

DEP SPECIFICATION

PRECOMMISSIONING OF PIPELINES

DEP 31.40.50.30-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements for the dewatering, cleaning, drying and preservation of pipelines. These activities are termed precommissioning and may be necessary to prevent unacceptable internal corrosion and fluid contamination during commissioning and operation of the pipeline.

The requirements for preparing the precommissioning work, the health, safety and environmental precautions, and the equipment and media are also specified in this DEP.

This DEP should be used as a technical specification to be incorporated into a precommissioning or construction contract. The Principal is responsible for providing in the scope of work, the relevant pipeline and hydrotest water data and defining the activities to be performed, media to be used and other requirements as stated in this DEP.

This DEP is applicable to onshore and offshore carbon steel pipelines, flowcoated and non-flowcoated, and GRP/GRE pipelines which have passed the hydrostatic pressure test and are filled with the hydrotest water. Appendix A specifies the additional requirements for duplex stainless steel pipelines and pipelines with internal CRA steel cladding.

This DEP is not applicable to commissioning activities.

- NOTES:
- 1) Activities requiring the introduction into the pipeline of fluid to be conveyed become part of commissioning. Relevant requirements of this DEP may be incorporated in the commissioning procedure.
 - 2) Methanol swabbing shall only be performed with the final product as a driving medium.

This is a revision of the DEP of the same number dated January 2005; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorization to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil refineries, chemical plants, gas plants and exploration and production facilities and supply/distribution installations. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process should be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regards to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Specific definitions

Term	Definition
commissioning	activity where the fluid to be transported is initially introduced into the pipeline.
equipment	all temporary fittings, piping, pumps, compressors, pigs, materials and consumables used in precommissioning of the pipeline.
final cleaning	cleaning of the pipeline and its components beyond that carried out as part of the hydrostatic testing activities specified in DEP 31.40.40.38-Gen.
fluid	fluid(s) to be conveyed in the pipeline during operation.
golden weld	weld that is not subjected to a hydrostatic pressure test and is therefore subjected to additional non-destructive inspection.
hydrostatic pressure test	that part of the testing operations where the pipeline is pressurised. The hydrostatic pressure test includes a strength test and a leak tightness test.
isolation valve	valve used for interrupting the flow or isolating one section of a pipeline from an adjacent section or a facility connected to the pipeline. An isolation valve is normally either fully opened or fully closed. Also referred to as a block valve.
key personnel	personnel appointed and specially named by the Contractor to be in full charge of all precommissioning operations.
pipeline	section of a system of pipes and other components or the entire system used for the transport of fluids, between plants. A pipeline extends from pig trap to pig trap (including the pig traps), or, if no pig trap is fitted, to the first isolation valve within the plant.
precommissioning	series of activities that can include fresh water swabbing, dewatering, final cleaning and drying to prepare the pipeline internally for commissioning.
precommissioning plan	Contractor's plan for the preparation and execution of precommissioning activities including the equipment to be used.
scope of work	part of a contract which states the overall scope of precommissioning operations.
Shore (A)	a measure of hardness for rubbers/elastomers. The higher the number the greater the resistance to indentation.
sleeping pig	pig present in the pipeline at the commencement of precommissioning.

1.4 ABBREVIATIONS

CRA	Corrosion Resistant Alloy
GRP/GRE	Glass-fibre Reinforced Plastics / Glass-fibre Reinforced Epoxy
MAOP	Maximum Allowable Operating Pressure

1.5 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets. Other documents referenced by this DEP are listed in (10).

1.6 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2005. The following are the main, non-editorial changes.

This DEP has been split between two documents: a Specification and an Informative document. Where applicable, some specific requirements for deep water applications have been added.

1.7 ACTION ITEMS

An (S) in the margin is shown when the Principal is required to make a decision or to give the particular specification value of a parameter.

NOTE: If the Principal's decision is only required under certain circumstances, this is not shown by a margin marker.

An (A) in the margin is shown when the Contractor is required to obtain the Principal's approval for a particular action or procedure.

NOTE: Most, if not all, of these approvals are normally part of the test procedure which has to be approved by the Principal prior to the commencement of the hydrostatic testing operations.

1.8 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://sww.shell.com/standards> and on the main page of the DEPs DVD-ROM.

2. GENERAL REQUIREMENTS

2.1 BASIC REQUIREMENTS

- (S) The Contractor shall perform the precommissioning in accordance with the requirements of the scope of work and this DEP. The scope of work shall take precedence in case of conflict between the requirements of this DEP and the scope of work.

Hydrotest water and all water required for the precommissioning shall be supplied and disposed of in accordance with DEP 31.40.40.38-Gen.

Media other than water that will be introduced into the pipeline for precommissioning shall meet the following requirements:

- they shall be clean and free of oil;
- they shall not have any detrimental impact on the pipeline materials, including internal coating, if applicable;
- nitrogen, methanol and glycol shall have a purity of at least 99 %;
- the temperature of the media when entering the pipeline shall not be less than 0°C or the minimum pipeline design temperature, whichever is the highest, and not more than 50°C or the maximum pipeline design temperature, whichever is the lowest.

2.2 PRECOMMISSIONING PLAN

- (A) The Contractor shall execute the work in accordance with the precommissioning plan approved by the Principal before commencement of the work.
- (S) The Contractor shall prepare the final precommissioning plan for submission to the Principal for approval not later than 4 weeks before commencement of the work unless otherwise specified in the scope of work.

