MANUAL

FIELD INSPECTION PRIOR TO COMMISSIONING OF MECHANICAL EQUIPMENT

DEP 61.10.08.11-Gen.

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DESIGN AND ENGINEERING PRACTICE

PREFACE

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The Hague, The Netherlands,

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The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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APPENDICES

1. INTRODUCTION

1.1 SCOPE

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

This DEP is a revision of the DEP with the same number dated November 1992. Other than editorial changes, this revision has not been extensive; a summary of the main non-editorial changes is given in (1.5).

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.

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

1) Manufacturing - which should be covered by the appropriate specifications, standards and codes laid down in the equipment purchase order.

2) Erection and precommissioning

3) Operational maintenance - which should be covered by local procedures at the operating site.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by SIOP and SIEP, the distribution of this document is confined to companies forming part of or managed by the Royal Dutch/Shell Group, and to Contractors nominated by them (i.e. the distribution code is "C", as defined in DEP 00.00.05.05-Gen.).

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

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 as regards safety, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this document 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 with the object of obtaining agreement to follow this document 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.

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 (34).

1.5 SUMMARY OF CHANGES SINCE LAST REVISION

Other than editorial changes, the following are the main changes since the last revision:

Section	Change
3.1	Added reference to DEP 31.40.40.38-Gen.
3.2	“Potable water” redefined
6	Deleted items 6 and 8; minor changes elsewhere
7	Deleted items 6, 12 and 13
8	Deleted item 7
14 (item 20)	Pressure testing is now permitted on fully painted piping spools (including welds) under certain conditions
16	Revised item 1; added new items 8, 9 and 10
26	Completely revised
27	Added new item 37
31	Revised item 9

2. INSPECTION

2.1 GENERAL

Handover procedures shall be agreed between the Principal and the Contractor before precommissioning commences, and shall include the respective responsibilities of the Contractor, Manufacturer and the Principal.

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

As it will not normally be possible to complete all checks on any one item at the same time, checklists should be used to ensure that essential points are not overlooked. Systematic performance of the handover inspections will facilitate the collection of accurate 'as-built' information and baseline measurements essential for completion of the Equipment Record Cards, see DEP 70.10.01.10-Gen.

The objective of inspection during construction or maintenance is to ensure that:

1. the equipment has been supplied in accordance with the purchase order;
2. the equipment has been installed correctly;
3. all required documentation has been completed.

A piece of equipment or part of an installation which is meant to operate with other equipment shall be inspected and tested in conjunction with the latter to ensure proper operation of the complete assembly, for example, a compressor together with its drive, auxiliary gear and piping system.

A record of all manufacturing data books, shop inspection reports, and Manufacturer's inspection and test reports should be kept in the equipment file. This information shall be recorded on the appropriate Equipment Record Card, which shall be completed before commissioning. All pressure testing, when performed by a Contractor, shall be witnessed by the Principal and shall be recorded on the appropriate Equipment Record Card.

2.2 ROGUE MATERIALS

A 'rogue material' is a material of incorrect type or grade.

Many materials are similar in appearance and so the installation of rogue materials can easily occur.

In order to eliminate rogue materials from equipment or an installation, explicit procedural checks shall be established for critical circuits.

Critical circuits are selected according to process flow schemes, inspection data and inspection experience. The criteria for selection shall be:

- service conditions (high temperature, low temperature, high pressure);
- nature of products (corrosive, flammable, lethal);
- type of material (alloys and alloy steels, carbon steel with special requirements).

For these critical circuits the minimum special inspection requirements shall apply:

1. Full traceability of all materials used, i.e transfer and recording of heat numbers or other unique identifiers.
2. Random alloy verification prior to installation (only for alloys and alloy steels such as 5 Cr- $^{1}/_{2}$ Mo steel).
3. A 100% alloy verification check, including all weldments, after completion of erection of these systems (only for alloys and alloy steels such as 5 Cr- $^{1}/_{2}$ Mo steel).

