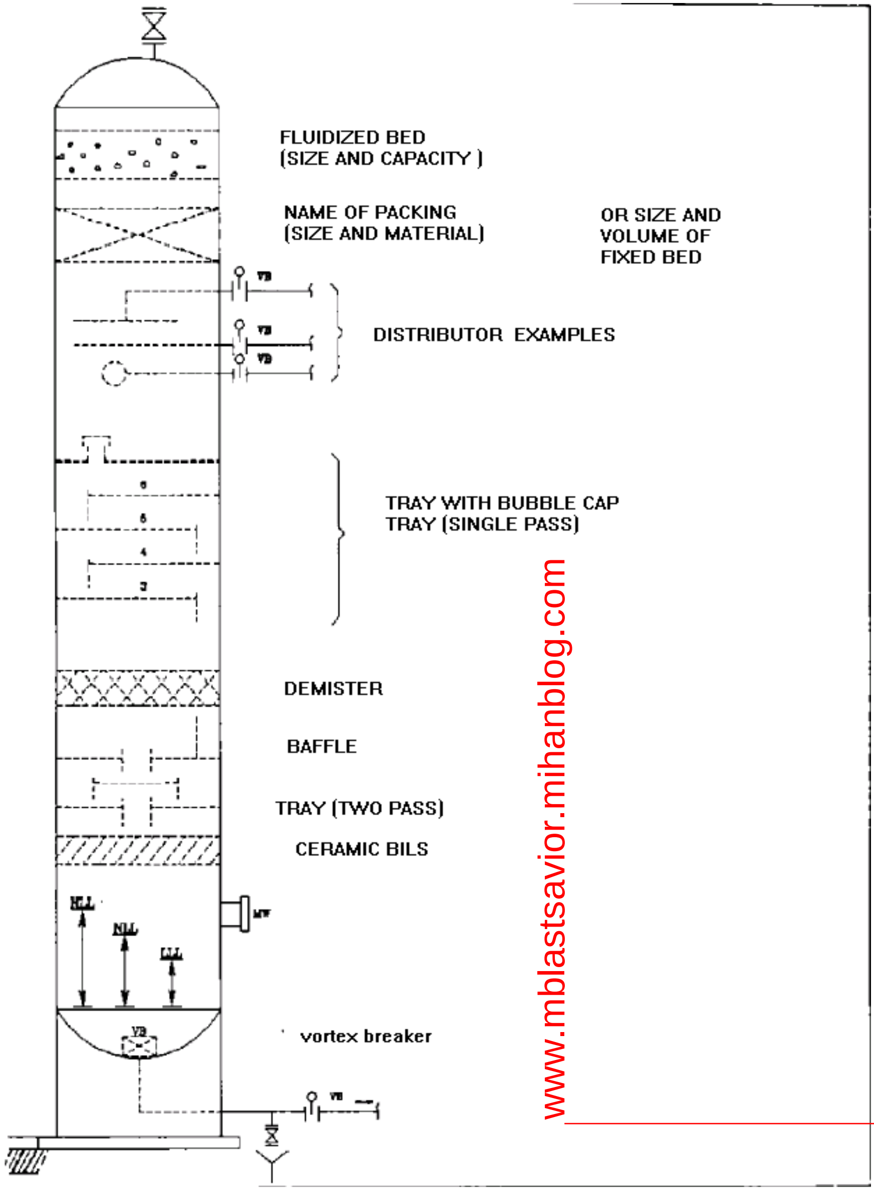


JAW CRUCHER

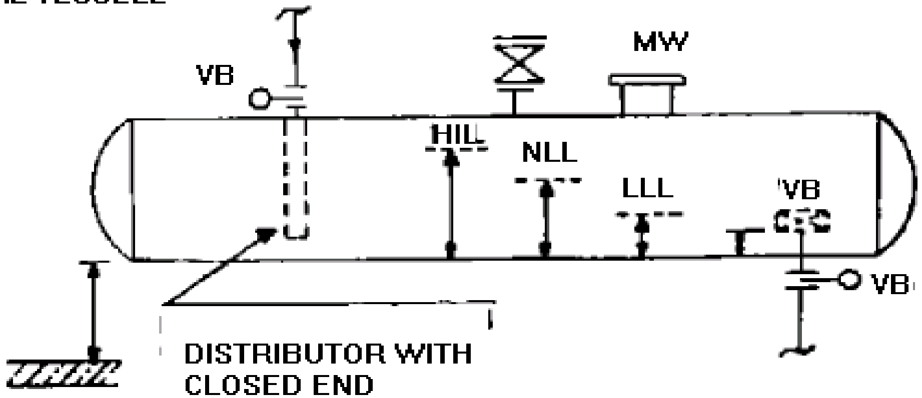


GYRATORY CRUSHER

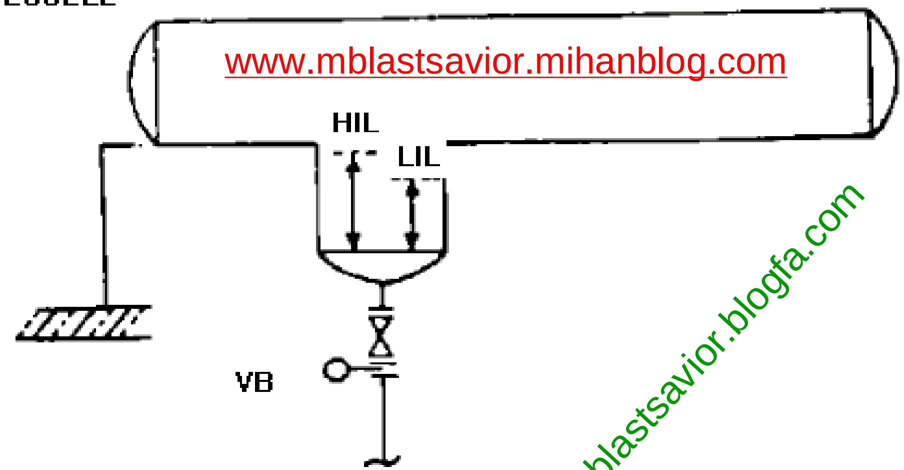
Equipment:Tower, column, vessel and reactor



A.2.3.1.2 HORIZONTAL VESSELE

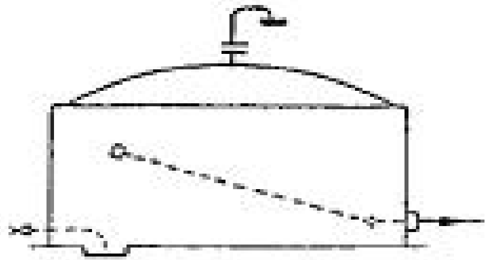


(A) HORIZONTAL VESSELE

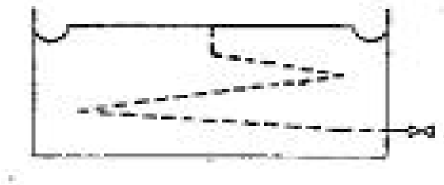


B) HORIZONTAL VESSELE WITH BOOT

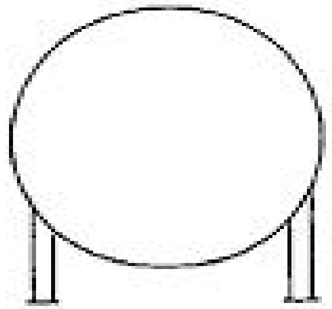
Note:
All tanks and spheres on each flow diagram are to be shown in Approximate relative size to each other



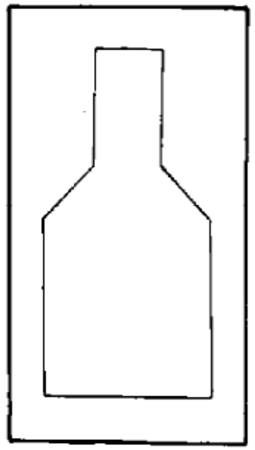
DOME ROOF
WITH SWING PIPE FLOAT TYPE



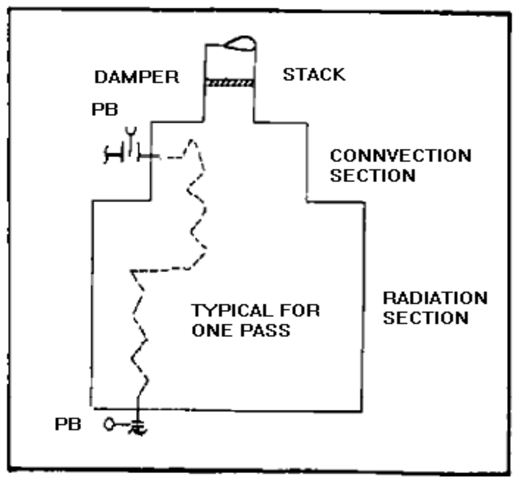
FLOATING ROOF



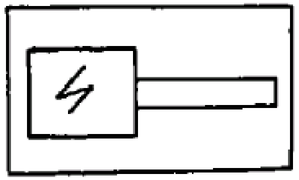
SPHERE



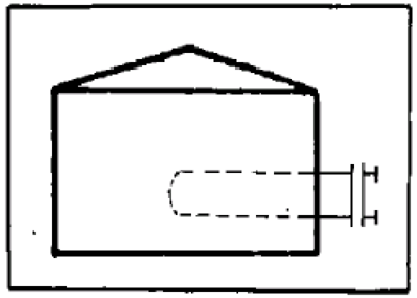
A) FURANCE (BASIC SYMBOL)



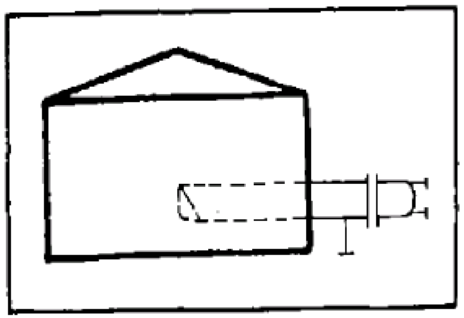
B) FIRED HEATER (BOX OR CYLINDERICAL TYPE) WITH COVECTION SECTION

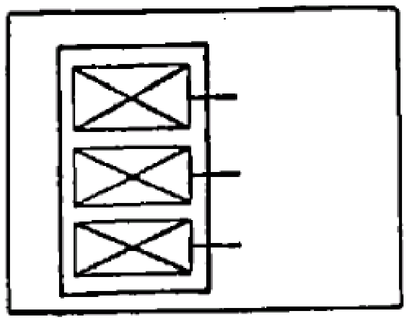


C) ELECTERICAL HEATER

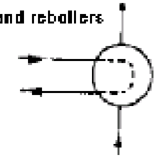


D) TANK HEATER

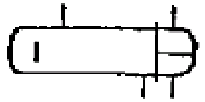
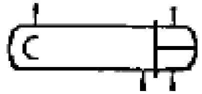
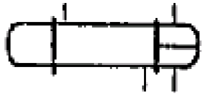
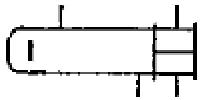
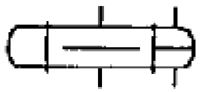
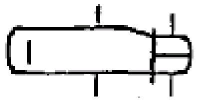
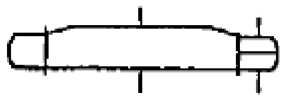




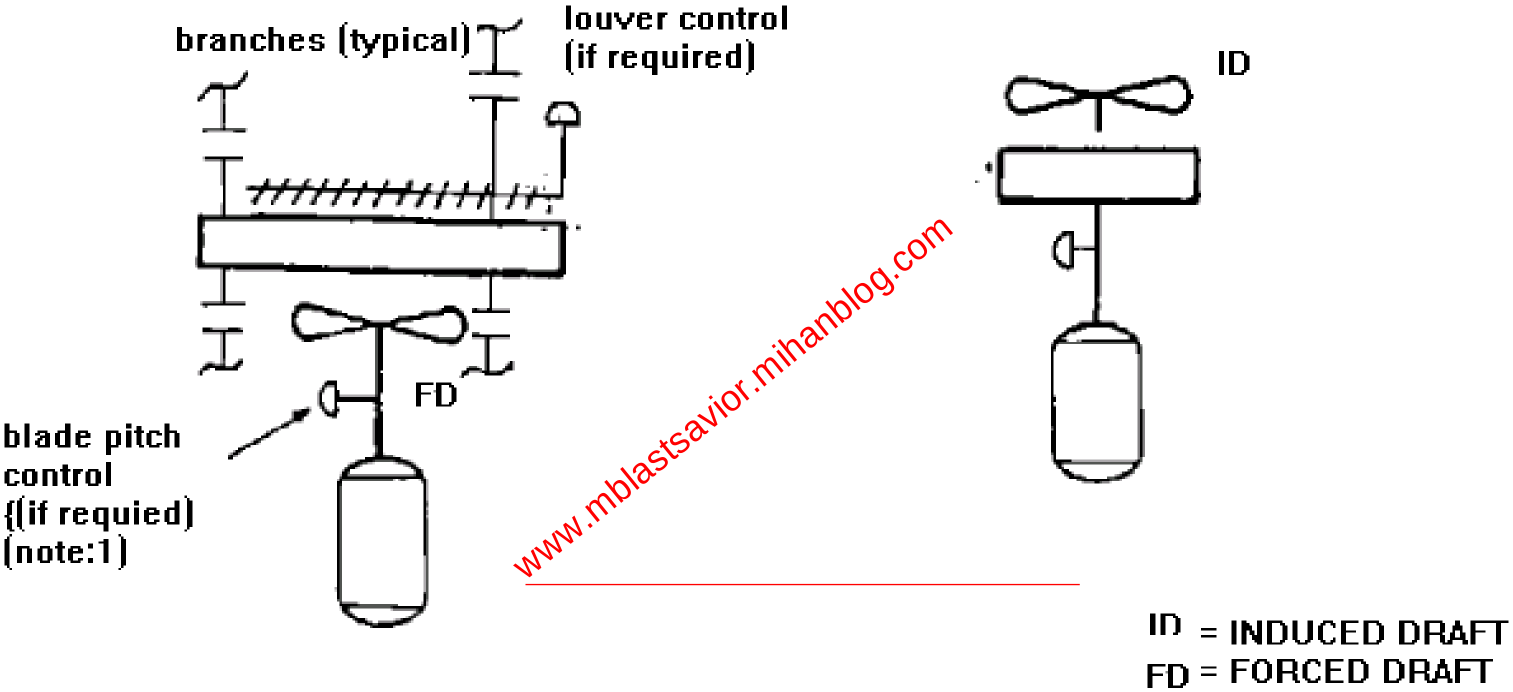
A.2.3.3.2 exchangers water coolers and reboilers



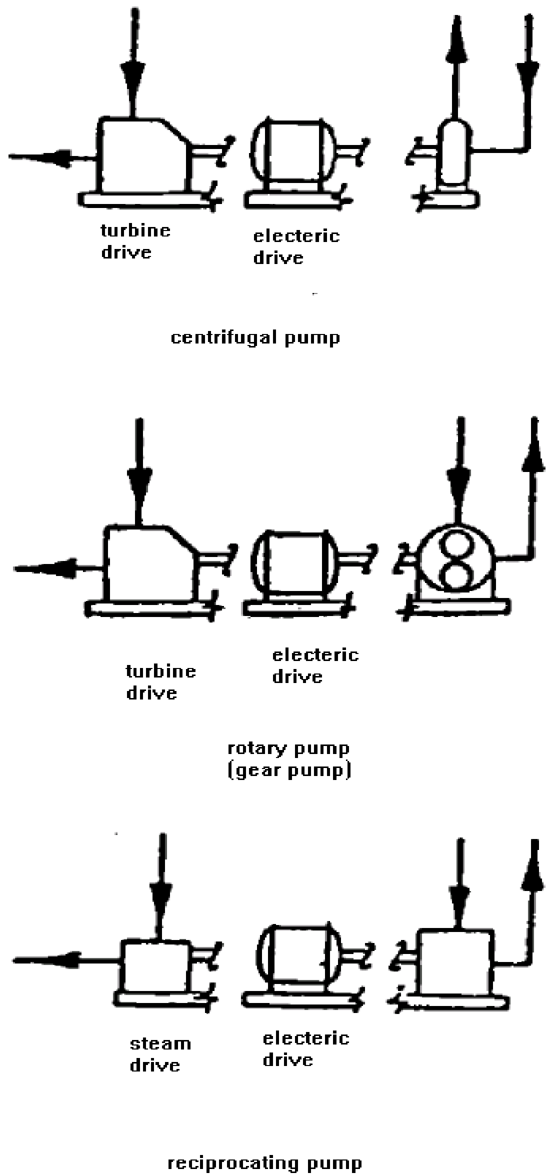
shell and tube heat exchanger(basic symbol)

	heat exchanger/cooler/condenser , with floating head
	heat exchanger/cooler/condenser u tube
	heat exchanger/cooler/condenser fixed tube sheet
	cooler/ condenser with floating head and cover plate
	horizontal reboiler fixed tube sheet
	kettle type rebloler u-tube
	kettle type vaporizer floating head
	kettle type vaporizer fixed tube sheet

Air coolers

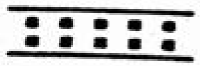
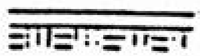

branches (typical)
louver control
(if required)
ID
FD
blade pitch
control
{(if requied)
(note:1)
ID = INDUCED DRAFT
FD = FORCED DRAFT

Pumps



turbine drive
electeric drive
centrifugal pump
turbine drive
electeric drive
rotary pump
(gear pump)
steam drive
electeric drive
reciprocating pump

Concrete/Birck/Soil

SYMBOL	DESCRIPTION
	Brickwork
	Concrete (reinforced)
	Refractory clay, Refractory bricks
	Soil

NOZZLES IDENTIFICATIONS ON VESSELS, REACTORS AND TOWERS

NOZZLE	IDENTIFICATION SYMBOL
A,A2	Inlets
B	Outlet
C	Condensate
D	Drain or Draw-off
E*	
F	Feed
G	Level gage or gage glass
H	Handhold
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 non of the other symbols apply. Do not use I, O, Q, U, X, Y, or Z.

اصطلاحات متفاوت با معانی یکسان در زبانهای انگلیسی و آمریکایی

Different words are used, in different countries, to describe the same job or piece of equipment. Some of the principal differences between the United States and the United Kingdom are listed here. Within each country, however, there are differences between companies.

Management Terms

Job	U.S.	UK
Operator of plant	Operator	Process worker
Operator in charge of others	Lead operator	Chargehand or Assistant foreman or Junior supervisor
Highest level normally reached by promotion from operator	Foreman	Foreman or Supervisor
First level of professional management (usually in charge of a single unit)	Supervisor	Plant manager
Second level of professional management	Superintendent	Section manager
Senior manager in charge of site containing many units	Plant manager	Works manager
Plant personnel	Craftsman or mechanic	Fitter, electrician, etc.

اصطلاحات متفاوت با معانی یکسان در زبانهای انگلیسی و آمریکایی

The different meanings of the terms *supervisor* and *plant manager* in the U.S. and UK should be noted.

In this book I have used the term *foreman* as it is understood in both countries, though its use in the UK is becoming outdated. *Manager* is used to describe any professionally qualified person in charge of a unit or group of units. That is, it includes people who, in many U.S. companies, would be described as supervisors or superintendents.

