13. STANDARD PROCEDURES FOR PRE – COMMISSIONING AND COMMISSIONING ACTIVITIES – EQUIPMENT, STANDARD FORMS FOR TESTING, PRE – COMMISSIONING AND COMMISSIONING
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Commissioning Procedures

These Procedures covers the following:

- Pre-commissioning, which covers all activities and approvals necessary to allow purging with gas and pressurizing to normal operating pressure to commence.

- Pipeline preservation, in case gas-initiation of the pipeline is performed later than six months after the installations are completed the pipeline is preserved.

- Commissioning of dry pipelines. The criteria for being considered a dry pipeline are as follows:
  - Dew point temperature must be $<-20^\circ$ C measured at atmospheric pressure.
  - Over-pressure following sealing of the lines must be at least 1 barg.
  - The acceptable minimum standard during the whole period of preservation is a dew point temperature of $-10^\circ$ C.

- Commissioning of wet pipelines. Wet pipelines are considered those that are not met the previous criteria.
1. PRE-COMMISSIONING

1.1 PRE-COMMISSIONING ACTIVITIES

On substantial completion of construction activities, Contractor mobilizes its commissioning team to initiate pre-commissioning activities in a phased manner.

The objective of pre-commissioning is to ensure that the pipeline as well all the facilities have been completed according to the Project Specifications and that commissioning and operation will take place safely and effectively.

Also during the pre-commissioning should be verified that all the relevant data with the commissioning of the pipeline has been received and that the commissioning procedure is presented and discussed with all personnel involved.

Another important aspect which has to be verified during this procedure is that all the necessary drawings, technical information, and O & M manuals have been received and that the operating plan has been existing.

Pre-commissioning may therefore be defined as all the checks that are to be completed prior to commissioning being permitted to commence.
The pre-commissioning phase includes three main types of field activities:

a) Systematic conformity checks, carried out on each item of equipment or component, such as pressure gauges, cables, etc., to verify visually the condition of the equipment, the quality of the installation, the compliance with project drawings and specifications, manufacturer's instructions, safety rules, codes, standards and good engineering practices. These checks will confirm the following:

• All pipe assemblies and weldings have been completed.

• All pipeline pressure and leak tests have been completed and relevant certified test documents have been received (weld radiographs, hydrostatic test documents etc).

• Electrical and control installations have been completed and are functioning.
• Cathodic protection systems have been completed and are functioning.

• Security fences have been installed around all above ground high pressure pipeline facilities.

• Emergency vehicle access is provided to all pipeline facilities (land valve stations, MIR-stations, Scraper Stations).

• Right-of-way restoration has been completed according to specifications and landowner agreements and all environmental concerns have been addressed.

b) Equipment static/de-energized tests, to ensure the quality of a number of critical components. This "cold" testing concerns all disciplines, e.g. calibration of instruments, machinery alignments, setting of safety valves, pressure testing of piping, cable continuities, etc.

c) Dewatering and drying of the pipeline and the vessels has been completed in accordance with specifications and approved procedures.
As soon as practical, the Pre-commissioning team shall acquire a complete set of drawings and data as listed below:

1. As built drawings and technical information regarding:
   - Pipeline sections between line valve stations: pipe logs showing the location, size, wall thickness, and pipe grade
   - Line Valve stations: schematic showing venting and valving arrangements, as well as technical data regarding material, fittings, valves, etc.
   - M/R Stations: schematics showing venting arrangements, customer interconnections for gas service and by-pass technical data regarding material, fittings, valves, etc.
   - Scraper Stations: schematics showing piping arrangement as well as technical data regarding material, fittings, valves, etc.
   - Cathodic protection facilities: including type and description of rectifiers, number and type of sacrificial anodes, measuring posts, insulating couplings, type of pipeline external and internal coating
2. Route Maps which indicate among the others the pipeline routing, the depth of pipeline, the access routes to valve stations, M/R Stations, Scraper Stations, cathodic protection rectifiers and measuring posts have been received.

3. 3. Vendor-supplied equipment design specifications, installation drawings, operation and maintenance manuals.

4. 3. All QC documentation relating to the construction testing i.e. hydro test packs, cable checklists etc. as well as emergency procedures and operating plans.

Pre-commissioning work described herein will require all necessary tools, test instruments, water, air and electric power etc to be made available to the Pre-commissioning team. Also spare parts and repair materials as well as that all the necessary tools and work equipment as pipe locators, gas detection equipment etc should be available.