2.3 DESIGN MODIFICATIONS

Design modifications during the manufacturing period may not be incorporated in the plant equipment after the final inspection in the shop. An up to date record shall be kept of all

design modifications and associated specifications and drawings. The plant equipment shall be examined on arrival at site for compliance with purchase order requirements and any non-conformity reported and recorded. If the plant equipment requires modification on site it is essential that full and explicit information shall be made available, together with the certified materials required to perform the modifications. The modifications shall be performed in such a manner that the Manufacturer's guarantees are not invalidated.

Plant equipment which has been modified on site shall be subject to the same inspection requirements as for the original equipment.

3. PRESSURE TEST PROCEDURES

3.1 GENERAL

Equipment design codes and local regulations, which may vary from country to country, often lead to differences of opinion as to the correct test pressure to be applied to pressure-containing equipment.

Local regulations shall be strictly adhered to unless exemption has been obtained. If these regulations are less stringent than the design code, the latter shall prevail.

Equipment which has been pressure tested at the Manufacturer's works shall not be re-tested after installation, unless required by local regulations or if there is any reason to suspect the integrity of the equipment, e.g. due to damage during transport. In such circumstances a retest shall be carried out in accordance with the governing code or specification.

After major repairs such as replacement of a nozzle, renewal of a shell plate or changes in piping, the affected equipment shall be re-tested to the original test pressure. If the equipment is to be pressure-tested in the installed position, it shall be ensured that all parts of the assembly, including the supporting structure, can withstand the loading resulting from the pressure test. Where necessary, temporary supports shall be erected prior to hydrotesting.

All non-destructive testing and stress relieving shall be completed with acceptable results before pressure testing.

The equipment to be pressure tested shall be properly vented during filling to avoid air pockets.

Only a hand or air operated small-capacity test pump shall be used. Where bellows are installed in the test circuit, special precautions shall be taken to prevent overpressurizing. A pressure relief valve and pressure gauge shall be installed at the highest point of the equipment and on the test pump. The gauges shall have an accuracy as specified in the applicable code and shall have a scale range suitable for the test pressure.

For pressure testing of new pipelines, see DEP 31.40.40.38-Gen.

3.2 HYDROSTATIC TESTING

Wherever reference is made to pressure testing in this DEP, the medium used shall be water.

NOTE If this is impractical the use of other non-flammable liquids may be considered if agreed by the Principal.

The water quality to be used for hydrostatic testing depends on the material(s) from which the equipment to be tested is manufactured (see below). Whatever the source of the hydrotest water, it shall be filtered through a 10 µm filter when filling the system.

Special precautions shall be taken if weather conditions can cause freezing or heating up of the test water.

After testing, the equipment shall be drained and dried to prevent corrosion. Do not leave systems filled with water. During draining a vent valve shall be open at the highest point of the equipment to prevent vacuum.

NOTES:
1. Leaving systems filled with water requires the consent of the Principal.
2. Check for thermal expansion and freezing conditions when leaving systems filled with water.
3. See Section 3.2.2 for materials other than carbon steel.
4. In the context of this DEP, the term “potable water” means water having a chloride content of no more than 250 mg/kg. In some areas, drinking water may have a slightly higher chloride content and may be considered “potable” for this DEP if approved by the Principal.
5. In the context of this DEP, the terms “condensate”, “boiler feed water” and “demineralised water” mean water having a chloride content of no more than 2 mg/kg.

3.2.1 Low-carbon and low-alloy steel

Equipment manufactured from carbon steel or low-alloy steel may be hydrostatically tested with potable, brackish or salt water as available. If potable water is not used, the test water shall be completely drained and the equipment flushed with potable water immediately after testing and thoroughly dried with hot air or steam.

3.2.2 Austenitic stainless steel

The water used for hydrostatic testing shall not contain a concentration of chlorides, either present originally or resulting from evaporation, that may precipitate stress corrosion cracking or pitting. If biological components are left in systems or introduced with the testing water, there is also the possibility of Microbiologically Induced Corrosion (MIC).

The stainless steel shall be clean prior to final assembly and hydrostatic testing.

The equipment and/or piping shall be tested with condensate, boiler feed water or demineralized water.