The precommissioning plan shall include as a minimum:

- a) an outline description of the required precommissioning work including sequence of activities and programme. For the individual activities, the programme should include the start and completion dates, and the dates of mobilisation and demobilisation of equipment, personnel and supplies to the work sites;
- b) the Contractor's organisation chart for the work with a description of the responsibilities of key personnel;
- c) names of any subcontractors and Suppliers and their scope of work or supply, and how they shall be managed by the Contractor;
- d) description of the interfaces and lines of communication with the Principal;
- e) identification of all potential health, safety and environmental hazards with a description of the contingency procedures and an emergency plan;
- f) a procedure for each main activity covering:
 - a step by step description of the work;
 - description of the required personnel, equipment and consumables, certification, monitoring, records and verifications;
 - location and layouts with hazardous area classifications for equipment and supplies, including water supply and disposal facilities;
 - calculations and any other evidence necessary to demonstrate that the work will be executed in accordance with the requirements of the Principal;
- g) contingency procedure(s) for the removal of stuck pigs;

- h) the "Table of Contents" for the "Final Precommissioning Report" with sample copies of Contractor's standard forms and sheets.

2.3 CHECKS AND COMPLIANCE

The Contractor shall verify throughout that all the work is executed in full compliance with all the requirements of the scope of work and this DEP. Verifications shall, as a minimum, include:

- a) availability of the approved precommissioning plan at the work site(s) before commencement of and during the work;
- b) identification, certification and condition of equipment and supplies to be provided in good serviceable condition, at the work site(s) prior to mobilisation and throughout precommissioning;
- c) positioning of necessary warning notices, marker tapes, protective barriers, safety and fire fighting equipment;
- d) compliance with the hazardous area requirements;
- e) installation, earthing and protection of equipment;
- f) compliance with safe storage requirements of chemicals;
- g) instruction of personnel on their responsibilities and tasks and possible hazards with the necessary safety measures;
- h) availability and functioning of safety and communication equipment, including backup equipment;
- i) availability of required permits and adherence to their requirements.

2.4 PRECOMMISSIONING RECORDS AND REPORTS

The Contractor shall take the records specified in the scope of work and this DEP and keep them for inclusion in the "Final Precommissioning Report". All record charts shall be signed by the Contractor immediately before they are placed in and after they are taken out of the recorder.

The Contractor shall prepare a "Final Precommissioning Report" which shall include as a minimum:

- overall debrief of the precommissioning work;
 - analysis of performance against the precommissioning plan;
 - records specified in this DEP.
- (A) The draft of the report shall be submitted for approval to the Principal within 14 days following the completion of the site work. In the event of comments by the Principal, the Contractor shall update the report within 14 days.
 - (S) The Contractor shall issue one final report with all original records/documents and three copies (or more if specified in the scope of work) within 14 days of approval of the draft report by the Principal.

3. HEALTH, SAFETY AND ENVIRONMENT

- (S) The Contractor shall, in the precommissioning plan, identify the hazards associated with the precommissioning activities and work sites, including those advised by the Principal, and shall define the necessary hazard mitigation measures. The Contractor shall comply with any permit-to-work system in force at any location affected by the precommissioning activities.

- (S) The Contractor shall provide gas detection devices and/or breathing apparatus when required for safe working practices and when specified in the scope of work. Users of such equipment shall be thoroughly trained in their use.

Equipment should be installed at locations away from public places, roads or living quarters. The Contractor shall control access to and activities at these locations.

The Contractor shall place warning signs and notices, such as 'KEEP AWAY - PIPELINE UNDER PRESSURE' or 'KEEP AWAY - PIPELINE UNDER VACUUM', at appropriate places such as affected pipework, isolation valves in branches and main line block valve stations. Notices shall be in English and the local or working languages.

The Contractor shall provide radio or other means for dedicated communication between locations where precommissioning work is being carried out or that are affected by Shell work.

The Contractor shall ensure that the hazards associated with the use of nitrogen and the safety precautions to protect personnel are known, understood and applied by all personnel carrying out the work.

Material safety data sheets shall be available at the site where chemicals are stored or handled. Chemicals shall be stored, handled, used, recycled and disposed of in accordance with the recommendations of the Supplier and other applicable requirements. Chemicals should be stored in properly marked original packings, in small quantities and away from sources of heat and fire. The Contractor shall inform all personnel at the work sites of the hazards and provide the necessary training and protective means. The Contractor shall be responsible for carrying out any Chemical Hazard Assessment and Risk Assessment required by local authorities before using the proposed chemicals.

Soil and water contamination from spilled liquids shall be prevented. Drip pans shall be placed underneath pig trap doors, engine driven equipment, drains and other places of possible liquid spillage to collect liquids which may cause contamination.

The unsafe release of toxic, flammable and explosive gas mixtures shall be prevented by providing facilities for safe venting or disposal as appropriate.

- (S) Noise emission levels shall be kept as low as practical by the selection of appropriate equipment and by attenuation measures such as noise absorbing barriers and silencers. Maximum permissible levels for safe working, as specified in the scope of work, shall not be exceeded. The Contractor shall at all times ensure that the noise level does not exceed 85 dB in areas accessible to the general public unless otherwise agreed by the Principal.

The Contractor shall be responsible for obtaining all necessary approvals and permits from the appropriate local authorities, owners and third parties concerning the disposal of water from the pipeline. Water may only be directly discharged into the environment after it has been filtered/separated and neutralised, and the environmental acceptability of the effluent has been confirmed.

- (A) The location of the precommissioning work sites and the arrangement of the equipment (including water supply and disposal sites and facilities) shall be approved by the Principal.
- (A) The Contractor shall prepare an emergency plan which defines the actions, personnel and facilities required in case of an emergency. The Contractor shall obtain the Principal's approval of the emergency plan in writing before commencing precommissioning activities.

The plan shall address at least the following aspects:

- a) handling of spillages and other incidents;
- b) requirements for personnel and equipment;
- c) requirements for informing others;
- d) first aid and medical facilities;
- e) telephone numbers of stand-by crews;
- f) telephone numbers of police, medical and other authorities to be contacted;
- g) telephone number(s) of the contact(s) of the Principal.

