9. QUALITY MANAGEMENT SYSTEMS – CONSTRUCTION PROCEDURES
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1. Historical Background
2. Quality Management Systems
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1. HISTORICAL BACKGROUND

Historically the quality of a product or construction activity was the responsibility of the craftsman who was performing it. The introduction of industrial manufacturing and complicated construction projects created the need for Quality Planning and Management of Quality Related and Inspection Activities.

The modern industrial manufacturing and Construction environment requires the cooperation of manufacturers and construction companies from around the world and creates the need for a Quality Management System that will generate trust in the capability of a company to fabricate or construct a product of sufficient quality.

In the modern competitive environment a company has to make the best of the triangle of Quality – Cost – Delivery Schedule.
At the 2000 edition this standard series introduced the concept of a process for the development the implementation and the improvement of a Quality Management system.
2. QUALITY MANAGEMENT SYSTEMS

When used within a quality management system, the process approach emphasizes the importance of:

- understanding and meeting requirements,
- the need to consider processes in terms of added value,
- obtaining results of process performance and effectiveness, and
- continual improvement of processes based on objective measurement.
## STEPS FOR THE DEVELOPMENT OF A QUALITY MANAGEMENT SYSTEM

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
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</table>
| 1.   | The order of the managing director  
|      | - appointing a management representative for quality  
|      | - fixing the target (objective) that the ISO 9000 series should be applied  
|      | - order for listing the existing processes |
| 2.   | Listing the existing processes  
|      | - arranging the process  
|      | - duty of performance and responsibility is at the management. |
| 3.   | Valuation of the result of Step 2  
|      | - Task of managing director and management representative |
| 4.   | Fix the measures  
|      | - the management (director) gives the order and has to decide  
|      | → who, what, when, what kind of resources |
| 5.   | Writing the QM-Manual and the system procedures  
|      | - QM-Manual  
|      | - quality policy (managing director)  
|      | - processes  
|      | - system procedures  
|      | - made by the concerning department |
| 6.   | Valuation and approval of the Rev. O of the QM. Documentation  
|      | - Task of the management (director) |
| 7.   | Introducing the QM-System in the company  
|      | - official announcement by the managing director.  
|      | - executed by the head of the department. |
| 8.   | Internal quality audits  
|      | - carried out by the management representative for quality  
|      | - Valuation (review) of the system by the managing director. |
| 9.   | Application of granting a Certificate  
|      | - Third party inspection |
QUALITY MANAGEMENT SYSTEMS – CONSTRUCTION PROCEDURES

QUALITY MANAGEMENT SYSTEM HIERARCHY

- QM - policy
- QM - targets (objectives)

- QM - policy / targets
- Organisational structure
- Responsibility organisation
- Process flow diagram
- Guidelines for carrying out the QM - activities

- Guidelines for carrying out the different activities
- Quality system procedures
- Work instructions
- Product specific quality programs

Managing Director

QM - representative

Management (heads of the departments)

Departments / specialists
### TYPICAL QUALITY MANAGEMENT SYSTEM DOCUMENT HIERARCHY

<table>
<thead>
<tr>
<th>Document contents</th>
<th>Extend of validity</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Describes the quality system in accordance with the stated quality policy and objectives and the applicable standard</td>
<td>the entire company</td>
<td>internal (company) external (customer)</td>
</tr>
<tr>
<td>Describes the activities of individual functional units needed to implement the quality system elements</td>
<td>single organisational units (departments)</td>
<td>only for internal use</td>
</tr>
<tr>
<td>Consists of detailed work documents</td>
<td>single activities</td>
<td>only for internal use</td>
</tr>
</tbody>
</table>

Any document level in this hierarchy may be seen separately or used with references, or in combination.
The quality requirements related to the product have nothing to do with the model of a quality management system acc. to ISO 9000. The quality requirements for products are not given in these standards.

The quality management system of a company is influenced by a lot of internal and external parameters.