Certain items of plant equipment have different names in the two countries. Some common examples are:

اصطلاحات متفاوت با معانی یکسان در زبانهای انگلیسی و آمریکایی

Chemical Engineering Terms

U.S.	UK
Accumulator	Reflux drum
Agitator	Mixer or stirrer
Air masks	Breathing apparatus (BA)
Blind	Slip-plate
Carrier	Refrigeration plant
Cascading effects	Knock-on (or domino effects)
Check valve	Nonreturn valve
Clogged (of filter)	Blinded
Consensus standard	Code of practice
Conservation vent	Pressure/vacuum valve
Dike, berm	Bund
Discharge valve	Delivery valve
Division (in electrical area classification)	Zone
Downspout	Downcomer
Expansion joint	Bellows
Explosion proof	Flameproof
Faucet	Tap
Fiberglass-reinforced plastic (FRP)	Glass-reinforced plastic (GRP)
Figure-8 plate	Spectacle plate
Flame arrestor	Flame trap
Flashlight	Torch
Fractionation	Distillation
Gasoline	Petrol
Gauging (of tanks)	Dipping
Generator	Dynamo or alternator
Ground	Earth
Horizontal cylindrical tank	Bullet
Hydro (Canada)	Electricity
Install	Fit
Insulation	Lagging
Interlock*	Trip*
Inventory	Stock
Lift-truck	Forklift truck
Loading rack	Gantry

اصطلاحات متفاوت با معانی یکسان در زبانهای انگلیسی و آمریکایی

U.S.	UK
Manway	Manhole
Mill water	Cooling water
Nozzle	Branch
OSHA (Occupational Safety and Health Administration)	Health and Safety Executive
Pedestal, pier	Plinth
Pipe diameter (internal)	Pipe bore
Pipe rack	Pipebridge
Plugged	Choked
Rent	Hire
Rupture disc or frangible	Bursting disc
Scrutinize	Vet
Seized (of a valve)	Stuck shut
Shutdown	Permanent shutdown
Sieve tray	Perforated plate
Siphon tube	Dip tube
Spade	Slip-plate
Sparger or sparge pump	Spray nozzle
Spigot	Tap
Spool piece	Bobbin piece
Stack	Chimney
Stator	Armature
Tank car	Rail tanker or rail tank wagon
Tank truck	Road tanker or road tank wagon
Torch	Cutting or welding torch
Tower	Column
Tow motor	Forklift truck
Tray	Plate
Turnaround	Shutdown
Utility hole	Manhole
Water seal	Lute
Wrench	Spanner
C-wrench	Adjustable spanner
Written note	Chit

اصطلاحات متفاوت با معانی یکسان در زبانهای انگلیسی و آمریکایی

$M	Thousand dollars
$MM	$M or million dollars
STP	60°F, 1 atmosphere
32°F, 1 atmosphere	STP
NTP	32°F, 1 atmosphere

**In the UK,* interlock *is used to describe a device that prevents someone opening one valve while another is open (or closed).* Trip *describes an automatic device that closes (or opens) a valve when a temperature, pressure, flow, etc., reaches a preset value.*

Fire-Fighting Terms

U.S.	UK
Dry chemical	Dry powder
Dry powder	Dry powder for metal fires
Egress	Escape
Evolutions	Drills
Excelsior (for fire tests)	Wood wool
Fire classification:	
Class A: Solids	Class A: Solids
Class B: Liquids and gases	Class B: Liquids
Class C: Electrical	Class C: Gases
Class D: Metals	Class D: Metals
Fire stream	Jet
Nozzle	Branchpipe
Standpipe	Dry riser
Tip	Nozzle
Wye connection	Dividing breeching

Numbering System

بر مبنای IPS

شماره گذاری مدارک ،ابزار دقیق، جریانها و تجهیزات

instrumentation identifications

equipment abbreviations (codes)

fluid abbreviations

painting, insulation and heat tracing designations.

SCOPE

numbering for instrument and electrical equipment, piping line and engineering documents such as specifications, purchase orders, and other facilities.

REFERENCES

ISA (INSTRUMENT SOCIETY OF AMERICA)

S 5.1-1984. "Instrumentations Symbol and Identification Formerly", Ed. 1989

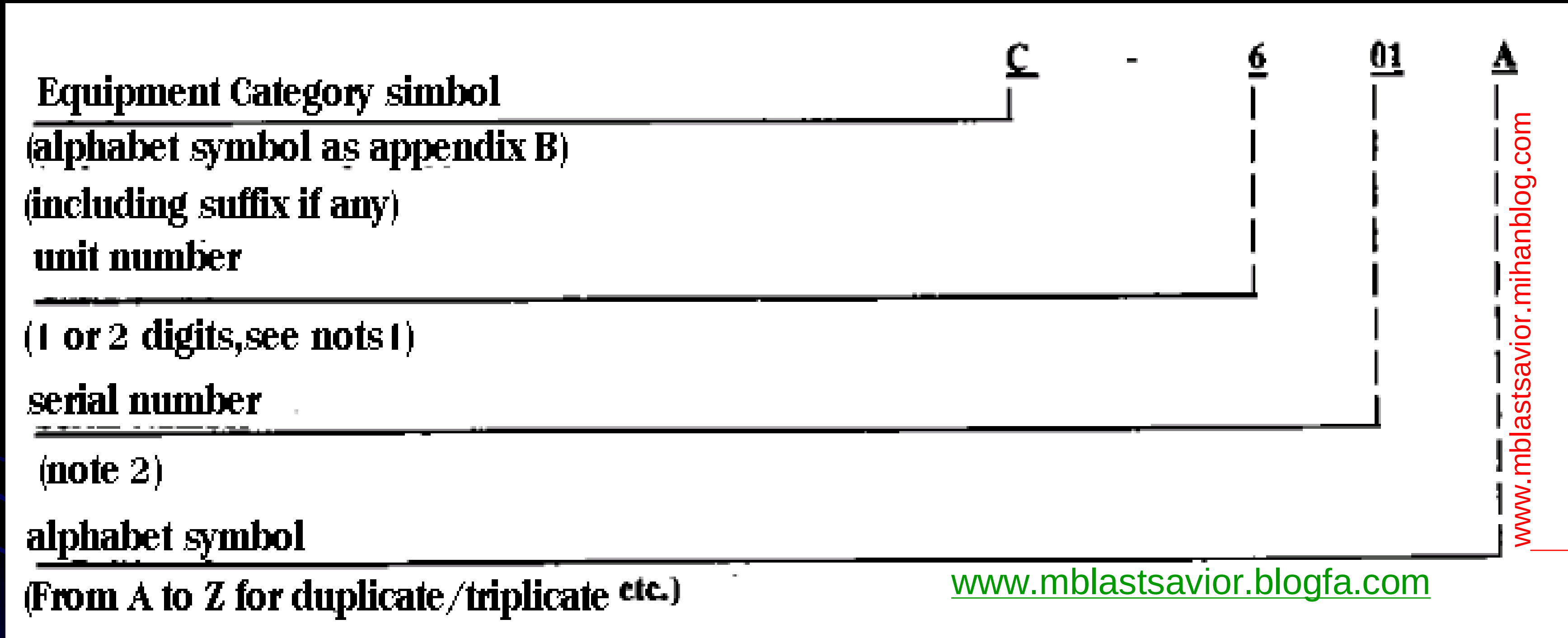
ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

6708-1995 (E) "Pipe Components Definition and Selection of Nominal Size", 2nd. Ed., 1995.

EQUIPMENT NUMBERING SYSTEM

شماره گذاری تجهیزات

Main Equipment & Package Unit



Notes:

1) Unit number for the equipment shall start from 1 (not from 01). For a typical refinery units see Appendix A.

2) Serial number for equipment including mechanical, machinery, electrical, ancillary facilities, buildings, general items, etc., shall be from 01 to 99 unless otherwise specified. The numbering of instruments and control equipment should be from 001 to 999. For the units with more than one section (e.g., crude and vacuum distillation unit, etc.), equipment serial number to be utilized for each section shall be determined by the Contractor (e.g., from 01 t0 50 and from 50 to 99 to crude distillation and vacuum distillation sections respectively).

APPENDIX B EQUIPMENT CATEGORY SYMBOL

AGITATOR	AG
AIR CONDITIONER	AC
BLENDER	BR
COMPRESSOR	C
CONTINUOUS MIXER, PLASTICS	CM
CONTROL PANEL	CPL
CONVEYOR, MECHANICAL OR PNEUMATIC	CV
COOLING TOWER	CT
CRANE	CN
CRUSHER	CR
CRYSTALLIZER	CS
CUTTER	CU
CYCLONE AND HYDROCLONE	CY
DESALTER	DE
EVAPORATOR	EV
EXCHANGER, SHELL-AND TUBE, DOUBLE PIPE, PLATE, COILS, AIR COOLED, REBOILER, BOX COOLER, CASCADE COOLER, SURFACE CONDENSER	E
EXTRUDER	EX

APPENDIX B EQUIPMENT CATEGORY SYMBOL

FAN	FA
FILTER	F
FLARE STACK	FST
HEATER, FIRED	H
LOADING ARM	LA
MILL	MI
PUMP	P
REACTOR	R
SAMPLER	SA
SEPARATOR, ATMOSPHERIC	SE
SPECIALITY MOBILE EQUIPMENT, (FIRE TRUCK, SNOW REMOVAL)	SM
STACK, CHIMNEY	S
STEAM TRAP	STP
STRAINER	STR
SUMP	SU
TANK; API, SILO, HOPPER	TK
VALVE, SLIDE (SEE GATE, SLIDE)	SG
VALVE, ROTARY	RV
VALVE, MOTORIZED	MOV
VESSEL, PRESSURE (COLUMN, ACCUMULATOR, K.O. DRUM SPHERE, BULLET)	V

Appendix A
UNIT IDENTIFICATION NUMBER

for a typical refinery

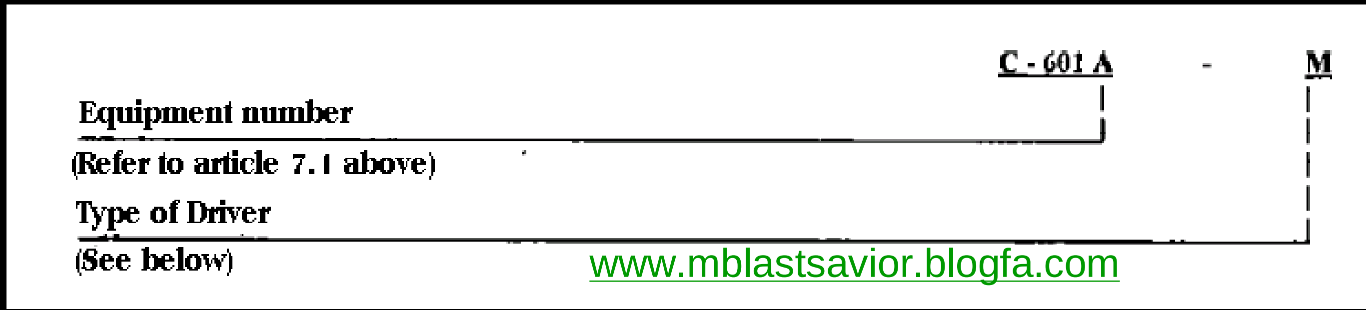
UNIT No.		ABBREVIATION		UNIT NAME AND DESCRIPTION
00		COMMON		Common (Subject related to all units)
01		CDU/VDU		Crude and Vacuum Distillation Unit (including Atmospheric and Vacuum Distillation, Desalter and Gasoline Stabilizer and Splitter Sections)
02		NHT/CCR		Heavy Naphtha Hydrotreater and Continuous Catalyst Regeneration Platformer Unit
03		VBU		Visbreaker Unit (Visbreaker including Tempered Water System)
05		LPG/CAU		LPG Recovery and Caustic Dissolving Unit
06		HCU		Hydrocracker Unit (HC-Unibon)
07		HPU		Hydrogen Production Unit
08		AMN/SWS		Amine Treating and Sour Water Stripper Unit
09		SRU/SSU		Sulphur Recovery and Sulphur Solidification Unit
10		ABU		Asphalt Blowing Unit
11		NIT		Nitrogen Unit
20		OFF-SITE		Offsite Unit (including Tankage, Blending and Product

APPENDIX A (continued)

26		WWT		Waste Water Treatment Unit (including Waste Water Treatment, Evaporation Pond, Sewage Treatment and Disposal)
30		LPG/LOAD		LPG Tankage and Loading Unit
40		ANCILLARY		Ancillary Facilities (including all Ancillary Refinery Building, Civil Works and all general items)
45		INTERCONN		Interconnections

Drivers for Main Equipment

Drivers for main equipment shall be numbered as follows:



Note:

Type of drivers shall be as follows:

DE : Diesel Engine

GE : Gas Engine

GT : Gas Turbine

HT : Hydraulic Turbine

M : Electric Motor

ST : Steam Turbine

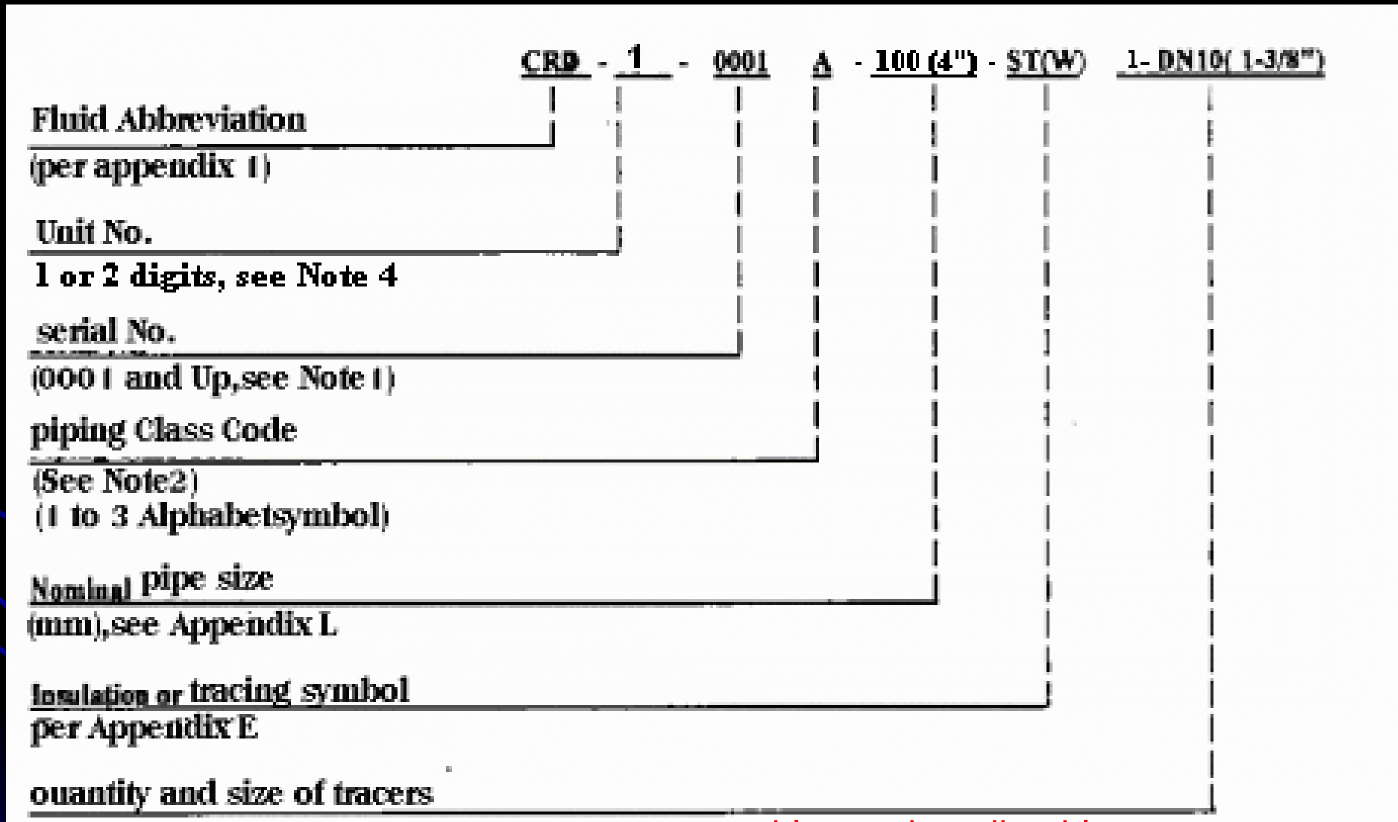
TEX: Turbo Expander.

PIPING LINE NUMBERING SYSTEM

شماره گذاری جریانها

Piping lines shall be numbered in the following manner:

Numbering of All Lines Excluding Steam Tracing Spools



Notes:

1) Piping serial number, in general is started from 0001 and Up except for the units which are characterized by more than one section such as crude and vacuum distillation unit. In such cases, split of piping serial numbers to be assigned for each section of the unit shall be determined by the Contractor.

Special number 7001 : 9999 shall be used for all drains, relief headers and utility services including fuel oil and fuel gas for all units except for the units which are producing the subject utility services.

For assigning the piping serial number, the following items should be taken into consideration:

a) The individual line number shall be held up to the point where the line ends at the inlet of equipment such as a vessel, exchanger, pump, etc., an other number is required for the line downstream of the equipment.

b) All utility headers (systems) shall be numbered with their respective units. All branches serving a specific unit will be numbered with that unit.

f) All firewater and sewer branches serving a specific unit shall be numbered.

2) Piping class code shall be in accordance with the line classes utilized in project piping material specification.

3) Piping components not identified by instrument or mechanical equipment numbers, etc., and not covered by the piping material specification, are identified by a special item number.

4) Unit number of the plant shall start from 1 (not from 01). For a typical refinery units see Appendix A.

Steam Tracing Spools

For steam tracing numbering and material take off, the contractor can use his own system.

APPENDIX I
FLUID ABBREVIATION SYMBOLS

حروف اختصاری جریانهای مختلف

a) Air Systems

ISA	Instrument Air
PLA	Plant Air

b) Blowdown and Pump Out Systems

BDN	Blowdown
CBD	Continuous Blowdown
IBD	Intermittent Blowdown

c) Condensate Systems

COC	Cold Condensate
HPC	High Pressure Condensate
LPC	Low Pressure Condensate
MPC	Medium Pressure Condensate

d) Drain (Sewer) Systems

CDH	Closed Drain Header
CSW	Chemical Sewer
NSW	Non Oily Sewer
OSW	Oily Sewer
SSW	Sanitary Sewer

e) Flare Systems

FL	Flare (Normal)
HFL	High Pressure Flare
LFL	Low Pressure Flare

f) Fuels

FLG	Fuel Gas
FLO	Fuel Oil
NG	Natural Gas
RFO	Refinery Fuel Oil

APPENDIX I
FLUID ABBREVIATION SYMBOLS

حروف اختصاری جریانهای مختلف

g) Special Gas Systems

ACG	Acid Gas
AIR	Air (Drying Service)
CHL	Chlorine
HEL	Helium
HYD	Hydrogen
NIT	Nitrogen
NOX	Nitrous Oxide
OXY	Oxygen
UTA	Utility Air

h) Special Chemical and Solvent Systems

AMN	Amine
AMO	Ammonia
CAU	Caustic Soda
CHM	Chemicals
DEA	di-Ethanol Amine
DGA	di-Glycole Amine
FS	Flushing Solvent
MEA	mono-Ethanol Amine
MEK	Methyl Ethyl Ketone
TOL	Toluene

APPENDIX I
FLUID ABBREVIATION SYMBOLS

حروف اختصاری جریانهای مختلف

i) Oil Utility Systems

INO	Injection Oil
LBO	Lubricating Oil
SLO	Seal Oil

j) Steam systems

DKS	Decoking Steam
DLS	Dilution Steam
HOR	Hot Oil Return
HOS	Hot Oil Supply
HPS	High Pressure Steam
LLS	Low Low Pressure Steam
LPS	Low Pressure Steam
MPS	Medium Pressure Steam

l) Water Systems

BFW	Boiler Feed Water
CLW	Chlorinated Water
CWR	Cooling Water Return
CWS	Cooling Water Supply
DIW	Distilled Water
HWS	Hot Water Supply
HWR	Hot Water Return
TWR	Tempered Water Return
TWS	Tempered Water Supply
DMW	Demineralized Water
DWA	Drinking Water
FWA	Fire Water
HBW	High Pressure Boiler Feed Water
HCW	Hot and Chilled Water
MBW	Medium Pressure Boiler Feed Water
PHW	Phenol Water
PRW	Process Water
PWA	Plant Water
PTW	Potable Water
QHW	Quench Water
RWA	Raw Water
SWA	Sour Water
TWA	Treated Water
WAT	Water

Appendix I:Process Services

حروف اختصاری جریانهای مختلف فرآیندی

ACE	Acetylene
ALC	Alchohol
ASP	Asphalt
BZN	Benzene
BUT	Butane
CAT	Catalyst
CRD	Crude
CRG	Cracked Gas
ETA	Ethane
ETN	Ethylene
FOP	Fuel Oil Product
GAS	Gas
GHS	Natural Gas with Hydrogen and Steam
GSL	Gasoline بنزین
GSO	Gas oil نفت گاز
HRG	Hydrogen Rich Gas
HCB	Hydrocarbon
HCH	Hydrocarbon with Hydrogen
HSR	Heavy Straight Run Naphtha
HNA	Heavy Naphtha
JP4	Jet Fuel (JP-4)
JTA	Jet A-1
KER	Kerosene
NGH	Natural Gas with Hydrogen

Appendix I:Process Services

LNA	Light Naphtha
LPG	Liquefied Petroleum Gas
MEL	Methanol
MET	Methane
NAP	Naphtha
PNT	Pentane
PRP	Propane
PPN	Propylene
PRA	Process Air
PRO	Process Fluid
RAF	Raffinate
REG	Recycle Gas
RES	Residue
SLG	Sludge لجن غلیظ رسوب مخازن سوخت
SLP	Slop لجن
SUL	Sulfur

APPENDIX L
DEFINITION OF NOMINAL SIZE

1) Definition

Nominal size (DN): A numerical designation of size which is common to all components in a piping system other than components designed by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions.

