Design Basis

Rev.	Description	Date	Made by	Chd.	Appd.
4	Revised as indicated	06-APR-2011	LOJ	ST	ST
3	Revised as indicated	05-NOV-2010	LOJ	ST	ST
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1	Revised O2 and NG pressure	21-SEPT-2009	CRS		
0	First issue	11-SEPT-2009	LOJ/BON		

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1 Design basis

This document defines the design basis for a methanol plant with a nameplate production capacity of 5,000 MTPD of purified methanol to Sabalan Industrial Petrochemical Co. The plant will be located in Bandar Assaluyeh in Iran.
The plant must be able to operate at 100% on lean as well as rich natural gas.

1.1 Plant capacity for design

Methanol product, MTPD (Grade AA), as 100% MeOH	5,000

1.2 Hours of operation

One year is defined as 7,920 hours.

1.3 Raw material

1.3.1 Natural gas

Natural gas will be used as feed and fuel for the production.

Composition, mol%,	Lean	Rich
Lower heating value, (MJ/Nm³)	34. 5	37.0
Methane	95.0	85.8
Ethane	0.44	5.5
Propane	0.23	2.0
i-Butane	-	0.3
n-Butane	-	0.5
C4+	-	0.04
Nitrogen	4.0	5.0
Carbon dioxide	0.327	0.857
Water	0.003	0.003

Sulphur content	
Total sulphur, mol ppm, max.	5.0
Maximum possible content of organic sulphur, mg/Nm^3	17.3
Maximum possible content of hydrogen sulphide, mg/Nm^3	5.3

1.3.1.1 Battery limit conditions

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	55	55	55	60
Temperature	°C	35	40	40	85

1.3.2 Oxygen

Composition, mole%	
O_2	99.80
Ar	0.195
N_2	0.05

1.3.2.1 Battery limit conditions

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	40	42	43.5	47
Temperature	°C		Ambient		85

1.4 Products

1.4.1 Methanol

As Grade AA specification

Acetone and aldehydes, wt, percent max	0.003
Acetone wt percent max:	0.002
Ethanol, wt percent:	Less than 0.0008
Acidity (as acetic acid), wt percent max.	0.003

Appearance and hydrocarbons

Free of opalescence suspended matter and sediment (clear – colourless)

Carbonizable substances colour

Not darker than colour standard no.30 of ASTM, D1209, platinum – cobalt scale

Colour,

Not darker than colour standard no.5 of ASTM-D1209, platinum-cobalt scale

Distillation range

Not more than 1^0C and shall include 64.6 ^{0}C + 0.10 ^{0} C at 760 mmHg

Specific gravity, max	0.7928 at 20 ^{o}C/20 ^{o}C
Percent methanol by weight, minimum	99.85
Non-volatile content, mg / 1000 ml max	8

Odour

Characteristics non-residual

Permanganate fading time

No discharge of colour in 50 minutes

- Water content, wt percent max	0.10
Alkalinity (as ammonia)	0.003 wt% max
Iron (ppm)	Lees than 0.03
Chloride (ppm)	Less than 0.1
TMA (ppb)	Less than 20

1.4.1.1 Battery limit conditions

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	4.5	5.0[1]	7.0	8.5[2]
Temperature	°C	25	48	50	85

[1] The methanol pump must be designed for transport to storage tank. Distance 2.5 km, height of tank 20 m. level difference on site +12meter

[2] Must be confirmed by maximum pump shut off pressure

1.5 Utilities

1.5.1 Steam

1.5.1.1 HHP superheated steam

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	-	98	-	112
Temperature	°C	-	454	-	490

Min fouling factor for heat exchanger design, m²°C/W 0.00020

1.5.1.2 HP superheated steam import/export

HP super heated steam must be available for start up and shut down.

