

DEP SPECIFICATION

FIELD INSPECTION PRIOR TO COMMISSIONING OF MECHANICAL EQUIPMENT

DEP 61.10.08.11-Gen.

February 2017

DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for field inspection prior to the commissioning of mechanical equipment (e.g., during new construction projects and minor projects, and existing equipment following maintenance or plant modifications).

The information given in this DEP has been arranged according to the type of equipment, such as columns, furnaces, compressors, pumps etc., and a separate section is dedicated to pressure testing procedures.

Excluded from the scope of this DEP is the inspection of the instrumentation associated with the mechanical equipment, refer to DEP 62.10.08.11-Gen. for recommendations and requirements relating to the inspection of the instrumentation.

Inspection of equipment can be divided into three main stages, only the second of which is within the scope of this DEP:

- Manufacturing, which should be covered by the appropriate specifications, standards and codes laid down in the equipment purchase order;
- Erection and pre-commissioning;
- Operational maintenance, which should be covered by local procedures at the operating site.

This DEP is a revision of the DEP with the same number dated February 2011.

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.

This DEP is intended for use in oil refineries, chemical plants, gas plants, supply/marketing installations and, where applicable, in exploration and production.

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 may 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

For the purposes of this DEP the following definitions shall apply:

1.3.1 General definitions

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

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

The **Principal** is the party which initiates the project and ultimately pays for its design and construction. The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorised to act for the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

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

1.3.2 Specific definitions

Term	Definition
Hydrostatic Test	A test carried out using water or other relatively incompressible liquid to prove the integrity of a component or system, at a pressure specified by the design code. (In ASME B31.3 para. 345.4 referred to as Hydrostatic leak test.)
Piping System	Assembly of straight and bent pipes, fittings, flanges, gaskets, valves and other components (e.g., expansion joints, swivel joints, strainers, devices for mixing, separating, distributing, metering and flow control. It also includes pipe supporting elements and insulation. Piping does not include supporting structures (such as frames of buildings, stanchions or foundations) or equipment (e.g., heat exchangers, vessels, columns, pumps) or instrument impulse pipes.
Pneumatic Test	A test carried out using air or inert gas to prove the integrity of a component or system, at a pressure specified by the design code.(In ASME B31.3 para. 345.5 referred to as Pneumatic leak test.)
Rogue Material	Equipment or piping components installed in a specific alloy (or special carbon steel) system that do not meet the material specification for that system. This includes welding consumables.

1.3.3 Abbreviations

Term	Definition
ITP	Inspection and Test Plan
NDE	Non-destructive examination

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 (30).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a version of the DEP of the same number dated February 2011. The following are the main, non-editorial changes.

Section/Clause	Change
ALL	Restructured and clarified requirements. Enforced shall/should.

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. INSPECTION

2.1 GENERAL

Early inspection of individual items will allow any non-compliance to be identified at an early stage, thus avoiding subsequent delays in construction progress. Attention to precommissioning inspection will contribute to equipment reliability when the equipment is brought on stream.

1. Handover procedures, detailing, deliverables and responsibilities shall be agreed between the Contractor, the Manufacturer and the Principal before precommissioning commences.
2. Checklists should be used to ensure that essential points are not overlooked.

It is frequently not possible to complete all checks on any one item at the same time, and checklist recommendation serves to capture work completed.

Systematic performance of the handover inspections facilitates collection of accurate 'as-built' information and baseline measurements, that are essential for completion of the Equipment Record Cards, see DEP 82.00.10.30-Gen. (3.7).
3. Inspection during construction or maintenance shall ensure the following:
 - a. equipment has been supplied in accordance with the purchase order;
 - b. equipment has been installed correctly;
 - c. all required documentation has been completed.
4. Equipment or parts of an installation meant to operate with other equipment shall be inspected and tested together to ensure proper operation of the complete assembly (e.g., a compressor together with its drive, auxiliary gear and piping system).
5. A record of all manufacturing data books, shop inspection reports, and the Manufacturer's inspection and test reports should be kept in the equipment file.
 - a. This information shall be recorded on the appropriate Equipment Record Card.
 - b. Equipment Record Cards shall be completed before commissioning.
6. Field pressure testing pressure shall be recorded on the appropriate Equipment Record Card.
7. A general inspection shall be conducted to check personnel hazards (e.g., tripping and headroom) associated with the accessibility of operating equipment.
 - a. Hazards shall be removed or permanently marked and additional access provided as needed.