The precommissioning work sites shall be left in a clean condition and free of debris. All waste, chemicals, etc. shall be disposed of by the Contractor in accordance with the Principal's waste disposal requirements.

4. EQUIPMENT

4.1 PRESSURE OR VACUUM RETAINING EQUIPMENT

All pressure or vacuum retaining precommissioning equipment shall be designed, fabricated, tested and marked, in accordance with recognised standards, for a safe operating pressure of not less than the maximum/minimum pressure predicted during the precommissioning. Certificates, approved by an independent certifying authority, specifying the applicable standards, confirming compliance with them and stating the hydrostatic pressure test data, shall be provided with all such equipment. The certificates shall be available at the work sites at all times.

4.2 FILTERS, PUMPS AND COMPRESSORS

The Contractor shall define the number, size and performance of each component required for the work, including standby units and spare parts. Pumps and compressors shall be supplied with test performance data sheets.

- (S) Delivery pressures of pumps and compressors shall not at any time exceed the MAOP of the pipeline and of the precommissioning equipment, including allowances required for transient pressures e.g. due to surges and static head effects. Pumps and compressors shall be fitted with dedicated over-pressure protection devices if the maximum delivery pressure they can generate exceeds the MAOP. 50 µm water filters, or a size specified in the scope of work, with a capacity sufficient for the required flowrates shall be provided. It should be possible to clean the filters without interrupting operation.
- (S) All equipment shall be suitable for continuous use at the required operating conditions under the specified local environmental conditions.

4.3 PIG TRAPS

- (S) Where available and agreed by the Principal, permanent pig trap facilities may be used for precommissioning. If precommissioning is carried out in the reverse direction to normal operations, the Contractor shall be responsible for identifying and providing any temporary modifications and/or additional facilities that may be required.

Any temporary pig trap facilities required shall be designed, fabricated, installed and tested in accordance with the same code as the pipeline and shall be suitable for the worst conditions that may arise during precommissioning. Temporary pig traps shall be provided with a major barrel capable of storing at least three pigs, unless otherwise specified in the scope of work. They shall be connected to the pipeline by flanging to permanent pipeline flanges, or by welding. Temporary deep water subsea pig traps may be connected using mechanical connectors.

4.4 WELDING OF TEMPORARY EQUIPMENT

Requirements for the welding of temporary pig trap facilities to the permanent pipeline are:

- a) connecting welds that have not been subjected to the hydrostatic pressure test of the pipeline shall be treated as "golden welds";
- b) the minimum wall thickness of the temporary equipment shall be not less than 4.8 mm and the ratio between pipeline and equipment wall thickness should not exceed 1.5;
- c) existing weld metal and the heat affected zone shall be removed by cut-back over at least 12 mm;
- d) the full circumference of the prepared weld ends of the pipeline and the pig trap shall be ultrasonically tested to confirm the absence of laminations, over a minimum distance of 25 mm from the bevelled ends;
- e) welding shall be carried out in accordance with DEP 61.40.20.31-Gen or DEP 37.81.40.31-Gen as applicable.

Upon completion of precommissioning activities the temporary pig trap facilities shall be removed by cutting out the complete connecting weld and heat affected zone.

4.5 FLEXIBLE HOSES

Flexible hoses may be used only for short length connections such as those required to pig traps and instruments. They shall be of the armoured type and be manufactured and tested to recognised standards applicable to permanent hydraulic installations. All hoses and connections shall be of one type only. Prior to each re-use, all hoses and connections shall be visually inspected for damage. Damaged hoses shall be marked accordingly and shall not be used. Hoses shall be protected against external damage and be anchored adequately so that pressure and/or flow variations cannot cause them to jump.

For safety reasons, any temporary or permanent manifolds used in precommissioning operations shall be rigidly supported. Vibrating hoses shall not be allowed to transmit their forces into the manifold, otherwise failure due to fatigue may occur leading to potentially serious incidents.

4.6 ELECTRICAL INSTALLATIONS

- (S) Electrical installations shall comply with the requirements for temporary equipment as given in DEP 33.64.10.10-Gen. The rules governing the use of electrical equipment in hazardous areas shall be complied with. The zone classification shall be as advised by the Principal.

Equipment shall be earthed for protection against lightning and the accumulation of static electricity.

4.7 DIESEL ENGINES

If diesel engines are used in hazardous areas, their protection shall be considered. No such engines should be used in, or within 15 m of, a Zone 1 area. Their use in a Zone 2 area should be avoided wherever possible. If the use of diesel engines within 15 m of a Zone 1 or 2 area, or within a Zone 2 area, is unavoidable the following shall apply:

- a) Surface temperature limitation to 250°C or to the specified temperature class.
- b) Exhaust flame trap and spark arrestor.
- c) Non-electric starting system.
- d) An inlet air shut-down control system to operate in response to high temperature, overspeed and gas detection.
- e) Cooling fan blades should be non-metallic and all fan belts of the antistatic fire resistant type.
- f) Any ancillary electrical equipment shall comply with DEP 33.64.10.10-Gen.

4.8 TEST CABIN

Test cabins should be air-conditioned or heated, as appropriate, for continuous monitoring and recording, and shall be fully equipped and tested prior to mobilisation to the work sites. Flexible hoses shall not be allowed inside the test cabin.

4.9 INSTRUMENTATION

All instruments and cabling shall have current certificates of calibration/testing from a recognised certifying authority or third party approved by the Principal. Calibration/testing certificates shall not be older than 6 months at commencement of work at the work site.

Reading divisions, ranges and accuracies of instruments shall be in accordance with Table 4.1.

