

DEP SPECIFICATION

INSTRUMENT AIR SUPPLY

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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 instrument air supply systems to provide a reliable supply of instrument air of the required quality. In addition, where instrument air systems are combined with nitrogen generation, industrial/tool air and air supply to safety equipment, some minimum requirements are provided.

The scope of this DEP covers the mechanical piping of main header system and does not cover the individual instrument connections. The demarcation is typically where the mechanical piping ends and the instrument tubing begins.

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 January 2005 (including DEP Circular 03/09); 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 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.

1.3.2 Specific definitions

Term	Definition
ASU	Air Separation Unit
DCS	Distributed Control System
DN	Nominal Diameter
DP	Differential Pressure
IA	Instrument Air
NPT	National Pipe Thread (American Standard)
OD	Outside Diameter
PDIC	Proportional derivative and integrating controller
PIA	Priority Instrument Air
PLC	Programmable Logic Controller
PVC	Poly Vinyl Chloride
SIA	Secured Instrument Air

1.4 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).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2005 (including DEP Circular 03/09-Gen.). The following are the main, non-editorial changes.

Old section	New section	Change
General	General	Added mandatory requirements to mitigate process safety risks in accordance with Design Engineering Manual DEM 1 – Application of Technical Standards.
2.2	2.2	Changed specification solids in instrument air from 0.1 g/m ³ to 5 mg/m ³ in line with DEP 32.36.01.17-Gen. and industrial standards.
2.2	2.2	Higher temperatures than the 40°C normally specified restricted from 70°C to 60°C to prevent need for personnel protection and should be replaced with shall requirement.
2.2	2.2	Added specification for oil content in instrument air in line with DEP 32.36.01.17-Gen. and industrial standards.
2.3 and 2.4	2.3 and 2.4	Re-emphasised and clarified the importance of backflow protection for industrial consumers in light of recent HSE incidents.
2.4	2.4	Added intake air quality to be continuously monitored when using instrument air for safety equipment.
2.7	2.7	Added that PIA supply to utilities is in particular important when process relief scenarios do not take into account the failure of multiple utilities at the same time.
3	3	Added remark that essential process instrumentation should, besides network segregation, also be protected by having independent sources (air compressor drivers).

Old section	New section	Change
3	3	Changed requirements to have no low points between compressor aftercooler and drier inlet.
3	3	Added remark to measure flow to main lines downstream the driers.
4.3	4.3	Added remark on additional requirements/specifications for air compressor to allow stand-by operation.
4.4	4.4	Added specific requirements for the location of the compressor air intake in particular for non land-based situation.
5	5	Added remark that material selection for water separators that are integrated with the aftercooler should be carefully considered and cannot automatically be stainless steel.
6.1	6.1	Expanded the 10°C description to avoid plants operating with dewpoint 10°C below actual ambient.
6.2	6.2	Added use of molsieve material as drier.
6.4	6.4	Added recommendation to use valve position indication and alarms/logics in the regeneration sequence.
6.5	6.5	Clarification added on filter locations.
6.6	6.6	Added note that coolers downstream driers are not desired and should be avoided if possible.
7	7	Sharpened the definition of sizing of the instrument air buffer vessel calculation.
7	7	Added referenced to DEP 31.22.11.32-Gen. and DEP 31.22.20.31-Gen. to allow buffer vessels to be designed to AMSE and EN standards apart from BS code.
8.5	8.5	Added pulse blowing cleaning method for larger piping based on recent experience.
9.3	9.3	Added use of instrument air for removal of inert gases prior to space entry as special use based on recent Project experience.

1.6 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://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

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.

2. GENERAL

2.1 ARRANGEMENT

The instrument air supply system shall provide the required quantity of:

- instrument air of the quality specified in (2.2);
- industrial air for approved cases, as specified in (2.3);
- air for safety equipment (2.4).

The system shall comprise an air supply plant as specified in (3) to (7), and a main air supply piping system as specified in (8). Specific guidelines for applications are provided in (9).

2.2 INSTRUMENT AIR QUALITY

2.2.1 General

The instrument air shall follow strict specifications on level of solids (2.2.2) and liquid contamination [(2.2.3) and (2.2.5)] to avoid malfunctioning of instruments and to prevent corrosion/blockages of the distribution system.

Instrument air SHALL [PS] be free from toxic, corrosive, flammable and obnoxious gases or vapours; nitrogen or carbon dioxide SHALL [PS] not be used as back-up for IA systems. Remote stand-alone control valves may be supplied with process gas (e.g., natural gas / nitrogen) however this application is considered outside the scope of this DEP and is subject to Principal approval.