Each craftsman such as pipe fitter, millwright, mechanic, instrument technician, or electrician, who is assisting the Pre-commissioning team, shall have his normal tools available.
All necessary tags, warning tapes, barricade tapes and safety supplies shall be made available at the site. The following signs are posted at strategic locations before proceeding with the appropriate Pre-commissioning activities:

**Tags:**

- No smoking
- Danger, high voltage
- Do not enter beyond this point
Finally, the following safety supplies are made available to all staff involved in the pre-commissioning activities.

- Ear Protection
- Safety Glasses
- Hard Hats
- First Aid Kit
- Face Shield
- Chemical Gloves
- Safety Goggles
- Padlocks with Multi-Lock Clips
- Safety Boots
- Boiler suits/overalls
For the purpose of pre-commissioning, the facilities will be subdivided suitably into a few systems.

The pre-commissioning checks of each piece of equipment are to be as complete and as comprehensive as possible to ensure that the equipment are installed as specified and will operate as designed. Proper pre-commissioning will ensure that the facilities can be made operable with the least number of problems. To achieve this,

1. The Pre-commissioning Team shall become familiar with all data and information.

2. The Pre-commissioning Team shall start all pre-commissioning checks as early as possible during the construction activities to ensure that the final installation of all equipment is as designed and specified.
All personnel involved in the pre-commissioning and commissioning activities have to be educated with regard to the following:

- Access routes to line valve stations, MfR stations, and scraper stations.
- Vehicle and equipment use and capabilities.
- The overall commissioning plan and the co-ordination and procedures to be utilized.
- The job responsibilities of each individual and his part in the overall plan.
- Determination of gas volumes required for purging and loading.
- Sequence of valve sections to be purged and loaded.
- Details of purging and loading procedures. Details of emergency and operating plans and responses to any problems or difficulties that may be encountered.
- The effects and precautions necessary when working with high pressure natural gas.
- Use and capabilities of telecommunication and mobile telecommunications systems.

Also it has to be verified that involved personnel have been trained and qualified for operating the pipeline.
The following guidelines summarize all activities to be completed during the pre-commissioning phase of the project.

1. Testing and adequate flushing of all piping systems.

2. Removal of all blinds or spool pieces used during hydrostatic testing.

3. Proper positioning of spectacle blinds.

4. Witness or calibrate, and test all instruments in accordance with the Pre-commissioning procedures, and record all calibrations and test data on the checklists provided for each instrument and instrument loop.

5. Verify that lubricants, oils, coolants, etc., required for all equipment are on the job site and in good condition (i.e. not contaminated).

6. Ensure that fire extinguishers are in place.

7. Check all electrical closures.

8. Ensure that all escape routes are clear of obstacles.
9. Ensure that all eyewash stations are operational.

10. Wear personal safety equipment.

11. Clear area from unauthorized personnel.

12. Be aware of the wind direction.

13. Be aware of the designated meeting area location.

14. Ensure that fire detection equipment is operational.
2. Preservation of pipeline

General

Preservation of a pipeline is carried out to maintain the pre-commissioning condition, which the installations are in until commissioning comes into force.

2.1 Preservation with dry air

If the initial gas filling of the pipelines is carried out later than six months after the installation-works are completed preservation of the pipelines takes place according to the dry air method. The main criteria for a dry pipeline are as follows:

- Dewpoint temperature must be \( \leq -20^\circ C \) measured at atmospheric pressure.
- Overpressure after sealing of the pipelines must be at least one barg.
- The acceptable minimum norm during the entire preservation-period is a measured dewpoint temperature of \( \leq -10^\circ C \) (measured at atmospheric pressure and at an overpressure of one barg).
The dewpoint temperature and the pressure is measured and registered within the preservation period with stated intervals since the pipeline-contractor as well as a neutral third party is involved.

2.2 Preservation with nitrogen (N\textsubscript{2})

If it is decided to preserve the pipeline by the use of nitrogen the criteria are as follows:

- Purge with nitrogen until achieving 100% N\textsubscript{2}
- The overpressure after sealing must be at least 2 barg.

Measurements of the pressure at stated intervals during the preservation period is required.
3. Commissioning Activities

3.1 Commissioning of dry pipelines

3.1.1 General

Commissioning includes the following activities:

The supervision and execution of the Commissioning activities are to be carried out by DESFA’s personnel who are suitably trained and qualified for this task.

Commissioning check list is to be strictly adhered to during execution of the commissioning.

Commissioning is to take place in coordination with Gas Control Center. No valves are to be opened without prior approval from Gas Control Center.
Purging of a section of pipeline is to be considered as complete when 100% gas is measured 3 times at the exhaust point with two independent gas measuring instruments.