For Example:
- The individual target (quality objectives)
- The specific product
- The organisational structure
- The size of the company

Therefore a standardized quality management system cannot exist for all the existing companies and manufacturing activities. Each company has to produce its own Quality Management System.
The main task of the different Management methods is to achieve satisfaction of the customer. To be successful the company has to offer products that fulfill the following requirements:

- it has to be utilizable.
- it has to meet the expectation of the customers.
- it has to fulfill the standard requirements
- it has to fulfill the requirements of national, an international laws.
- it has to be inexpensive

To reach those targets, the company needs an organization structure that combines the technical, administrative, and human factors which influence the quality of the product. The ISO 9000 series describes a model of organizational structures.
3. TYPICAL QUALITY SYSTEM MANAGEMENT REQUIREMENTS FOR A CONSTRUCTION PROJECT

- MANAGEMENT RESPONSIBILITY AND ORGANIZATION
- MANAGEMENT REVIEW
- RESOURCE MANAGEMENT
- CONTROL OF DOCUMENTS AND QUALITY RECORDS
- DESIGN CONTROL
- PROCUREMENT
- MANUFACTURE FABRICATION AND CONSTRUCTION
- INSPECTION AND TESTING
- CONTROL OF NON CONFORMANCES
- QUALITY AUDITS
- CONTINUAL IMPROVEMENT
MANAGEMENT RESPONSIBILITY AND ORGANIZATION

The Contractor shall define his proposed organisation for undertaking all aspects of the work. Organization chart(s) including lines of communication shall be included in the Quality Manual and maintained for the duration of the Contract.

The responsibilities and authority of key staff, (foremen and above), shall be documented in the Quality System. Clearly defined responsibilities and authority shall be assigned to adequately qualified project personnel.
4. TYPICAL QUALITY SYSTEM MANAGEMENT REQUIREMENTS FOR A PIPELINE CONSTRUCTION PROJECT

- MANAGEMENT REVIEW
The Contractor’s Management shall review the implementation of the quality management system during the various construction stages to ensure its suitability and effectiveness. Information to be provided in the management review meetings include:

- Results of Audits
- Customer Feedback
- Construction Performance and Conformity
- Results of Inspection and Testing Activities
- Status of non Conformances
- Changes Affecting Quality
- Recommendations for Improvement

Records form management review meetings shall be maintained.
• RESOURCE MANAGEMENT

The Contractor shall determine and provide all the resources needed to perform every construction activity according to the required technical specifications, quality system requirements and time schedule.

Such resources include:
- The necessary type and quantity of equipment needed for every construction activity
- Properly trained and qualified personnel based on project technical requirements
- The required premises (buildings, warehouses) and supporting services (transport, communication)
• CONTROL OF DOCUMENTS AND QUALITY RECORDS

Documents shall be uniquely numbered in accordance with a specific numbering system. Document control procedures shall include the issue/receipt of documents outside the Contractor's organisation. All transmission of technical documents shall be made with a transmittal sheet.

The Contractor shall initiate develop and maintain a Master Document List. The List shall include all documents, and drawings required for the completion of the project. The Master Document List shall also cover documents and drawings produced/to be produced by suppliers and sub-contractors.

All documents shall be revised and approved by Contractor prior to submission to the project OWNER. The OWNER reserves the right to approve/reject, pass comment and/or request modification of any document.
• DESIGN CONTROL

The Quality System shall ensure that no design work is carried out until necessary design input has been reviewed and approved in accordance with the quality manual. The Quality System shall ensure that design input incorporates the requirements of Contract specifications. Any incomplete, ambiguous or conflicting requirements shall be resolved with those responsible for drawing up these requirements. The contractor shall follow the OWNER's Technical Query (TQ) procedure in all such matters.

Design activities shall incorporate the requirements of relevant regulatory authorities.

Review/Approval of Drawings issued for construction is performed by Supervising Engineer or Engineering Reviewer.
PROCUREMENT

The Contractor shall establish and maintain records of acceptable vendors and sub-contractors. The Contractor shall continuously monitor and document the performance of vendors and sub-contractors. In particular, he shall monitor and document their quality performance.

The Contractor shall maintain in a single index the names of appointed sub-contractors and vendors. The index shall include date of appointment and a summary of scope of supply/work for which they are approved.

For the procurement of critical materials and/or services approval of the vendors and sub-contractors may be required.
MANUFACTURE FABRICATION AND CONSTRUCTION

The Contractor shall segment manufacturing fabrication, manufacturing and construction work into logical and manageable activities and this shall be included in the Quality Plan.

No fabrication, manufacturing or construction activity shall take place which is not covered by an approved Quality Plan and associated approved procedures/method statements e.t.c.
INSPECTION AND TESTING

The Contractor's Quality System shall include procedures to ensure that inspection and test status is satisfactory before progressing to subsequent activities.