Table 4.1 Reading division, range and accuracy of Instrumentation

INSTRUMENTATION	READING DIVISION	RANGE	ACCURACY
DEWATERING, CONDITIONING, PRESERVATION AND PIGGING			
Flowmeter and recorder	m ³ /h	(Note 1)	± 2 % (Note 7)
Pressure gauge and recorder	0.5 bar 1 bar 5 bar	0 bar to 16 bar 0 bar to 60 bar 0 bar – 300 bar	± 0.6 % (Note 6)
HIGH VELOCITY WATER, AIR OR GAS CLEANING			
Flowmeter and recorder for liquids for other media	m ³ /h	(Note 1)	± 2 % ± 5 % (Note 7)
Pressure gauge and recorder	0.5 bar 1 bar 5 bar	0 bar to 16 bar 0 bar to 60 bar 0 bar – 300 bar	± 0.6 % (Note 6)
METHANOL OR GLYCOL SWABBING			
Density meter	kg/m ³	(Note 2)	± 1 % (Note 7)
DRYING WITH DRY AIR, DRY GAS AND VACUUM			
Dewpoint meter	1.0 °C	+ 40 °C to –50 °C	± 1.0 °C
Ambient air temperature recorder (24 h)	0.5 °C	0 °C to 80 °C	± 1 % (Note 7)
Temperature probes (digital)	0.1 °C	+ 20 °C to –50 °C 0 °C to 50 °C	± 0.2 °C
Pressure gauge and recorder	0.5 bar	0 bar to 10 bar	± 1 % (Note 7)
Flowmeter and recorder	m ³ /h	(Note 3)	± 2 % (Note 7)
VACUUM DRYING			
Barometer	1 mbar	(Note 4)	± 0.8 mbar
Pressure gauge and recorder 1	20 mbar	0 mbar to 1000 mbar	± 1 % (Note 6)
Pressure gauge and recorder 2	1 mbar	0 mbar to 100 mbar	± 1 % (Note 6)
Pressure gauge and recorder 3	0.5 mbar	0 mbar to 50 mbar	± 1 % (Note 6)
Pressure gauge and recorder 4	0.1 mbar	0 mbar to 10 mbar	± 1 % (Note 6)
Flowmeter	m ³ /h	(Note 5)	± 2 % (Note 7)

- NOTES:
- 1) Depending on flowmeter size (pipeline diameter).
 - 2) Depending on the drying medium to be used.
 - 3) Depending on pipeline diameter and/or air drying unit capacity.
 - 4) Depending on site altitude.
 - 5) Depending on vacuum plant capacity.
 - 6) Percentage of measured value.
 - 7) Percentage of full range.

5. PIGGING REQUIREMENTS

5.1 PIG SELECTION AND PLANNING

- (A) The Contractor shall identify the pigs in the Precommissioning Plan. The selection criteria for the pigs shall be documented and provided to the Principal for approval, and should include:
- a) Bidirectionality
 - b) Travel limits
 - c) Material selection
 - d) Pressure losses across the pig
 - e) Pig monitoring
- (S) Pigs shall be able to pass through pipelines with minimum bore and minimum bend radius and through pipeline valves and fittings as specified in the scope of work.
- Foam pigs shall be oversized as required for their duty.
- (A) Any sealing or solid gels shall be compatible with the media used during precommissioning and not cause contamination of the fluid or downstream facilities during operations. The Contractor shall specify and submit all details of the gel, including composition, compatibility, quantities, stability, minimum and maximum pigging speed and impact on driving pressure to the Principal for approval prior to their use.

5.2 PLANNING PIGGING OPERATIONS

The Precommissioning Plan shall define the inlet flows and pressures for the driving medium; and shall account for pipeline elevation, density of fluid in the pipeline, pressure loss across the pig or pig train and back-pressure at the receiving end.

Control of the pig travelling speed shall be assisted by maintaining a back-pressure of 1 bar (ga) for liquids and 3 bar (ga) for other media above the ambient pressure at the receiving end. This pressure shall be increased where necessary to counteract acceleration of the pig in downhill sections. In liquid-filled pipelines, the pressure of the receiving end shall always be equal to or greater than the static pressure that can occur behind the pig during pigging operation.

Single pigs or pig trains shall be separated by distances that provide sufficient time for receivers to be unloaded without reducing the travelling speed of any following pigs or pig trains. Pig trains shall be split if they contain more pigs than the receiver can hold before being unloaded

The distance between pigs in a train shall be at least 2 % of the pipeline length, with a minimum distance of 150 metres when separated by liquids and 300 metres when separated by other media.

Prior to any pigging operations the Contractor shall verify that:

- all valves have been correctly positioned and are functional. All main line valves shall be in the fully open position; and
- discharge and/or storage facilities have been connected and are in good working order.

Pigs should be removed from the pig receiver immediately upon arrival, and then inspected.

5.3 DISLODGING STUCK PIGS

- (A) The Contractor shall advise the Principal when higher pressures are required to dislodge pigs and shall proceed in accordance with the contingency procedures only after approval by the Principal.

5.4 PIGGING RECORDS

All pigging operations shall be recorded in a pig data register with the following data as a minimum:

- a) identification number and date of the pig run;
- b) number and type(s) of pig;
- c) volumes and pressures of the driving media;
- d) time of launching and receiving;
- e) condition of pigs before launching and upon arrival; and
- f) volumes and natures of material and substances arriving in front of the pig at the receiving end.

6. DEWATERING

6.1 GENERAL

- (S) When specified by the Principal in the scope of work, the Contractor shall dewater the pipeline using the specified medium.
- (S) Sleeping pigs shall be recovered by the Contractor. These pigs shall be used for dewatering only if specified in the scope of work.

Dewatering of the pipeline by gravity alone shall not be permitted, as this can result in a broken water column which can seriously affect the pressure needed to propel pigs due to the accumulation of multiple static heads.

The Contractor shall drain remaining free water from valve body cavities and dead ends of piping and if applicable blow through with compressed air. The method and timing of draining shall be specified in the dewatering procedure of the precommissioning plan.