When commissioning a new section of pipeline, or possibly a modified section of pipeline (e.g. in case of repair or construction activity) notification is to be carried out by means of form 2.2.b.

- Purging, loading, and placing into service may be carried out only after presentation of the notification of placing into service.

- The person responsible for observation of the commissioning policy is DESFA’s District Manager, or alternately, a deputy named by him.

The criteria for being considered a dry pipeline are as described here above, and if those criteria are not fulfilled then the pipeline is considered as wet.

Sections of the pipeline which have been constructed, as well as sections of the pipeline on which repairs have been carried out, contain air or a mixture of gas and air. These pipelines or sections of pipelines must be placed into service in a safe, economical and environmentally responsible manner.
The following description and points to be observed ensure a trouble-free process for commissioning of dry pipelines.

- Prepare the scope and the technique for commissioning and complying with Gas Control requirements
- Establish the purge direction
- Determine whether inert gas is required and eventually required volume
- Calculate the purge time
- Determine which will be the inlet throttle valve and exhaust valve and carry out a function test of these valves
- Establish the purge velocity. This velocity is usually between 5 m/sec in the main pipeline if no inert gas is used or 7-10 m/sec if inert gas is used
- Check all facilities which have a relation to the commissioning according to the safety check list which is herewith

- Ensure that capable and adequate personnel is assigned

- Ensure satisfactory performance of vehicles, equipment, and instruments

- Ensure effective and reliable communications between the inlet point, the exhaust point, and Gas Control Center

- Advise Gas Control Center of commencement of purging, loading, and placing into service

- Ensure with the Gas Control Center for the availability of the required quantities of gas

- In case of use of inert gas, the adequate volume will be determined from the cross sectional area of the pipe. An inert gas plug approx. 300 m in length is recommended as it may be difficult to maintain a purge velocity of 3 - 7 m/s. The supervisor in charge of commissioning will determine if inert gas is to be used
3.1.2 Commissioning procedure

- The procedure begins with the injection of gas, or inert gas if it is decided, into the inlet throttle valve which is opened slowly, while measuring the velocity at the outlet throttle valve.

- Then should regulate the purge velocity (usually approx. 10 m/sec in the main pipeline - 90 m/sec from vent stack) following always the be given by a person at the vent stack.

- Commence timing of the purge only after regulation of the purge velocity has been achieved.

- Close to the expiration of the purge time, the gas concentration is to be measured by means of two independent gas measuring instruments.

- After verification of measurements of 100 % Vol gas at least 3 times then first the throttling valves of the exit and then the valves of the insert point are to be closed in that order.

- All vented gas quantities are to be reported for the calculation of the vented gas.
Two pressure gauges and one pressure recorder are installed at the start and end of the pipeline section to be loaded (one additional pressure gauge is to be kept in reserve in case of malfunction). The range of the scales of the gauges and recorders must be at least equal to the maximum possible loading pressure.

The pipeline is loaded in stages so that the pressure in the pipeline rises to 5 - 10 bar during the first hour.

The second hour the throttle inner valve is opened further so that the pressure rises to 10 - 20 bar.

Finally the inlet throttle valve is opened further so that final loading pressure is reached after three hours.

Depending on the quantity of gas supply available for loading the pipeline, lower pressure increments are to be selected in accordance with Gas Control Center.
After each hour a leak test of susceptible points on the pipeline (e.g. tie-in welds, flange connections, etc.) is to be carried out using a foam producing liquid. If any leaks are found permanent repairs are to be carried out in accordance with specifications before proceeding with the loading operation.

Leaks from fittings should be tightened in accordance to vendors instructions.

Loading time for the pipeline or section of pipeline will generally be determined by the gas volumes available and the configuration at the inlet and throttle valve.

After the pipeline has been loaded (pressure equalization) it will be connected to the pipeline system.

For further commissioning of pipeline downstream Section the above procedure is repeated.
3.2 Commissioning of wet pipelines

In the case of wet pipeline and before purging with natural gas it is necessary to dry the pipeline.

The cause of this is that under certain pressure and temperature conditions, gas hydrates will form when hygroscopic water (i.e. water remaining after de-watering) comes into contact with gas. The range of pressure and temperature, within which natural gas hydrates form, lies above 0°C (water dew point) and 6 bar. A decomposition of gas hydrates occurs by an increase in temperature or reduction in pressure.

Based on present experience the following dehydration procedures are generally accepted:

- Drying with dry air
- Absorption of residual water by alcohol
- Drying of residual water by vacuum

After the drying of the pipeline the procedure for the commissioning of dry pipeline is followed.