2.2 ROGUE MATERIALS

1. Refer to DEP 31.10.00.10-Gen. for requirements and recommendations related to mitigation of the risks associated with rogue materials.

2.3 DESIGN MODIFICATIONS

1. Design modifications during the manufacturing period shall not be incorporated in the plant equipment after the final inspection in the shop.
2. Refer to DEP 82.00.10.30-Gen. Section 3.1 for requirements and recommendations regarding "As-Built" red line documents.
3. The plant equipment shall be examined on arrival at site for compliance with purchase order requirements and any non-conformity reported and recorded.
4. If the plant equipment requires modification on site, all information shall be made available, together with the certified materials required to perform the modifications.
5. The modifications shall be performed in such a manner that the Manufacturer's guarantees are not invalidated.
6. Plant equipment which has been modified on site shall be subject to the same inspection requirements as for the original equipment.

3. MECHANICAL EQUIPMENT, GENERAL

The following points are generally applicable to mechanical equipment. Point's specific to particular types of equipment are included in the subsequent sections.

1. Shims shall be made in one piece (i.e., not of multiple layers of thin plates) and be located on either side of each foundation bolt.
2. Field welds shall be subject to the NDE required by local code, the contract and applicable project standards and the results formally recorded consistent with Code and project standards.
3. If a hydrostatic test is required in accordance with the design code and has not been carried out at the Manufacturer's works, such a test shall be performed locally.
4. Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing.
5. Particular attention should be paid to pressure testing those parts of equipment which have been modified during construction and erection.
6. Conditions for functional tests shall be mutually agreed between the equipment Manufacturer, Contractor and Principal.
7. Refer to Table 3 for detailed checks and items that may be applicable.

Table 3 Mechanical Equipment (General) pre-commissioning checklist

Mechanical Equipment (General) pre-commissioning checklist		Reviewed		
		Y	N	NA
1	Check that all packing materials and protective devices used during transport and handling have been removed from the equipment, such as shock-absorbent materials from machined faces, blanking plates from orifices, blocking of shafts or rolling bearings and restraining devices from instruments, safety devices and protective equipment.			
2	Check whether special (maintenance) tools and instruction manuals have been supplied.			
3	Check and inspect any alterations made during plant construction and erection for compliance with the design specification, and record any deviations.			
4	Check that specified materials have been used, see (2.2), and that welding, heat treatment, stress relieving and non-destructive testing have been carried out properly and fully documented.			
5	Check wall thickness of shells, heat exchanger and furnace tubes, and nozzles and compare them with those stated on the Equipment Record Cards. Correct and complete these cards as necessary.			
6	Check the equipment for out-of-roundness, bulges or dents that can be a result of transport, handling, field welding or other cause, and report any such defects. <i>This is of particular importance for vacuum equipment.</i>			
7	Check that the nozzle facings, flanges, flange finish, gaskets and stud bolts are in accordance with specified requirements and the alignment of flanges on process connections is correct.			
8	Check that earth bosses are connected and in electrical contact with the shell.			
9	Check that the nameplate is properly attached to the equipment in accordance with the specification. Compare the nameplate rating with the Equipment Record Card and note any variations.			
10	Check the foundation bolts to make sure that they are straight and vertical and securely tightened.			
11	Check that shims are located on either side of each foundation bolt and made in one piece (e.g., not comprised of multiple layers of thin plates).			
12	Check that the specified grouting is used and properly applied to baseplate and support.			
13	Check that the insulation and fireproofing have been applied in accordance with the specification and that precautions have been taken to prevent the ingress of water.			
14	Check that the applied surface protection system complies with specified requirements.			
15	Check the equipment for internal cleanliness before final sealing.			
16	Check that ladders, stairways, platforms and walkways are correctly installed, with handrails and flooring properly secured.			
17	Check operating platforms for alternative escape routes, that they are freely accessible and clearly indicated.			