Methanol shall not be used in dewatering operations where air drying is to follow, as this can lead to potentially explosive methanol/air mixtures. Glycol may be used with triethylene glycol being preferred due to its lower toxicity level.

6.2 DEWATERING RUNS

One pig train run shall be required as a minimum when the driving medium is:

- nitrogen, glycol or methanol;
- nitrogen in combination with glycol swabbing.

Two pig train runs shall be required as a minimum when the driving medium is:

- air;
- air in combination with glycol swabbing.

Methanol shall not be used in dewatering operations where air drying is to follow, as this can lead to potentially explosive methanol/air mixtures. Glycol may be used with triethylene glycol being preferred due to its lower toxicity level.

6.2.1 First dewatering run

The first dewatering run shall be carried out as follows:

- the travelling speed of the pig train should be constant and within the range of 0.5 to 1.0 m/s;
- the internal pipeline pressure shall be kept at least 1 bar (ga) above the ambient pressure at any point along the pipeline by control of back-pressure at the discharge end;
- when dewatering with air or nitrogen only, pigs shall be separated as specified in (5.3);
- when dewatering with methanol or glycol only, pigs shall be separated by a volume of the driving medium to be determined in accordance with (8.5.1).

Fresh water swabbing shall be performed if salt water was introduced into the pipeline for hydrostatic pressure testing or precommissioning and final air cleaning or drying is required. This is to prevent salt deposits forming, especially during evaporation. The requirements for fresh water swabbing are:

- fresh water, of about 4 % of the pipeline volume, shall be driven through the pipeline in batches contained by pigs;
- the volume of fresh water between two pigs shall be determined in accordance with (8.5.1);
- the travelling speed and internal pipeline pressure shall be as specified above.

If the fresh water batches are driven by air, swabbing shall be repeated until the salt content of a received batch is less than 200 mg per kg of water. If the driving medium is glycol or methanol, or is followed by glycol swabbing, swabbing should be stopped once the specified volume of fresh water has been pigged through the pipeline.

6.2.2 Second dewatering run

A pig train with one high sealing disc pig, followed by at least by two foam pigs with a density of 80 kg/m³, shall be driven by air through the pipeline as follows:

- the dewpoint of the air for pigging shall be at least 5°C below the minimum ambient temperature along the pipeline measured at 1 bar (ga);
- the travelling speed of the pigs should be between 0.5 m/s and 1.0 m/s, but shall not exceed 1.5 m/s.

Pigging with foam or brush foam pigs shall continue until they arrive without free water in front.

6.3 DEWATERING RECORDS

The Contractor shall measure and record the following:

- details of test water and other media received at receiving end;
- salt content of the last fresh water batch at the receiving end, if applicable;
- for each dewatering run the quantities, pressure and flowrate records of the driving medium;
- for the second run the dewpoints of the air.

7. FINAL CLEANING

7.1 INTRODUCTION

- (S) The Contractor shall adopt the method for final cleaning as specified by the Principal in the scope of work.
- (S) The Principal shall specify the cleanliness criteria to be achieved consistent with the selected cleaning method and the intended pipeline service.

Regular samples shall be taken from the effluent. The solids content shall be measured and the results recorded. Cleaning shall be considered complete when the quantity of debris in the samples directly ahead of the last pig is less than one percent by volume.

The pipeline system shall be considered clean when the water/air coming out of the pipeline does not leave any debris on a filter with size 50 μm (300 mesh).

7.2 LOW VELOCITY WATER CLEANING

Low velocity water cleaning shall be carried out by pigging the pipeline with pig trains consisting of a series of brush cleaning pigs followed by a high sealing disc pig as follows:

- clean and filtered water shall be used as driving medium;
- high sealing disc pigs should be run with open bypass ports of approximately 8 % of the pipeline bore;
- the pig travelling speed should be within the range 0.5 m/s to 1.0 m/s.

Pigging shall continue until the specified cleanliness criteria have been achieved. Final cleaning of carbon steel pipelines shall be concluded by a run with a magnetic cleaning pig.

7.3 HIGH VELOCITY WATER CLEANING

High velocity water cleaning shall be carried out by continuously pumping water at high velocities through the pipeline, as follows:

- clean and filtered water shall be pumped continuously through the pipeline at a minimum velocity of 3 m/s;
- the minimum volume to be pumped through the line shall be three times the volume of the pipeline.

Cleaning shall be considered complete when the specified cleanliness criteria have been achieved whilst replacing the line content at the specified velocity.

7.4 LOW VELOCITY AIR CLEANING

Low velocity air cleaning shall be carried out in combination with pigging. Pig trains consisting of a series of brush cleaning pigs or brush coated foam pigs followed by a high sealing disc pig shall be driven through the pipeline using dry air, as follows:

- high sealing disc pigs should be run with open bypass ports of approximately 5 % of the pipeline bore;
- the pig travelling speeds should be within 0.5 m/s to 1.0 m/s;
- the dewpoint of the air shall be as for drying.

Pigging shall continue until the specified cleanliness criteria have been achieved. Final cleaning of carbon steel pipelines shall be concluded by a run with a magnetic cleaning pig.

7.5 HIGH VELOCITY AIR CLEANING

High velocity air cleaning shall be carried out after dry air or vacuum drying. Dry air shall be purged continuously through the pipeline as follows:

- the dewpoint of the dry air shall be as specified for the dry pipeline;
- a minimum air velocity of 10 m/s shall be maintained in the pipeline at the inlet;
- the quantity of air to be used for purging shall be sufficient to replace the volume of the pipeline three (3) times at the purging pressure.

Cleaning shall be complete when the specified cleanliness criteria have been achieved whilst the line content is replaced at the specified velocity.

When using this method, special attention shall be given to knocking out any entrained debris/dust before the air is exhausted to the atmosphere.

