طرح نگهداشت و افزایش تولید ۲۷ مخزن

CALCULATION NOTE FOR PIPELINE WALL THICKNESS

نگهداشت و افزایش تولید میدان نفتی بینک

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Status:

IDC: Inter-Discipline Check
IFC: Issued For Comment
IFA: Issued For Approval
AFD: Approved For Design
AFC: Approved For Construction
AFP: Approved For Purchase
AFQ: Approved For Quotation
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AB-R: As-Built for CLIENT Review
AB-A: As-Built –Approved

REVISION RECORD SHEET

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1.0 INTRODUCTION

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

As a part of the Project, New Gas/Condensate Pipelines (from Binak New GCS to Siahmakan GIS/Binak PU) shall be constructed.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – Surface Facilities; Gas & Gas-Condensate Pipelines
EPD/EPC CONTRACTOR (GC):	Petro Iran Development Company (PEDCO)
EPC CONTRACTOR:	Joint Venture of : Hirgan Energy – Design & Inspection (D&I) Companies
VENDOR:	The firm or person who will fabricate the equipment or material.
EXECUTOR:	Executor is the party which carries out all or part of construction and/or commissioning for the project.
THIRD PARTY INSPECTOR (TPI):	The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods.
SHALL:	Is used where a provision is mandatory.
SHOULD:	Is used where a provision is advisory only.
WILL:	Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR.
MAY:	Is used where a provision is completely discretionary.

2.0 SCOPE

This specification covers the wall thickness calculation for BINAK Gas & Gas-Condensate Pipelines.

3.0 NORMATIVE REFERENCES

3.1 LOCAL CODES AND STANDARDS

- IPS-E-PI-140 Engineering Standard for Onshore Transportation Pipelines
- IPS-M-PI-190 Material and Equipment Standard for Line Pipe
-

3.2 INTERNATIONAL CODES AND STANDARDS

- ASME B16.5 Pipe Flanges and Flanged Fitting
- ASME B16.47 Large Diameter Steel Flanges
- ASME B31.3 Process Piping
- ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- ASME B31.8 Gas Transmission and Distribution Piping Systems
- ASME B36.10M Welded and Seamless Wrought Steel Pipe
- ASME B36.19M Stainless Steel Pipe
- ASTM A105/A105M Carbon Steel Forgings for Piping Applications
- ASTM A106/A106M Seamless Carbon Steel Pipe for High-Temperature Service
- ASTM A153/A153M Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM A182/A182M Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service
- ASTM A216/A216M Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- ASTM A234/A234M Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service
- ASTM A240/A240M Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- ASTM A312/A312M Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes
- ASTM A320/A320M Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service
- ASTM A333/A333M Seamless and Welded Steel Pipe for Low-Temperature Service

- ASTM A350/A350M — Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components
- ASTM A351/A351M — Castings, Austenitic, for Pressure-Containing Parts
- ASTM A352/A352M — Steel Castings, Ferritic and Martensitic, for Pressure Containing Parts, Suitable for Low-Temperature Service
- ASTM A358/A358M — Electric-Fusion-Welded Austenitic Chromium-Nickel Stainless Steel Pipe for High-Temperature Service and General Applications
- ASTM A403/A403M — Wrought Austenitic Stainless Steel Piping Fittings
- ASTM A420/A420M — Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service
- ASTM A516/A516M — Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service
- ASTM A671/A671M — Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures
- ASTM A694/A694M — Carbon and Alloy Steel Forgings for Pipe Flanges, Fittings, Valves, and Parts for High-Pressure Transmission Service
- ASTM A860/A860M — Wrought High-Strength Ferritic Steel Butt-Welding Fittings
- ASTM B148 — Aluminum-Bronze Sand Castings
- API 5L — Specification for Line Pipe
- MSS SP-6 — Standard Finishes for Contact Faces of Pipe Flanges and Connecting-End Flanges of Valves and Fittings
- NACE MR0175-ISO 15156 — Petroleum and Natural Gas Industries-Materials for Use in H2S-Containing Environments in Oil and Gas Production
- NACE TM-0284 — Standard Test Method - Evaluation Of Pipeline And Pressure Vessel Steels For Resistance To Hydrogen-Induced Cracking
- NACE TM-0177 — Laboratory Testing Of Metals For Resistance To Sulfide Stress Cracking And Stress Corrosion Cracking In H2s Environments