Mechanical Equipment (General) pre-commissioning checklist		Reviewed		
		Y	N	NA
18	Check that field welds have been subjected to the NDE required by local code, the contract and applicable project standard; and the results formally recorded consistent with Code and project standards			
19	Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing. <i>Pay particular attention to those parts of equipment which have been modified during construction and erection.</i>			
20	Check that the instruments and safety devices are correctly installed and in accordance with instrument data sheets and flow diagrams, including utility systems and subsystems.			
21	Check proper installation of all safety guards (e.g.coupling, belt drive, pinch point)			



4. VESSELS, COLUMNS, REACTORS AND THEIR INTERNALS

1. Before before final sealing and making pressure tight, a check on proper installation of internals, correct flange finishes and cleanliness shall be carried out jointly by operational and technical staff.
2. Refer to Table 4.1 for detailed checks and items that may be applicable.

Table 4.1 Vessels, Columns, Reactors and associated internals checklist

Vessels, Columns, Reactors and associated internals checklist		Reviewed		
		Y	N	NA
1	Check and inspect equipment internals for correct tray levels, weir heights, downcomer clearances, seal pans, draw-off trays, position of spiders, demisters and correct fastening, packing and bolts.			
2	Check beam fastening and ensure one end is free to move.			
3	Check the presence of drain holes where required and the hole configuration of liquid inlet devices in relation to the trays below.			
4	Check and inspect the welds of stiffening rings, especially for vacuum equipment.			
5	Check and inspect the strip lining, if applicable, especially at nozzle locations.			
6	Check and inspect the lining of the cylindrical parts of manholes and nozzles, and the flange surface lining, if fitted.			
7	Check that test holes in reinforcement plates are open.			
8	Check that dewatering holes are located in appropriate positions.			
9	Check the adjacent (steel) structure for interference with nozzles due to expansion/ contraction.			
10	Check the verticality of tall equipment and the correct slope, if any, of horizontal equipment.			
11	Test for leaks from the draw-off trays. An allowable leakage rate might be stated in the specification.			

5. FIRED EQUIPMENT

1. The burner installation shall verify the following:
 - a. the correct position and shape of burner throats;
 - b. the correct position of fuel guns in the throats;
 - c. adjustability of air registers;
 - d. fuel guns;
 - e. the correct position and size of peepholes and observation windows.

Ensure that burner throats and ignition burner are visible from observation windows. Ensure that observation windows are not obstructed by furnace tubes. Check that observation windows are not obstructed by furnace tubes.
2. Record the result of the burner position measurement a 'burner protocol' shall be issued to and this record filled by the inspection department.
3. The soot blower equipment shall be inspected and tested, for correct working within the full range of operation.
 - a. The sootblower system tests shall verify:
 - i. expansion;
 - ii. purge facilities;
 - iii. self-draining of steam supply piping system;
 - iv. tightness of valves.
4. A smoke-bomb test shall be applied as a final check on the tightness of the firebox, ducting, dampers, air preheater etc.
 - a. During this test the flue gas side shall be kept under pressure with the forced-draught fan.

5.1 Furnaces

1. The steam to the furnace shall be inspected and tested, i.e., snuffing steam to fire box and header boxes and steam for soot blowing and burners.
2. Concrete lining of the ducting shall be inspected for voids by tapping with a very light hammer.
3. Inspect the lining for cracks wider than 1.5 mm (60 mil). These cracks shall be cut out in such a way that a dovetail is obtained for repairs. For further checks on refractory, anchors, etc. Refer to DEP 44.24.32.30-Gen. Section 7 for recommendations and requirements regarding the inspection of refractory.
4. A tightness test shall be carried out on air preheaters.
5. Hydrostatically test the furnace coils in accordance with the design data sheets. The test pressure shall be maintained for approximately half an hour plus the time required for checking on leaks. Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing of equipment and piping.
6. After a furnace with horse-shoe type fittings has been closed following a routine cleaning or inspection shutdown, a tightness test shall be carried out to check that the horse shoe fittings do not leak.

This test can be conducted with medium pressure steam, provided that the pressure and temperature do not exceed the furnace design conditions.

7. If tubes or fittings have been repaired, a hydraulic test is required. The set pressure for this strength test shall be established by the plant inspector in accordance with local rules.