Notes:

1) It is designated by DN followed by a number.

2) It should be noted that not all piping components are designated by nominal size, for example steel tubes are designated and ordered by outside diameter and thickness.

3) The nominal size DN cannot be subject to measurement and shall not be used for purposes of calculation.

جدول معادل سازی اندازه

TABLE G.1- PIPE COMPONENT-NOMINAL SIZE (METRIC- IMPERIAL)

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

1) Diameter Nominal, mm.
2) Nominal pipe Size. Inch.

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جدول معادل سازی فشار

IMPERIAL-METRIC		IMPERIAL	METRIC
PRESSURE CLASSES		PRESSURE CLASSES	PN DESIGNATION
150	20	25	2.5
300	50	125	6
400	68	250	10
600	100	800 (1)	16
900	150	800 (2)	25
1500	250		
2500	420		
4500	760		

Equivalent pressure ratings designations.

Rating designations which have not exact equivalents

APPENDIX E
PAINTING, INSULATION AND HEAT TRACING DESIGNATION
INSULATION OR HEAT

TRACING TYPE	SERVICE
ET	Electrical Traced and Insulated
ETT	Electrical Traced With Heat Transfer Cement and insulated
IS	Insulation for Personnel Protection
SJ	Steam Jacketed and Insulated
ST	Steam Traced and Insulated
STS	Steam Traced With Spacers and Insulated
STT	Steam Traced with Heat Transfer Cement and Insulated
TB	Trace Body and Insulate
PT	Painting
NP	NO Painting, No Insulation
UW	Underground Wrapping

Numbering for Structure

Structure and pipe rack shall be numbered in the following manner:

Notes:

1) Structure Identification

AT = Antenna Tower

CPS = Concrete Pipe Sleeper

MP = Miscellaneous Platform

PS = Pipe Support

SL = Stiles نردبان

SS = Steel Structure

- **2) Structure numbering shall be South to North and West to East.**

Drawing title block

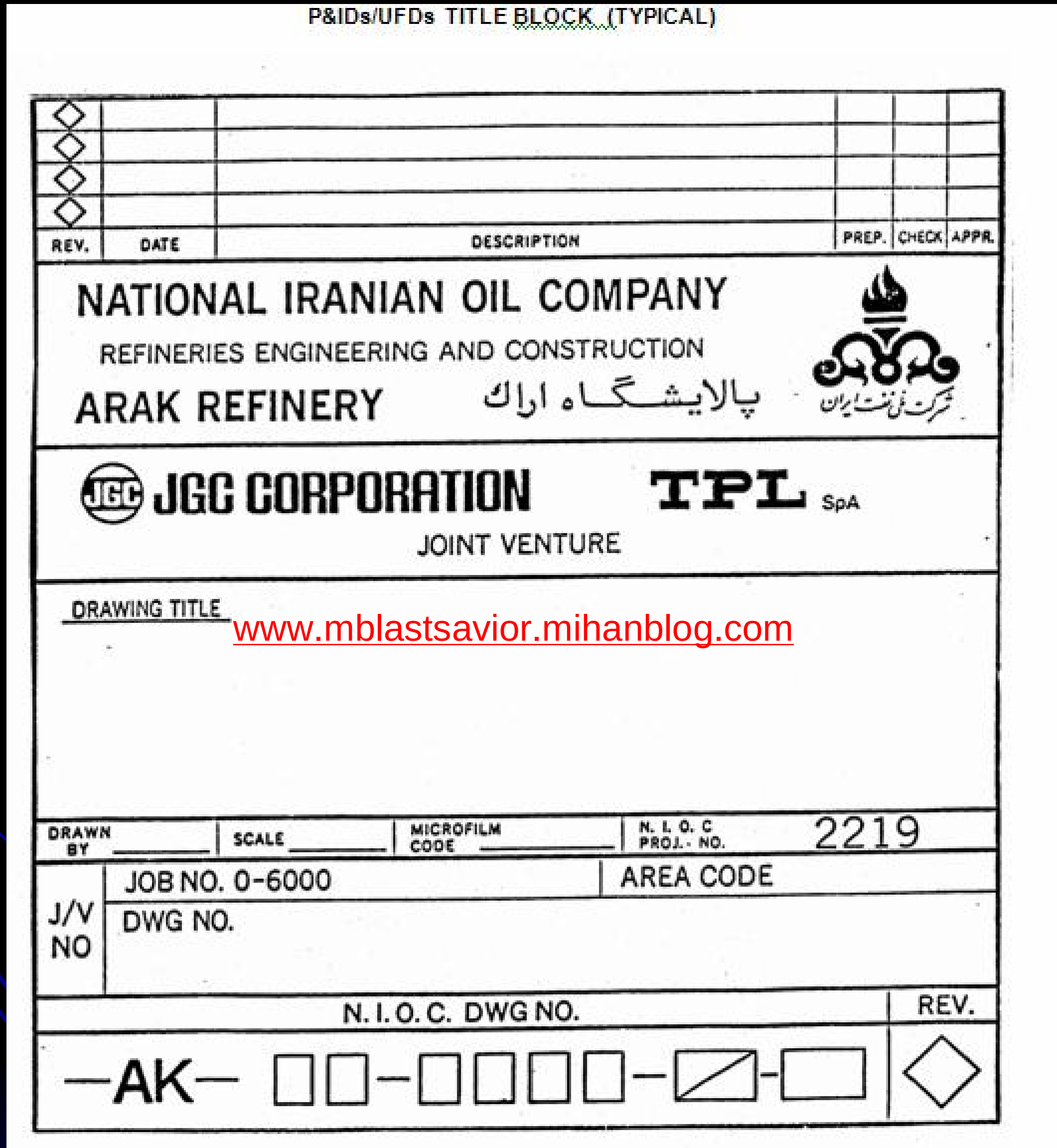
The following requirements shall be shown on the title block of each drawing (see Appendix B):

- revision table;
- main Company's name (e.g., National Iranian Oil Company);
- name of Company Relevant Organization, (if any), (e.g., Refineries Engineering and Construction);
- name of refinery or plant (**in English and Persian words**);
- Company's emblem;
- Contractor's name;
- drawing title;
- Company's project No.;
- Contractor's job No. (**optional**);
- Contractor's drawing No. (**optional**);
- Company's drawing No.

Title block sizes and drawing dimensions shall be as follows:

DRAWING DIMENSIONS (mm × mm)	TITLE BLOCK SIZE (INCLUDING REVISION TABLE) WIDTH (mm) × LENGTH (mm)
A0 = 841 × 1189	180 × 190
A1 = 594 × 841	130 × 175
A2 = 420 × 594	100 × 155
A3 = 297 × 420	75 × 120

یک مثال


P&IDs/UFDs TITLE BLOCK (TYPICAL)

REV.	DATE	DESCRIPTION	PREP.	CHECK	APPR.

NATIONAL IRANIAN OIL COMPANY

REFINERIES ENGINEERING AND CONSTRUCTION

ARAK REFINERY پالایشـــگـــاه اراك

شرکت ملی نفت ایران

JGC CORPORATION TPL SpA

JOINT VENTURE

DRAWING TITLE www.mblastsavior.mihanblog.com

DRAWN BY ____ SCALE ____ MICROFILM CODE ____ N. I. O. C PROJ.- NO. 2219

J/V NO JOB NO. 0-6000 AREA CODE

DWG NO.

N. I. O. C. DWG NO. REV.

—AK— □□–□□□□–□–□

Line widths
ضخامت خطوط برای جریانهای مختلف

To obtain a clear representation, different line widths shall be used. Main flow lines or main piping shall be highlighted.

The following line widths shall be applied:

- 0.8 mm for main process lines;
- 0.5 mm for other process lines; utility lines, and underground lines;
- 0.5 mm for graphical symbols for equipment and machinery, except valves and fittings and piping accessories;
- 0.5 mm for rectangular boxes for illustrating Unit operations, process equipment, etc.;
- 0.5 mm for subsidiary flow lines or subsidiary product lines and for energy carrier lines and auxiliary system lines;
- 0.4 mm for class changes designation;
- 0.3 mm for graphical symbols for valves and fittings and piping accessories and for symbols for process measurement and control functions, control and data transmission lines;
- 0.3 mm for all electrical, computer and instrument signals;
- 0.3 mm for reference lines;

Line widths of less than 0.3 mm shall not be used.

Drawings Title block size

Drawing sizes to be used are:

Size Designation		Drawing Dimensions (mm x mm)		Title Block Size (mm x mm)
A4		210 × 297		
A3		297 × 420		75 × 120
AG		297 × 630		
AF		297 × 840		
A2		420 × 594		100 × 155
A1		594 × 841		130 × 175
A0		841 × 1189		180 × 190

Note:
The final (As Built) isometric drawings shall include the material take off table and should be in A3 size.

Drawing Scales

Drawings scales shall be any of the following:

1: 10

1 : 20

1: 25

1 : 33-1/3

1 : 50

1 : 100

1 : 250

1 : 500

1 : 1000

1 : 2500 (Overall Plot Plan Only)

NUMBERING OF PROJECT SPECIFICATIONS AND DATA SHEETS
اختصارات حروف انواع مختلف مدارك

SP	- Specification
DW	- Drawings
PC	- Performance Curves
FS	- Fabrication Schedule
DS	- Data Sheets
PR	- Procedures
CE	- Certificates
WS	- Welding Specification
IR	- Inspection Record
CA	- Calculations
MU	- Manuals
OT	- Others

Engineering Disciplines Coding

اختصارات حروف دیسیپلینهای مختلف

AC	Heating, Ventilation, Air conditioning & Refrigeration Engineering
CI	Civil Engineering (General) including Architectural
EL	Electrical Engineering
GM	General Machineries
GN	General
HM and/or	Heat and Mass Transfer Engineering (Thermal Equipment Engineering)
IN	Instrumentation Engineering
ME	Fixed Mechanical Equipment Engineering (Non Rotating Equipment Engineering)
PI	Piping Engineering (General Mechanical and Interconnection Engineering)
PR	Process and Chemicals Engineering
PV	Pressure Vessel Engineering (Generally, Vessels Engineering)
RE and/or (PM)	Rotating Equipment and/or (Process Machineries) Engineering
SF	Safety, Fire Fighting & Environmental Control Engineering
ST	Structural Engineering
TC	Telecommunication Engineering
TP	Technical Protection Engineering

Commodity Account No.:

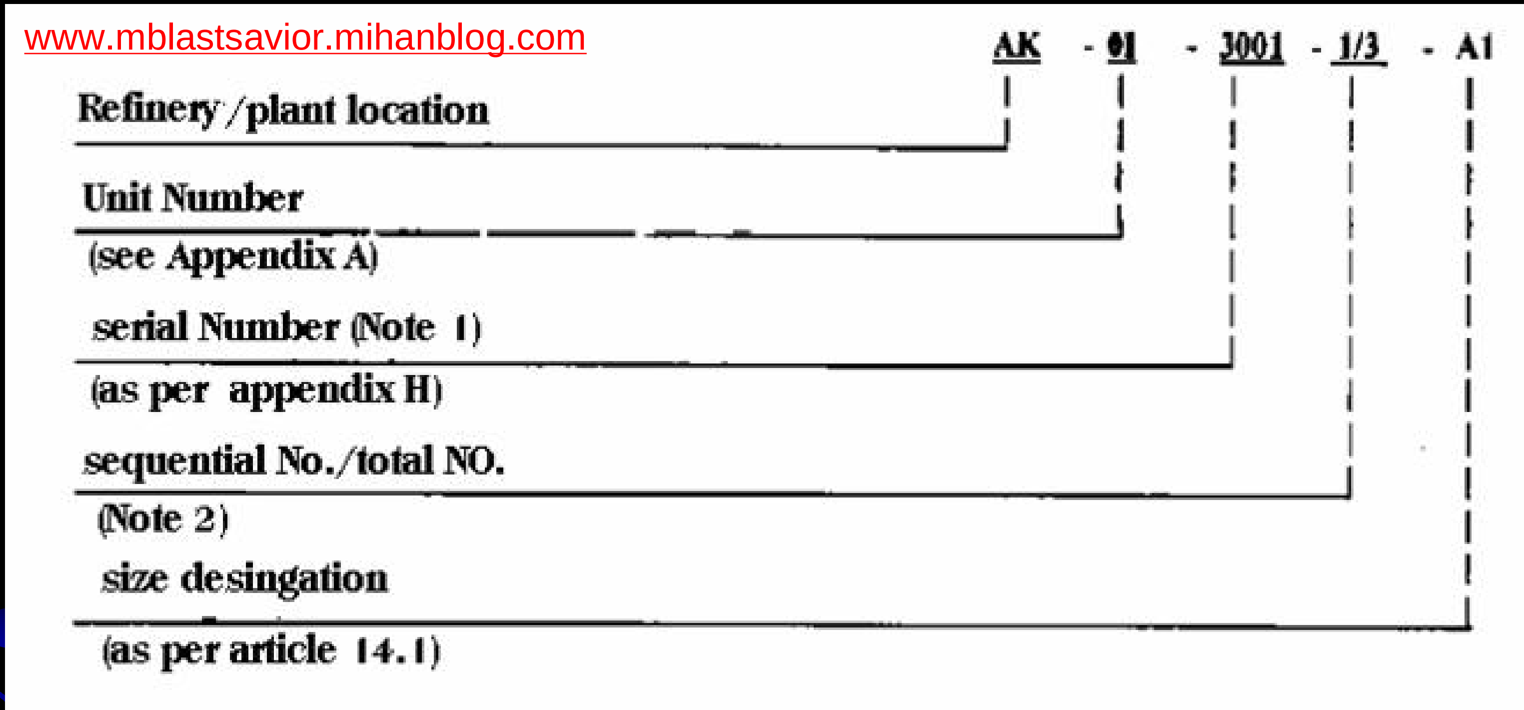
- Civil	01
- Instrumentation	02
- Electrical	03
- Machinery	04
- Heaters	05
- Heat Exchangers (including reboilers, coolers, double pipe heat exchangers, coils, plate heat exchangers, etc.)	06
- Vessels, Towers or Drums	07
- Tanks and Spheres	08
- Package Units	09
- Miscellaneous Mechanical	10
- Piping	11
- Management	12
- Site Construction	13
- Miscellaneous	14

Project Sections Coding

AC	Accounting
CC	Cost Control
CN	Construction
DC	Document Center
FN	Finance
GN	General
PC	Project Coordination
PE	Project Engineering
PN	Planning
PM	Project Management
PQ	Procurement
QA	Quality Assurance
QC	Quality Control

Numbering of Drawings

نامگذاری مدارک



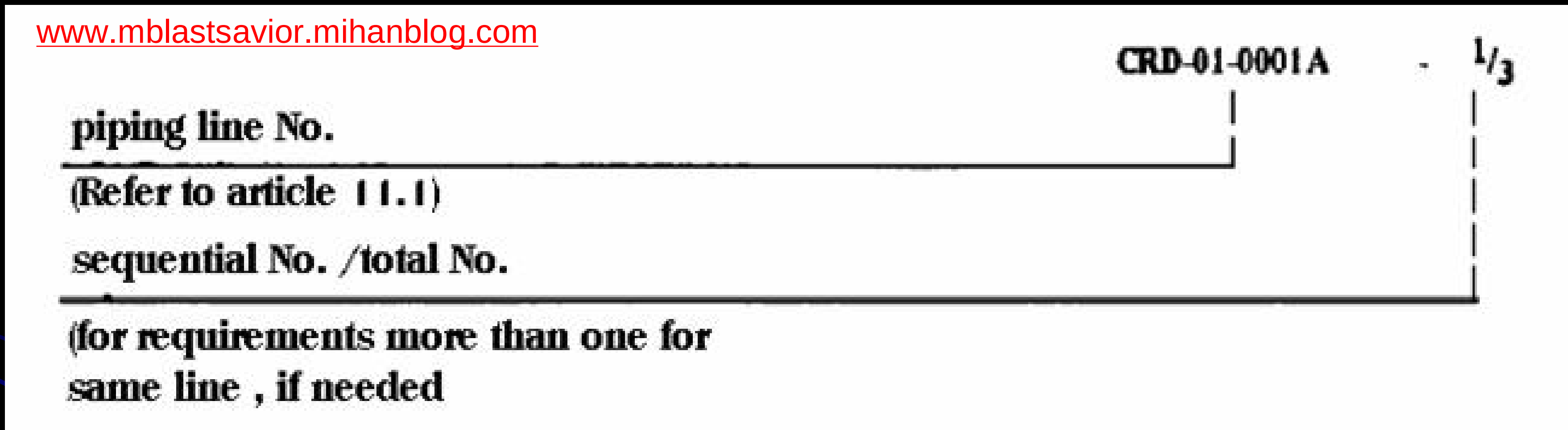
Notes:

1) Two drawings may have the same serial number but different unit number.

2) When drawings have same title and function, they shall have the same serial number and shall be identified by using Sequential No./Total No.

Numbering of Isometric Drawings

Numbering of Isometric Drawings shall be the same as the piping line number which is shown on the Isometric Drawing.



SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION	DESCRIPTION
AK	Arak
BD	Building
CRD	Crude
DN	Diameter Nominal, in (mm)
HVAC	Heating Ventilation and Cooling
LG	Level Gage
PDB	Distribution Panel Board
PFD	Process Flow Diagram
P & IDs	Piping and Instrument Diagrams
PO	Purchase Order
PS	Pipe Support
PSV	Pressure Safety Valve
SI	System International
TEL	Tetra Ethyl Lead

DRAWING SERIAL NUMBER

شماره سریال انواع مختلف مدارک

TYPE OF DRAWING	SERIAL NUMBER (4 Digits)
- PROCESS FLOW DIAGRAM	0001 - 0099
- MECHANICAL FLOW DIAGRAMS (P & IDs)	0100 - 0199
- UTILITY FLOW DIAGRAM	0200 - 0399
- PLOT PLAN	0500 - 0599
- CONCRETE	1000 - 1999
- STRUCTURAL STEEL	2000 - 2999
- VESSEL	4000 - 4999
- PIPING	5000 - 5999
- ELECTRICAL	6000 - 6999
- INSTRUMENT	7000 - 7999
- INSULATION	8000 - 8999
- MISCELLANEOUS	9000 - 9999

Special Chemical and Solvent Systems

AMN	Amine
AMO	Ammonia
CAU	Caustic Soda
CHM	Chemicals
DEA	di-Ethanol Amine
DGA	di-Glycole Amine
MEA	mono-Ethanol Amine
MEK	Methyl Ethyl Ketone
TOL	Toluene

FLUID ABBREVIATION SYMBOLS

a) Air Systems

ISA	Instrument Air
PLA	Plant Air

b) Blowdown and Pump Out Systems

BDN	Blowdown
CBD	Continuous Blowdown
IBD	Intermittent Blowdown

c) Condensate Systems

COC	Cold Condensate
HPC	High Pressure Condensate
LPC	Low Pressure Condensate
MPC	Medium Pressure Condensate

d) Drain (Sewer) Systems

CSW	Chemical Sewer
NSW	Non Oily Sewer
OSW	Oily Sewer
SSW	Sanitary Sewer

FLUID ABBREVIATION SYMBOLS

e) Flare Systems

FL	Flare (Normal)
HFL	High Pressure Flare
LFL	Low Pressure Flare

f) Fuels

FLG	Fuel Gas
FLO	Fuel Oil
NG	Natural Gas
RFO	Refinery Fuel Oil

g) Special Gas Systems

ACG	Acid Gas
CHL	Chlorine
HEL	Helium
HYD	Hydrogen
NIT	Nitrogen
OXY	Oxygen
UTA	Utility Air

FLUID ABBREVIATION SYMBOLS

i) Oil Utility Systems

LBO	Lubricating Oil
SLO	Seal Oil
FGO	Flushing Oil

j) Steam systems

DLS	Dilution Steam
HOR	Hot Oil Return
HOS	Hot Oil Supply
HPS	High Pressure Steam
LLS	Low Low Pressure Steam
LPS	Low Pressure Steam
MPS	Medium Pressure Steam

FLUID ABBREVIATION SYMBOLS

I) Water Systems

BFW	Boiler Feed Water
CLW	Chlorinated Water
CWR	Cooling Water Return
CWS	Cooling Water Supply
DIW	Distilled Water
HWS	Hot Water Supply
HWR	Hot Water Return
TWR	Tempered Water Return
TWS	Tempered Water Supply
DMW	Demineralized Water
DWA	Drinking Water
FWA	Fire Water
HBW	High Pressure Boiler Feed Water
HCW	Hot and Chilled Water
MBW	Medium Pressure Boiler Feed Water
PRW	Process Water
PWA	Plant Water
RWA	Raw Water
SWA	Sour Water
TWA	Treated Water
WAT	Water

تهیه کننده:محمد بهزادی

FLUID ABBREVIATION SYMBOLS

k) Process Services

ACE	Acetylene
ALC	Alchohol
ASP	Asphalt
BZN	Benzene
BUT	Butane
CAT	Catalyst
ETA	Ethane
ETN	Ethylene
FOP	Fuel Oil Product
GAS	Gas
GSL	Gasoline
GSO	Gas oil
HRG	Hydrogen Rich Gas
HCB	Hydrocarbon
HCH	Hydrocarbon with Hydrogen
JP4	Jet Fuel (JP-4)
JTA	Jet A-1
KER	Kerosene
NGH	Natural Gas with Hydrogen
RGH	Reformed Gas with Hydrogen

FLUID ABBREVIATION SYMBOLS

LNA	Light Naphtha
LPG	Liquefied Petroleum Gas
MEL	Methanol
MET	Methane
NAP	Naphtha
PNT	Pentane
PRP	Propane
PPN	Propylene
PRA	Process Air
PRO	Process Fluid
RAF	Raffinate
REF	Reformate
REG	Recycle Gas
RES	Residue
SLG	Sludge
SLP	Slop
SUL	Sulfur

ENGINEERING STANDARD
FOR
PROCESS DESIGN OF VALVES
AND
CONTROL VALVES

استاندارد انتخاب شیرها و شیرهای کنترل

0. INTRODUCTION

Valves are the components in a fluid flow or pressure system which regulate either the flow or the pressure of the fluid. This duty may involve stopping and starting flow, controlling flow rate, diverting flow, preventing back flow, controlling pressure, or relieving pressure.