The Contractor shall initiate and maintain an overall program for all testing and inspection activity. This will be incorporated in the Quality Plan. The program shall indicate the dates on which tests/inspections shall take place and shall also show who shall be present.

The Contractor shall maintain a schedule of all inspection, measuring and test equipment which is used in activities covered by his test and inspection plans. Equipment shall be given a unique identification number/code. The schedule shall include the previous and next calibration dates. Test numbers and dates shall be recorded against the identification number of the equipment.
CONTROL OF NON CONFORMANCES

Non-conformance reports (NCR) shall be copied to the OWNER for every identified non-conformance. Each NCR shall be uniquely identified in an NCR register. Date of issue, person issuing, person responsible for disposition and the current status of the non-conformance shall be indicated.

If corrective action is pending or in progress, the date for disposition shall be included in the List. When the non-conformance has been dealt with, the date of disposition shall be included and corrective or rectification action shall be referenced. Disposition action taken shall be added to the revised non-conformance report and forwarded to OWNER for information.

All non-conformance reports, together with revisions as they are actioned, shall be immediately transmitted to the OWNER.
# Corrective Action Request

<table>
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<tr>
<th>Audited Organization/Group</th>
<th>Audit Purpose/Criteria</th>
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<tr>
<th>Auditor:</th>
<th>Audites</th>
<th>Audit Area:</th>
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## Deficiency Descriptions:

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## Analysis of Cause:

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## Action to Correct Deficiency:

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## Action to Prevent Recurrence:

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## Comments:

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<tr>
<th>Auditor:</th>
<th>CAR Close-Out Date:</th>
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## Non-Conformance Status Log

(Attachment 2 to "35.48.01.201-U2300-PRC-QAC-003 Control of Non-Conformances" Procedure)

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<tr>
<th>#</th>
<th>Inspection Report</th>
<th>NCR/CAR</th>
<th>Subject</th>
<th>References</th>
<th>Findings</th>
<th>Actions Performed</th>
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Prepared by: ____________________________  Name: ____________________________

Signature: ____________________________
• QUALITY AUDITS

The Contractor's Quality System will be subject to audit by the OWNER or their representative. Audit frequency shall be at the OWNER’s discretion.

The Contractor shall modify his Quality System in line with any findings of audits.

The Contractor shall conduct internal audits of the performance of the Quality System to an audit schedule agreed by the OWNER.

All audits shall be documented. All findings and recommendations shall be actioned within the specified time scale.
• CONTINUOUS IMPROVEMENT

The Contractor shall throughout the construction period improve the effectiveness of the quality management system through the use of the quality policy, quality objectives, audit results, analysis of data corrective and preventive actions and management review.

Documented procedures shall be established to define requirements for the management of corrective and preventive actions in order to ensure that non-conformities do not recur and potential future problems are prevented.
5. CONSTRUCTION ACTIVITIES AND PROCEDURES

- ROW STAKING AND PREPARATION

The survey crew carefully surveys and stakes the right-of-way to ensure that only the pre-approved construction workspace is cleared.

The ROW preparation crew is responsible for removing trees, boulders and debris from the construction right-of-way and preparing a level working surface for the heavy construction equipment that follows.

The crew installs silt fences along edges of streams and wetlands to prevent erosion of disturbed soil. Trees inside the right-of-way are cut down and removed or stacked along the side of the right-of-way. Brush is commonly shredded or burned.

As may be necessary in agricultural areas, topsoil may also be stripped to a predetermined depth and stockpiled along the sides of the right-of-way.
## QUALITY MANAGEMENT SYSTEMS – CONSTRUCTION PROCEDURES

### ROW DIMENSIONS

<table>
<thead>
<tr>
<th>Distance between trench centre line and left ROW limit</th>
<th>A</th>
<th>0m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance between trench centre line and right ROW limit</td>
<td>B</td>
<td>0m</td>
</tr>
<tr>
<td>Working Row Width</td>
<td>C</td>
<td>0m</td>
</tr>
</tbody>
</table>

### Remarks

- Topsoil removal [see AF Job Spec. 8100-95/1 Rev. 3] □ YES (depth 0.3m) □ NO (Meadows area)

### Signed by:

- Checked by:
- Approved by: Supervising Eng.
• STRINGING

The pipe will be transported from the pipe mill to a pipe storage yard in the vicinity of the project location. The pipe lengths typically are 12 to 18 meters long. A stringing crew using specialized trailers will move the pipe from the storage yard to the pipeline right-of-way.