2.2.2 Solids

The quantity of solids shall be less than 5 mg/m³ (0.14 mg/ft³) and the diameter of the particles shall not be more than 3 µm. In-line fine filters shall be installed downstream of the driers to meet these requirements.

2.2.3 Dew point

To prevent condensation in the supply piping and instruments, the dew point of the air at operating pressure shall be at least 10°C (18°F) below the lowest expected ambient temperature for the air system at any location.

In mild and cold climates this normally results in standard dew point specification of -40°C (-40°F) at atmospheric conditions, whereas in tropical climates 0°C (32°F) will suffice. Arctic conditions typically result in a dewpoint of -65°C (-85°F) at atmospheric conditions.

Integrated IA systems to supply nitrogen/oxygen generators with compressed air may require pressure dew points specified at -65°C (-85°F) depending on the possible combined air drier service.

2.2.4 Maximum temperature

The maximum instrument air supply temperature downstream the driers shall be 40°C (105°F), unless approved otherwise by the Principal.

NOTE: In order to ensure proper operation of instruments and to prevent the need for personal protection, the maximum temperature shall in all cases not be higher than 60°C (140°F) – see also (6.6).

2.2.5 Oil contamination

Oil contamination shall be below 0.01 mg/Nm³ (8 ppb), which is preferably achieved by selection of oil-free compressors.

For less critical service, non oil-free compressors may be selected in combination with filtration upstream the driers. In this case the following filter configuration (in series) shall be selected to meet above specification:

- Coalescing filter to remove the bulk of the oil
- High efficiency cartridge filtration to meet the specification on liquids

- Activated carbon filtration to remove any oil in the vapour phase.

NOTES:

1. The requirements given above are in accordance with IEC 60654 (see also ISA 7.0.01 and ISO 8573-1, 2010 edition).
2. Systems where non oil-free compressors are used, typically are relatively small (up to 1000 Nm³/h) and have a limited instrument air distribution system with a limited number of valves. Chance and consequence of filter breakthrough should be carefully considered in the final decision.
3. Performance of activated carbon filters is deteriorating at higher air temperatures. Oil removal to 0.01 mg/Nm³ may not be achievable at high ambient temperatures without frequent change of activated carbon cartridge. Principal shall be contacted to allow for reduction of specification to 0.1 mg/Nm³. (see also ISA 7.0.01 and ISO 8573-1, 2010 edition).

Where compressed air is used to feed an air separation unit (ASU), an oil free compressor as well as additional filtration to remove air-born contaminants SHALL [PS] be used. For a detailed specification of air requirements for an ASU, reference is made to DEP 30.05.10.30-Gen.

2.2.6 Pressure

Unless otherwise specified, the instrument air pressure in the air supply piping shall be 7 barg (100 psig) under normal operation, unless approved otherwise by the Principal. The Principal may specify a lower pressure, however, for proper operation of the instruments, this shall not be less than 4.2 barg (60 psig). The supply pressure downstream compressor and driers is typically 1 to 2 bar (15 to 30 psi) higher to allow for pressure drop over piping and control valve(s).

2.3 INSTRUMENT AIR SUPPLY FOR INDUSTRIAL CONSUMERS

Instrument air may be supplied to the following industrial consumers provided a separate system is installed branching off the instrument air supply system at the battery limit of each processing unit:

- oil mist lubrication systems;
- flare ignition equipment.

Instrument air shall only be supplied to industrial consumers if:

- a) there is no possibility, under any circumstances, of backflow from piping from industrial consumers to the instrument air supply.

NOTE: A normal industrial air operating pressure above the downstream process pressure is not sufficient to prevent backflow as the industrial air can be loadshedded, resulting in lower or even atmospheric pressure. In this case, e.g., a single non return valve will not form a sufficient barrier and a HAZOP/IPF should identify if sufficient mitigation can be achieved by additional measures such as instrumented backflow protection.

- b) a non-return valve and safeguarding device are installed, ensuring priority for instrument air; see (Appendix G) and (Appendix H)
- c) the required quantity of instrument air for industrial use has been incorporated in the required total supply/consumption of instrument air, see (2.5)
- d) no connections are made between the industrial air system and the instrument air system at any other position.

Individual tool air systems shall only be supplied by the air supply plant if:

- the tool air piping is separate from the main instrument air system piping;
- the buffer vessel is adequately sized to prevent interruption to the IA system;
- the main instrument air system is protected against low pressure cut-off. This can be achieved by a valve closing at low pressure as shown in (Appendix G) and (Appendix H).

NOTE: Notwithstanding the above, large demands for tool air, e.g., during plant shutdown periods, should preferably be supplied by mobile compressors, so as to avoid the need for large compressed air plants covering wide fluctuations in demand.

For all other applications not specified above, agreement shall be obtained from the Principal; see also (9.3) for examples.

