

DEP SPECIFICATION

**NITROGEN / OXYGEN SUPPLY SYSTEMS;
NITROGEN DISTRIBUTION SYSTEMS**

DEP 30.05.10.30-Gen.

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DESIGN AND ENGINEERING PRACTICE

DEM1



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design and engineering of nitrogen supply and distribution systems to provide a reliable supply of nitrogen of the required quality. Oxygen supply is also in the scope of this DEP; however, distribution of gaseous oxygen is subject to DEP 31.10.11.31-Gen. due to its specific hazards.

This DEP does not cover design and use of oxygen for welding, cutting, respiratory systems, calibration systems and laboratory setups.

This DEP contains mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual (DEM) 1 - Application of Technical Standards.

This is a revision of the DEP of the same number dated February 2017; 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 authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in facilities related to oil and gas production, gas handling, oil refining, chemical processing, gasification, distribution and supply/marketing. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall 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 capitalised term **SHALL [PS]** indicates a process safety requirement.

The word **should** indicates a recommendation.

The word **may** indicates a permitted option.

1.3.2 Specific definitions

Term	Definition
Design Class	A categorization defining fit-for-purpose facilities developed through Value Improvement Processes (VIPs) during a project Front End Development (FED) phase.

1.3.3 Abbreviations

Term	Definition
ABC	Air Borne Contaminants
Cryogenic ASU	Cryogenic Air Separation Unit
BAM	Bundesanstalt für Materialforschung und -prüfung
DCS	Distributed Control System. Also referred to as BPCS (Basic Process Control System)
EO	Ethylene Oxide
GOX	Gaseous Oxygen
GTL	Gas-To-Liquids
HSSE & SP	Health, Safety, Security, Environment & Social Performance
IGC	Industrial Gases Council
IPF	Instrument Protective Function, now known as SIF (Safety Instrumented Function)
LIN	Liquid Nitrogen
LNG	Liquefied Natural Gas
LOX	Liquid Oxygen
MAC	Main Air Compressor
NPSH	Net Positive Suction Head
NRV	Non Return Valve
P&ID	Piping and Instrumentation Diagrams
PEFS	Process Engineering Flow Schemes
PLC	Programmable Logic Controller
PSA	Pressure Swing Adsorber
QMI	Quality Measuring Instruments
SAE	Society of Automotive Engineers

Term	Definition
SCGP	Shell Coal Gasification Process
SGP	Shell Gasification Process

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section or clause number is shown in brackets (). Other documents referenced by this DEP are listed in (9).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated February 2017. This is an administrative update only to correct references to DEPs that have been involved in either a merge or a split.

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be submitted to the Administrator using one of the following options:

Shell DEPs Online (Users with access to Shell DEPs Online)	Enter the Shell DEPs Online system at https://www.shelldeps.com Select a DEP and then go to the details screen for that DEP. Click on the "Give feedback" link, fill in the online form and submit.
DEP Feedback System (Users with access to Shell Wide Web)	Enter comments directly in the DEP Feedback System which is accessible from the Technical Standards Portal http://swwww.shell.com/standards . Select "Submit DEP Feedback", fill in the online form and submit.
DEP Standard Form (other users)	Use DEP Standard Form 00.00.05.80-Gen. to record feedback and email the form to the Administrator at standards@shell.com .

Feedback that has been registered in the DEP Feedback System by using one of the above options will be reviewed by the DEP Custodian for potential improvements to the DEP.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

1.8 NON NORMATIVE TEXT (COMMENTARY)

Text shown in italic style in this DEP indicates text that is non-normative and is provided as explanation or background information only.

Non-normative text is normally indented slightly to the right of the relevant DEP clause.

2. GENERAL REQUIREMENTS

2.1 VENTS AND DRAINS OF GASEOUS AND CRYOGENIC STREAMS

1. All vapours originating from nitrogen and oxygen storage and from nitrogen and oxygen producing units that either contain more oxygen than 23.5 vol % or contain less oxygen than 19.5 vol % SHALL [PS] be vented at a safe location as determined by dispersion calculations as per IGC Doc 154/09.
2. Any cryogenic liquid from the cold box of a cryogenic Air Separation Unit that requires disposal SHALL [PS] be vapourised and routed to a safe location as determined by dispersion calculations as per IGC Doc 154/09.
3. Cryogenic liquid from storage vessels that requires disposal on an intermittent basis (e.g., for start-up/shut down, loading activities) shall be routed to a drain location through a stainless steel pipe as follows:
 - a. With at least 1 m (3 ft) between valve and pipe exit;
 - b. With the exit at a maximum of 30 cm (1 ft) above the ground.