The crew will be careful to distribute the various pipes according to the design plan since the type of coating and wall thickness can vary based on soil conditions and location.

The pipes transported on site must be positioned on special wooden crossbars or earth filled sacks in order to avoid damaging the pipe coating.

Pipes with damaged coating are removed from the line and are specially marked so that they will not be used prior to rectification.
• TRENCHING

The trenching crew will use suitable equipment to dig the pipe trench. The minimum depth that the top of the pipe will be buried is described in the project technical specifications (e.g. 1 m) and may be different for rural and non rural locations or crossings.

Trench geometry and dimensions are in accordance with a standard drawing. Special care shall be given to the slope of the trench to avoid collapse.

The use of explosives in rocky areas is performed only when necessary and always under controlled conditions.

The bottom of the trench is conditioned so that damage on the pipe coating can be avoided. Sand Bedding may be required in rocky grounds or other special crossings.
## Trenching Details

### Key Details
- **Client:** DESFA - W.B.S. No. 353.112.04
- **Supervising Eng.:**
- **Job No.:** 09/7520
- **Date:** 00.03.2010
- **Place:** Stefan - Aliveri, Kavala

### Trench Section

<table>
<thead>
<tr>
<th>Distance from K point (m)</th>
<th>To K point</th>
<th>Distance/bed K point (m)</th>
<th>Length (m)</th>
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### Building Material
- **Rock**
- **Semi Rock cat 2**
- **Earth**

### Trench Condition
- **Dry**
- **Wet [Water]**
- **Other**

### Trench Dimensions

<table>
<thead>
<tr>
<th>Diagram Description</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>H</th>
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### Table of Measurements

<table>
<thead>
<tr>
<th>Diameter Measurement</th>
<th>Pipe OD</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>H</th>
<th>K</th>
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### Remarks

**Issued by:** Ghizzoni  
**Checked by:** Ghizzoni  
**Approved by:** Supervising Eng.

<table>
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<td>Date</td>
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</table>
• PIPE BENDING

The pipe bending crew will use a bending machine to make slight bends in the pipe to account for changes in the pipeline route and to conform to the topography. The bending machine uses a series of clamps and hydraulic pressure to make a very smooth, controlled bend in the pipe.

All bending is performed so that for each section of pipe whose length is equal to its diameter a permanent bending no greater than $13^\circ$ is achieved. Satisfactory bending is verified by visual examination and passage of an internal gauge in the finished bend. The gauge has a diameter 5% smaller than the internal diameter of the pipe.
QUALITY MANAGEMENT SYSTEMS – CONSTRUCTION PROCEDURES

<table>
<thead>
<tr>
<th>GHIZZONI S.p.A.</th>
<th>COLD BENDING REPORT</th>
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<tbody>
<tr>
<td>Report No.</td>
<td>000</td>
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<tr>
<td>Plant</td>
<td>Stefanò-Allveri, (GR)</td>
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<tr>
<td>From K Point</td>
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<td>To K Point</td>
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<td>From L (additional)</td>
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<td>To L (additional)</td>
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<table>
<thead>
<tr>
<th>Pipe Trunk</th>
<th>Pipe Trunk</th>
<th>Pipe No.</th>
<th>Qts.</th>
<th>Forging (mm)</th>
<th>Direction</th>
<th>Angle (°)</th>
<th>Cleaning</th>
<th>Bend</th>
<th>Diameter</th>
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(1) Bending Data (Direction) Legend
- Horiz. right
- Vert. low
- Vert. high
- Vert. high left oblique
- Vert. low right oblique
- OK
- Acceptable Results
- Not OK
- Not Acceptable Results

Remarks:

Issued by: GHIZZONI
Checked by: GHIZZONI
Approved by: Supervising Eng.
Welding is considered a special process and as such must satisfy specific requirements for all the relevant activities.