3.3 THE PROJECT DOCUMENTS

- BK-PPL-PEDCO-320-PI-RT-0001 — Corrosion Study & Material Selection Report
- BK-PPL-PEDCO-320-PL-SP-0001 — Pipeline Material Specification

- BK-GNRAL-PEDCO-000-PL-DC-0001 Pipeline Design Criteria

- BK-GNRAL-PEDCO-000-PI-SP-0008 Specification For Material Requirements in Sour service

3.4 ENVIRONMENTAL DATA

Refer to "Process Basis of Design; Doc. No. BK-GNRAL-PEDCO-000-PR-DB-0001"

3.5 ORDER OF PRECEDENCE

In case of any conflict between requirements specified herein & the requirements of any other referenced document, this subject shall be reflected to CLIENT and the final decision will be made by CLIENT.

4.0 ABBREVIATIONS

AFC	Approved For Construction
AFD	Approved For Design
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Material
CL	Class
Cr	Chromium
C.S.	Carbon Steel
EFW	Electric Fusion Welded
FF	Flat Faced
Gr.	Grade
HIC	Hydrogen-Induced Cracking
L.T.C.S.	Low Temperature Carbon Steel
MSS	Manufacturers Standardization Society
NPS	Nominal Pipe Size
PWHT	Post Weld Heat Treatment
RF	Raised Face
RTJ	Ring Type Joint

SAW	Submerged Arc Welding
SCH.	Schedule
SMLS	Seamless
SMYS	Specified Minimum Yield Strength
S.S.	Stainless Steel
STD	Standard
THK	Thickness

5.0 DESIGN

5.1 DEFINITION AND TERMINOLOGY

5.1.1 CA

Corrosion Allowance (based on Piping Material Specification)

5.1.2 DESIGN LIMITS

Design Pressure / Design Temperature limits given in piping classes (based on Piping Material Specification) and are applied in Wall Thickness Calculation Table

5.2 PIPELINE WALL THICKNESS CALCULATIONS

5.2.1 GENERAL

Based on ASME Codes for Pressure Piping Systems B31, there are three main different codes which are applicable in this project regard to Wall Thickness Calculation as follow.

5.2.2 PIPES WHICH ARE SUBJECTED TO REQUIREMENTS OF ASME B31.3

This codes deals with the pipes that are typically found in Petrochemical, Oil refineries, Gas Plants, Cryogenic Plants and related terminals.

Pressure Design of Pipes

Piping wall thickness calculation process follows the following formula:

t_{mil} = tm / ((100-M)/100)= t_m /0.875

$t_m = t + c$

Where:

t_{mil} = Calculated wall thickness considering Mill Tolerance

M= Mill Tolerance=12.5

t_m = Minimum required thickness including mechanical, corrosion, and erosion allowances.

C = Sum of mechanical allowances (groove and thread depth) plus corrosion and erosion allowances

t = Pressure designed thickness calculated as following formula if $t < D/6$

$$t = \frac{PD}{2(SEW + PY)}$$

Where:

P = Internal Design Gauge Pressure. The design pressure of each component in a piping system shall be not less than the pressure at the most severe condition of coincident internal or external pressure and temperature (minimum or maximum) expected during service.

D = Outside Diameter of Pipe

S = Stress Value for Material from Table A-1 of ASME B31.3 code.

Stress valve is indicated in that table as Basic Allowable Stress at metal Temperature. This value can easily be extracted with base of material and design metal temperature.

E = Quality Factor, A factor deals with the manufacturing (Cast, Welded, Seamless) of the components. The factors can be extracted from table A-1A for components manufactured by casting method and Table A-1B for the components manufactured by welding or seamless methods. According to the project specification casting method cannot be used for piping components except valves. So the factor E is extracted only from Table A-1B.