Normally, the test pressure amounts to 1.5 times the design pressure multiplied by a factor S/S' where S and S' represent the allowable material stress values at ambient temperature and design temperature respectively. Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing.

8. Refer to Table 5.1 for detailed checks and items that may be applicable.

Table 5.1 Furnace pre-commissioning checklist

Furnace checklist		Reviewed		
		Y	N	NA
1	Check the proper position and support of radiant and convection bank tubes.			
2	Check that the furnace tubes are straight and that there is proper clearance between the tubes; if not, adjust the roof tube supports by installing or removing shims.			
3	Check whether tubes have been correctly expanded into fittings, see (Appendix 1). Take readings of original expansion and enter these into the records			
4	Check that the return fitting plugs are properly bolted.			
5	Check the fuel supply system, both oil and gas for leakage.			
6	Check expansion joints for free movement (when hot).			
7	Check the furnace structure and plating for correct bolting/welding, construction and painting of plates and beams; check roof for rain water draining facilities.			
8	Check the dampers for correct operation. Ensure that the position marker on the outside coincides with the real position of the damper inside. Ensure that dampers will not close under the effect of gravity.			
9	Check expansion pieces in ducting for tightness and adequate support near the expansion pieces.			
10	Check provisions for installation and removal of spade-type blinds in flue gas ducting.			
11	Check the heater access doors. They should move freely and at the angle specified and should not be obstructed.			
12	Carefully check cleaning devices of fixed-type preheaters.			
13	Check packing between flanges for tightness.			
14	Check proper installation of skin thermocouples (if applicable); see Standard drawing S 24.615.			
15	Check operation of observation windows and the functioning of the air purge to the windows on the radiant cell.			
16	Check that the locking pin of any spring hanger support is removed and the pointer within the operation range. <i>Record the position in the cold, and later in the hot, condition.</i>			

5.2 Boilers

1. Refer to Table 5.2 for detailed checks and items that may be applicable.

Table 5.2 Boiler pre-commissioning checklist

Boiler checklist		Reviewed		
		Y	N	NA
1	Check the boiler structure and plating for correct bolting/welding, construction/conservation plates, beams and painting.			
2	Check that the air and flue gas ducts are adequately supported and that sufficient allowance has been made for expansion.			
3	Check the fuel oil and gas supply system for leakage.			
4	Check that the internals of the steam drum are in the correct position, properly fastened and free of debris. Check the downcomer and riser tubes, if possible.			
5	Check the air preheater, if any.			
6	Check that the intermittent blowdown lines are adequately supported and clamped. Make sure that the line size is not smaller than the blow-down connection.			
7	Check that the blowdown valves are fail to close and check that continuous blowdown lines have position indicators (from 0 – 100% with intervals of 10%).			
8	Check whether cleaning and boiling-out procedures have been carried out in accordance with the method described in DEP 70.10.80.11-Gen.			
9	Check that statutory requirements have been satisfied.			
10	Check the proper position of observation doors. Ensure that the burner throats, burner tips, side wall tubes, rear end tubes and superheater tubes are clearly visible.			
11	After starting up the boiler, check the set pressure, maximum relief and the reseating pressure of the safety valves, at working temperature and adjusted if necessary.			

6. DESUPERHEATERS - STEAM TEMPERATURE CONTROL EQUIPMENT

1. Refer to Table 6 for detailed checks and items that may be applicable.

Table 6 Desuperheater pre-commisioning checklist

Desuperheater checklist		Reviewed		
		Y	N	NA
1	Check that the direction of injection is correct.			
2	Check the size of the injection nozzle and venturi.			
3	Check that the bolts are in accordance with specified requirements.			
4	Check that the forces and movements on flange connections are within acceptable limits and the equipment is adequately supported.			
5	Check for proper installation of the low-alloy carbon steel inner tube, if fitted.			

7. SHELL-AND-TUBE HEAT EXCHANGERS

New heat exchangers which have been tested at the Manufacturer's works in accordance with the design test pressures need not be retested after installation, unless required by local regulations.

It is good practice, however, to test the tightness of the floating head and channel flanges.

Pneumatic testing at a pressure of 1 bar (ga) is normally sufficient.