The equations of this Standard are used to predict the flow rate of a fluid through a valve when all the factors including those related to the fluid and its flowing condition are known, when the equations are used to select a valve size, it is often necessary to use capacity factors associated with the fully open or rate condition to predict an approximate required valve flow coefficient (C_v).

This group includes the following Standards:

STANDARD CODE	STANDARD TITLE
IPS-E-PR-830	"Process Design of Valves & Control Valves"
IPS-E-PR-845	"Process Design of Steam Traps"

"PROCESS DESIGN OF VALVES AND CONTROL VALVES"

The valves discussed here are manually operated valves for stop and starting flow, controlling flow rate and diverting flow. The manual valves are divided into four groups according to the way the closure member moves into the seat. The many types of check valves are likewise divided into groups according to the way the closure member moves onto the seat. The basic duty of these valves is to prevent back flow. Predicting the flow of compressible and incompressible fluids through control valve, and cavitation are covered as parts of this Engineering Standard Specification.

1. SCOPE

This Engineering Standard Specification is intended to cover minimum requirements for process design of manual valves, and control valves as well as field of application, selection of types, control valve sizing calculations, and cavitation in design consideration for valves and control valves.

The application of this Engineering Standard Specification shall be exercised, only in combination with the relevant Piping & Pipelines and Instrument Standards, i.e., IPS-M-PI-110/I-VI, "Valves", and IPS-G-IN-160, "Control Valves", respectively.

2. REFERENCES

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

ISA/ANSI **(INSTRUMENT SOCIETY OF AMERICA/AMERICAN NATIONAL STANDARDS INSTITUTE)**

"Flow Equations for Sizing Control Valves", ANSI/ISA-S 75.01-1985, Approved August 15, 1986

IPS **(IRANIAN PETROLEUM STANDARDS)**

IPS-M-PI-110/I-VI	"Material and Equipment Standard for Valves"
IPS-G-IN-160	"Engineering and Material Standards for Control Valves"

3. SYMBOLS AND ABBREVIATIONS

ANSI	American National Standards Institute.
C_d	Required 6.45 C_v /d^2 at a specified flow condition.
C_f	Critical factor, (dimensionless).
C_{fr}	Reducer critical factor, dimensionless.
C_v	Valve flow coefficient.
d	Valve inlet diameter.
D	Internal diameter of the pipe.
E_q	Equation.
F_d	Valve style modifier (see Table A.3 in Appendix A).
F_F	Liquid critical pressure ratio factor, dimensionless.
F_k	Ratio of specific heats factor, dimensionless.
F_L	Liquid pressure recovery factor of a valve without attached fittings, dimensionless.
F_{LP}	Product of the liquid pressure recovery factor of a valve with attached fittings (no symbol has been identified) and the piping geometry factor, dimensionless.
F_P	Piping geometry factor, dimensionless.
F_{Re}	Reynolds number factor, dimensionless.
F_s	Laminar, or streamline, flow factor, dimensionless.

g	Local acceleration of gravity, (9.806 m/s²).
G	Relative density (specific gravity).
G_f	Liquid relative density (specific gravity) at upstream conditions [ratio of density of liquid at flowing temperature to density of water at 15.5°C (60°F)], dimensionless.
G_g	Gas relative density or specific gravity (ratio of density of flowing gas to density of air with both at standard conditions, which is equal to the ratio of the molecular mass of gas to the molecular mass of air), dimensionless.
IPS	Iranian Petroleum Standards.
ISA	Instrument society of America..
K	Flow characteristic of valve.
K_B	Bernoulli coefficient, dimensionless.
K_{B1}	Bernoulli coefficient for an inlet fitting, dimensionless.
K_{B2}	Bernoulli coefficient for an outlet fitting, dimensionless.
K_c	Coefficient of incipient cavitation, **Kc** = $\frac{\text{change in flow}}{\text{change in lift}}$ **(Eq. 1)**
K_i	Velocity head factors for an inlet fitting, dimensionless.
K_1	Resistance coefficient for inlet fitting.
M	Molecular mass (weight), atomic mass units.
MPa	Megapascal = 1- bar.

N_1, N_2 etc.	Numerical constants for units of measurement used.
P_1	Upstream absolute static pressure, measured two nominal pipe diameters upstream of valve-fitting assembly.
P_2	Downstream absolute static pressure, measured six nominal pipe diameters downstream of valvefitting assembly.
ΔP	Pressure differential, $\Delta P = P_1 - P_2$, in (bar).
ΔP_{crit}	Critical pressure drop, $\Delta P_{crit} = C_f^2 (P_1 - P_v)$
P_c	Absolute thermodynamic critical pressure.
P_r	Reduced pressure, dimensionless
P_R	Valve Pressure drop ratio; is the ratio of valve Pressure drop to total dynamic pressure drop.
P_v	Absolute vapor pressure of liquid at inlet temperature.
P_{vc}	Apparent absolute pressure at vena contracta.
R	Sub-critical flow capacity correction factor, dimensionless.
q	Volumetric flow rate.
q_{max}	Maximum flow rate (choked flow conditions) at a given upstream condition.
Re_v	Valve Reynolds number, dimensionless.
T	Absolute temperature, in kelvin (K).

V	Specific volume, in (m^3/kg) . **V =** $\frac{1}{\gamma}$
W	Mass or (weight) flow rate (mass fraction), in (kg/h).
W_f	Mass flow rate of fluid, in (kg/h).
W_g	Mass flow rate of gas, in (kg/h).
X	Ratio of pressure drop to absolute inlet pressure, ($X = \Delta P/P_1$), dimensionless.
X_T	Pressure drop ratio factor, dimensionless.
X_{TP}	Value of X_T for valve-fitting assembly, dimensionless.
Y	Expansion factor, ratio of flow coefficient for a gas to that for a liquid at the same Reynolds number, dimensionless.
Z	Compressibility factor, dimensionless.
γ **(gamma)**	Specific mass (weight), in (kg/m^3).
γ_1**(gamma)**	Specific mass (weight), upstream conditions, in (kg/m^3).
γ_f**(gamma)**	Specific mass (weight) of liquid, in (kg/m^3).
μ (mu)	Viscosity, absolute.
ν **(nu)**	Kinematic viscosity, in centistokes (cSt).
ρ **(rho)**	Density (mass density).

Subscripts:

1	Upstream conditions.
2	Downstream conditions.
s	Non-turbulent.
t	Turbulent.

4. UNITS

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

5. GENERAL

5.1 Manual Valves

Manual valves serve three major functions in fluid handling systems:

a) stopping and starting flow;

b) controlling flow rate;

c) diverting flow.

5. GENERAL

5.1 Manual Valves

Manual valves serve three major functions in fluid handling systems:

a) stopping and starting flow;

b) controlling flow rate;

c) diverting flow.

5.1.1 Grouping of valves by method of flow regulation

Manual valves may be grouped according to the way the closure member moves onto the seat. Four groups of valves are thereby distinguishable:

5.1.1.1 Closing-down valves

A stopper-like closure member is moved to and from the seat in direction of the seat axis.

5.1.1.2 Slide valves

A gate-like closure member is moved across the flow passage.

5.1.1.3 Rotary valves

A plug or disc-like closure member is rotated within the flow passage, around an axis normal to the flow stream.

5.1.1.4 Flex-body valves

The closure member flexes the valve body.

5.1.2 Valve guides

The main parameters concerned in selecting a valve or valves for a typical general service are:

a) Fluid to be handled

This will affect both type of valve and material choice for valve construction.

b) Functional requirements

Mainly affecting choice of valve.

c) Operating conditions

Affecting both choice of valve type and constructional materials.

d) Flow characteristics and frictional loss

Where not already covered by (b), or setting additional specific or desirable requirements.

e) Size of valve

This again can affect choice of type of valve (very large sizes are only available in a limited range of types); and availability (matching sizes may not be available as standard production in a particular type).

f) Any special requirements-quick-opening, free draining

In the case of specific services, choice of valve type may be somewhat simplified by following established practice or selecting from valves specifically produced for that particular service.

Table B.1 in Appendix B summarizes the applications of the main types of general purpose valves.

Table B.2 in Appendix B carries general selection a stage further in listing valve types normally used for specific services.

Table B.3 in Appendix B is a particularly useful expansion of the same theme relating the suitability of different valve types to specific functional requirements.

5.1.3 Selection of valves

a) Valves for stopping and starting flow

Such valves are slide valves, rotary valves and flex-body valves.

b) Valves for control of flow rate

c) Valves for diverting flow

Such valves are plug valves and ball valves.

d) Valves for fluids with solids in suspension

The valves best suited for this duty have a closure member which slides across a wiping motion.

5.1.4 Globe valves

The sealing of these valves is high.

Applications

Duty:

- Controlling flow.
- Stopping and starting flow.
- Frequent valve operation.

Service:

- Gases essentially free of solids.
- Liquids essentially free of solids.
- Vacuum.
- Cryogenic.

5.1.5 Piston valves

Applications

Duty:

- Controlling flow.
- Stopping and starting flow.

Service:

- Gases.
- Liquids.
- Fluids with solids in suspension.
- Vacuum.

5.1.6 Parallel gate valves

Parallel gate valves are slide valves with a parallel-faced gate-like closure member. The advantages of these valves are as follows:

- Their low resistance to flow.
- Capable of handling fluids which carry solids in suspension.
- With closure member if a single disc or twin discs with a spreading mechanism in-between. Limitation to the operation of parallel gate valves.
- If fluid pressure is low, the seating force may be insufficient to produce a satisfactory seal between metal-to-metal seating.
- Frequent valve operation may lead to excessive wear of the seating face. For this reason, parallel gate valves are normally used for infrequent valve operation only.
- Flow control from a circular disc traveling across a circular flow passage becomes satisfactory only between the 50% closed and the fully closed positions. Therefore they are normally used for on-off duty only.

Applications

Duty:

- Stopping and starting flow.
- Infrequent operation.

Service:

- Gases.
- Liquids.
- Fluids with solids in suspension.
- Knife gate valve for slurries, fibers, powders, and granules.
- Vacuum.
- Cryogenic.

5.1.7 Wedge gate valves

Wedge shape is to introduce a high supplementary seating load against high but also low fluid pressures.

Applications

Duty:

- Stopping and starting flow.
- Infrequent operation.

Service:

- Gases.
- Liquids.
- Rubber-seated wedge gate valves without bottom cavity for fluids carrying solids in suspension.
- Vacuum.
- Cryogenic.

5.1.8 Plug valves (cocks)

Applications

Duty:

- Stopping and starting flow.
- Moderate throttling.
- Flow diversion.

Fluids:

- Gases.
- Liquids.
- Non-abrasive slurries.
- Abrasive slurries for lubricated plug valves.
- Sticky fluids for eccentric and lift plug valves.
- Sanitary handling of pharmaceutical and food stuffs.
- Vacuum.

5.1.9 Ball valves

Applications

Duty:

- Stopping and starting flow.
- Moderate throttling.
- Flow diversion.

Service:

- Gases.
- Liquids.
- Non-abrasive slurries.
- Vacuum.
- Cryogenic.

5.1.10 Butterfly valves

Butterfly valves are available for wide range of pressures and temperatures based on variety of sealing principles.

Applications

Duty:

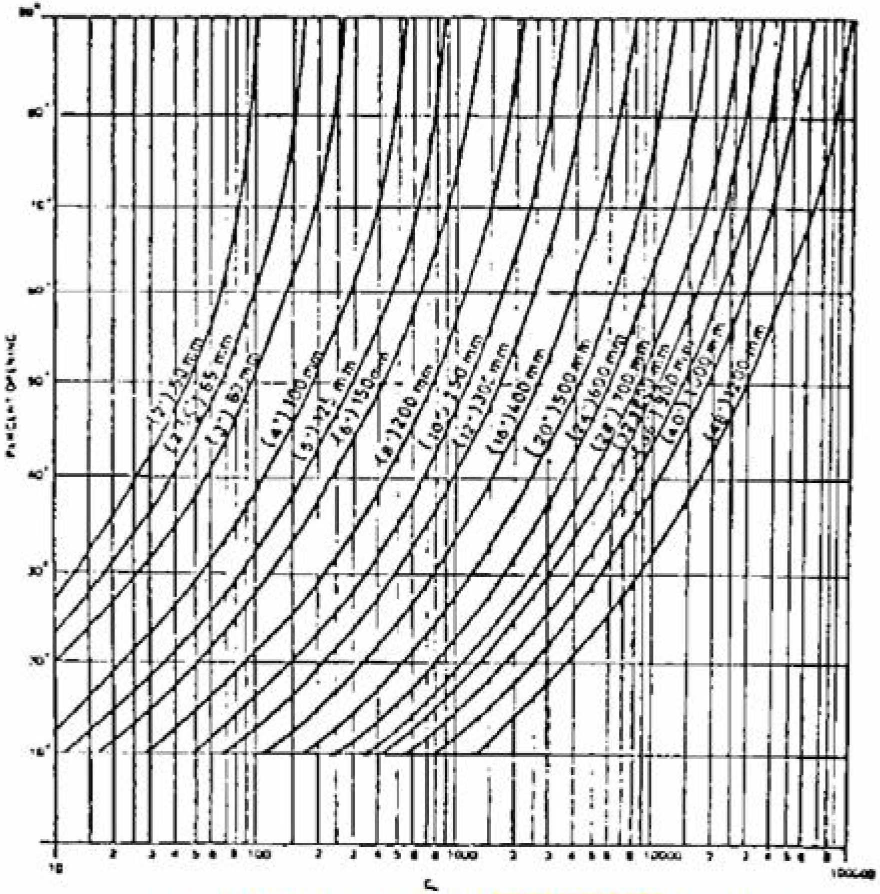
- Stopping and starting flow.
- Controlling flow.

Service:

- Gases.
- Liquids.
- Slurries.
- Powder.
- Granules.
- Sanitary handling of pharmaceuticals and food stuffs.
- Vacuum.

5.1.10.1 Flow characteristic of butterfly valve

Fig. 1 gives flow coefficients for a series of butterfly valves of similar design but different size, those being representative of good design.



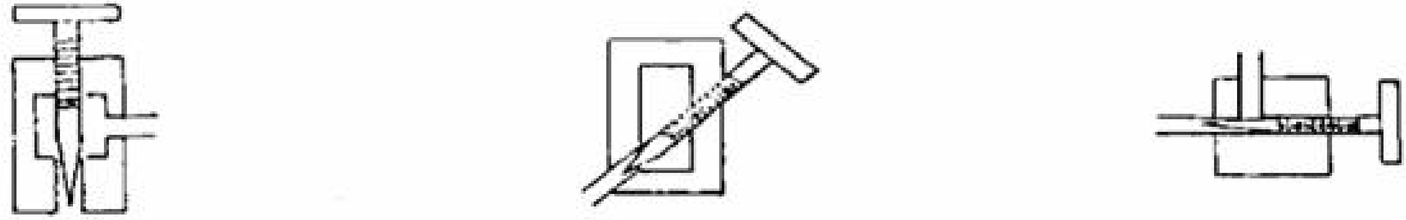
C_v DIAGRAM FOR TYPICAL BUTTERFLY VALVE

Fig. 1

Fig. 1

5.1.11 Needle valves

Small sizes of globe valves fitted with a finely tapered plug are known as needle valves:



a) b) c)

Fig. 2

Three basic configurations are shown in Fig. 2, (a) is a simple screwdown valve; (b) is an oblique version, offering a more direct flow path; (c) is another form where the controlled outlet flow is at right angles to the main flow (and may be distributed through one or more passages).

5.1.12 Pinch valves

Pinch valves are flex-body valves consisting of a flexible tube which is pinched either mechanically, or by application of a fluid pressure to the outside of the valve body.

Applications

Duty:

- Stopping and starting flow.
- Controlling flow.

Service:

- Liquids.
- Abrasive slurries.
- Powders.
- Granules.
- Sanitary handling of pharmaceuticals and food stuffs.

5.1.13 Diaphragm valves

Diaphragm valves are flex-body valves in which the body flexibility is provided by a diaphragm. Diaphragm valves fall into two main types:

- Weir-Type Diaphragm valves which are designed for a short stroke between the closed and fully open valve positions.
- Straight-Through Diaphragm valves which have a relatively long stroke which requires more flexible construction materials for the diaphragm.

Applications

Duty:

For weir-type and straight-through diaphragm valves:

- Stopping and starting flow.
- Controlling flow.

Service:

For weir-type diaphragm valves:

- Gases, may carry solids.
- Liquids, may carry solids.
- Viscous fluids.
- Leak-proof handling of hazardous fluids.
- Sanitary handling of pharmaceuticals and food stuffs.
- Vacuum.

Service for straight-through diaphragm valves:

- Gases, may carry solids.
- Liquids, may carry solids.
- Viscous fluid.
- Sludges.
- Slurries may carry abrasives.
- Dry media.
- Vacuum (consult manufacturer).

5.2 Check Valves

Check valves are automatic valves which open with forward flow and close against reverse flow. They are also known as non-return valves. Check valves shall operate in a manner which avoids:

1) The formation of an excessively high surge pressure as result of the valve closing.

2) Rapid fluctuating movements of the valve closure member.

Check valves are commonly used in combination with flow control valves, the type and operating characteristics of which can influence the choice of check valve type. Suitable combinations are:

- Swing check valve-used with ball, plug, gate or diaphragm control valves.
- Tilting disc check valves-similar to swing-type check valve but with a profiled disc.
- Lift check valve-used with globe or angle valves.
- Piston check valve-used with globe or angle valves.
- Butterfly check valve-used with ball, plug, butterfly, diaphragm or pinch valves.
- Spring-loaded check valves-used with globe or angle valves.
- Diaphragm check valves-the closure member consists of a diaphragm which deflects from or against the seat.

5.2.1 Lift check valves

Lift check valves may be sub-divided into:

a) disc check valves;
b) piston check valves;
c) ball check valves.

5.2.2 Swing check valves

- Dirt and viscous fluids cannot easily hinder the rotation of the disc around the hinge.

5.2.3 Tilting-disc check valves

- Potentially fast closing.
- Being more expensive.
- More difficult to repair.

5.2.4 Diaphragm check valves

- Are not as well known as other check valves.
- Is well suited for applications in which the flow varies within wide limits.
- The pressure differential is limited to 1 Megapascal (MPa).
- Operating temperature is limited to 70°C.
- Sizes as small as DN3 (NPS 1/8 inch) and as large as DN 3000 (NPS 120 inch).

5.2.5 Foot valves

- Is basically a check valve
- Often include a strainer.
- Are fitted to the end of a suction pipe.
- Prevent the pump emptying when it stops.

7.1.2 Butterfly valve

The butterfly valve is a rotating-vane, high-pressure recovery type of valve used in applications where high-capacity and low-pressure drop are required. Although not normally used on minimum leakage applications.

7.1.3 Ball valve

The ball control valve is a rotating-stem, high-pressure recovery type of valve, in which the flow of fluid is restricted by using a full-or partial-type ball in the valve body. This valve has a high flow coefficient and may be used to control many types of fluids.