Min. steam quality:

		Pure Steam
Conductivity µS/cm (after cationic exchanger, and CO_2 removal)		<1
Ammonia wt-ppm (water treatment in deaerator by amine (morpholine))	Natural Gas	<1
Volatile alkalizing Amines, wt-ppm		<15
Methanol, wt-ppm		<4
CO_2, wt-ppm		<2
SiO_2, wt-ppm		<0.02
Fe, wt-ppm		<0.02
Cu, wt-ppm		<0.03
Na+K, wt-ppm		<0.02

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	38	43	47	52
Temperature	°C	400	410	430	470

Min fouling factor for heat exchanger design, m²°C/W 0.00025

1.5.1.3 LP steam

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Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	6.5	7	8	9.5
Temperature	°C	-	217[3]		340

1.5.2 Nitrogen

Nitrogen for process

Quality:		
Nitrogen, vol %, min.	99.9	
Oxygen, ppm (vol), max	2	.
CO, ppm (vol), max.	10	
CO_2, ppm (vol), max.	10	
Water, ppm (vol), max.	1	
Sulphur, ppm (wt), max.		0.2
Oil	Nil	

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	6	6	8	10.5
Temperature	°C		Ambient		75

1.5.3 Hydrogen for start-up (Optional)

Flow, Kg/h	500
Quality:	
Hydrogen, vol %, min.	95
N2 and Ar,	Balance

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	-	25	-	28
Temperature	°C	-	40	-	85

Start up with methanol must be considered.

[3] Extraction steam from steam turbine

1.5.4 Demineralised water

Quality:

Parameters	Unit	Quantity
pH	-	6.5-7.5
Total hardness	mg/kg as $CaCO_3$	Absent
Chloride as Cl	mg/kg as Cl	<0.1
Iron	mg/kg as Fe	<0.02
Silica	mg/kg as SiO_2	<0.02
Total dissolved solid	mg/kg	<0.1
Copper	mg/kg as Cu	<0.003
Conductivity	µS/cm	<0.15
Sulphur (as SO_4^{2-})	mg/kg	<0.2
Sodium (Na)	mg/kg	<0.01
$KMnO_4$ consumpt. Mn(VII)□Mn(II), as $KMnO_4$	mg/kg	<3
Oil, grease	mg/kg	<1

Min fouling factor for heat exchanger design, m²°C/W 0.00020

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g		5		7
Temperature	°C		Ambient		65

1.5.5 Cooling water

Closed loop water as cooling media:

Quality
pH 7.5
Chloride, as Cl, mol ppm 10

Min. fouling factor for heat exchanger design, m²°C/W 0.00030

Battery limit conditions:

Parameter	Units	Supply	Return	Mech. design
Pressure	bar g	4.5	1.5	7.5
Temperature	°C	38	Max. 48	100

Turbine steam condenser will be cooled by closed loop cooling water.

1.5.6 Instrument air

Dew point, at 9 bar g -40
Quality Free from oil, dust and water droplets

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	6	7	7.5	10.5
Temperature	°C		Ambient		75

1.5.7 Plant air

Quality Free from oil, dust and water droplets

Battery limit conditions:

Parameter	Units	Min.	Norm.	Max.	Mech. design
Pressure	bar g	7	7.5	8	10.5
Temperature	°C		Ambient		75

1.5.8 Electricity

Electricity is to be generally supplied at 20000 V, 3 phases, 3 wires 50HZ. The standard voltage ratings for various utilization loads are as follows:

Item No.		AC/DC	Rated Voltage	Phase/Wire
1.	Motors			
	2500 KW and above	AC	11 kV	3/3
	Above 150KW	AC	6000V	3/3
	0.2KW and including 150KW	AC	400V	3/3
	below 0.2KW	AC	230V	1/2
2.	Construction &	AC	230/400V	1/2
	Maintenance			3/4
3.	Lighting Fixtures	AC	230V	1/2
4.	Emergency Lighting Fixtures	AC	230V	1/2
5.	Instruments	AC	110V	1/2
6.	Controls for H.T. Boards	DC	110V	-
7.	Controls for L.T. Boards	AC	230V	1/2
8.	Expected short circuit level	500 MVA at 20 KV supply		

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1.6 Process effluents

1.6.1 Boiler blow down to BL

	Normal	Mech. design
Pressure, bar g	5.0	8.0
Temperature, °C	48	85

1.6.2 Liquid off stream to BL

	Normal	Mech. design
Pressure, bar g	3.0	8.0
Temperature, °C	48	85

1.7 Plot area

The plot area of the ISBL unit is: 356.23 m x 196.5 m

1.8 Mechanical design conditions

1.8.1 Design pressure

The design pressure has to be determined as the largest pressure calculated based on the design criteria listed below.