2.4 AIR SUPPLY FOR SAFETY EQUIPMENT

Safety equipment, such as breathing air masks, shall be supplied from separate air bottles rather than from the IA system, in order to prevent contamination or conflict of use. This is particularly relevant in large distributed systems.

When IA is supplied to safety equipment such as breathing air masks, separate branch-off points SHALL [PS] be provided on the instrument air header in the processing unit, with all valves identified and locked open to ensure guaranteed air supply from the buffer vessel to the breathing apparatus.

The branch-off points shall be of size DN 15 (½ in) and shall be located close to the required consumer.

The following additional requirements SHALL [PS] apply:

1. air quality must be continuously monitored using QMIs (minimum H₂S, CO and hydrocarbons) to ensure that there are no re-circulated process emissions and that all contaminants are below the occupational exposure limits. Reference is made to EN 12021 or local standards if more strict.
2. provisions to segregated rotary machines (air compressors, gas turbines) from the IA system during cleaning must be provided;
3. air quality to be improved by using extra filters at breathing air connection to remove dust and rust.
4. air quality must be in accordance with the relevant breathing air standard for compressed air (e.g., EN 12021).
5. backflow protection must be assured for all industrial air connections; see also (2.3).

2.5 INSTRUMENT AIR QUANTITY

The quantity of required (consumed) instrument air shall be estimated taking into account the requirements for:

1. pneumatically operated instrumentation, based on the data stated by the Manufacturers of such equipment;
2. pressurizing electrical instruments/equipment in order to prevent an explosive gas atmosphere inside their enclosures, by maintaining an over-pressure relative to the surrounding atmosphere and, where necessary, by continuous dilution;
3. purging/cooling of essential instruments;
4. industrial users as defined in (2.3).

The consumption thus obtained should be multiplied by a factor to account for;

- a) Uncertainties in the data used for the estimate and future losses; the capacity margin to be used is as per design class.
- b) Uncertainties in the air consumption data estimate in the early phase of project; an additional allowance can be included to manage the data inaccuracies. At more detailed stages of a Project this factor can be reduced or even removed.

This quantity is referred to as the 'Design Quantity of Instrument Air'.

2.6 INSTRUMENT AIR SUPPLY SYSTEMS

Where the entire facility is periodically shut down for major overhauls, the supply of instrument air may be permitted to be interrupted during these overhauls to allow inspection and maintenance of the instrument air supply piping. At such facilities, a single header air

supply plant and air supply piping system may be applied; see (Appendix B) and (Appendix G).

Where the facility is only partly shutdown for major overhauls, the instrument air supply cannot be interrupted. In these facilities, the instrument air supply shall be designed as a double header system; see (Appendix A). The instrument air supply piping shall be designed as a ring main header system for those parts of the supply piping where an uninterrupted supply of instrument air is required; see (Appendix H).

2.7 SEGREGATION

Where required for plant operation, the air supply system shall be segregated into an instrument air (IA) system and a priority instrument air (PIA) system. This segregation shall primarily be based on the importance of continued operation of a particular plant section or selected instruments.

In this context, utility supply plants such as electric power plants, boilers with related deaerators and boiler feed water systems fuel and cooling water systems, shall normally be connected to the PIA system. In particular when process units do not take into account the failure of multiple utilities at the same time in the relief scenarios, this is essential. Certain processing units (e.g., less critical or less profitable units) may be segregated from the IA system during shortage, depending on the probability of damage to the asset and margin loss as a result of an unexpected shutdown.

The above segregation shall be achieved by installing one or more isolating control valves in the instrument air supply piping; see (Appendix G) and (Appendix H). Each isolating control valve shall consist of a pneumatically operated control valve with a local pneumatic pressure indicating controller, operating as a back-pressure controller, i.e., throttling the valve in the event of low air pressure in the upstream piping. The control valve shall be provided with a position switch, which will initiate an alarm on the main panel/console when the valve starts to close. Each isolating control valve shall have block valves and a by-pass valve.

PIA is maintained by loadshedding. In the event of low air pressure; industrial and tool air supplies shall be isolated from the air supply system, followed by instrument air if pressure continues to fall.

NOTE: The option of installing manually operated isolating valves in the supply piping for segregating certain sections, e.g., to allow the commissioning of individual sections before plant construction is complete, should also be considered.

Consumers connected to the IA system which must stay in operation after a total air supply failure, e.g., valves for the depressurizing of equipment, SHALL [PS] be supplied from a 'secured instrument air' (SIA) system which incorporates a buffer vessel connected to the distribution piping via a non-return device in accordance with DEP 32.45.10.10-Gen.; see (Appendix J).

Details for functional design, such as back-up time and consumption rates, shall be supplied by instrument engineering.