7.1.4 Three-way valve

The three-way valve is a special type of valve primarily used for splitting (diverting) or mixing (combining) service. The most common applications are through or around exchangers to control the heat transferred or in the controlled mixing of two streams.

7.2 Flashing

If the cavitation process could be halted before the completion of the second stage, so that vapor persists downstream of the region where bubble collapse normally occurs, the process would be known as flashing. Flashing, like cavitation, can cause physical damage and decreased valve efficiency. Manufacturers should be consulted for recommendations.

جدول مهم

TABLE B.1 - APPLICATIONS OF VALVE TYPES

Valve category	General application(s)	Actuation	Remarks
Screw-down stop Valve	Shut-off or regulation of flow of liquids and gases (e.g. steam)	(i) Handwheel. (ii) Electric motor. (iii) Pneumatic actuator. (iv) Hydraulic actuator. (v) Air motor.	(a) Limited applications for low pressure/low volume systems because of relatively high cost. (b) Limited suitability for handling viscous or contaminated fluids.
Cock	Low pressure service on clean, cold fluids (e.g. water, oils, etc.).	Usually manual.	Limited application for steam services.
Check valve	Providing flow in one direction.	Automatic.	(a) Swing check valves used in larger pipelines. (b) Lift check valves used in smaller pipelines and in high pressure systems.
Gate valve	Normally used either fully open or fully closed for on-off regulation on water, oil, gas, steam and other fluid services.	(i) Handwheel. (ii) Electric motor. (iii) Pneumatic actuator. (iv) Hydraulic actuator. (v) Air motor.	(a) Not recommended for use as throttling valves. (b) Solid wedge gate is free from chatter and jamming.
arallel slide valve	Regulation of flow, particularly in main services in process industries and steam power plant.		(a) Offers unrestricted bore at full opening. (b) Can incorporate venture bore to reduce operating torque.
Butterfly valve	Shut-off and regulation in large pipelines in waterworks, process industries, petrochemical industries, hydroelectric power stations and thermal power stations.	(i) Handwheel. (ii) Electric motor. (iii)Pneumatic actuator. (iv)Hydraulic actuator. (v) Air motor.	(a) Relatively simple construction. (b) Readily produced in very large sizes [e.g. up to 5.5 m (18 ft) or more.]
Diaphragm valve	Wide range of applications in all services for flow regulation.	(i) Handwheel. (ii) Electric motor. (iii)Pneumatic actuator. (iv)Hydraulic actuator. (v) Air motor.	(a) Can handle all types of fluids, including slurries, sludges, etc., and contaminated fluids. (b) Limited for steam services by temperature and pressure rating of diaphragm.
Ball valve	Wide range of applications in all sizes, including very large sizes in oil pipelines, etc.	(i) Handwheel. (ii) Electric motor. (iii)Pneumatic actuator. (iv)Hydraulic actuator.	(a) Unrestricted bore at full opening. (b) Can handle all types of fluids. (c) Low operating torque. (d) Not normally used as a throttling valve.

جدول مهم

Pinch valve	Particularly suitable for handling corrosive media, solids in suspensions, slurries, etc.	(i) Mechanical. (ii) Electric motor. (iii) Pneumatic actuator. (iv) Hydraulic actuator. (v) Fluid pressure (modified design).	(a) (b) (c) (d)	Unrestricted bore at full opening. Can handle all types of fluids. Simple servicing. Limited maximum pressure rating.

جدول مهم

TABLE B.2 - VALVE TYPES FOR SPECIFIC SERVICES

Service	Main	Secondary
Gases	Butterfly valves Check valves Diaphragm valves Lubricated plug valves Screw-down stop valves	Pressure control valves Pressure-relief valves Pressure-reducing valves Safety valves Relief valves
Liquids, clear up to sludges and Sewage	Butterfly valves Screw-down stop valves Gate valves Lubricated plug valves Diaphragm valves Pinch valves	
Slurries and liquids heavily contaminated with solids	Butterfly valves Pinch valves Gate valves Screw-down stop valves Lubricated plug valves	
Steam	Butterfly valves Gate valves Screw-down stop valves Turbine valves	Check valves Pressure control valves Presuperheated valves Safety and relief valves

جدول مهم

TABLE B.3 - VALVE TYPE SUITABILITY

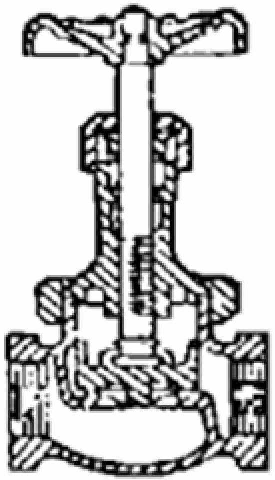
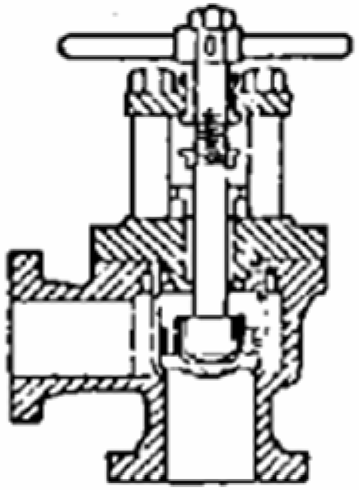
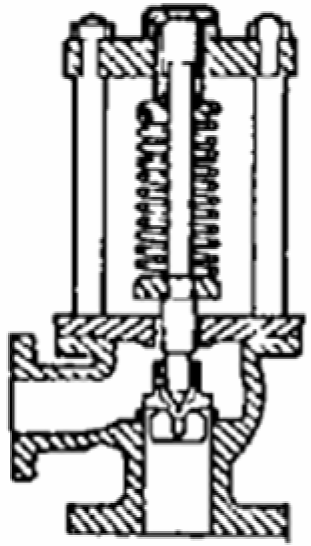
Valve type	SERVICE OR FUNCTION										
	On-off	Throttling	Diverting	No reverse flow	Pressure control	Flow Control	Pressure relief	Quick opening	Free draining	Low pressure drop	Handling solids suspension
Ball	S	M	S	---	---	---	---	S	---	S	LS
Butterfly	S	S	---	---	---	S	---	S	S	S	S
Diaphragm	S	M	---	---	---	---	---	M	M	---	S
Gate	S	---	---	---	---	---	---	S	S	S	---
Globe	S	M	---	---	---	M	---	---	---	---	---
Plug	S	M	S	---	---	M	---	S	S	S	LS
Oblique (Y)	S	M	---	---	---	M	---	---	---	---	---
Pinch	S	S	---	---	---	S	---	---	S	S	S
Slide	---	M	---	---	---	M	---	M	S	S	S
Swing check	---	---	---	S	---	---	---	---	---	S	---
Tilting disc	---	---	---	S	---	---	---	---	---	S	---
Lift check	---	---	---	S	---	---	---	---	---	---	---
Piston check	---	---	---	S	---	---	---	---	---	---	---
Butterfly check	---	---	---	S	---	---	---	---	---	---	---
Pressure relief	S	---	---	---	---	---	S	---	---	---	---
Pressure reducing	---	---	---	---	S	---	---	---	---	---	---
Sampling	S	---	---	---	---	---	---	---	---	---	---
Needle	---	S	---	---	---	---	---	---	---	---	---

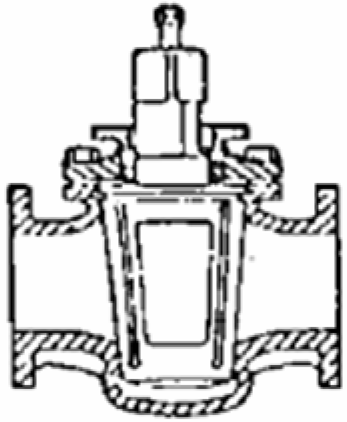
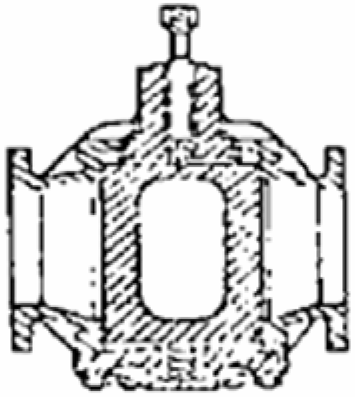
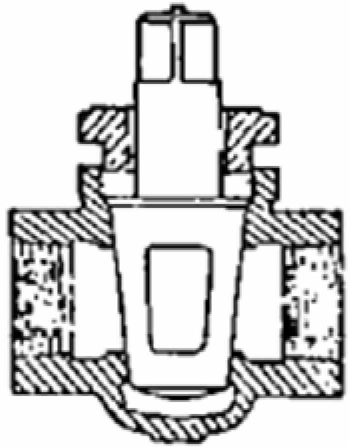
Key:

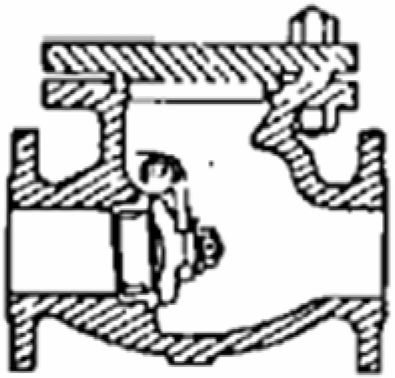
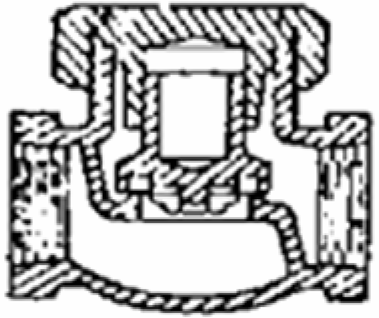
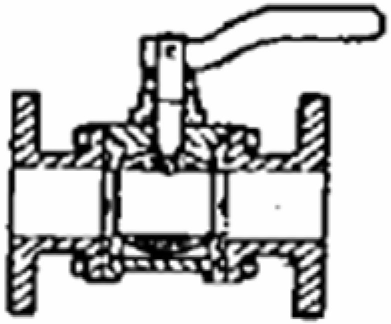
S = Suitable choice

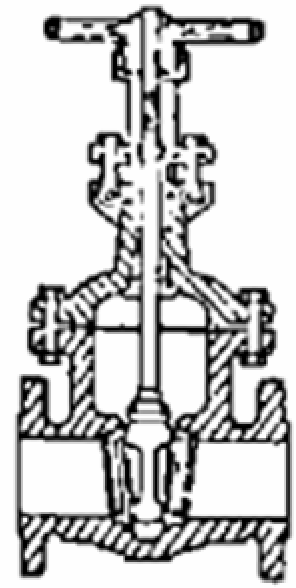
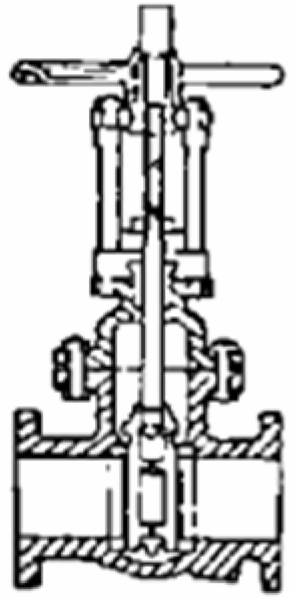
M = May be suitable in modified form

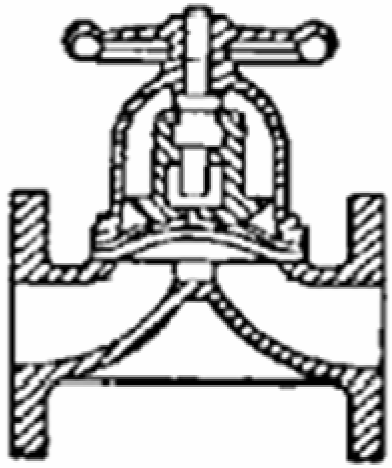
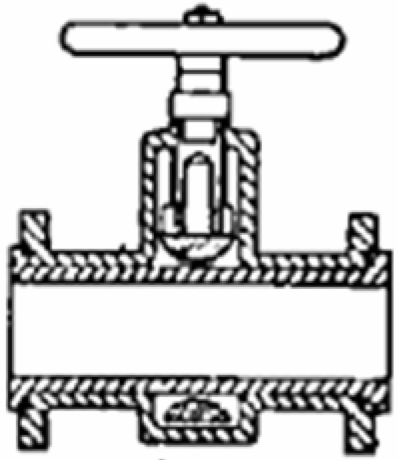
LS = Limited suitability

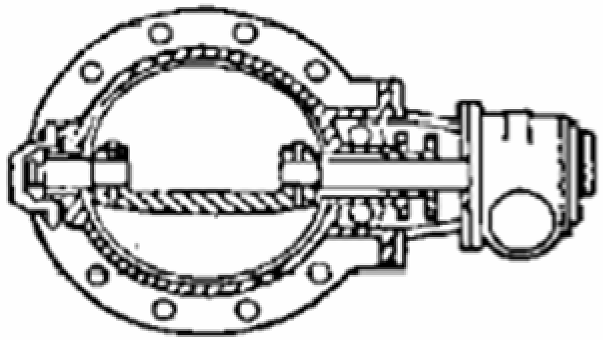
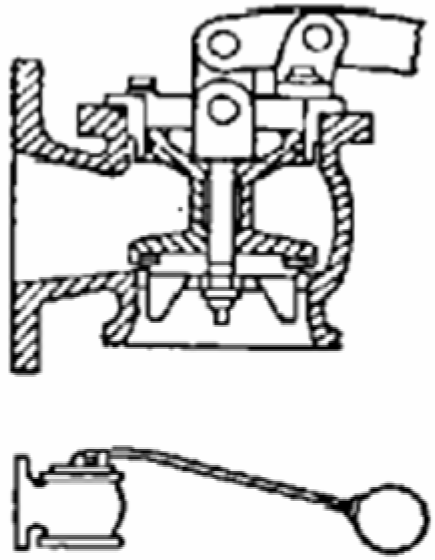
Valve Selection Guide	 Globe Valve	 Combined Stop and Check Valve	 Safety Valve
Size range, mm (in)	DN3 to 80 (1/8 to 3)	DN15 to 600 (1/2 to 24)	DN15 to DN16 (1/2 to 16)
Pressure range, kPa (psi)	to 2,070 (to 300)	to 2,070 (to 300)	to 10,340 (to 1,500)
Temperature range, °C (F)	-40 to 149 (-40 to 300)	-40 to 176 (-40 to 350)	-40 to 260 (-40 to 500)
Materials of construction	Bronze, iron, steel, stainless steel	Bronze, brass, iron, steel, stainless steel	Brass, bronze, steel, iron, stainless steel
Primary function	On-off service and coarse metering	On-off and metering service along with flow reversal prevention	Pressure control

	 Lubricated Plug Valve, Taper Plug	 Lubricated Plug Valve, Parallel Plug	 Gland Cock
Size range, mm (in)	DN9 to DN600 (3/8 to 24)	DN9 to DN600 (3/8 to 24)	DN 3 to DN6 (1/8 to 6)
Pressure range, kPa (psi)	to 2,760 (to 400)	to 2750 (to 400)	to 3450 (to 500)
Temperature, range (°F, °C)	-40 to 121 (-40 to 250)	-40 to 121 (-40 to 250)	-51 to 260 (-60 to 500)
Materials of construction	Brass, bronze, aluminum, ductile iron, semi steel, stainless steel	Brass, bronze, aluminum, ductile iron, semi steel, stainless steel	Brass, bronze, iron, ductile iron, semi steel, stainless steel
Primary function	On off service	On-off service	Shut off

	 Check Valve, Swing Type	 Check Valve, Piston Lift Type	 Ball Plug Valve
Size range, mm (in)	DN6 to DN600 (1/4 to 24)	DN6 to DN 600 (1/4 to 24)	DN15 to DN 600 (1/2 to 24)
Pressure range, kPa (psi)	to 2,070 (to 300)	to 2070 (to 300)	to 2,760 (to 400)
Temperature range, °C (F)	-40 to 176 (-40 to 350)	-40 to 176 (-40 to 350)	-40 to 121 (-40 to 250)
Materials of construction	Bronze, brass, iron, semi-steel, steel, aluminum, stainless steel	Bronze, brass, iron, semi-steel, steel, stainless steel	Brass, bronze, iron, aluminum, steel, stainless steel
Primary function	Prevent flow reversal	Prevent flow reversal	On-off service and direction control

	 Gate Valve, Rising Stem	 Gate Valve, Traveling Stem
Size range, mm (in)	DN6 to DN 600 (1/4 to 24)	DN6 to DN 600 (1/4 to 24)
Pressure range, kPa (psi)	to 2,760 (to 400)	to 2,760 (to 400)
Temperature range °C (°F)	-45 to 260 (-50 to 500)	-45 to 260 (-50 to 500)
Materials of construction	Bronze, brass, iron, semi-steel, stainless steel	Bronze, brass, iron semi-steel, stainless steel
Primary function	Metering or throttling	On-off service and throttling

	 Diaphragm Valve	 Pinch Valve
Size range, mm (in)	DN15 to DN600 (1/2 to 24)	DN6 to DN300 (1/4 to 12)
Pressure range, kPa (psi)	to 5170 (to 750)	to 3450 (to 500)
Temperature range, °C (F)	-45 to 760 (-50 to 500)	-35 to 176 (-30 to 350)
Materials of construction	Brass, bronze, iron, steel, stainless steel	Brass, bronze, steel, stainless steel
Primary function	On-off service	Metering

		
	Butterfly Valve, Offset Disc	Ball Float Valve
Size range, mm (in)	DN25 to DN 600 (1 to 24)	DN15 to DN300 (1/2 to 12)
Pressure range kPa (psi)	to 1,725 (to 250)	to 3,450 (to 500)
Temperature range °C (°F)	-450 to 538 (−50 to 1,000)	-45 to 260 (−50 to 500)
Materials of construction	Brass, bronze, aluminum, iron, steel, stainless steel	Brass, bronze, aluminum, iron, steel stainless steel
Primary function	On-off service	Metering and level control

Engineering Specification
for
Site Conditions

مشخصات سایت

1 **GENERAL**

2 **DEFINITIONS/ABBREVEATIONS**

3 **LOCATION**

4 **SITE CONDITION**

Temperature

Humidity

Barometric Pressure

Rainfall

Snow

Wind

Design data for Air Conditioning

Summer

Winter

Fresh Air changes

Pressurization

Earth Quake

Others

5 **SPECIFICATION OF UTILITIES**

6 **ELACTRICAL POWER SPECIFICATIONS**

1. GENERAL

This engineering specification covers general information regarding site data and climatic conditions. The equipment supplied must be able to withstand the ambient conditions as described below for transport, storage and operation of the plant.

2. DEFINITIONS/ABBREVEATIONS

OWNER	Means B PETROCHEMICAL COMPANY (Tehran, Islamic Republic of Iran)
VENDOR	Means any Company or Organisation appointed by CONTRACTOR on whom PURCHASE ORDERS are placed to supply any EQUIPMENT of the CONTRACT
EQUIPMENT	Means any equipment, material and components to be permanently installed in the PLANT and special tools , test equipment and erection- ,pre-commissioning- ,commissioning-,start-up-, two years- and capital-spare-parts
CONTRACT	Means contract between OWNER and CONTRACTOR and VENDOR
PURCHASE ORDER	Means document of commitment between CONTRACTOR and VENDOR for the supply of EQUIPMENT
PLANT	Means the area within battery limits
SITE	Means the area B Petrochemical, ARAK/IRAN

3 LOCATION

The town of shazad is situated about 300 km south-west of Tehran/Iran. The site for B is located 35 km South-west of shazad.

4 SITE CONDITION

Materials shall be protected against corrosion during transit as necessary , when required , materials shall be painted or Coated in accordance with Particulars Contained in the purchase order and/or specification.

4.1 Temperature

- Ambient Temperature	
• Highest maximum on record	44°c
• Lowest minimum on record	-28°c
- Design temperature	
• Process design dry bulb	Max. 40°c Min. -16°c
• Process design wet bulb	21°c
• Mechanical design of equipment, steel structures, civil works,	Max. 44°c Min. –28
• Design temperature for outdoor electrical and instrument equipment	50°c
• Design temperature for air coolers	40°c
• Winterizing	-21°c
• Design temperature for equipment exposed to sunlight	83°c
• Soil temperature for cable sizing	30°c
• Design temperature for electrical equipment in substations	45°c
• Design temperature for chillers and condensing unit refrigeration	40°c

4.2 Humidity

- relative in January	Max. 86%

Barometric Pressure

• Min. / Max.	802 / 818 millibars
• Average	810 millibars

4.5 Wind

- Prevailing wind direction West-East
- Wind velocity at 10 m above grade 120 km/h max .
- Wind loads as per UBC 1985 edition chapter 23 vol. 1.