7.6 FINAL CLEANING RECORDS

The Contractor shall measure and record the following:

- total volume, pressure and flowrate of cleaning medium for each cleaning step;
- quantities and nature of materials received at the end of the pipeline;
- details of media received at the receiving end;
- for air cleaning the dewpoints of the air from both ends of the pipeline.

8. DRYING

8.1 INTRODUCTION

- (S) The Contractor shall adopt the drying method and achieve the dryness as specified in the scope of work.

8.2 DRY AIR AND NITROGEN DRYING

8.2.1 General

- (S) Air introduced into the pipeline during dry air drying shall have a dewpoint of at least 15°C below the final dewpoint of the pipeline as specified in the scope of work.

Nitrogen used during drying shall have a minimum dewpoint of –50°C at atmospheric pressure.

8.2.2 Pigging

The pipeline shall be pigged with high sealing disc pigs driven by dry air or nitrogen in combination with water absorbing foam pigs having a large water absorption capacity (approximately 80 % of their body mass), high abrasion resistance and a density between 30 to 50 kg/m³ as follows:

- the travelling speed of the foam pigs should not exceed 1.2 m/s;
- a back-pressure of at least 0.5 bar (ga) shall be maintained at the receiving end; and
- pigs in a pig train should be separated by at least 300 linear pipeline metres.

Pigging shall continue until the dewpoint of the drying medium at the receiving end remains below the dewpoint specified in the scope of work and does not fluctuate by more than 3°C whilst replacing the content of the line by a pig.

8.2.3 Purging for drying

After pigging, the pipeline should be purged with the drying medium with a minimum velocity of 3 m/s in the pipeline at the discharge end. Purging shall continue until the dewpoint at the discharge end remains below the specified dewpoint whilst replacing twice the content of the pipeline at purging pressure.

8.2.4 Purging for acceptance testing

Upon completion of purging, the pipeline shall be blocked-in for a period of at least 12 h and at a pressure of 0.5 bar (ga) above the ambient pressure at all points along the pipeline. After this period the pipeline content shall be replaced at the lowest possible pressure and the dewpoint continuously measured at the discharge end.

Drying is complete when the dewpoint during acceptance purging remains below the final dewpoint specified for the pipeline whilst replacing the line content. Purging for drying shall recommence and the acceptance test shall be repeated until this requirement has been met.

Upon completion of the drying, the pipeline shall be blocked in at a pressure of 0.5 bar (ga) above the ambient pressure at any point along the pipeline.

8.3 VACUUM DRYING

8.3.1 General

- (S) Water vapour shall be evacuated from the pipeline by vacuum units alone or in combination with dry air or dry nitrogen vacuum purging as specified in the scope of work. The final dewpoint of the dry pipeline shall be –20°C, which is equivalent to a pressure of 1 mbar (abs), unless otherwise specified in the scope of work.

The Contractor shall prepare a theoretical pressure/time graph for each of the drying phases, which shall be included in the precommissioning plan.

8.3.2 Pre-drying checks

Before commencement of vacuum drying the Contractor shall verify that:

- the pipeline has been isolated from other pipelines and pipework;
- valves are designed for vacuum drying and have been placed into the half open position;
- valve body bleeder parts are vacuum tight;
- temporary connections, pig trap valves and pig trap end closure seals are able to withstand the prevailing vacuum pressure. If this is not the case, the Contractor shall provide adequate seals for the vacuum drying operation and replace these seals by the permanent seals once the vacuum drying operation has been completed.

8.3.3 Leak tests

The pipework connecting the vacuum unit with the pipeline, including pig trap(s) and vacuum unit(s), shall be isolated from the pipeline and the pressure in the isolated pipework lowered to slightly above the theoretical evaporation pressure.

The vacuum unit shall be switched off and the isolated pipework checked for leaks by visual/audio inspection. Leaks shall be cured by flange tightening, taping flange circumferences, taping grease nipples and applying plasticine or equivalent to valve stems.

The pipeline shall then be opened to the vacuum unit(s) and the pressure in the entire system reduced to a pressure of 50 mbar (abs) to 100 mbar (abs) for the final leak test. The pressure shall be maintained at this level and all other piping, such as at inline block valve stations and the pig trap system at the other end of the pipeline if vacuum drying is carried out from one end only, shall be checked for leaks. Leaks shall be cured as stated above.

After all leaks have been cured, where possible, the vacuum unit shall be turned off and isolated from the pipeline and the pressure in the pipeline and the associated pipework monitored for at least 1 h. Pressure increases shall be recorded and plotted on a pressure/time chart. From the measured pressure increase, the total leak rate shall be calculated. Curing of leaks shall be continued until the calculated total leak rate is less than 10 % of evacuation capacity of the vacuum units at the initial leak test pressure. The final in-leak rate shall be recorded for use when analysing the final soak test results.

8.3.4 Pump-down

The pressure in the pipeline shall then be reduced at a steady rate to the level predicted for the evaporation of the residual water. The time required to pump down shall be compared to the theoretical time to ensure freezing has not occurred.

8.3.5 Evaporation/evacuation

As the pressure in the pipeline approaches the saturated vapour pressure at the pipeline's ambient temperature, the rate of vapour evolution will increase, resulting in a reduction in the rate of pressure decrease. The vaporisation pressure shall be maintained and water vapour evacuated by pumping until all residual water has evaporated. Once all the free water has evaporated from the pipeline, the rate of pressure decrease will increase.

Ice formation in the pipeline and associated fittings shall be avoided by control of the evacuation rate through the vacuum units.

Vaporisation and evacuation by pumping shall continue until the vapour pressure has reached the level that is equivalent to the dewpoint specified for the dry pipeline. This pressure shall be maintained for at least 3 h to confirm that a stable balanced vacuum pressure is established throughout the pipeline. Evacuation shall then be stopped and a soak test carried out.