- For max operating pressure below 2 barg use 3.5 bar g
- For max operating pressure between 2 barg and 15 bar g use max operating pressure + 1.5 bar
- For max operating pressure between 15 barg and 100 bar g use max operating pressure x 110%
- For max operating pressure equal or above 100 barg use max operating pressure + 10 bar.

1.8.2 Design temperature

Design temperature for process equipment should be whichever is higher:

- 60 °C
- Maximum operating temperature + 15 °C at least (+25ºC for feed/effluent exchanger)
- Boiling temperature at design pressure of process medium inside, if applicable.

Design temperature should be rounded up to full 5 °C steps.

Design minimum temperature should be specified only if the minimum operating temperature is below 0 °C. Design minimum temperature should be 5 °C less than the minimum operating temperature. Special attention should be given to low boiling liquids such as LPG.

1.8.3 Corrosion allowance

Materials of construction and corrosion allowance for all equipment and machinery should be for a design life of 20 years (except for heat exchanger tubes).

However, minimum corrosion allowance should be for carbon steel (including 0.5 Mo alloy steels)

Pressure vessels and other applicable equipment	3 mm
Storage tanks	1.5 mm
Piping	1.5 mm
Removable parts or internals	
(on each side in contact with operating fluid)	0.75 mm
For stainless steel/titanium / aluminium / alloy	0 mm
Carbon steel with epoxy resin coating	3 mm

1.9 Site conditions

1.9.1 Temperature

Maximum recorded temperature :	52 °C
Minimum dry bulb temperature (*winter*)	5 °C
Winterizing temperature	Not to be considered
Max. wet bulb temperature (*summer*):	33 °C
Max. dry bulb temperature (*summer*):	48 °C
Dry bulb temperature for design of air coolers:	50 °C
Max temperature for mechanical, civil and structural design:	55 °C
Max temperature for equipment exposed to sunlight (design):	85 °C
Design temperature for electrical equipment	
Max. outdoor	48 °C
Max. indoor	45 °C

1.9.2 Humidity

Relative humidity for design	
Ambient Air Relative Humidity	
Maximum in summer	76%
Minimum in winter	74%
Design relative humidity :	
At max. temp. (summer)	65%
At min. temp. (winter)	100%
Electrical equipment	80%

1.9.3 Barometric pressure

Min., mbar	990
Max., mbar	1100

1.9.4 Wind

Shape factor, please refer to building standards as per contractual codes & standards.

Note: Wind design criteria to be based on the UBC. code.

Maximum wind velocity (up to 10m elevation):

Structure calculation:	125 km/h
Flare thermal radiation:	16 m/sec

Prevailing wing direction from NW to SE for mechanical & civil design purpose is to be considered from all directions

1.9.5 Precipitation and snow level

3 min, mm	17
10 min, mm	24
60 min, mm	40
Maximum daily precipitation (24 h)	70

Snow load

Design snow load:	25 kg/m^2

1.9.6 Earthquake

The area has to be classified as a zone 4 as per the uniform building code.

1.9.7 Emissions

NOx, vol ppm, (dry, 3%O_2) max.	100
CO, vol ppm, (dry, 3%O_2) max.	20

1.9.8 Noise

Maximum dB(A) at 1 m from equipment	85

1.10 Codes and standards

The below codes and standards will be applied. Topsøe uses the latest edition of the codes and standards available on the effective date of the contract.

1.10.1 Topsøe internal standards

Over the years of development of process technology, Topsøe has established standards that will be used in parallel with and as a supplement to the international codes and standards.

Topsøe's standards have been developed based on experience accumulated from the construction and operation of MeOH plants erected by Topsøe worldwide.

Topsøe is to provide the buyer, as a part of the basic engineering design package, the Topsøe standards involved in the basic engineering design package.