Welding requirements for natural gas piping systems are covered by EN 12732 “Gas Supply Systems – Welding Steel Pipework – Functional Requirements.” This standard covers all the welding activities including:

- Quality System Requirements
- Supervisory Personnel Requirements
- Welding Qualifications (personnel and process)
- Production Welding Guidelines
- Inspection and Testing
- Acceptance Levels for Welding Defects
• WELDING

• In addition to ISO 9001 requirements which were described earlier, specific quality system requirements for pipeline projects are described in EN ISO 3834 (former EN 729) series “Quality requirements for fusion welding for metallic materials”

• Supervisory Personnel requirements are covered in EN ISO 14731 (former EN 719) series “Welding coordination - Tasks and responsibilities”

• Qualification requirements for welding process and welders are described in EN ISO 15614-1 “Specification and qualification of welding procedures for metallic materials -- Welding procedure test -- Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys” and EN 287-1 “Qualification test of welders. Fusion welding of Steels” respectively.

• Inspection and Testing is performed in accordance with the relevant European standards (to be covered later) with the acceptance levels of welding defects given by EN 12732.

• Strict implementation of all the welding process requirements during field welding is critical for the integrity of the pipeline.
## WELDING PARAMETERS

**Client:** DESFA - WBS No. 27.03.01.014  
**Supervising Eng.:**  
**Gtl Job:** 0979.30  
**Report No:** 000  
**Date:** 00.00.2010  
**Place:** Stavros - Alloveri (GR)

### REFERENCE DATA
- Welding Procedure:
- WPS No.: 
- Material Source / Material Grade: 
- Weld Dia (mm): 
- Weld Dia (mm):
  - API 5L
  - EN 10217 2
  - DIN 1712
  - Other (specify): 
- Welder's Name: 
- Position & Welding Direction: 
- Preheat Temperature: 
- Post-Weld Heat Treatment: 
- Dev. Preparation:
  - As per WPS
  - Other [state below]
- Welding sequence:
  - As per WPS
  - Other [state below]

### WELDING PREPARATION
- Out of scale drawing (dimensions in mm):
- Out of scale drawing (dimensions in mm):

### WELDING DATA
- Welding Sequence:
- Welder's Name:
- Position:
- Weld Dia (mm):
- Preheat Temperature (°C):
- Post-Weld Heat Treatment (°C):
- Thermal heat input (kJ/mm):
- Welding gas composition:
- Gas flow rate (l/min):
- Electrode stock:
- Electrode type:
- Electrode length (mm):
- Electrode manufacturer:
- Electrode type:
- Electrode diameter (mm):
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COATING

Following field welding of pipes, an area of about 30 cm around the weld needs to be coated. Pipeline companies use several different types of coatings for field joints, the most common being polyethylene heat-shrinkable sleeves.

Each coating system has its own application procedure which is given by the coating manufacturer and needs to be strictly followed to ensure proper bonding with the steel surface.

Inspection of the field coating is performed prior to lowering of the pipeline in the trench and includes visual testing, holiday testing and adhesion testing.

Coating crews must be properly trained (usually by the coating system manufacturer) for the application of each specific coating system.

An approved repair procedure is followed for the restoration of defective coatings.
QUALITY MANAGEMENT SYSTEMS – CONSTRUCTION PROCEDURES

![Image of a document with tables and figures related to quality management systems and construction procedures.]

---

**FIELD WELDS COATING REPORT**

<table>
<thead>
<tr>
<th>Field No.</th>
<th>Surface Preparation</th>
<th>Surface Tension (T)</th>
<th>Visual Inspection</th>
<th>Holiday</th>
<th>Results</th>
</tr>
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<tbody>
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</tbody>
</table>

**Remarks:**

**Inspected by:** G. Zizopoulos  
**Checked by:** G. Zizopoulos  
**Approved by:** Supervising Eng.
### Holiday Detection Report

**Client:** DESFA – W.B.S. No. 378.01.100  
**Supervising Eng:**  
**Date:** 00.00.2010  
**Plant:**  
**Location:** Stefani - Aliverti, GR

