طرح نگهداشت و افزایش تولید 27 مخزن

SPECIFICATION FOR PIPELINE STRESS ANALYSIS

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IFA: Issued For Approval
AFD: Approved For Design
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REVISION RECORD SHEET

PAGE	D00	D01	D02	D03	D04
1	X	X	X	X	X
2	X	X	X	X	X
3	X	X		X	
4	X	X	X	X	X
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PAGE	D00	D01	D02	D03	D04
66					
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117					
118					
119					
120					
121					
122					
123					
124					
125					
126					
127					
128					
129					
130					

CONTENTS

1.0 INTRODUCTION 4

2.0 SCOPE 4

3.0 NORMATIVE REFERENCES 5

3.1 LOCAL CODES AND STANDARDS 5
3.2 INTERNATIONAL CODES AND STANDARDS 5
3.3 THE PROJECT DOCUMENTS 6
3.4 SITE CONDITION 6
3.5 ORDER OF PRECEDENCE 6

4.0 UNIT 6

5.0 PIPELINE STRESS ANALYSIS 6

5.1 STRESS ANALYSIS LOAD CASES 6
5.2 PARAMETERS FOR STRESS ANALYSIS 7
5.2.1 CALCULATION TEMPERATURE 7
5.2.2 DESIGN PRESSURE 7
5.2.3 FRICTION 7
5.2.4 FLEXIBILITY FACTOR 7
5.2.5 STRESS INTENSIFICATION FACTOR 8
5.2.6 SECTION MODULUS 8
5.2.7 SOIL PROPERTY DATA 8

6.0 METHODOLOGY 8

6.1 CLASSIFICATION OF ABOVE GROUND LINES 8
6.2 CLASSIFICATION OF BURIED LINES 9

7.0 LOAD ANALYSIS 10

7.1 TEST LOADS 10
7.2 WEIGHT EFFECT 10
7.3 THERMAL EXPANSION AND CONTRACTION EFFECTS 11
7.4 FRICTION EFFECT 11
7.5 DYNAMIC EFFECTS 11

8.0 REQUIREMENTS 12

8.1 PIPELINE ANCHORING SYSTEM DESIGN 12
8.2 PIPELINE ROAD CROSSING DESIGN 12
8.3 MINIMUM ELASTIC BEND RADIUS 12

9.0 STRESS ANALYSIS REPORT 13

ANNEX "A" 14

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.

GENERAL DEFINITION

The following terms shall be used in this document.

CLIENT:	National Iranian South Oilfields Company (NISOC)
PROJECT:	Binak Oilfield Development – General Facilities
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

04

This specification indicates the minimum Basic Criteria and Methodology to be followed in performing the stress analysis relevant pipelines.

The pipelines stress analysis shall check (as minimum but not limited to) the following states: Design, testing, operating conditions and supports.
The stress analysis shall be aimed to guarantee pipes are routed and supported in a correct way, so that no damage occurs on pipe systems and components for effects of thermal expansion or contraction, internal pressure and other design internal or external loads..

3.0 NORMATIVE REFERENCES

The latest revision of following code and standards shall be applied besides the documents mentioned in purchase order or material requisition.

3.1 Local Codes and Standards

- IPS-E-PI-140 Construction Standard for Transportation Pipelines (Onshore)
- IPS-E-PI-200 Engineering Standard for Piping Flexibility Analysis
- IPS-G-PI-280 General Standard for Pipe Support
- IPS-D-PI-130 Pipe Supports Standard Drawings

3.2 International Codes and Standards

- ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- ASME B31.8 Gas Transmission and Distribution Piping Systems
- ASME B31.8 Gas Transmission and Distribution Piping Systems
- ASME B31.3 Chemical Plant & Petroleum Refinery Piping
- MSS SP 58 Pipe hangers and supports - Materials, design and manufacture
- MSS SP 69 Pipe hangers and supports - Selection and Application
- MSS SP 89 Pipe hangers and supports - Fabrication and installation practices
- WRC 107 Local Stresses in Spherical and Cylindrical Shells due to external loadings
- WRC 297 Local Stresses in Cylindrical Shells due to external loadings on Nozzles-Supplement to WRC 107
- WRC 537 Precision equations and enhanced diagrams for local stresses in spherical and cylindrical shells due to

external loadings for implementation of WRC Bulletin 107

- API 5L Specification for Line Pipe

3.3 The Project Documents

- BK-GNRAL-PEDCO-000-PR-DB-0001 Process Basis of Design

3.4 SITE CONDITION

Refer to "Process Basis of Design; Doc. No.: BK-GNRAL-PEDCO-000-PR-DB-0001" & "Basic Engineering Design Data; Doc. No.: 151-BK-FL-PR-DOC-0001".