Wind force "H"–The wind force shall be computed as the product of the design wind pressure "P" the project area of the windward face "A" the appropriate shape factor "C" , and the standard projected area increase factor "I".

Thus $H = PACI$

Where H = Wind Force (kg)
P = Design Wind Pressure (kg/m^2) (see table 2.1)
A = Projected Area of the Windward Face (m^2)
C = Shape Factor (see table 2.2)
I = Project Area Increase Factor (see table 2.2)

Table 2.1 - Design Wind Pressure "p"

Height Zone (M.)	"p" Kg/m^2
0-10	100
10-20	120
20-30	133
30&up	150

Table 2.2-Factor "I"

Surface	Typical use	C	I
Cylindrical	Process vessels		
24" thru. 30" Dia.		0.6	1.50
36" thru. 48" Dia.		0.6	1.37
54" thru. 72" Dia.		0.6	1.28
78" thru. 96" Dia.		0.6	1.20
102" and up		0.6	1.18
Spherical	Storage vessels		
	(any diameter)	0.6	1.1
Flat	Closed structure	1.0	1.0
Steel or concrete open structure:			
Wind normal to one of the sides		2.2	1.0
Wind acting on corners:			
- 3 cornered structures		2.2	1.0
- 4 cornered structures		2.4	1.0
- Individual elements:			
Cylindrical sections with diameter equal to or less than 2 inches		0.8	1.0
Flat or angular section		1.3	1.0

4.6 Design data for Air Conditioning

4.6.1 Summer

- Technical offices and control rooms

• Indoor required temp. (dry bulb)	25 ^{o}c ± 1^{o}c
• Relative humidity	50% ± 5%

- Electrical Substations

• Indoor required temp. (dry bulb)	35 ^{o}c ± 1^{o}c
• Relative humidity	50% ± 10%

- Outdoor temperature (dry / wet bulb)	37/21^{o}c

4.6 Design data for Air Conditioning

4.6.1 Summer

- Technical offices and control rooms

• Indoor required temp. (dry bulb)	25 ^{o}c ± 1^{o}c
• Relative humidity	50% ± 5%

- Electrical Substations

• Indoor required temp. (dry bulb)	35 ^{o}c ± 1^{o}c
• Relative humidity	50% ± 10%

- Outdoor temperature (dry / wet bulb) 37/21^{o}c

4.6.2 Winter

- Technical Offices and control Rooms

• Indoor required temp. (dry bulb)	22 ^{o}c ± 1 ^{o}c
• Relative humidity	45% ± 5%

- Electrical Substations

1 • Indoor required temp. (dry bulb) 2 ^{o}c min.

- Outdoor temperature -16 ^{o}c

4.6.3 Fresh Air Changes

- Minimum for air conditioning system	25 m^3/h person
- Sanitary rooms	37 m^3/h m^2 surface
- Battery rooms	15 cph
- Kitchens	15 cph
- Toilets	20 cph

4.6.4 Pressurization

- Technical offices, control rooms electrical substation	5 mm w.g.
- Closed warehouses	2 mm w.g.
- Cold storage warehouses	3 mm w.g.

4.7 Earth Quake

Seismic factor in accordance with zone 3 of UBC, latest edition.

4.9 Others

- Frost line	: 1.0 m below grade level
- Water table	: Approx. 15 m below grade level
- Thunder and lighting	: To be considered
- Sand storm	: To be considered
- Altitude above sea level	: 1888.48 m
- Ground resistivity	: 400 Ohm.m

5 SPECIFICATION OF UTILITIES

Run- off coefficients shall be as follows:

- Buildings and shelter roof	1.00
- Asphalt roads and yards concrete paved areas	0.85
- Macadamized roadways	0.40
- Unpaved areas	0.20

Unless otherwise deduced from soil report.

6 ELECTRICAL POWER SPECIFICATIONS

(3) Circuit Voltage

- D.C. control circuit

Voltage: 110 Volt

- A. C. control circuit

Voltage : 230 Volt

Phase: ☐ 3-phase ■ single-phase

Wire: ☐ 3-wire ■ 2-wire

- Instrument circuit

A.C.

Voltage: 110 Volt

Phase: ☐ 3-phase ■ single-phase

Wire: ☐ 3-wire ■ 2-wire

D.C.

Voltage: 24 Volt

Baseic engineering Design Data

E-PR-200

جمع آوری اطلاعات لازم برای یک پروژه

تهیه کننده:محمد بهزادی

BEDD	**Basic Engineering Design Data**
BEDQ	**Basic Engineering Design Questionnaire**
CON	**Contractor**

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.

LHV	Low Heating Value
LLP	Low Low Pressure
LLPS	Low Low Pressure Steam
LP	Low Pressure
LPS	Low Pressure Steam
MEA	mono-Ethanol Amine
MP	Medium Pressure
MPS	Medium Pressure Steam
PD-Meter	Positive Displacement Meter
ppm	Part Per Million
TI	Temperature Indicator
TSS	Total Suspended Solids
UOP	Universal Oil Products

SYMBOL / ABBREVIATION	DESCRIPTION
AFC	Air Fin Cooler
BEDD	Basic Engineering Design Data
BEDQ	Basic Engineering Design Questionnaire
BFW	Boiler Feed Water
BHP	Break Horse Power
BkW	Identical to Break Horse Power Converted to kilowatts
BOD	Biological Oxygen Demand
BOD_5	The 5 Day Biological Oxygen Demand
BWG	Birmingham Wire Gage
COD	Chemical Oxygen Demand
CON	Contractor
CRT	Cathode Ray Tube
DCS	Distributed Control System
DEA	di-Ethanol Amine
DEDD	Detailed Engineering Design Data
DGA	di-Glycol Amine
DN	Diameter Nominal, in (mm)
FDF_s	Forced Draft Fans
HP	High Pressure
HPS	High Pressure Steam
ID	Inside Diameter
KO Drum	Knockout Drum

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 to 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

6.5 Explanations on Individual Items of "BEDD"

6.5.1 General matters

6.5.1.1 Design capacities

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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."

Utility services

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

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

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.

6.5.3.2.2.3 Cooling tower design conditions such as wet bulb temperature, type of treating system, cycles of concentration, filteration, 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.

WATER SPECIFICATION

DESCRIPTION	SERVICE			
SERVICE	CIRCULATING COOLING WATER	COOLING TOWER MAKE - UP	RAW WATER	TREATED WATER (BFW)
- Availability over use (dm^3/s)				
- Value (CENT/1,000 dm^3)				
- pH				
- Total hardness as $CaCO_3$ (mg/kg)				
- CALCIUM as $CaCO_3$ (mg/kg)				
- MAGNESIUM as $CaCO_3$ (mg/kg)				
- Total ALKALINITY as $CaCO_3$ (mg/kg)				
- SODIUM as $CaCO_3$				
- POTASSIUM as $CaCO_3$ (mg/kg)				
- SULFATE as $CaCO_3$ (mg/kg)				
- CHLORIDE as $CaCO_3$ (mg/kg)				
- NITRATE as $CaCO_3$ (mg/kg)				
- SILICA as SiO_2				
- Total IRON (mg/kg)				
- Suspended SOLIDS (mg/kg)				
- Dissolved SOLIDS (mg/kg)				
- COD (mg/kg)				
- Others				

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^3/s).

c) Value, in (cent/1,000 dm^3).

d) pH.

e) Total Hardness as $CaCO_3$, in (mg/kg).

f) Calcium as $CaCO_3$, in (mg/kg).

g) Magnesium as $CaCO_3$, in (mg/kg).

h) Total Alkalinity as $CaCO_3$, in (mg/kg).

i) Sodium as $CaCO_3$, in (mg/kg).

l) Potassium as $CaCO_3$, in (mg/kg).

j) Sulfate as $CaCO_3$, in (mg/kg).

k) Chloride as $CaCO_3$, in (mg/kg).

m) Nitrate as $CaCO_3$, in (mg/kg).

n) Silica as 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) Other

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

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) SOx.

b) NOx.

c) Solid Particles.

d) H2S, NH3, HCl, HF, etc..

e) Cl2, F2.

f) CO.

g) Hydrocarbons.

h) Metal and its compounds; Hg, Cu, As, Pb, Cd, etc.

Chemicals and Additives

The following chemicals shall be stipulated:

a) Solvents such as Furfural, etc..

b) NaOH, H_2SO_4, 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.

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					....	....	....	....	....	....
HPS Utility Area	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	....	....	....	....	....	....
Process Area	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	....	....	....	....	....	....
MPS (5)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	....	....	....	....	....	....
LPS (5), (2)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	.... (min.) .... (max.)	....	....	....	....	....	....
LLPS (3)	....	....	....	....	....	....	....	....	....	....

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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)	.....	.....	.....	.....	.....	.....	.....	.....

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TABLE A.3 - WATER

UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS

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
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.	....	....	....	....	....	....	....	....		

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TABLE A.5 - CONDENSATE

UNIT BATTERY LIMIT OPERATING AND EQUIPMENT MECHANICAL DESIGN CONDITIONS

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
HP Hot condensate										
LP Hot condensate										
Cold condensate										
Pump flashed condensate										

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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.

- The following information 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.

TABLE A.6 - ELECTRICAL POWER

A.6.1 ELECTRICAL SYSTEM VOLTAGE LEVELS

SYSTEM	VOLTAGE (volt)
- Generation - Power receiving from national grid - Distribution - Power (medium voltage) - Power (low voltage) - Lighting - Instrumentation - Instrumentation (Shut-Down) - Control power for all - Switchgears	

A.6.2 VOLTAGES TO THE MOTORS

MOTOR SIZE	VOLTAGE	PHASE
- Less than 0.4 kW - 0.4 kW and up to 150 kW - 151 kW and above		

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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_2S, in (mg/kg).

b.14) Header Pressure, in normal [bar(ga)].

b.15) Header Temperature, in (°C).

- The following information 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.

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
- API gravity						
- Relative density at 15.6°C						
- Viscosity at 100°C (Pa.s)						
- Viscosity at the Burner (Pa.s)						
- Temperature at the Burner (°C)						
- Lower heating value for liquid fuels (kJ/kg)						
- Lower heating value for gas fuels (MJ/Nm³)						
- Availability over use (m³h)						
- VANADIUM / NICKEL (mg/kg)						
- SODIUM (mg/kg)						
- SULFUR (mg/kg)						
- ASH content (mg/kg)						
- Flash point (°C)						
- H_2S (mg/kg)						
- Header pressure, normal [bar(ga)]						
- Header temperature (°C)						

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								

Air

a) Plant Air.

b) Instrument Air.

c) Catalyst regeneration Air.

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^3/h.

b) Driver Type of Compressor.

c) Dry Air Dew Point.

d) Oil Free Air Requirement.

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_2S flare.

6.5.4.3 Total number and service of flare KO Drums.

6.5.4.4 Status of H_2S flare stack.

6.5.4.5 Selection criteria for pressure relieve valves which shall be discharged into the H_2S 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).

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								

TABLE A.10 - AIR

AIR SYSTEM SPECIFICATIONS

DESCRIPTION	SERVICE	
	PLANT AIR	INSTRUMENT AIR
Availability, Nm^3/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		

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								

TABLE A.6 - ELECTRICAL POWER

A.6.1 ELECTRICAL SYSTEM VOLTAGE LEVELS

SYSTEM	VOLTAGE (volt)
- Generation	
- Power receiving from national grid	
- Distribution	
- Power (medium voltage)	
- Power (low voltage)	
- Lighting	
- Instrumentation	
- Instrumentation (Shut-Down)	
- Control power for all	
- Switchgears	

A.6.2 VOLTAGES TO THE MOTORS

MOTOR SIZE	VOLTAGE	PHASE
- Less than 0.4 kW		
- 0.4 kW and up to 150 kW		
- 151 kW and above		

TABLE A.10 - AIR

AIR SYSTEM SPECIFICATIONS

DESCRIPTION	SERVICE	
	PLANT AIR	INSTRUMENT AIR
Availability, Nm^3/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		

AIR SYSTEM SPECIFICATIONS

DESCRIPTION	SERVICE	
	PLANT AIR	INSTRUMENT AIR
Availability, Nm^3/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		

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 should 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:

VESSEL ID	DRAIN SIZE	VENT SIZE	STEAM OUT NOZZLE
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")

Vessels and columns

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

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

Minimum tray spacing.

Flooding factors for hydraulic design of towers.

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

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

Towers, vessels and vessel boots minimum diameter.

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

Provision of separate steam out nozzle on all vessels.

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

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

VESSEL ID	DRAIN SIZE	VENT SIZE	STEAM OUT NOZZLE
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")

On all horizontal vessels, a blanked off ventilation nozzle should 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.

Storage tanks and offsite facilities

The following requirements shall be specified on "BEDD".

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

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

Maximum blending time for preparation of each finished product.

Type of blending of the finished products.

Basic philosophy for selection of type of the tanks.

Height of the tanks.

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

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

Gas blanketing source and requirement for the storage tanks if applicable.

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 if applicable.

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(30ft). Standard lengths are 4,572(15), 6,096(20), 7,315(25) and 9,114(30) mm(ft).

d) Process fluid shall be cooled to 60°C unless otherwise noted on the process data sheet.

e) Overdesign capacity shall be considered.

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(10), 4,877(16), and 6,096(20)(ft). 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 have a TI in the control room.

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 shall be considered.

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).
- Regenerati ve (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_x emissions" shall be indicated.

6.5.5.4.4 Overdesign capacity shall be considered.

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^3/h.
- Vapor: Nm^3/h.
- Steam: kg/h.
- Chemicals: m^3/h or dm^3/s.
- Water: m^3/h.

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

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								

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 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).

6.5.7 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_2S, in mg/kg.
- CO, in mg/kg.
- SO_2, in mg/kg.
- NO_x, 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_5 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 top ographical survey drawings shall be made).

6.5.9.1.8 Direction of Mecca.

Climatic data

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 rooms, 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.

'.3.6 Emergency shut-down

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

Jtility 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.

'.3.7 Reduced operation

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

'.4 Necessary Informations

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.

7.4.1.1 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.

Process Design Criteria

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1. GENERAL

These design criteria specify the minimum requirements of the BP UNIT OF REFINERY. The PLANT shall be designed to operate satisfactory at a capacity 150 ton/day, 10 hours in a day.

2. EQUIPMENT DESIGN BASIS

DESIGN PRESSURE AND TEMPERATURE

Design Pressure (General Rules)

Design pressure of process static EQUIPMENT shall be based on the maximum operating pressure.

Design pressure shall be selected as follows:

- for max operating pressure below 2 barg use 3.5 barg
- for max operating pressure between 2 barg and 15 barg use max operating pressure + 1.5 bar

Design Pressure For Complete System

When several pieces of equipment are protected by the same relief valves, each piece of equipment shall be designed, at least, for the pressure imposed by the discharge conditions of the relief valve in case of emergency.

1. Exchangers,vessels,and other equipment on the discharge of a pump

Equipment which could have to bear the shut-off pressure of a pump in case of a valve closing (either control valve or block valve) to be designed for the following design pressure:

Design pressure= design pressure of the suction vessel + liquid height at vessel HHL at pump suction +120% of pump differential pressure at normal flow rate.

2. Thin walled Tanks and Vessels

Design pressure shall be equal to Barometric pressure plus hydrostatic pressure considering the tank full of liquid .

Design Temperature

a) Unless otherwise specified, equipment design temperature shall be established according to the criteria:

Operating Temperature (OT)	Design Temperature (DT).Min/Max.
Between -29˚C and +60˚C	Min.oper.temp./85˚C
Between +60˚C and 343˚C	Max.oper.temp./+25 ˚C

b) The design temperature is determined for the maximum temperature coincident with the design pressure as determined above. Indicate any higher temperatures as alternate design condition.

c) When, due to the possible loss of flow of the cooling medium in coolers, the tubes, tube sheets and floating heads may be subject to the full inlet temperature, it shall be selected in accordance with the maximum temperatures likely occur on each exchanger in both clean and fouled condition. The design temperature indicated in the process data sheet is the temperature of the hottest exchanger.

All calculation shall be based on the information noted on the process data sheet for worse conditions.

Purging Equipment with Steam

For equipment subject to steam purging at start-up or shutdown indication shall be given on the specification sheet.

CORROSION ALLOWANCE

Carbon steel (including low Alloy >5%Cr. Steel)

Whichever is greater:

- Corrosion allowance calculated for 20 years service.
- 3mm. for Carbon steel & .5 MO Alloy steels & 1.5mm for low Alloy steels.

NOTE: For removable Carbon steel parts o internal, a minimum of 1.5mm of corrosion allowance on each side in contact with the operating fluid shall be given.

High Alloy/Stainless Steels

High Alloy/Stainless Steels

Whichever is greater:

- Corrosion allowance calculated for 20 years of service.

- 0.75mm.

NOTE: In general no corrosion allowance will be given for removable alloyed parts of internals, however, corrosion allowance shall be specified for internal submitted to severs condition such as reactor internals.

VESSELS

Minimum flange rating shall be 150 pounds except for the following cases which shall be 300 pounds:

i. Level instrumentation pipe columns.

ii. Pressure relief valve connections.

iii. Nozzle sizes lower than 1-1/2“.

iv. Control Valve connections.

All nozzles over 1-1/2” shall be flanged. Connections 1-1/2” and smaller may be with forged steel couplings. Such connections shall be limited to vessels for which the design pressure and temperature is less than 41.4 barg and 232° C respectively. Couplings shall be 3000 PSI rating for 1-1/2” and smaller connections. Coupling shall not be used in lined portion of alloy lined vessel, on bottom heads of vertical vessels. Threaded fittings or tapped holes are permitted. The minimum size of nozzles shall be 1” except that for alloy lined nozzles the minimum size is 1-1/2”.

Separate steam-out connections shall be provided for each vessel.

On outline horizontal vessels, a manway shall be provided on the top or side of the vessel at or below the horizontal centerline. If the bottom half of the horizontal vessel is lined, the manway shall be located on the upper side or the top of the vessel.

Additionally, on horizontal vessels over 3 meters in tangent length, a blanked off ventilation nozzle shall be provided on the top of the vessel near the end, opposite the manway. The ventilation nozzle shall be sized as follows:

Vessel Tangent Length	blanked of nozzle size
-3.0 meters through 4.4 meters	4"
- Over 4.4 meters through 7.5 meters	6"
-Over 7.5 meters	8"

The minimum manway size is to be 18" (460mm). Large size to be specified when required to accommodate internal.

Manways shall be provided as follows:

- Horizontal vessels:

* 900 to 1300 mm ID: Manway on the head

* Larger than 1300 mm ID: Manway on the side or on the top

-Vertical vessels:

* Under 900 mm ID: Top head flanged

* 900 to 1300 mm ID: Manway, In shell, 18" ID

* Large than 1300 mm ID: Manway, In shell, 20" ID

All vessels shall be sized according to inside diameter and 2: 1 elliptical heads or hemispherical heads.

Liquid residence Time

The following criteria shall be used unless otherwise specified by the Licensor.

1. In case LSLL and / or LSHH is provided, the following additional hold-up times shall be taken into consideration (where, LSHH and LSLL are located above HLL and below LLL respectively):

   -Liquid hold-up time between LLL and LSLL shall be minimum 2 minutes based on the total inflow to the vessel (or section of the tower) or 3 minutes based on the liquid stream flow from the vessel, whichever is greater.

-Liquid hold-up time between HLL and LSHH shall be minimum 3 minutes based on the total inflow to the vessel (or section of the tower) or 4 minutes based on the liquid stream flow from the vessel, whichever is greater.

The minimum vapor spaces above the high liquid level in horizontal vessels should not be less than 25 percent of the vessel inside diameter or 12 inches, whichever is greater.

Sizing criteria of nozzles on vessels and towers:

a) Size of vent, drain and steam out nozzles

Vessel Diameter (mm)	Vent (Inch)	Drain (*) (Inch)	Steam-out (Inch)
Up to 1200	1½"	1½"	1"
1200-2500	2"	2"	1½"
2500-3500	3"	3"	1½"
3500-6000	4"	3"	2"
Greater than 6000	4"	4"	3"

NOTES:

- Drain on vertical vessel maybe located on bottom line.

- Select drain size to be same as process line, when process connection is to be smaller than the above table.

NOZZLES IDENTIFICATION

The following symbols shall be used for identification for the nozzles on pressure nozzles, tank, exchangers, pumps, compressors, etc.