2.2 PROTECTION OF BACKFLOW OF CRYOGENIC LIQUIDS

1. Design of liquid and vapour disposal systems that have a common header SHALL [PS] prevent both of the following:
 - a. liquid backflow into the gas vent headers;
 - b. plugging of cryogenic relief valve discharges with ice from water accumulating in the header.

3. NITROGEN GENERAL

3.1 GENERAL USERS

The systems that are the subject of this DEP are typically designed to supply the site with gaseous nitrogen for the purposes including but not limited to the following:

- *purging systems of explosive and/or combustible gases before shutdown or maintenance activities will take place;*
- *blanketing of tanks and expansion vessels to ensure product quality;*
- *blanketing to avoid air and moisture ingress that may result in corrosion;*
- *blanketing to prevent formation of explosive mixtures when air can be drawn into a tank;*
- *inerting of piping systems before introduction of combustible gases to avoid creating an explosive atmosphere during start-up when systems have been exposed to air/oxygen;*
- *purging of small bore piping/nozzles to prevent accumulation of debris that causes restrictions or even blockages; (This should only to be considered in case there is no other, more economical, medium possible.*
- *compressors and pump sealing applications; (dry gas seal)*
- *flare purging to prevent oxygen ingress.*

A number of other special usages of nitrogen also include

- *continuous purge of cryogenic insulation spaces to prevent ice formation;*
- *make-up of mixed refrigerants for liquefied natural gas (LNG) plant applications;*
- *purge drying of lines and equipment preservation.*

1. Refer to DEP 31.37.00.11-Gen., clause 2.2.1, item 2 for use of nitrogen as back-up for Instrument Air.
2. The use of nitrogen supply to drive individual valve(s) shall be subject to approval by the Principal.

3.2 NITROGEN PURITY

The required nitrogen purity is dependent on the usage as per (3.1) and directly influences the generation options.

1. The nitrogen purities shown in Table 1 should be used.

Table 1 Nitrogen Purity

Activity	Purity	Rationale
Purging of flammable substances	> 95 vol %	Purging quantities are dependent on purity. Purging quantities need to be determined after the technology has been selected.
Refrigerant make-up	> 99.5 vol %	Quality is typically achieved using cryogenic Air Separation Unit (ASU) (even up to a maximum of 3-10 ppm O ₂) or Pressure Swing Adsorber (PSA) technology as the limit, but in exceptional cases might also be possible with membranes.
Blanketing for corrosion prevention or product quality	>99.9 vol %	Specification for amine and MEG/TEG is 99.9 vol % to prevent formation of degradation products or corrosion in the system that is treated (Upstream applications).
Blanketing of heat transfer oil expansion vessel	>99.5 vol %	To prevent formation of degradation products.
Blanketing most cargo and storage tanks	>95 vol %	This quality can be achieved using membrane technology.

2. For specific applications, such as purging of cryogenic storage tanks or refrigerant make-up, the water dewpoint temperature is critical. In case the specified dewpoint cannot be reached (e.g., using membrane technology), additional drying facilities shall be provided.

The atmospheric dewpoint (temperature at which water condenses from nitrogen vapour) ranges from -50 °C (-58 °F) to -76 °C (-105 °F) and is usually determined by the nitrogen generation process.

3. The normal operating pressure for nitrogen distribution systems should be determined by the user(s) with the highest required pressure.

Typical pressure range that is selected is around 6 barg to 12 barg (90 psig to 175 psig).

4. The normal operating temperature of a nitrogen distribution system should be at or slightly above ambient air temperature.

Due to the nature of an ambient air vapouriser, a temperature slightly below ambient is acceptable.

5. For applications that require multiple consumers of nitrogen above ambient temperature, a subheader should be used for such nitrogen.

3.3 NITROGEN QUANTITY

1. To determine the quantity of nitrogen each of the following, should be considered:
 - a. For purging to remove flammable substances for maintenance or confined space entry, reference is made to the HSSE & SP Control Framework, Manual 04, Personal Safety.
 - b. For purging to remove flammable substances from cargo systems, a threshold value of 8 vol % O₂ should be achieved.