3.5 ORDER OF PRECEDENCE

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

4.0 UNIT

This specification is based on international system of units (SI).

5.0 PIPELINE STRESS ANALYSIS

The pipeline stress analysis shall be carried out using CEAZARII, latest version that contains the reference project codes and standards.

The pipeline system shall have sufficient flexibility and so designed to avoid the following:

- pipeline stress in excess of those permitted in reference codes, standard and specification
- Excessive stresses, forces and moments at equipment terminal connections.
- Leakage of joints
- Excessive deflection in pipeline system

When the routing of a pipeline system does not provide above mentioned avoiding criteria; routing of the pipeline system shall be modified.

5.1 STRESS ANALYSIS LOAD CASES

During stress analysis of the pipeline system, pipeline stress engineer shall take in to account every mode of operation, expected during operation of the system. A check list of the loads shall be prepared and following load sources as a minimum shall be taken into consideration:

- Internal pressure load
- Temperature and loads due to expansion of the pipeline system
- Functional loads comprising the effects of temperature and pressure, also taking into

account the longitudinal frictional resistance between the pipeline and the soil

- Dead loads including load of the pipe, coating, etc
- Live loads including load fluid service, etc
- Loads by vehicles at the road crossing
- Soil loads
- Environmental loads taking into account the thermal effects of the exposed pipeline to the sun.
- Hydrodynamic loads caused by effects such as changes in water table level
- Loads due to Hydro test operation
- Loads due to transient (fluid hammer) acoustic thrust

5.2 PARAMETERS FOR STRESS ANALYSIS

5.2.1 Calculation Temperature

The temperature difference (ΔT) to be considered in the pipes stress verification shall be as

Indicated here below:

ΔT = MOT - TMIN	if:	MOT > TMAX
ΔT =TMAX - TMIN	if:	TMIN < MOT < TMAX
ΔT =TMAX - MOT	if:	MOT < TMIN

Where MOT is the maximum and/or minimum operating temperature, TMIN is minimum ambient temperature and TMAX is maximum ambient temperature.

For aboveground pipeline systems, pipe temperature due to solar radiation shall be 85 °C and shall be considered as TMAX and Installation temperature or TMIN for calculation in Caesar II shall be considered 5°C (Refer to Process Basis of Design) .

For underground sections the installation temperature shall be the maximum or minimum soil temperature.

5.2.2 Design pressure

The design pressure of the pipeline system shall be considered for calculation of the pressure loading of the pipeline system for pipeline stress analysis.

5.2.3 Friction

The passive resistance of soil to axial movement.

5.2.4 Flexibility Factor

Flexibility factor is defined as the ratio of the rotation per unit length of the part in question produced by a moment, to the rotation per unit length of a straight pipe of the same nominal size

and schedule or weight produced by the same moment.

5.2.5 Stress Intensification Factor

Will be defined as the ratio of the bending moment producing fatigue in a given number of cycles in a straight pipe of nominal dimensions, to that producing failure in the same number of cycles in the part under consideration.

5.2.6 Section Modulus

The ratio of the moment of inertia of the cross section of a pipe undergoing flexure to the greatest distance of an element of the pipe from the center line.

5.2.7 Soil Property Data

Soil data shall be extracted by EPC Contractor as per results obtained from geotechnical soil survey. Soil data shall be extracted before carrying out stress analysis of the pipeline system. It is Contractors responsibility to assess the ground conditions and make due allowance for it. Soil data for pipeline system stress analysis design shall be subject to Company approval.

6.0 METHODOLOGY

6.1 Classification of Above Ground Lines

The following critical features are reviewed for the classification of the above ground pipeline system.

- Pipe material
- Service
- Equipment connections
- Design and operating temperature
- Design pressure
- Pipe Diameter
- Displacements
- External Loads

The lines are classified into three (3) categories, which determine the type of analysis required.

Category 1: Exempted From Analysis

It is an approximate, visual inspection method. It shall be restricted to lines that are similar to other calculated lines, or lines having a clear and adequate flexibility.

If not, these lines shall be classified as level 2 or 3.

No actual values of forces and moments acting on supports are requested for a level 1 analysis

Category 2: Simplified analysis

This method includes the use of charts, nomographs and simplified formulae which may only be a ccepted if they are used in the range of configuration for which their accuracy is acceptable.

In case of doubt, the line shall be classified as level 3.

The result of a level 2 analysis may be shown only on the calculation isometric, or in a simplified report including isometric and a computer calculations output restrain summary.

Category 3: Comprehensive analysis

The main basis for categorizing lines is based on critical line selection criteria attached in Annex “A”.