1.10.2 Heat exchangers

Shell and tube exchangers and double pipe heat exchangers and process gas waste Heat Boilers	ASME Sec. II, V, VIII Div. 1 or 2, and TEMA Class R, API 660
Surface condensers	ASME Sec. VIII Div.1 / HEI (Heat Exchanger Institute)
Air cooled exchangers	API 661, ASME Sec. VIII
Plate exchangers	API 662, ASME Sec. VIII Div. 1
Welded type heat exchanger	Vendor's standards and / or ASME Sec. VIII Div. 1

1.10.3 Pressure vessels, reactors and columns

Pressure vessels	ASME Sec. VIII Div.1 or 2

1.10.4 Storage tanks

Design and construction of large, welded, low-pressure storage tanks	API 620
Welded steel tanks for oil storage	API 650
Pressurized and spherical storage tanks	ASME Section VIII, Div. 1 or Div. 2

1.10.5 Rotating machinery for process

Compressors	
- Axial and centrifugal compressors and expander-compressors	API 617
- Reciprocating compressors	API 618
- Rotary-type positive displacement compressors	API 619
- Packaged, integrally geared centrifugal air compressors	API 672
Pumps	
- Centrifugal pumps	API 610, except for slurry pumps or any other particular pumps which cannot be covered by API, well known International standard to be specified.
- Positive displacement pumps – reciprocating	API 674
- Positive displacement pumps – controlled volume	API 675
- Positive displacement pumps – rotary	
- Sealless centrifugal pumps	API 676 API 685
Fan	
- Centrifugal fans	API 673
Liquid ring vacuum pumps and compressors	API 681
Steam turbines	
- General purpose steam turbine	API 611
- Special – purpose applications steam turbines	API 612

Gear	
- General – purpose gear units	API 677
- Special purpose gear units	API 613
Lubrication, shaft-sealing and control-oil systems and auxiliaries	API 614
Pumps-shaft sealing systems for centrifugal rotary pumps	API 682
Machinery protection systems	API 670
Gas turbines	API 616
Chemical injection units	VENDOR'S standard
Ancillary items	VENDOR'S standard

1.10.6 Boiler (except for process gas waste heat boilers)

ABMA, Press. parts ASME Sec.1**,** others vendor's standard or equivalent European standard.

1.10.7 Piping

Process piping: ASTM

1.10.8 Electrical

General	IEC, NEC,NEMA, ISO,ANSI, API,EN,CENELEC,BS
Bearing of motors	ISO R281 or equivalent
Illumination level	API 540
Fire alarm system	NFPA, IEC, BS or equivalent
Air craft warning system	IEC 529, ICAO or equivalent
Cathodic protection system	NACE, IEC, NEC or equivalent
Area classification	API RP 505 HTAS suggest to use IEC 60079-10 and IP 15 from the Energy Institute of London- HOLD
Classification of equipment for hazardous areas:	IEC,EN,CENELEC,BS,NFPA,ANSI,API or equivalent (as per licensee approval)
Ex-type electrical equipment selection	IEC 79

1.11 Instrumentation

General	ISO, ISA, API, IEC, NFPA
Orifice	ISO 5167
Thermocouple	IEC-60584

1.12 Battery limits

The Topsøe battery limits are: to be shown on plot plan

Appendix 1 - Numbering and codification

Drawing format and identification

The drawing format and identification code system will be according to HTAS standard.

Appendix 2 - Units of measurements

The following units of measurements must be applied:

Temperature	[°C]
Pressure	[bar g[4]], [mm WG]
Volume	[m^3], [l]
Length/diameter	[m], [mm]
Mass or weight	[kg], [MT], [ton]
Volume (gases)	[Nm^3], [kmol]
Flow rate:	
- volume	[m^3/h], [Nm^3/h], [kmol/h]
- mass	[kg/h], [ton/h]
Velocity	[m/s]
Energy	[MJ], [kJ]
Power	[kW], [MW]
Work	[kWh]
Heat capacity	[kcal/kg °C]
Thermal conductivity	[kcal/h m °C]
Heat transfer coefficient	[kj/h m^2 °C]
Absolute viscosity	[cP],
Density	[kg/m^3]
Sound	[dBA]
Electric current	[A]
Voltage	[V]
Frequency	[Hz]
Rotational frequency	[RPM]
Nominal pipe diameter	[inch]
Nozzle size	[inch]

[4] When ever bar g is used 'bar g' has to be specified

Appendix 3 - Process design criteria

1 Plot Plan

ASU	excluded
Polishing unit	included
Cooling tower	included
Yard office	included
Gas receiving station	included
Control room	included
Control room west of unit	

2 Vent and flare systems

Flammable gases will be disposed to the flare system, when pressure exceeds the back-pressure of the flare system:.