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>S/N</th>
<th>Calibration Certificate / Date</th>
<th>Type</th>
<th>Grid S/N</th>
<th>Inspection Sensitivity (kV)</th>
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</thead>
<tbody>
<tr>
<td>POLYETHYLENE</td>
<td>X</td>
<td>Synthetic Resin</td>
<td>Concrete</td>
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<tr>
<td>PIPELINE SECTION</td>
<td>X</td>
<td>Connecting</td>
<td>Valves / Fittings</td>
<td>Other</td>
<td></td>
</tr>
<tr>
<td>Pipeline Section</td>
<td>From</td>
<td>Joint</td>
<td>To</td>
<td>Joint</td>
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<tr>
<td>Crossing</td>
<td>Crossing No (Deg No)</td>
<td>Crossing Name</td>
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<tr>
<td>Valves / Fittings</td>
<td>Description / Specification</td>
<td>Item ID / Item No</td>
<td>O.D. / W.T.</td>
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<tr>
<td>Other / Specific</td>
<td>Description / Specification</td>
<td>Item ID / Item No</td>
<td>O.D. / W.T.</td>
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#### Defects:

<table>
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<tr>
<th>Description of Defect</th>
<th>Repair</th>
<th>Repair Result</th>
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<tbody>
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**Remarks:**

Approved by: Supervising Eng

**Issued by:** Girolamo  
**Checked by:** Girolamo

Name / Stamp:  
Signature:  
Date:  

Name / Stamp:  
Signature:  
Date:  

Name / Stamp:  
Signature:  
Date:
• LOWERING IN

• Lowering of a welded pipeline section in the trench is an important activity that requires close coordination and skilled operators.

• A lowering in stress calculation must be performed and approved prior to any lowering activities. This calculation is different for each pipe diameter and thickness existing in the project. The calculation provisions must be strictly followed in order to avoid overstressing the pipeline section.

• For lowering in activities the required number of side booms and other cranes must be available. The calculated distances between the lifting points must be strictly followed.

• The condition of the trench bottom shall be examined prior to any lowering in activities to ensure that no damage will take place on the pipeline coating.
LOWERED IN

Pipeline lowering in shall always begin with any bends present to ensure that they are correctly positioned in the trench.

The pipeline section shall be lowered avoiding bumping against the trench walls as well as sudden dropping of the pipeline.

During halts in lowering – in the equipment shall continue to support the pipeline in the correct position. On completion of lowering operations the pipeline shall:
- be in contact with the trench bottom
- sit away from the walls of the trench (0.2 m min distance)
- not be under strain.

The ends of the lowered pipeline shall be closed with water tight caps. Pipeline internal area shall be kept clean and free of foreign bodies.
### Lowering Stress Calculation

**Deflection Graphic Scheme**

**Point A Deflection**
- \( y_A = y_{A1} + y_{A2} + y_{A3} \)
- \( y_{A1} = \frac{M_A L_A}{EI} \)
- \( y_{A2} = \frac{M_D L_D}{EI} \)
- \( y_{A3} = \frac{M_C L_C}{EI} \)

**Point B Deflection**
- \( y_B = y_{B1} + y_{B2} + y_{B3} \)
- \( y_{B1} = \frac{M_B L_B}{EI} \)
- \( y_{B2} = \frac{M_D L_D}{EI} \)
- \( y_{B3} = \frac{M_C L_C}{EI} \)

**Stress Calculation for Maximum Stress Moment \( M_A \)**

- **Bending Moment of the pipe section at \( R \) position:**
  \[
  M_A = \frac{1}{2} (L_1^2 - L_2^2) \]
  \[
  I = \frac{1}{6} (D_2^4 - D_1^4) \]
  \[
  S = \frac{1}{6} (D_2^4 - D_1^4) \]
  \[
  d = \frac{D_2}{2} \]

  - Maximum Tensile Stress calculation:
    \[
    \sigma = \frac{M_A}{I} \cdot \frac{S}{d} \]
  - Minimum Allowable Yield Stress:
    \[
    \sigma_{min} = \frac{450}{350} \text{ MPa} = 1.3 \text{ MPa} \]
    \[
    \sigma_{min} = 1.3 \times 186 \text{ MPa} = 241 \text{ MPa} \]

**Lowering Elastic Bend Calculation**

- **Lowering Elastic Bend Radius:**
  \[
  R = \frac{E \cdot D_2}{K} \]
  \[
  K = 2.015 \times 10^6 \]

- **Lowering Elastic Bend Radius:**
  \[
  H = \frac{R \times (R^2 + L^2)^{3/2}}{2 \cdot R^2} \]
  \[
  L = 20,000 \text{ m} \]
  \[
  \theta = 10 \text{ m} \]
  \[
  \gamma = 6 \text{ m} \]
**LOWERING IN REPORT**