It is a comprehensive method by computer calculations exclusively that shall meet the requirements of the code.

The accuracy level selection shall be indicated in a document called "Critical Line List". This document shall include all the lines to be reviewed by the stress analyst and shall be submitted to the CLIENT for approval.

6.2 Classification of Buried Lines

Buried pipelines are considered restrained. Stress calculations are necessary for buried pipelines whenever significant temperature changes are expected or the pipeline deviates from a straight line. Safe operation of a buried pipeline is predicated on the assumption that the pipeline is maintained in its position in the ground through support of the soil below and on the sides. The pipeline must also be provided with proper soil cover to prohibit it from rising out of the ground at over bends. At the ends of a buried pipeline, thermal and pressure forces may cause significant longitudinal movement of the pipe, as the soil is normally unable to provide the restraint to prevent movement. The length of the pipeline subject to axial movement may be several hundred feet and the end of the pipeline should be either anchored to prevent movement, or be designed to accommodate movement at the end of the pipeline.

Buried sections of pipe that are not fully restrained, such as in a pump station, will move through

the soil and should be analyzed for overstressing by reaction with the soil.

7.0 LOAD ANALYSIS

The load analysis is the evaluation of the expected permanent and incidental loads on pipeline systems during their operative life. Load means any physical process that result in stress and/or displacement in the pipe.
The following loads are considered in the analysis.

- Test Loads
- Weight Effect
- Thermal Expansion and Contraction Effects
- Friction Effect
- Dynamic Effects

These loads or combinations of loads form the basis for the analysis of the pipeline systems in terms of strength, deformation and stability. They can differ for restrained and unrestrained supported systems.

7.1 Test Loads

Test loads consist in following items.

- Test Pressure
- Weight full water content

Weight loads are due to weight of pipe and full water content without coating.

7.2 Weight Effect

The following weight effects, combined with loads and forces from other causes, shall be taken in to account in the design of pipeline.

7.2.1 Live Loads

These loads include the weight of the medium transported or the medium used for test. Snow and ice loads due to both environmental and operating conditions shall be considered.

7.2.2 Dead Loads

These loads consist of the weight of pipeline components, insulation, and other superimposed permanent loads supported by the pipeline like valves, flanges, etc.

7.3 Thermal Expansion and Contraction Effects

7.3.1 Thermal loads due to restraints

These loads consist of thrusts and moments which arise when free thermal expansion and contraction of the pipeline are prevented by restraints or anchors.

7.3.2 Loads Due to Temperature Gradients

These loads arise from stresses in pipe walls resulting from large rapid temperature changes or from unequal temperature distribution as may result from a high heat flux through a comparatively thick pipe causing bowing of the line.

7.3.3 Loads due to differences in expansion characteristics

These loads result from differences in thermal expansion where materials with different thermal expansion coefficients are combined.

7.4 Friction Effect

The effect of frictional resistance to thermal movement of the pipe for all sizes.

Friction force shall be calculated based on the properties of the sliding surface and contact material.

Contact Surface	Friction Coefficient
Stainless Steel on PTFE	0.1
Steel on Steel	0.3
Steel on Concrete	0.5

7.5 Dynamic Effects

7.5.1 Impact

Impact forces caused by external or internal conditions (including changes in flow rate, hydraulic shock, liquid or solid slugging, flashing, surge and geysering) shall be taken into account in the design of pipeline.

7.5.2 Wind

Wind loading shall be considered in accordance with ASCE 7. Wind effects shall be analyzed by applying wind load in one of four horizontal, perpendicular directions which would cause the most severe condition of pipeline stress.

For the design of pipeline system for wind effects, the force drag coefficient, Cd=0.7 shall be used In following conditions wind load calculation shall be applied:

BOP Elevation ≥ 10 m

OD + Insulation ≥ 400 mm

7.5.3 Earthquake

The effect of earthquake loading shall be taken into account in the design of pipeline.

According to site condition, the seismic coefficient with forced acceleration shall be considered

All critical lines (Level 3) shall be analyzed for seismic loads.

8.0 REQUIREMENTS

8.1 Pipeline Anchoring System Design

Anchoring of the pipeline system shall be designed as part of the mechanical design of the pipeline. The buried pipeline anchoring system shall be designed in accordance with calculated virtual anchor length, anchor force, and pipeline expansion. The pipeline system shall be restrained by either friction between soil and pipe or by the use of anchor system of the fully thrust or drag type.

Expansion shall be considered acceptable when it does not over stress end or branch connection pipe work, or cause any external soil disturbance or pipeline coating damage. Pipeline end expansion shall be limited to 50mm maximum at the above and below ground transition. In calculation maximum allowable expansion, immediately after start up, the long term friction relaxation shall be considered.