Purging to remove flammable substances is usually achieved by cyclic pressurisation with a minimum of four pressurisation cycles.
 - c. For purging before the introduction of flammable substances, the final oxygen concentration should not exceed 1 vol % before the flammable substances are introduced to the system.

This purging is usually achieved by cyclic pressurisation with a minimum of three to four pressurisation cycles.
 - d. For blanketing of tanks and vessels, the maximum amount of nitrogen required to maintain the inert atmosphere should be based on the inbreathing of the tank considering the maximum draw-off rate from the tank as well as thermal breathing.
 - e. Purging to prevent debris should be based on achieving a velocity over the internal cross section of 1 m/s (3 ft/s).
 - f. To determine the quantity of nitrogen required for purging vents and flare stacks, reference is made to Appendix 8 of DEP 80.45.10.10-Gen.
 - g. For commissioning and pre-commissioning purposes.
2. Provisions shall be made in the design of the nitrogen distribution system to restrict the amount of nitrogen that can be taken off for each (group of) consumer(s). Refer to (7.3) for implementation details.
3. The total consumption should consider continuous and intermittent usage to determine the minimum nitrogen generation capacity and the optimum nitrogen back-up quantity.
4. The total consumption should be multiplied by a factor to account for the following:
 - a. Uncertainties in the data and future losses; the capacity margin to be used is as per design class.
 - b. Uncertainties in the nitrogen consumption data estimate in the early phase of the project;
 - i. At more detailed stages of a Project, this factor may be reduced or even removed.

The highest combination of normal and peak demand is referred to as the 'Peak Quantity of Nitrogen'.

3.4 BACK-UP SUPPLY

1. A dedicated back-up nitrogen storage vessel system SHALL [PS] be included in the design for consumers that require a minimum amount of nitrogen to safely shutdown during an emergency.
2. The valves of the nitrogen back-up system SHALL [PS] be provided with either secure instrument air (refer to Section 3.2 of DEP 32.45.10.10-Gen. and Standard Drawing S 36.701) or secure electricity (UPS).

3. For critical consumers that require relatively small back-up volumes, (5.3) and (5.4), back-up nitrogen cylinder supply should be considered.
4. Critical and non-critical users (e.g., tank purge for product quality) should be prioritised in the supply from the back-up system to prevent excessive equipment sizing.

A back-up system might be required to supplement peak demand or for improved availability during maintenance of a cryogenic ASU.

4. OXYGEN GENERAL

4.1 GENERAL USERS

Oxygen generation systems that are subject to this DEP are generally used for applications such as the following:

- *Partial oxidation in the Shell Gasification Process (SGP).*
- *Partial oxidation in the Shell Coal Gasification Process (SCGP).*
- *Reactant in the Ethylene Oxide (EO) process.*
- *Debottlenecking projects replacing air (i.e., use of oxygen-enriched air or pure oxygen for the Claus reaction or in biotreaters).*

4.2 OXYGEN PURITY

The oxygen purity required is dependent on its purpose (4.1). Typical values are as follows:

- *For SGP applications, the purity usually is > 99.5 vol % to prevent high inert levels in the downstream catalytic processes (e.g., Gas-To-Liquids (GTL) or H₂ production).*
 - *For SCGP applications, the purity is usually > 99.5 vol % for applications where high inert levels in the downstream processes are undesired and at least 95 vol % for applications with no such downstream limitations.*
 - *For EO applications, the purity usually is > 99.8 vol %.*
 - *For oxygen enriched air applications, the purity is > 23.5 vol %.*
1. The required oxygen purity should be determined at an early stage of the Project, as a lower purity will reduce capex and/or operational costs of the air separation unit.

4.3 BACK-UP SUPPLY

1. The design of the backup oxygen supply should take into consideration the scenario when the shutdown interval of the unit consuming the oxygen is not in parallel with that of the air separation plant.
2. Cryogenic oxygen generation shall include a liquid storage/vapourising system to ensure continuous supply of oxygen in case of short duration trips or maintenance on the air separation unit.

5. NITROGEN SUPPLY

5.1 GENERAL

The nitrogen supply strategy depends on the consumption profile, the required purity of nitrogen and the local market situation.

Source options include:

- *Gaseous nitrogen import*