Nozzle	Identification Symbol
A,A1,A2	Inlet
B	Outlet
C	Condensate
D	Drain
E*	-
F	Feed
G	Level Gauge or Gauge Glass
H	Hand hole
J	Pumpout
K*	-
L	Level Instrument (Also LT,LI)
M	Manhole
P	Pressure Connection (Also PT,PI)
S	Steam or Sample Connection
T	Temperature Connection(also TI,TE,TW)
V	Vapor Vent
W	Relief Valve Connection (Oversize unless
	Use E or K when none of the other symbols

LINE AND NOZZLE SIZING CIRITERIA

GENERAL

2.6.1.1 The fluid quantity to be used in the determining line sizes shall be those called for by the maximum process design flowrates and in any case shall not be less than 110% of the unit design throughput.However, line sizes shall be in compliance with the equipment (pump, exchangers, ets.) design capacity.

2.6.1.2 The friction loss shall be calculated in accordance with the standards of Hydraulic Institute on the basis of the following figures for absolute roughness of pipe:

PIPE MATERIAL	ABSOLUTE ROUGHNESS(mm)
Commercial steel	0.05
Cast Iron	0.26
Drawn Tubing	0.0015
Concrete/Cement Lining	0.30

LIQUID LINE SIZING CRITERIA (1)

Service	Friction Loss Ranges (Bar /100 m)	Velocity Range (m/s)
Pump Suction	0.05 ~ 0.10	(note 2)
Pump discharge	0.20 ~ 0.45	(note 2)
Cooling water (heater)	0.06 ~ 0.24	(note 2)
Cooling water (branches)	0.30 ~ 0.45	(note 2)
Gravity Flow	0.035 ~ (MAX.)	

NOTES:

1. The limiting factor in line sizing is either the upper limit of the friction loss range or maximum velocity (upper limit of the velocity range).

When available pressure drop in the system calls for a lower friction loss/velocity as compared to the above ranges, then such lower friction loss/velocity shall apply.

2. Velocity limit depend on line diameter.

		SUBCOOLED	BOILING
Pump suction (4) & (5)	Up to 2	0.3 ~ 0.6 m/s	Max. 0.5 m/s
	From 3 to 6	0.6 1.0 m/s	Max. 0.9 m/s
	From 8 to 10	0.8 ~ 1.5 m/s	Max. 1.2 m/s
	Over 12	0.9 ~ 3.0 m/s	Max. 2.0 m/s
Pump discharge	Up to 2	0.6 ~ 1.2 m/s	Max. 1 m/s
	From 3 to 6	1.0 ~ 2.4 m/s	Max. 2 m/s
	From 8 to 10	1.5 ~ 2.8 m/s	Max. 2.4 m/s
	Over 12	2.4 ~ 3.6 m/s	Max. 3.2 m/s

3.Reciprocation pumps line sizing criteria shall be based on the maximum flow rate of the pulse flow. Suction and discharge line for simplex and proportioning pumps should be sized for 1.6 and 3.14 of the maximum pumping rate respectively.

4. Saturate liquid pump suction lines call for larger suction nozzles to prevent vortexing, when no enough liquid depth on vessel is provided.

The line must run 6~8 times nozzle diameter vertically before reducing the size of the line.

5. Pump suction lines to be primarily sized by NPSH requirement.

6. In general for corrosive or erosive fluids velocity limits should be halved. Lines in corrosive and erosive services shall be investigated individually and in case of requirement of lower. Velocity then such lower velocity shall be based upon for the design of such line.

7. Above friction loss/velocity ranges can be slightly exceeded for short branch line, when pressure-drop is not limiting or in intermittent services.

8. Cooling water header and branches shall be based on velocity range within a max. limit of 3 m/s for branches and 2.44 m/s for main header.

GAS AND STAEM LINES SIZING CRITERIA (1)

Service Gas & Vapor	Friction loss Ranges (Bar /100 m)	Velocity range (m/s (2))
Less than 1 bar (a) (vac.)	0.01 ~ 0.02	20 ~ 30
Up to 7 bar (g)	0.02 ~ 0.1	20 ~ 30
From 7 to 69 bar (g)	0.1 ~ 0.4	20 ~ 35
Steam (saturated)		
Less than 3.5 bar (g)	3.3% of the op.	15.2 (d) (3)
From 3.5 to 17.2 bar (g)	0.1 ~ 0.3	12.0 (d) (3)

NOTES:

1.The limiting factor in line sizing is either the upper limit of the friction loss range of maximum velocity (upper limit of the velocity range). When available pressure drop in the system calls for a lower friction loss/velocity as compared to the above range, then such lower friction loss/velocity shall apply.

2.Absolute maximum velocities limits, when technically applicable, are as follows:

- gas and vapors and superheated steam

Less than 17.2 bar (g) : 50% sonic (*)

- saturated steam and superheated steam

above 17.2 bar (g) : 30.5% (d)

subject to the following absolute limitations

* saturated steam 50 m/s

(*) sonic or acoustic velocity:

- sonic velocity: 19.2 {(T/M.W)}

Where:

T = fluid temperature, deg K.

M.W = fluid molecular weight

3.d= Nominal pipe diameter (inches)

4. For corrosive or erosive fluids velocity limits should be halved.

5.Above friction loss /velocity limits can be slightly exceeded for short branch lines, when pressure drop is not limiting or in intermittent services.

UNIT OF MEASUREMENT

The following units are proposed to be used throughout this project for each type of measurement listed below.

Type of Measurement	Units
Temperature	°C
Pressure	Bar
Vacuum	mm Hg
Mass	Ton
Volume	m^3
Flow of process fluid:	
Flow of steam	Kg/hr
Enthalpy	KJ/kg
Heat duty/power	MW, kW
Transfer rate	$kW/m^2.\ °C$
Fouling resistance	$m^2.°C/kW$
Viscosity	CP
Equipment size	Mm
Pipe length	km, m
Pipe diameter	Inch
Vessel nozzle sizes	Inch

REMARKS:

The normalized conditions for gas measurement are:

- Standard:760 mm Hg,15.5°C (60°F) (Sft /min or SCFM)
- Normal :760 mm Hg, 0°C (Nm /h)

ENGINEERING STANDARD
FOR
PRESSURE STORAGE SPHERES FOR (LPG)

0. INTRODUCTION

For storage of LPG, the principal above-ground storage methods are:

1) Pressure storage at ambient temperature

2) Fully refrigerated (at around atmospheric pressure)

3) Refrigerated-Pressure

For the purpose of this Standard only the pressure storage at ambient temperature and refrigerated pressure storage are considered.

1) Pressure Storage at Ambient Temperature.

Because of the high vapor pressure of LPG the liquid at ambient temperature must be stored under pressure in vessels and spheres designed to withstand safely the vapor pressure at the maximum liquid temperature.

2) Refrigerated-pressure Storage.

(Sometimes referred to as semi refrigeration storage) of LPG combines partial refrigeration with low or medium pressure. An attractive feature of refrigerated, pressure storage is its flexibility, making it possible for a vessel to be used at different times for butane or propane.

Thus, a storage sphere designed for pressure storage of butane at atmospheric temperature could be used for the refrigerated pressure storage of propane by chilling the propane and insulating the vessel so that the vapor pressure does not exceed the sphere normal working pressure.

Refrigerated-pressure storage in spheres has the following advantages:

a) The evolved vapor (boil-off-for re-liquefication) comes off at a sufficient pressure to overcome line friction where the refrigeration equipment is remote from the sphere.

b) The ratio of surface area to volume is less, and therefore heat leak from the atmosphere is proportionately less.

"Storage Tanks" are broad and contain variable types and usages of paramount importance therefore, a group of engineering standards are prepared to cover the subject. This group includes the following standards:

STANDARD CODE	STANDARD TITLE
IPS-E-ME-100	"Atmospheric above Ground Welded Steel Storage Tanks"
IPS-E-ME-110	"Large Welded Low Pressure Storage Tanks"
IPS-E-ME-120	"Aviation Turbine Fuel Storage Tanks"
IPS-E-ME-130	"Pressure Storage Spheres (FOR LPG)"
IPS-M-PI-150	"Material and equipment standard for flanges & fittings"

1. SCOPE

1.1 This Engineering Standard covers the minimum requirements for design of pressure storage spheres. In this Standard, pressure storage means storage spheres with design pressure above 100 kPa. (1bar) gage. The requirements of this Standard apply to both refrigerated and non-refrigerated LPG pressure storage spheres.

1.2 For design of pressure storage spheres intended for storage of Liquefied Natural Gas (LNG), reference is made to NFPA Standard 59 A. "Standard for the production, storage and handling of liquefied natural gas."

1.3 This Standard Specification shall be used together and in accordance with the referenced codes and standards mentioned in.2.2

In the case of conflict between this Specification and the referred codes and standards, the most stringent requirements shall govern.

1.4 Requirements for purchasing and shop fabrication of parts to be incorporated into pressure storage spheres are covered in IPS-M-ME-130 "Material and Equipment Standard for Pressure Storage Spheres".

Field erection of pressure storage spheres shall be in accordance with "Iranian Petroleum Construction Standard for Pressure Storage Spheres" (IPS-C-ME-130).

1.5 This Standard is intended for use in oil refineries chemical plants, marketing installations, gas plants and where applicable, in exploration, production and new ventures.

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 consultant.

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

Section VIII-89	"Pressure Vessels" Code Div.1 & 2
Section II-89	"Material Specification"
Section IX-89	"Welding and Brazing Qualifications"
Section V-89	"Non-destructive Examination"

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

ASTM-E-94	"Guide for Radiographic Testing"
A 578	"Specifications for Straight-beam Ultrasonic Examination of Plain and clad steel plates for special application"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

B 16.5	"Pipe Flanges and Flanged Fittings"

API (AMERICAN PETROLEUM INSTITUTE)

API 2510	"Design and Construction of LPG Installations" Sixth Edition April 1989

NFC (NFPA) (National Fire Codes (National Fire Protection Association))

NFC 59 A	"Standard for the Production,Storage and Handling of Liquefied Natural Gas (LNG)."

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-M-ME-130	"Material and Equipment Standard for Pressure Storage Spheres"
IPS-C-ME-130	"Construction Standard for Pressure Storage Spheres"
IPS-E-GN-100	"Engineering standard for units"

3. UNITS

International system of units (SI) in accordance with IPS-E-GN-100 shall be used.

Whenever reference is made to API/ASME or any other Standards, equivalent SI unit system for dimensions, fasteners and flanges shall be substituted.

For pipe size the international nomenclature "diameter nominal" written as DN 15, 25, 40, 50, etc. has been used in accordance with ISO 6708-1980. ANSI/ASME B16.5-1981 and ANSI/ASME B31.3-1983 Also for pipe flanges pressure temperature ratings "pressure nominal" written as PN 20, 50, 68, etc. has been used in accordance with said Standards.

4. MATERIAL SELECTION

4.1 All material of construction for pressure storage spheres shall meet the requirements of Section II of the ASME Boiler and Pressure Vessel Code.

4.2 The following requirements are supplementary:

4.2.1 The selector of the material of construction for pressure parts and their integral attachments shall take into account the suitability of the material with regard to fabrication and to the conditions under which they will eventually operate.

4.2.2 Special consideration should be given to the selection of materials for pressure storage spheres designed to operate below 0°C. Austenitic stainless steels and aluminum alloys are not susceptible to low stress brittle fracture and no special requirements are necessary for their use at temperatures down to -196°C.

4.2.3 Some carbon steel material for construction of pressure storage spheres for normal services are given in Table 1.

4.2.4 Casting shall not be used as pressure components welded to the shell of pressure storage spheres.

4.2.5 Materials having a specified minimum yield strength at room temperature greater than 483 mPa (70,000 Psi) shall not be used without prior approval of the Owner's Engineer.

4.2.6 Materials of non-pressure retaining parts to be welded directly to pressure retaining parts shall be of the same material as the pressure retaining parts.

4.2.7 Material of attachments other than those mentioned in para.4.2.6 above, such as lower support columns, platforms, stairways, pipe supports, insulation support rings, shall be carbon steel of ASTM A 283 Gr.C or equivalent. External non-pressure retaining part boltings shall be carbon steel of ASTM A 307 Gr. B or equivalent.

4.2.8 The internal bolts and nuts including U-Bolts shall be of type 410 or 405 stainless steel material.

4.2.9 Material of anchor bolts shall be carbon steel of ASTM A 307 Gr.B. or equivalent.

TABLE 1 - SOME CARBON STEEL MATERIAL FOR PRESSURE STORAGE SPHERES FOR NORMAL SERVICES

PARTS	ASTM SPECIFICATION
SHELL AND HEAD PLATES	A 285 A 442 A 516 A 537 CL.2 A 662
FLANGE MIN. OF PN 20 (150#)	A 105
NOZZLES NECK	A 53 GR. B SEAMLESS A 106 GR.B FOR LARGE SIZE NOZZLES AND MANHOLES NECK, SAME MATERIAL AS SHELL PLATES SHALL BE USED.
BOLTS NUTS	A 193 GR.B7 A 194-GR.2H

5. GENERAL INFORMATION

Whilst this Standard concerns pressure storage spheres for LPG only it is important to have some indication of the basic differences between LPG and LNG.

"Liquefied Petroleum Gas "(LPG) refers, in practice, to those C3 and C4 hydrocarbons, i.e. propane, butane, propylene, butylene and the isomers of the C4 compounds that can be liquefied by moderate pressure. Methane and mixtures of methane with ethane cannot be liquefied by pressure alone, since the critical temperatures of these gases are too low and some pre-cooling is required. The liquefied forms of methane/ethane are loosely referred to as liquefied natural gas (LNG) Some examples of the main gases, together with their boiling-points at atmospheric pressure are given in the Table 2 below:

TABLE 2 - FORMULA AND BOILING POINTS OF LPG AND LNG

LPG NAME	CHEMICAL FORMULA	B.P. °C	LNG NAME	CHEMICAL FORMULA	B.P. °C
PROPYLENE	C_3H_6	-47.7			
PROPANE	C_3H_8	-42.5	METHANE	CH_4	-161.5
BUTYLENE	C_4H_8	- 6.9	ETHYLENE	C_2H_4	-103.7
BUTANE	C_4H_{10}	0.5	ETHANE	C_2H_6	- 88.6

As it is seen from the boiling points listed in the Table 2 above, to liquefy these gases for ease of storage and transportation it is normally necessary to reduce the temperature to well below ambient or to pressurize them until a liquid is formed. In practice,temperature reduction by refrigeration, pressurization,or a combination of the two, are commonly used to achieve liquefaction.

Commercial grades of propane and butane are not pure compounds, thus commercial propane is mainly propane with small amounts of other hydrocarbons such as butane, butylene, propylene and ethane. and commercial butane is mainly normal butane and iso-butane, with small amounts of propane, propylene and butylene.

6. DESIGN

6.1 General

Design of pressure storage spheres shall be in accordance with Section VIII of the ASME "Boiler and Pressure Vessel Code" Div.1 or 2.

6.2 Design Data

6.2.1 The following requirements shall be considered as supplementary. The shell plates and column supports of pressure storage spheres shall be designed based on the severest loading under the following two conditions:

6.2.1.1 Condition I (Normal Operating Condition):

a) Load combination shall be considered on the assumption that the following loads act simultaneously:

-Internal or external pressure, when necessary, at design temperature.

-Operating weight.

-Wind load or earthquake load, whichever governs.

b) The shell plate thickness shall be that corresponding to the corroded condition, that is to say, nominal thickness minus corrosion allowance.

6.2.1.2 Condition II (Condition of hydrostatic testing at the operating position).

a) Load combination shall be considered on the assumption that the following loads act simultaneously:

-Internal pressure due to hydrostatic test.

-Empty weight of the sphere.

-Weight of water for testing.

-One-third the wind load.

b) The shell plate thickness shall be that corresponding to the corroded condition, i.e. nominal thickness minus corrosion allowance.

6.2.2 Corrosion allowance

6.2.2.1 Generally, minimum corrosion allowance of 1.5 mm shall be provided for carbon steel material, unless otherwise specified. No corrosion allowance shall be provided for high alloy or non-ferrous materials.

6.2.2.2 All pressure retaining parts shall be provided with the specified corrosion allowance on all surfaces exposed to corrosive fluid.

6.2.2.3 For non-removable internal parts, one-half of specified corrosion allowance shall be added to all surfaces and one-fourth of the corrosion allowance shall be added to all surfaces of removable internal parts.

6.2.2.4 No corrosion allowance shall be provided for external parts, unless otherwise specified.

6.2.3 The pressure retaining parts of pressure storage spheres and their support columns shall be designed to be filled with water.

6.2.4 Pressure storage spheres shall be supported so that the bottom is no less than 1 m above finished grade.

6.3 Calculation Of Safe Volume

6.3.1 The volume of liquid stored in a vessel must be limited to allow sufficient room for thermal expansion. The maximum volume (V) of liquid gas at a certain temperature (T°C) that may be charged into a vessel is determined by the formula:

$$V = \frac{D \not\subset W}{G \not\subset F \not\subset 100}$$

Where:

***W* =** Water capacity of storage vessel at 15.6°C (60°F)

***D* =** Maximum filling density. (Table 3).

***G* =** Specific gravity of liquid gas at 15.6°C.

***F* =** Liquid volume correction factor from temperature T° to 15.6°C. (Table 4)

6.3.2 The filling density (D) is the percent ratio of the weight of liquid gas in a vessel to the weight of water required to fill the vessel at 15.6°C and can be obtained from Table 3.

6.3.3 A volume correction Factor (F) is necessary because the lower the temperature of the liquid below ambient at the time of filling the vessel, the greater will be the expansion when the temperature of the liquid reaches ambient. Volume correction factor (F) can be obtained from Table 4.

ENGINEERING STANDARD
FOR
LAYOUT AND SPACING

This Standard Specification covers the basic requirements of the plant layout and spacing of oil & gas refineries, petrochemical and similar chemical plants to ensure safety and fire prevention together with ease of operation and maintenance.

API (AMERICAN PETROLEUM INSTITUTE)

RP-500 A "Recommended Practice for Classification of Location for Electrical Installation in Petroleum Refineries", Edition Fourth, Jan. 1982

API Std. 620 "On Large, Welded, Low Pressure Storage Tanks"

API Std. 650 "On Welded Steel Tanks for Oil Storage"

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

"Boilers and Pressure Vessel Codes":

- Section I, Power Boilers
- Section VIII, Pressure Vessels

ASCE (AMERICAN SOCIETY OF CIVIL ENGINEERS)

"Minimum Design Loads for Structures"

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-C-ME-100 "Atmospheric Above Ground Welded Steel Storage Tanks"

IPS-E-EL-110 "Electrical Area Classification & Extent"

IPS-C-ME-110 "Large Welded Low Pressure Storage Tanks"

IPS-C-ME-120 "Aviation Turbine Fuel Storage Tanks"

IPS-C-ME-130 "Pressure Storage & Spheres (for LPG)"

IPS-E-CE-160 "Geometric Design of Roads"

IPS-G-PI-280 "Pipe Supports"

IPS-E-PR-360 " Process design of liquid & gas transfer & storage "

IPS-E-SF-200 "Fire Fighting Sprinkler Systems"

IPS-C-SF-550 "Safety Boundary Limits"

IPS-D-PI-102 "Typical Unit Plot Arrangement & Pipeway Layout"

IPS-D-PI-103 "Pipeline Spacing"

ANSI (AMERICAN NATIONAL STANDARD INSTITUTE)

ANSI-MSS Standards, "Piping Hanger and Supports", 1969 Edition

NFPA (NATIONAL FIRE PROTECTION ASSOCIATION)

NFPA "Recommendation Codes and Standards" (See Table A-1 in Appendix A)

NFPA, 59 "Standard for the Storage and Handling of Liquefied Petroleum Gases", Ed. 1989

NFPA, 251 "Standard Methods of Fire Tests of Building, Construction and Materials", Ed. 1985

IRI (INDUSTRIAL RISK INSURANCE)

"Requirement on Spacing of Flare"

TEMA (TUBULAR EXCHANGER MFRS. ASSN. STANDARD)

Uniform Building Code, (UBC) "From International Conference of Building Office", 1991 Ed.

DEFINITIONS AND TERMINOLOGY

Dike بند

L3 Is an earth or concrete wall providing a specified liquid retention capacity.

Diversion Wall

Is an earth or concrete wall which directs spills to a safe disposal area.

Fire Resistive

Fire resistance rating, as the time in minutes or hours, that materials or assemblies have withstand a fire exposure as established in accordance with the test of NFPA 251.

L3 نگهداری

Lastsavior; 2007/08/23

High Flash Stock

Are those having a closed up flash point of 55°C or over (such as heavy fuel oil, lubricating oils, etc.).

This category does not include any stock that may be stored at temperatures above or within 8°C of its flash point.