8.2 Pipeline Road Crossing Design

The live, dead and impact loadings at all road crossings shall be calculated in accordance with API RP 1102. The following minimum requirements shall be used: wheel loading shall be 112 kilonewtons per wheel and the distance between wheels centers shall be 900mm. A maximum of four wheels per axle shall be utilized in any calculation.

8.3 Minimum Elastic Bend Radius

It is important that during design and installation of the pipeline system to consider the minimum allowable elastic bend radius for the pipeline system with specified size and wall thickness. This will determine the extent to which the pipeline may follow the natural contours of the land without the need to utilize hot or cold bends. The allowable minimum bend radius for the below ground pipeline system shall be calculated using simple beam theory, and general bending equations

and adopting von Mises stress criteria.

9.0 STRESS ANALYSIS REPORT

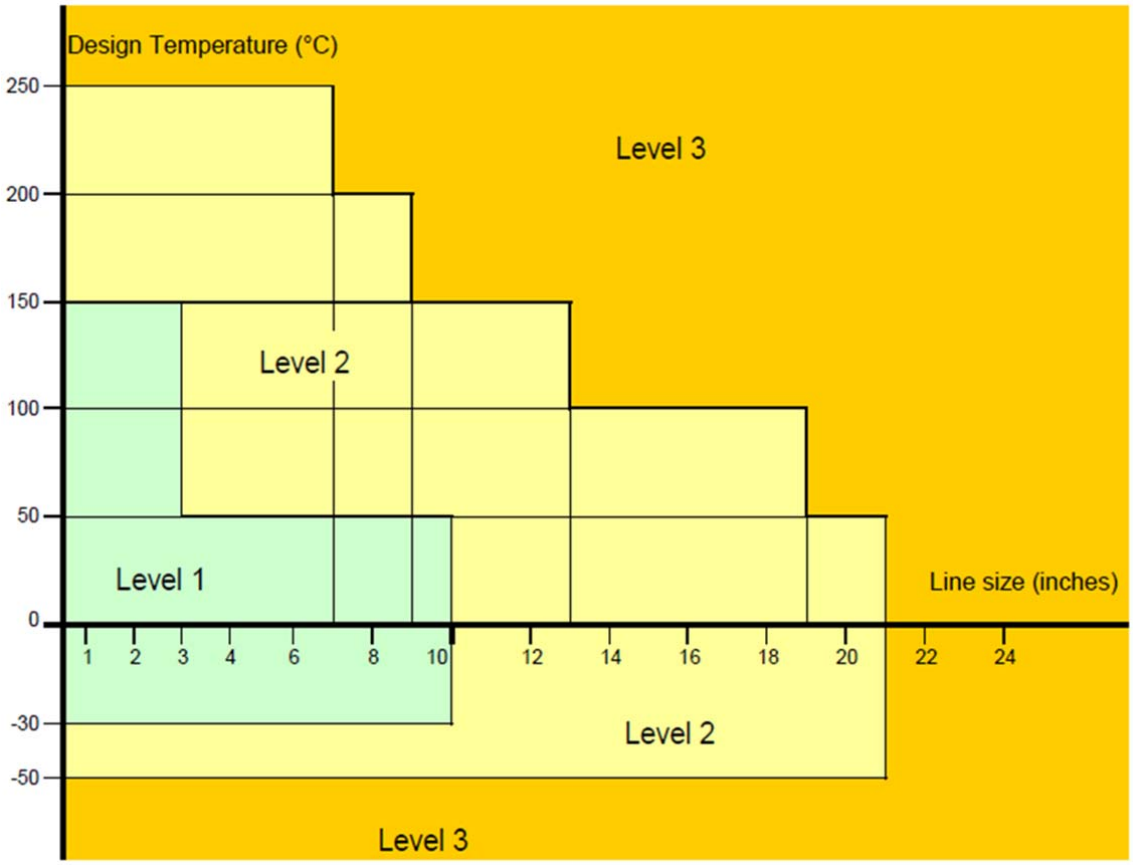
After completion of pipe stress analysis and pipeline design related activities, a stress analysis r eport containing the following shall be prepared by Stress Analyst:

- Coversheet
- Scope
- Results summary and Code compliance
- Input data and all hand calculations for input, if needed
- References, assumption and judgment, if necessary
- Description of calculations methodology
- Computer sketches
- Input print from Caesar II
- Computer output from Caesar II
- Stress analysis program input files

ANNEX A

STRESS ANALYSIS LEVEL REQUIREMENTS

GENERAL CHART



Note:

1) Except for flow lines, wellhead facilities and other pipelines should be analyzed.