Back-pressure Bar g,superimposed	1.5

3 Hydraulic retention times

Hydraulic retention time (hold up requirements) is defined between low level (LL) and high level (LH).

Type of service	Retention time
Feed surge drum	30 minutes
Reflux only	5 minutes
Column feed	
on flow control	15 minutes
on cascade level/flow control	8 minutes
Reboiling by fired heater on feed to heater	8 minutes
Reboiling by thermo siphon on circulation	10 to 30 seconds
Products to storage	
without pump	5 minutes
with pump	7 minutes
Feeds and products feeding another unit	
on flow control	15 minutes
on cascade/level flow control	8 minutes
Tanks	Individually, according to the agreement
Steam drum (LL to empty), min	
From high level to empty	12 minutes
From low level to empty	10 minutes
Deaerator, min	15 minutes

In case of pumps ensuring several services such as reflux and liquid distillate to storage, the retention time of the corresponding vessels will be whichever is greater from the above list. Retention time can be modified depending on each process.

4 Air coolers

Air coolers have to be used wherever economically feasible.

65°C is considered the economic break point temperature.

Air coolers are to be designed for 110 % of the operating duty based on the dry bulb design temperature.

5 Heat exchangers

In general heat exchangers have to be designed to 110 % of their operating duty.

Columns overhead coolers are to be designed to 120 % of their operating duty.

Large heat exchangers are to be split into two or more shells for easy operation and maintenance.

6 Pumps

Normally pumps are to be designed to 110 % of their maximum required flow rate in worse case of operation.

Pumps for fractionation column reflux, pump round and reboiler, flow rates are to be designed to 120% of their maximum required flow rates.

The shut off pressure should be estimated according to the following criteria whichever is higher:

- differential head at rated flow x 120 % + LH (level high) suction static head + max. operating pressure at suction side.
- differential head of pump at rated flow + LHH (level high high) suction static head + design pressure at suction side x 120 %.

No over design should be applied to the rated pressure.
High efficiency rotating equipment to be specified.
Capacity of large pumps such as the BFW pump has to be 3 x 60%

7 Compressors

In general, compressors should be designed to a minimum of 110 % of their maximum required flow. However, they are subject to special considerations according to the process.
High efficiency rotating equipment to be specified.

8 Pressure relief valves

Pressure relief valves should be supplied with locked open isolating valves.

Spares for pressure relief valves should be provided where necessary for process reasons.

The set pressure of pressure relief valves has to be equal to the design pressure.

All safety valves will have block valves on both sides. If required by process a lock system should be provided.

9 Column and vessel

9.1 Nozzle

Minimum size	3/4" (for S.S has to be 1 inch)
Nozzle rating for instrument according to once of connected piping, min.	Class 150 ANSI rating

9.2 Manhole

Manhole size 24 inches (*1)

Manhole installation for tray tower:

For tray towers, manholes are to be provided at top, bottom, feed point and draw-off point of tower and for each 20 trays or 15 m elevation distance, whichever is the shorter distance, as minimum.

(*1) In case there is restriction for diameter, minimum 20” should be used.

9.3 Hand hole or inspection hole

Preferable size	8 inches
Minimum size	6 inches

9.4 Vent and drain

Vent and drain for vessels will normally be provided at the minimum length on overhead or bottom line in accordance to the following table:

Volume or diameter of vessel (m^3 or mm)	Vent diameter (inches)	Drain diameter (inches)
V < 75 or D <= 4,500	2	2
75 < V <= 220 4,500 < D <= 6,000	3	3
20 < V <= 420 or D > 6,000	4	4
V > 420	6	4

Note: Vent and drain connections are not necessarily located on vessels.

9.5 Steam out

Steam out nozzles are to be sized as follows

	Nozzle (inches)
Drums and heat exchangers (when applicable)	2
Column diameter (m)	
D <= 4	2
4 < D <= 5.5	3
D > 5.5	4

9.6 Storage (product/chemical/catalyst/additives)

Licensor must consider all facilities necessary for safe, loading, unloading, storage, dilution, transportation within the plant measuring, preparation for process and waste disposal.
Crude methanol tank must be designed for 48 Hours.
Daily tank must be designed for 2 x 24 hours.