Vacuum purging with dry air or nitrogen at pressures in the range of 3 mbar (abs) to 10 mbar (abs) may be applied in addition to evacuation by pumping to reduce the time needed for conventional evaporation and water vapour evacuation. The rates and

pressures are dependent on the performance curves of the vacuum equipment, as the aim is to increase the pressure in the pipeline to an efficient volume transfer level. If applied, purging and evacuation shall continue until the dewpoint at the vacuum unit is constantly below the dewpoint for a dry pipeline as specified in the scope of work while replacing at least twice the contents of the pipeline. Purging shall then be stopped, and the pressure reduced to 3 mbar (abs) and maintained at this level for at least 3 h to achieve stable conditions in the pipeline. A soak test shall then be performed.

8.3.6 Soak test/acceptance test

- (S) The pipeline shall be blocked in and isolated from all equipment other than that required for pressure monitoring for a period of at least 24 h, at a pressure of:

- 1 mbar (abs) if vapour is being evacuated by pumping only;
- 3 mbar (abs) if vapour is being evacuated by pumping and purging;

or as specified in the scope of work.

Pressure monitoring shall be carried out by means of pressure gauges and recorders with range 0 mbar to 10 mbar, a reading division of 0.1 mbar and an accuracy of $\pm 1\%$ of the measured value.

8.3.7 Filling phase

- (S) After the soak test has been successfully completed, the Contractor shall fill the pipeline with either dry air or dry nitrogen as specified in the scope of work, to:

- 50 mbar (abs), for nitrogen when gas filling is to immediately follow drying.
- 500 mbar (ga) above the ambient pressure at any point along the pipeline, for nitrogen (if there will be a delay between drying and gas filling) or for dry air.

Warning signs, in English and the local or working languages, such as "PIPELINE UNDER VACUUM" or "PIPELINE FILLED WITH DRY AIR" shall be placed at all affected pipework, including block valve stations and pig trap systems.

8.4 DRY AIR PIGGING IN COMBINATION WITH VACUUM DRYING

Dry air pigging followed by vacuum drying shall be carried out as follows:

- (S)
- the dewpoint of the dry air shall be -40°C unless otherwise specified in the scope of work.
 - dry air pigging shall be continued until the dewpoint of the air received is -15°C at atmospheric pressure and remains at this level whilst the line content is replaced by a dry air driven pig.

8.5 GLYCOL SWABBING

8.5.1 General

This method shall only be used where there is no need to actually dry a pipeline, i.e. when the fluid will be water wet and the prime purpose is to protect against hydrate formation during line filling.

The driving medium for glycol swabbing shall be either dry air or nitrogen, as specified for dewatering.

Glycol samples shall be taken from the discharge end and analysed for water content. A direct-density metering system shall also be used to measure the specific gravity of the samples and determine the content of water. The water content and specific gravity data shall be available within 12 h of the swabbing train arriving at the discharge end.

8.5.2 Acceptance criteria for glycol swabbing

- (S) Swabbing shall continue until the water content of the glycol is less than the value specified in the scope of work, or 20 % if not specified. Swabbing shall be repeated until the maximum allowable water content has been achieved.

8.6 DRYING RECORDS

For each listed activity, the Contractor shall provide records of the following parameters:

Activity	Parameter to be recorded
a) pigging with dry air or nitrogen	dewpoint, temperature, pressure at inlet and outlet of the pipeline, plus flowrate and total volume of drying medium;
b) purging for drying	as specified ;
c) purging for acceptance testing	as specified, plus nitrogen product certificate, if applicable;
d) leak test	temperature, pressure over time chart, plus acceptance calculations;
e) pump-down phase	temperature, flowrate, total volume evacuated, plus pressure over time chart;
f) evacuation phase	temperature, flowrate, total volume evacuated, plus pressure over time chart;
g) purging phase	as specified , plus dewpoint at the inlet and outlets of the pipeline;
h) soak test	pressure over time chart, plus acceptance calculations;
i) filling phase	temperature, pressure, temperature and dewpoint of the medium at inlet of the pipeline, plus final pipeline pressure and nitrogen product certificate, if applicable;
j) dry air pigging and vacuum drying	as specified;
k) glycol swabbing	volume of glycol introduced and received, water content of the glycol received from the pipeline, plus glycol product certificate.

9. CONDITIONING AND PRESERVATION

9.1 CONDITIONING BY INHIBITION

- (S) The Contractor shall condition the pipeline by swabbing slugs of inhibitor liquids contained between pigs through the line, if specified in the scope of work.
- (S) The slug composition, required thickness of the liquid film on the internal pipewall and driving medium shall be as specified in the scope of work.

The requirements for conditioning with liquid slugs are as follows:

- the Contractor shall calculate the volume of liquid required to achieve the specified film thickness. The calculation shall account for the dynamic sealing performance of the pigs and the performance changes due to pig wear;
- the liquid shall be split into three batches separated by four high sealing disc pigs.
- the minimum length of each batch shall be 25 linear pipeline metres.

9.2 PRESERVATION AFTER DRYING

- (S) The Contractor shall increase the pressure in the pipeline with the same medium as specified.

The requirements for preservation are as follows:

- the final pipeline pressure to be achieved at the end of the filling operation shall be 0.5 bar (ga) above the ambient pressure at any point along the pipeline, plus a margin allowing for the maximum possible ambient temperature fluctuation during the post-precommissioning period;
- the dewpoint, pressure and temperature of the medium introduced into the pipeline shall be measured and recorded constantly at the inlet of the pipeline throughout the filling operation;
- Warning signs, in English and the local or working languages, such as "PIPELINE FILLED WITH NITROGEN" or "PIPELINE FILLED WITH DRY AIR" shall be provided and placed at block valve stations and pig trap systems.