W = Weld Joint Strength Reduction Factor. That says welded joint strength may decrease during operation because of the temperature. This factor can be extracted from Table-302.3.5 of ASME B31.3.

Y = Coefficient Value deals with the effect of dimension on a component. That can be extracted from Table 304.1.1 of ASME B31.3 if $< D/6$.

For $t \geq D/6$

$$Y = \frac{d+2c}{D+d+2c}$$

5.2.3 PIPES WHICH ARE SUBJECTED TO REQUIREMENTS OF ASME B31.8

This code deals with the Gas Transmission and Distribution Piping Systems.

Pressure Design of pipes:

Pipe wall thickness is calculated as mentioned in following formula:

$$P = \frac{2St}{D} FET \qquad \text{(British System)}$$

$$P = \frac{2000\,St}{D} FET \qquad \text{(SI System)}$$

Where:

P = Design Pressure. AS defined in paragraph 805.2 ASME B31.8.

D = Outside Diameter of pipe.

S = Specified minimum yield strength. It can be extracted from Appendix D of ASME B31.8.

F = Design Factor. This factor is dependent of the location which the pipe is going to founded in. so the location class of pipes shall be clearly specified based on the paragraphs 840.2, 840.3, and 840. 4 of the ASME B31.8.After specifying the location class the designer is able to extract the safety factor from table 841.1.6-2 of ASME B31.8.

Note:

1) Because of the fact that design factor effect on the wall thickness and wall thickness has to satisfy both safety and economical concerns, the location class shall be estimated carefully in site condition study which is normally issued in detail engineering.
2) Design factor also determined based on IPS-E-PI-140 and the result was same as the result of ASME B31.8.

E = longitudinal joint factor that deals with the manufacturing process of the components, obtained from table 841.1.7-1 of the ASME B31.8.

T = Temperature Derating factor obtained from Table 841.1.8-1 of ASME B31.8. This Factor deals with effect of temperature on metal strength.

t = Nominal Wall thickness.

Important Note:

The formula gives us the pressure can be tolerated by the pipe with the specific nominal wall thickness. Since most gas pipe lines have internal linings the allowances (mechanical, corrosion, erosion) may be omitted. But in this project pipe lines are not internally lined and allowances has taken into account in calculating of the thickness that means the designer has to calculating the thickness with the specific pressure and add the calculated thickness with the sum of allowances.

5.2.4 PIPES WHICH ARE SUBJECTED TO REQUIREMENTS OF ASME B31.4 AND IPS-E-PI-140

This code deals with the Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids Unified screw threads.

The required thickness of straight sections of pipe shall be determined in accordance with tm = t + c

Calculation of pres. design THK. for straight pipe requires special consideration of factors such as theory of failure, effects of fatigue, and thermal stress.

tm = [(P x D) / (2SMYS x FET)] + C3

where;

tm = minimum required thickness (mm)

t = calculated thickness (mm)

C = corrosion allowance (mm)

P = design pressure (Psig)

D = outside diameter (mm)

S = specific minimum yield strength (Psi)

E = Weld Joint Factor

F = design factor

T = Temperature Derating Factor = 1

6.0 GENERAL TESTING REQUIRMENTS

6.1 Pressure testing of the following piping shall be in accordance with ASME B31.3 test procedures. The test pressure shall be held for a sufficient time to allow detection of any leaks and for a minimum time of 1 hour.

a) Metallic piping including carbon steel, lined carbon steel, stainless steel, corrosion resistant alloys and ductile iron but excluding copper shall normally be tested at 1.5 x the design pressure.

6.2 Pipelines designed to ASME B31.8 where the operating pressure results in a hoop stress greater than 30% of the specified minimum yield strength shall be hydrostatically tested or tested with air or gas. The type of test and the test pressure is dependent on Location Class as defined in ASME B31.8 Para. 841.3.2. Test duration shall be a minimum of 2 hours.

7.0 APPENDIXES

Wall thickness calculation sheet has been attached in Appendix 1.

APPENDIX 1

D03

PIPELINE WALL THICKNESS CALCUALATION NOTE