Low-Flash Stocks

Are those having a closed up flash point under 55°C such as gasoline, kerosene, jet fuels, some heating oils, diesel fuels and any other stock that may be stored at temperatures above or within 8°C of it's flash point.

Non-Combustible

Material incapable of igniting or supporting combustion.

Pipe Rack

The pipe rack is the elevated supporting structure used to convey piping between equipment. This structure is also utilized for cable trays associated with electric-power distribution and for instrument tray.

Plot Plan

The plot plan is the scaled plan drawing of the processing facility.

Sleepers

The sleepers comprise the grade-level supporting structure for piping between equipment for facilities, e.g., tank farm or other remote areas.

Toe Wall

Is a low earth, concrete, or masonery unit curb without capacity requirements for the retention of small leaks or spills.

Vessel Diameter

Where vessel spacing is expressed in terms of vessel diameter, the diameter of the largest vessel is used. For spheroids, the diameter at the maximum equator is used.

Vessel Spacing

Is the unobstructed distance between vessel shells or between vessel shells and nearest edge of adjacent equipment, property lines, or buildings.

SYMBOLS AND ABBREVIATIONS

BP = Boiling Point

HVAC = Heating, Ventilation and Air Conditioning

IC = Incombustibles

IRI = Industrial Risk Insurance

LPG = Liquefied Petroleum Gas

NFPA = National Fire Protection Association

OD = Outside Diameter

OGP = Oil, Gas and Petrochemical

OIA = Oil Insurance Association

SIC = Sheathed Incombustible

TEMA = Thermal Exchargers Manufacturers Association

SOME KEY ISSUES RELATED TO LAYOUT

Safety and Environment

Familiarization with pertinent Environmental Regulations, (Local, National and International), and how they might change is essential perior to conclusion of pre-project studies.

Attention shall be given to the pertinent safety regulations, including health and welfare needs. Hazardous and flammable materials require special handling, which can take up layout space.

If the process fluids are especially toxic, layout is affected by the need for close chemical sewers and other protection measures. Security requirements may require special layout design when the plant produces a high-value product.

If a plant site is governed by particular building, piping, plumbing, electrical and other codes, these can affect plant layout. Similar governing standards and regulation

Throughput

It is important not only to know the initial capacity but also to have a good feel for how much the plant might be expanded in the future, as well as how likely the process technology is to be modernized. These factors indicate how much space should be left for additional equipment.

Multiple processing lines (trains), are often required for the plant. Pairs of trains can either be identical or be mirror images. The former option is less expensive. But the mirror image approach is sometimes preferable for layout reasons. Two such reasons are:

a) For operator access via a central aisle.

b) The need that the outlet sides of two lines of equipment (pumps, for instance) point toward each other so that they can be readily hooked to one common line.

BASIC CONSIDERATIONS

General

The plant layout shall be arranged for:

a) maximization of safety;

b) prevention of the spread of fire and also ease of operation;

c) maintenance consistent with economical design and future expansion.

Blocking

The plant site shall be blocked in consideration of hazards attendant to plant operation in the area. All blocked areas shall be formed as square as possible by divided access roads and/or boundary lines.

Location and Weather

The plant layout shall be arranged in consideration of geographic location and weather in the region of the site.

Prevailing Wind

Where the prevailing wind is defined, the administration and service facilities and directly fired equipment, etc., shall be located windward of process Units and storage tanks, etc.

Layout Indication

The basic requirements to be met in the appropriate diagram when making a piping and equipment layout are:

All equipment, ladders, structures, shall be indicated.

All instrument shall be located and indicated.

All valving and handwheel orientations shall be indicated.

Drip funnel locations for underground drains shall be indicated.

All electrical switch grears, lighting pannels shall be indicated.

All sample systems shall be indicated

PLANT LAYOUT

Area Arrangement

Classified blocked areas, such as process areas, storage areas, utilities areas, administration and service areas, and other areas shall be arranged as follows:

1) The process area shall be located in the most convenient place for operating the process Unit.

2) The storage area shall be located as far as possible from buildings occupied by personnel at the site, but should be located near the process area for ready operation of the feed stocks and product run-downs.

3) The utilities area shall be located beside the process area for ready supply of utilities.

4) Loading and unloading area shall be located on a corner of the site with capable connection to public road directly, for inland traffics. For marine transportation, the area shall be located on the seaside or riverside in the plant site.

5) The administration and service area shall be located at a safe place on the site in order to protect personnel from hazards. It shall preferably be located near the main gate alongside the main road of the plant.

6) Flare and burn pit shall be located at the end of the site with sufficient distance to prevent personnel hazard.

7) Waste water treating Unit shall be located near at the lowest point of the site so as to collect all of effluent streams from the processing Unit.

8) The process Unit to which the feed stock is charged first, shall be located on the side near the feed stock tanks, to minimize the length of the feed line.

9) The process Unit from which the final product(s) is (are) withdrawn, shall be located on the side near the products tanks to minimize the length of the product run-down line.

10) Process Units in which large quantities of utilities are consumed, should be preferably located on the side near the utility center.

Roadways

1) Road and access ways shall offer easy access for mobile equipment during construction and maintenance, fire fighting and emergency escape in a fire situation.

2) Unless otherwise specified by the Company, the defined roads shall be made as stated in **IPS-E-CE-160**, "Geometric Design of Roads".

3) Access roads shall be at least 3 m from processing equipment between road edges to prevent vehicle collisions.

Piperacks and Sleepers

piperack for process Units and pipe sleeps for the off-site facilities shall be considered as the principals support of the pipe way

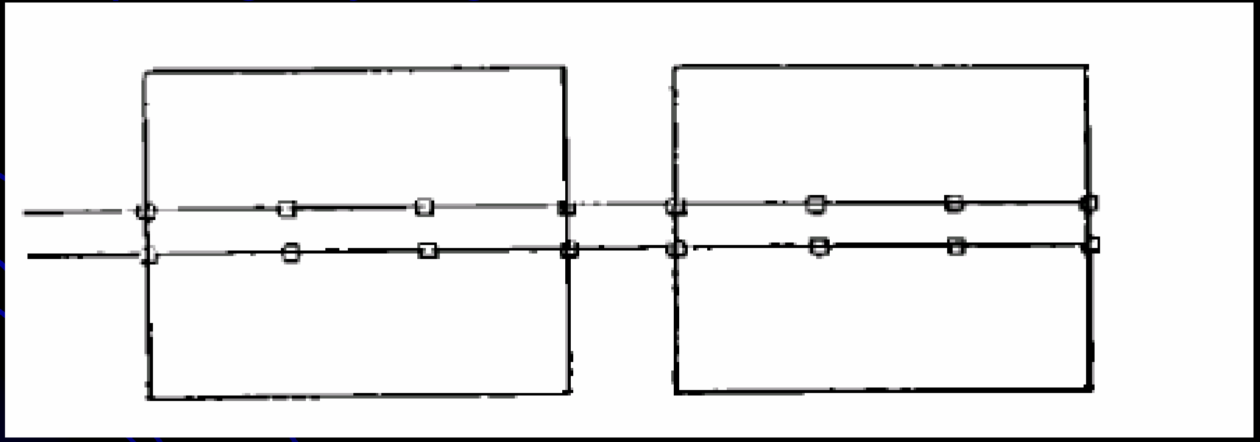
Single level pipe racks are preferred, if more than one level is required, the distance between levels oriented in the same direction shall be adequate for maintenance but not less than 1.25 meters

Maximum piperack widths shall be 10 m. If widths larger than 10 m are required, the piperack shall be designed to be of two stage. Actual widths shall be 110% of the required widths or the required widths plus 1m. In cases where air fin coolers are to be placed on the piperacks, the piperack widths shall be adjusted based on the length of the air coolers.

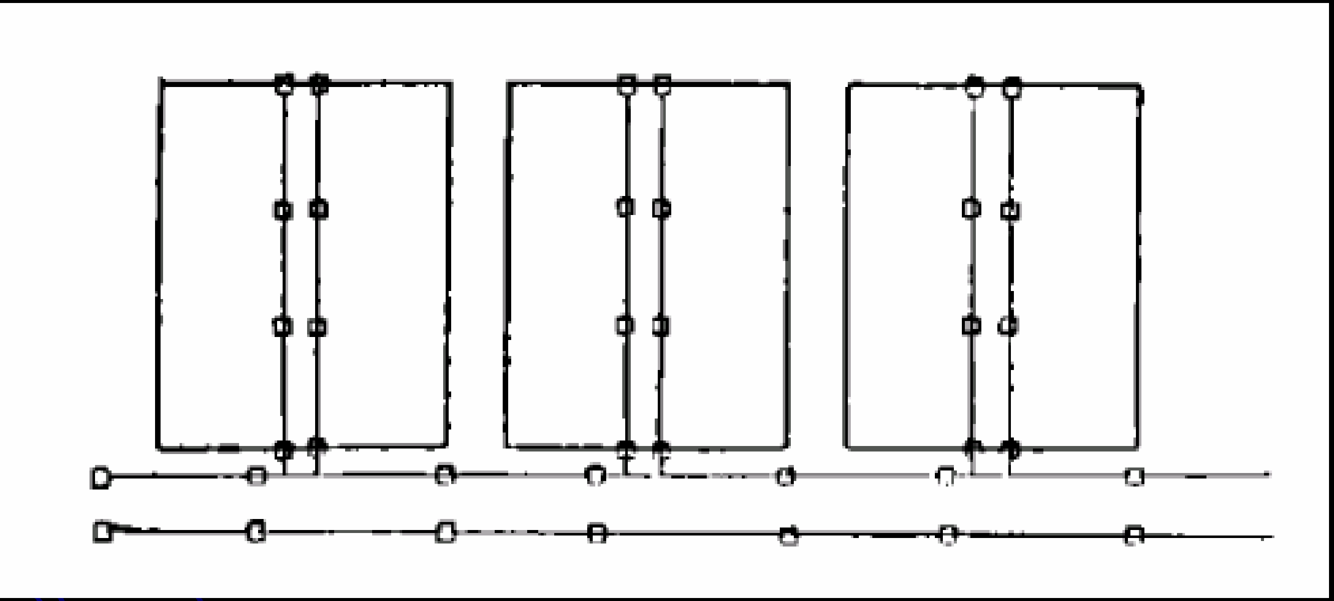
- Allow ample space for routing instrument lines and electrical conduit. Provide 25% additional space for future instrument lines and electrical
- Provide 20% additional space on the pipe rack for future piping
- Pipe racks outside process areas shall have the following minimum overhead refinery/plant clearances: main roadway -5 meters , access roads -4.5 meters, railroads -6.7 meters above top of rail.

Typical layout of piperack, for process plants depending on the number of process Units incorporated and the process complexities are given in Figs. 1 through 4 with reference descriptions as follow:

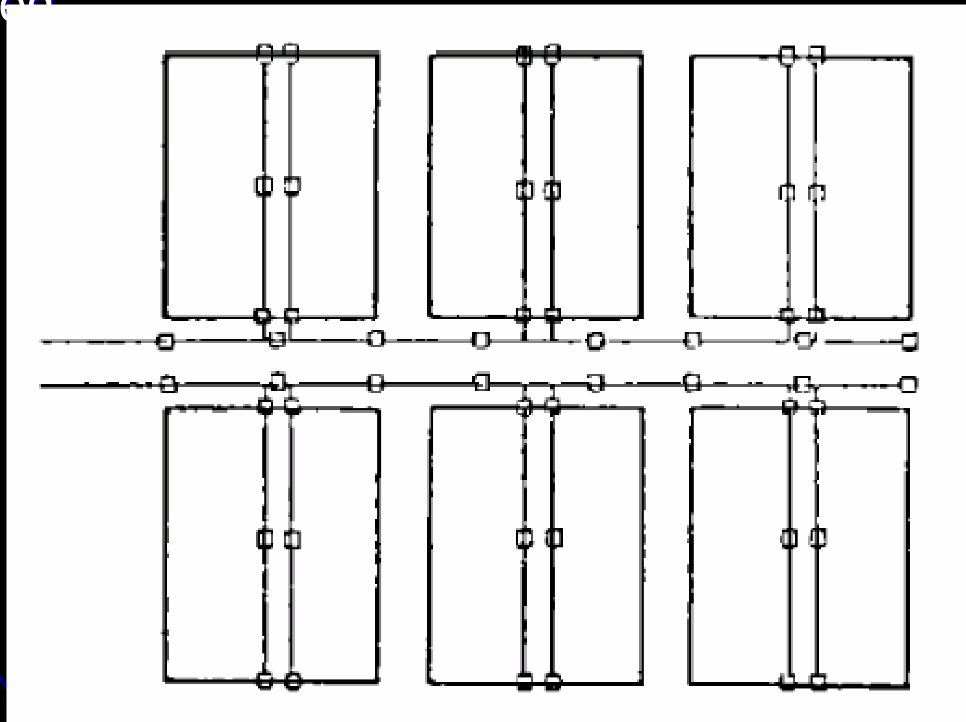
a) "Single Rack Type" layout, is suitable for small scale process complex consisting of two-three process Units. It is economical without requiring any large area.



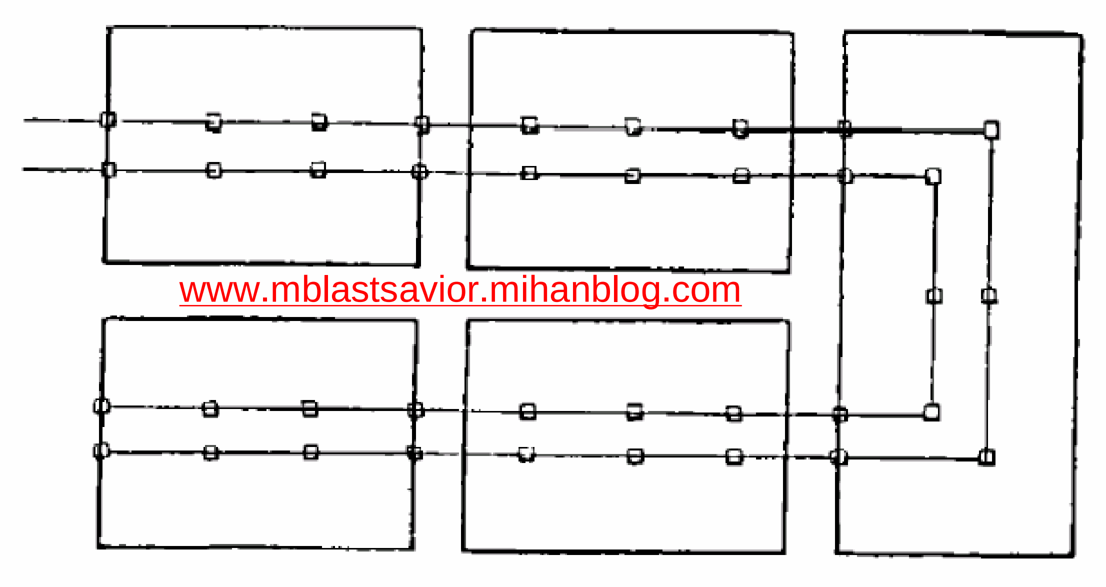
"Comb Type" layout shown in Fig. 2, is recommended for use in process, complex consisting of three or more process Units. "Single Rack Type" in this case will not be suitable since separate maintenance and utility administration in normal operation will be difficult because of the utility and flare line which are placed on the common rack.



"Double Comb Type" layout is an expansion of the "Comb Type" which is recommended for the use in largescale process complexes where five to ten process Units are to be arranged. This layout as shown below in Fig. 3, can be conveniently utilized.



"U Type" layout shown in Fig. 4, is recommended to be used in case of process Units whose maintenance cannot be conducted separately, within the complex. This type can be regarded as an expansion of the "Single Rack Type". Even process complexes of this nature, can be regarded as one process Unit in the planning of their layout.



- The control room and substation shall be located from an economical standpoint so as to minimize the length of electrical and instrument cables entering and leaving therefrom
- The control room shall be positioned so that the operator can command a view of the whole system which is under control. Large buildings, or equipment shall not be placed in front of the control room.

APPENDIX A (continue)

TABLE A.7 - PROXIMITY OF REFRIGERATED STORAGE VESSELS TOBOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES	MINIMUM SPACING OF DOME ROOF TANKS	MINIMUM SPACING OF SPHERES OR SPHEROIDS
Property lines adjacent to land which is developed or could be built upon public highways, and main, line railroads	60 m (1)	60 m (1)
Utility plants. buildings of high occupancy (offices, shops, labs, wear-houses etc.)	1½ vessel diameter but not less than 45m not exceed 60 m (1)	60 m (1)
Process equipment (or nearest process unit limits if firm layout not available)	1 vessel diameter, but not less than 45 m need not exceed 60 m (1)	60 m (1)
Non-Refrigerated pressure storage facilities	1 vessel diameter, but not less than 30 m need not exceed 60 m	¾ vessel diameter but not less than 30 m need not exceed 60 m
Atmospheric storage tanks (stock closed cup flash point under 55°C)	1 vessel diameter, but not less than 30 m need not exceed 60 m	1 vessel diameter, but not less than 30 m need not exceed 60 m
Atmospheric storage tanks (stock closed cup flash point 55°C or higher)	½ vessel diameter, but not less than 30 m need not exceed 45 m	½ vessel diameter, but not less than 30 m need not exceed 45 m

Note:

1) Distance from boundary line or facility to centerline of peripheral dike wall surrounding the storage vessel shall not be less than 30 m at any point.

APPENDIX A (continue)
TABLE A.8 - PROXIMITY OF ATMOSPHERIC STORAGE TANKS TO BOUNDARIES AND OTHER FACILITIES

BOUNDARY LINES OR OTHER FACILITIES:	MINIMUM DISTANCE FROM:			
	Low flash or crude stocks in floating roof tanks	Low flash stocks in fixed roof tanks	Crude stocks in fixed roof tanks	High flash stocks (1) in any type of tank
Property lines adjacent to land which is developed or could be built upon, public highways, main line railroads, and manifolds located on marine piers	60 m	60 m	60 m	45 m (3)
Buildings of high occupancy (offices, shops, labs, ware-houses, etc.)	1½ tank diam; but not less than 45 m need not exceed 60 m	1½ tank diam; but not less than 45 m need not exceed 60 m	60 m	1 tank diam., but not less than 30 m need not exceed 45 m (3)
Nearest process equipment, or utility plant (or nearest unit limits if firm layout not available)	45 m	45 m	60 m	1 tank diam., but not less than 30 m need not exceed 45 m (3) (3) (4)

سخن پایانی

به نظر می رسد در عصری که آن را عصرانفجار اطلاعات نامیده اند ومن آن را عصر روشن ایران می نامم، مهمترین دغدغه برای پیشرفت و ترقی پیدا کردن منابع درست مطالعاتی می باشد.در جزوات اخیر سعی شده است بر اساس تجربه و مطالعه چندین منبع مختلف بهترین سیستم آموزشی برای سریعترین نتیجه گیری ارائه شود.

مطمئن باشید که با بخشش علمی به اطرافیان درهای پنهان و ناگشوده علم را بر روی خود گشوده خواهید دید! این درسی است که از طبیعت گرفتم .قدرتمندی و ویران کنندگی یک گردباد به میزان خلا درون آن بستگی دارد.انتقال دانش به دیگران همان منشا خلا علمی شماست.

این جزوه تقدیم می شود به پدر و مادرم که پشتوانه ای بی بدیل برای این حقیر بودند.

و با تشکر از تمام کسانی که صمیمانه در این راه یاورم بودند که امیدم به ایران فردا به دلیل بخشندگی و تواضع علمی این گروه اندک است !!

از منابع دوستان با تشکر فراوان از زحمات این عزیزان در جزوات استفاده شده است:

اموزش **Hysys**	نوشته رضا درستی-غلامرضا باغمیشه
اموزش **Aspen Plus**	نوشته رضا درستی-غلامرضا باغمیشه
اموزش **Aspen Plus**	نوشته محمد پوربافرانی
روشهای کنترل فرآیند	مهندسین مشاور تهران رایمند
ابزار دقیق و کنترل فرآیند	مهندس محسن تقوی فر
Carl Branan	**Rules of thumb for chemical engineers**
ernest ludwig	**Applied process design**
Stanley walas	**Chemical process equipment**

به طور قطع این جزوه خالی از اشکال نمی باشد. خواهشمند است در تصحیح و بهتر نمودن آن از طریق تماس این حقیر را یاری نمایید.

در صورت تمایل آماده به همکاری علمی با دوستان جدیدم برای افزایش سطح علمی طرفین خواهم بود!

برای دریافت رایگان جزوات با اینجانب تماس و هماهنگی فرمایید.

همواره آخرین جزوه به روز شده هر مبحث از طریق وبلاگ قابل دانلود می باشد.(بخش مهندسی شیمی)

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