Client: DESFA – W.B.A. No. 35.81.1.214  
Supervision Eng.:  
Issue Date: 22-02-2010  
Des: 00.00.2010

**LOWERING IN REPORT Detail:**  

**Project:** Detailed Engineering, Procurement of Materials and Construction of The Onshore Part Of Stravas - Alikeri Natural Gas High Pressure Pipeline - DESFA Contract No.244/09  
Place: Stravas - Alikeri, (GR)

### PREVIEW SECTION

<table>
<thead>
<tr>
<th>From K point</th>
<th>Weld No.</th>
<th>To K point</th>
<th>Weld No.</th>
<th>Length [m]</th>
</tr>
</thead>
</table>

### PREVIEW SECTION

<table>
<thead>
<tr>
<th>Pipe D.D. [in]</th>
<th>20°</th>
<th>Pipe WT [mm]</th>
<th>Type of Coating</th>
<th>PE</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>PE</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. All welding activities performed, inspected and accepted</td>
<td>☑</td>
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<tr>
<td>2. All field coatings performed and relevant tests are accepted</td>
<td>☑</td>
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<tr>
<td>3. All coating defects are satisfactorily repaired</td>
<td>☑</td>
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<tr>
<td>4. Holiday detector inspection performed with acceptable result</td>
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<tr>
<td>5. Trench inspected and accepted (Dimensions, condition)</td>
<td>☑</td>
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<tr>
<td>6. Laying bed inspected and accepted (bedding material, depth, condition, conformance to specifications etc)</td>
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<tr>
<td>7. Adequacy and suitability of equipment (side booms, etc)</td>
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<td>8. Availability of relevant quality documentation</td>
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<td>9. Other (Specify)</td>
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### Jointed/Additional information:

The following section was lowered:
Starting from Pipe No. [ ] to Pipe No. [ ] as per current revision of Pipe Log Book.

No. of pipes lowered:

<table>
<thead>
<tr>
<th>Issued by: Client</th>
<th>Checked by: Client</th>
<th>Approved by: Supervision Eng.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name / Stamp / Signature</td>
<td>Name / Stamp / Signature</td>
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Date | Date | Date
# Quality Management Systems – Construction Procedures

**Survey Data After Lowering-In**

**Project:** Detailed Engineering, Procurement and Construction of the Onshore Part of Strategic Access Network Gas High Pressure Pipeline - ESMA Contract No. 264/08

**Location:** Samos - Almyros (GR)

<table>
<thead>
<tr>
<th>Reference Weld No.</th>
<th>Distance from Previous Weld</th>
<th>Cumulative Distance</th>
<th>Change [m]</th>
<th>X</th>
<th>Y</th>
<th>Top Pipeline Elevation [m]</th>
<th>General Elevation [m]</th>
<th>Cover [m]</th>
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Signed by: 
Checked by: 
Approved by: 

Date: 00.00.2010
• BACKFILLING

• Prior to backfilling, a final inspection of the trench is performed to make sure that no foreign material that can damage the pipe is present.

• Trench bedding with quarry or river sand at a thickness of 20 cm is applied in cases of rocky ground, extremely low resistivity soils or polluted soils.

• Padding which is the backfilling of the trench to a height up to 20 cm above the pipe top is performed with quarry or river sand in the situations described above or in case the excavated soil contains stones larger than 25 x 50 mm in size.

• The final backfilling above the padding layer is performed with the excavated material provided that stones larger than 150 mm in size have been removed by screening or crushed.

• Special measures shall be taken for backfilling of pipeline sections in steep slopes (> 36°) including the placement of sandbags below the pipeline and backfilling from the bottom of the slope to the top.
HYDROSTATIC TEST

Before the pipeline is put into natural gas service, the entire length of the pipeline is pressure tested using water. The hydrostatic test is the final construction quality test. Requirements for this test are prescribed in project specifications and standards. Depending on the varying elevation of the terrain along the pipeline and the location of available water sources, the pipeline may be divided into sections to facilitate the test.

Each section is filled with water and pressured up to a level higher than the maximum operating pressure. The test pressure is held for a specific period of time to determine if it meets the design strength requirements and if any leaks are present. Once a test section successfully passes the hydrostatic test, water is emptied from the pipeline in accordance with state and federal requirements. The pipeline is then dried to assure it has no water in it before gas is put into the pipeline.

Technical details for the hydrostatic test of pipelines will be discussed later in a different section.