1. Whenever a shell cover, channel or floating head cover has been removed for cleaning or repair purposes, the heat exchanger shall be subject to a hydrostatic test not exceeding 110% of the design pressure.
2. Re-tubed replacement bundles shall be subjected to a full pressure test in situ to prove the tightness of the tube-to-tubesheet connections. Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing.
3. In cases where the heat exchanger design is based on differential pressure, care should be taken not to overload the tubesheets.
4. In cases where the heat exchanger design is based on differential pressure, control measures should be implemented to ensure the tubesheets are not overloaded.
Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to precautions to be taken when pressure testing equipment including bellows.
5. Heat exchangers provided with sheet gaskets which have been idle for more than three months after the date of hydrostatic testing at the Manufacturer's works may be opened on a spot-check basis to check for deterioration of the gaskets.
6. Refer to Table 7.1 for detailed checks and items that may be applicable.

Table 7.1 Shell and Tube Heat Exchanger pre-commissioning checklist

Shell and Tube Heat Exchanger checklist		Reviewed		
		Y	N	NA
1	Check that the correct material has been used for drain/vent plugs.			
2	Check whether anodes/sacrificial plates have been installed where specified.			
3	Check that test holes in reinforcement plates are open and that dewatering holes are located in appropriate positions.			
4	Check that threaded holes for pulling eyes in contact with the fluid are plugged off with dummy bolts.			
5	Check that impingement protection, if provided, is properly installed.			
6	Check that the extended bolt ends for bolt tensioning (external as well as internal) are properly protected.			
7	Check that the test flange or test ring is present and properly stored.			
8	Check the verticality of vertical heat exchangers and correct slope, if any, of horizontal heat exchangers.			

8. AIR-COOLED HEAT EXCHANGERS

1. If fans are installed well in advance of being commissioned, consideration should be given to the manual rotating of motors and fans at regular intervals.

This is to prevent Brinelling of bearings and pre-setting of V-belts.

2. Bearings of fans and drives shall be inspected for cleanliness and proper lubrication.
3. After assembly the sections of air-cooled heat exchangers shall be tested together with the associated piping in accordance with the relevant codes Refer to DEP 74.00.10.10-Gen. for requirements and recommendations related to pressure testing.

Sections of heat exchangers of the air-cooled type are normally tested at the Manufacturer's works.

New heat exchangers which have been tested at the Manufacturer's works in accordance with the design test pressures need not be retested after installation, unless required by local regulations. It is good practice, however, to test the tightness of the bundle. Pneumatic testing at 1 bar (ga) is normally sufficient.

4. Damage to fins shall be noted and repaired or replaced per project specifications.
5. Refer to Table 8 for detailed checks and items that may be applicable.



Table 8 Air-Cooled Heat Exchanger pre-commissioning checklist

Air-Cooled Heat Exchanger checklist		Reviewed		
		Y	N	NA
1	Check the clearance between blade tips and fan ring and check for equal and proper pitch angle setting of all fan blades.			
2	Check whether fins of the cooler tubes have been damaged during transport or handling (8 Item 4)			
3	Check that the correct material has been used for drain/vent plugs.			
4	Check the sliding supports of the header box for free and unobstructed moving.			
5	Check the proper operation of the louvre adjustment mechanism, if fitted.			
6	Check that any lengths of grease tubing installed to facilitate re-greasing of out-of-reach overhead bearings have been disconnected and pumped through with fresh grease to clean and prime the tubing before it is reconnected to bearings. <i>After this step, consider the use of automatic lubricators.</i>			
7	Check that the fan rotation and blade setting is correct.			
8	If the fan blade pitch is automatically adjustable, check that the: - motor capacity is sufficient over the full pitch range; - correct positioning of fan blades in case of air failure			
9	Check the following: - the sealing between cooler bundles; - the correct sloping of the horizontal parts of the air plenum and tube bundles; - alignment of belt pulleys; - rigidity of fan and belt guards - proper tension of belt drives; - tube vibration check at maximum airflow; - guards protecting personnel from hot surfaces; - proper alignment of process piping to headers to ensure no excessive nozzle loading; - full priming of grease lines between grease nipple and bearing house; - tightness of fan blade securing bolts; - vibration of fan and motor as a baseline for further degradation of bearings.			