9.3 CONDITIONING AND PRESERVATION RECORDS

The Contractor shall provide product certificates of the media introduced into the pipeline plus the following parameters as a minimum:

- quantities introduced into and received from the pipeline;
- batch volume and pigging records in accordance with (5.3), if applicable;
- dewpoint, temperature, pressure and flowrates of the medium being used.

10. REFERENCES

In this DEP, reference is made to the following publications:

- NOTES:
1. Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.
 2. The DEPs and most referenced external standards are available to Shell staff on the SWW (Shell Wide Web) at <http://www.shell.com/standards/>.

SHELL STANDARDS

Hydrostatic pressure testing of new pipelines	DEP 31.40.40.38-Gen.
Electrical engineering design	DEP 33.64.10.10-Gen.
Welding of deepwater pipelines, flowlines and steel catenary risers (amendments/supplements to API 1104:20 th Edition)	DEP 37.81.40.31-Gen.
Field welding of duplex and super duplex stainless steel pipelines (amendments/supplements to API 1104)	DEP 61.40.20.31-Gen.

APPENDIX A DUPLEX STAINLESS STEEL AND CRA CLAD PIPELINES**A1. INTRODUCTION****A1.1 SCOPE**

This Appendix specifies additional requirements for the precommissioning of pipelines made of duplex or super duplex stainless steel or carbon steel with internal CRA steel cladding.

A1.3 DEFINITION**A1.3.1 General definition**

The numbering system in this Appendix is designed to allow for easy reference back to the remainder of the DEP by using the numbering system contained therein. Only additional requirements are given in this Appendix.

A2. GENERAL REQUIREMENTS**A2.1 BASIC REQUIREMENTS**

The Contractor shall prevent duplex or super duplex stainless steel or CRA material from coming into contact with all equipment made of carbon steel or other non-compatible materials, with the exception of the temporary pig launcher and receiver as specified in (A4).

If the metal temperature of the pipeline exceeds 50°C, then only condensed or demineralized water, with a chloride content of maximum 2 mg/kg, shall be used.

A4. EQUIPMENT**A4.4 WELDING OF TEMPORARY EQUIPMENT**

Only pig traps or components made of compatible materials shall be directly connected to the pipeline. Other pig traps or components shall be welded only via "pup" pieces made of compatible material and sufficient lengths to the pipeline.

- (S) Welding of duplex or super duplex stainless steel shall be carried out in accordance with DEP 61.40.20.31-Gen. or the pipeline construction specification, unless otherwise specified in the scope of work. CRA clad material shall be welded in accordance with the pipeline construction specification, unless otherwise specified in the scope of work.

A5. PIGGING**A5.1 PIG SELECTION**

Only high sealing disc pigs should be used for pigging operations.

A6. DEWATERING**A6.1 GENERAL**

The dewatering pigs shall be driven by nitrogen or the fluid, whenever practicable. Air/oxygen shall be prevented from entering the pipeline during the dewatering.

If the chloride content of the linefill water in the pipeline is greater than 200 mg/kg and air is being used as a driving medium, the following requirements shall apply:

- the pipeline shall be flushed or swabbed with slugs of potable water, condensed or demineralized, in combination with the first dewatering run;
- the volume of the water batches swabbed through the line shall be determined as specified in (6.2) for the fresh water;
- flushing or swabbing shall continue uninterrupted until the chloride content of the disposed water has been reduced to below 200 mg/kg;
- dewatering shall then continue as specified below.

If the chloride concentration of the linefill water or the residual water in the pipeline is less than 200 mg per kg of water and air is being used as a driving medium, the following requirements shall apply:

- the pipeline shall either be dewatered in accordance with (6.2) and (6.3), as applicable, and immediately dried in accordance with (A8), or
- the pipeline shall be flushed or swabbed with slugs of condensed or demineralized water, with a chloride content of maximum 2 mg per kg of water, until the chloride content of the disposed water and the introduced water is equal;
- dewatering shall continue with a second dewatering run as specified in (6.3).

- (S) The pipeline shall not be left dewatered with air for more than 2 weeks unless otherwise permitted in the scope of work. If no extension is permitted, the Principal may specify that the pipeline shall be re-filled with treated water.

NOTE: The required purity of the fluid may dictate further flushing or swabbing with condensed or demineralized water having a chloride content of maximum 2 mg/kg.

A7. CLEANING

A7.1 INTRODUCTION

High sealing disc pigs instead of wire brush type cleaning pigs, specified in (7.2.) and (7.4.), should be used. If brush type cleaning pigs have to be used, then only pigs with brushes made from a compatible material shall be used. Under no circumstances shall pigs having carbon steel brushes be used.

A8. DRYING

A8.1 INTRODUCTION

- (S) The Contractor shall adopt the method for drying and achieve the dryness specified in the scope of work. The general requirements for drying are:
- a) drying shall follow immediately after dewatering and shall be carried out in accordance with (A8.2) or (A8.3);
 - b) the second dewatering run shall be repeated if drying of the pipeline has not commenced within 36 h of completion of the dewatering;
 - c) valve body cavities and dead ends of piping shall be dried in compliance with the method and timing defined in the precommissioning plan;
 - d) the sizing of the drying equipment and calculations of the time required for drying shall be based on a film thickness of the residual water of not less than 0.05 mm. Lower values may be assumed if the Contractor can demonstrate their validity from previous experience to the Principal's satisfaction;
 - e) the period between drying and commissioning shall be kept as short as possible.

A8.2 DRY AIR OR NITROGEN DRYING**A8.2.1 General**

Only nitrogen with a purity of at least 99% shall be used as drying medium.

A8.3 VACUUM DRYING**A8.3.1 General**

The size of the vacuum unit(s) should be sufficient to reduce the pressure in the pipeline to the vaporisation pressure during pump-down within 24 h of commencement of the pump-down operation.

If vacuum purging and line filling is performed with dry air, only super-dry air with a dewpoint below -40°C shall be introduced into the pipeline.