Alternatively, it may be tested with potable water **provided** that it is either drained and mechanically dried immediately after the testing, or flushed with condensate, boiler feed water or demineralized water immediately after the testing.

NOTES:
1. Equipment such as shell-and-tube heat exchangers may have crevices which prevent proper draining and mechanical drying.
2. When flushing with condensate, boiler feed water or demineralized water it is essential that all surfaces previously wetted during the test are flushed. The quantity and velocity of the flushing water depends on the equipment volume and shall be determined in consultation with the Principal.
3. Removing water or drying by blowing with hot air or gas shall not be performed unless the testing or flushing has been done with condensate, boiler feed water or demineralized water.
4. In locations where water of the required quality is not available (initially or permanently), temporary facilities shall be used (e.g. mobile packaged demineralization units) to prepare the test water.
5. The risk of pitting corrosion is considerably reduced if the time between hydrostatic testing and start-up is short.
6. Clen systems and the use of boiler feed water or condensate as test water, minimises the risk of Microbiologically Induced Corrosion.
7. Consider the use of biocide to minimise the risk of Microbiologically Induced Corrosion.
8. If equipment or piping is to be left idle longer than one month, it shall be preserved in accordance with DEP 70.10.70.11-Gen.

Steam-traced or electrically traced systems should be tested or at least properly flushed with condensate or demineralized water prior to the functional testing of the tracing. Stainless steel bellows should preferably be isolated from the system during hydrostatic testing. If this is not possible, the hydrostatic testing shall be done with condensate, boiler feed water or demineralized water.

3.2.3 Ferritic stainless steels and medium/high nickel alloys

Due to the possibility of pitting corrosion, Section 3.2.2 shall also apply to ferritic stainless steels and medium/high-nickel alloys.

3.2.4 Duplex stainless steel

Duplex stainless steel is highly susceptible to crevice corrosion when in contact with oxygen-containing water.

The preferred hydrostatic testing method is to use potable water and to carefully rinse the equipment immediately after the pressure test with condensate, boiler feed water or demineralized water, followed by thorough drying or dewatering of the equipment and filling

with nitrogen in such a way that all oxygen is removed from the system.

3.2.5 9% Nickel alloy steel

When hydrostatically testing equipment manufactured from or containing 9% Ni steel, the water used shall be of a neutral pH value, clear and free from sulphides which may otherwise precipitate stress cracking of the equipment. Complete and thorough draining and drying of the equipment is required after the removal of the test water.

3.2.6 Aluminium and aluminium alloys

The test water shall be of a neutral pH value and free from ions of heavy metals, e.g. copper, nickel and iron. These metals are readily deposited on the aluminium surface and cause severe pitting.

The equipment shall be thoroughly cleaned and dried after removal of the test water.

3.3 PNEUMATIC TESTING

Pneumatic testing is potentially a more dangerous operation than hydrostatic testing and should only be considered if hydrostatic testing is impossible or impractical. In such cases pneumatic testing (with air or inert gas) may be considered for:

- testing the tightness of linings, nozzle welds or flanged connections, with a pressure of 0.5 to 1.0 bar (ga);
- strength/integrity testing. For this, a procedure shall be agreed upon between the Principal and the Contractor, which may include additional non-destructive testing. If required, approval by local authorities shall be obtained.

4. MECHANICAL EQUIPMENT, GENERAL

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

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 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.
4. Check the foundation bolts to make sure that they are straight and vertical and securely tightened. Shims should be located on either side of each foundation bolt and made in one piece. Layers of thin plates shall not be used.
5. Check whether the specified grouting is used and properly applied to baseplate and support.
6. 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.
7. Check and inspect any alterations made during plant construction and erection for compliance with the design specification, and record any deviations.
8. 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.
9. Check wall thicknesses 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.
10. 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.
11. Check the equipment for internal cleanliness before final sealing.
12. Check that the applied surface protection system complies with specified requirements.
13. Check that earth bosses are connected and in electrical contact with the shell.
14. Check that ladders, stairways, platforms and walkways are correctly installed, with handrails and flooring properly secured. Check operating platforms for alternative escape routes, which shall be freely accessible and clearly indicated.
15. Especially with vacuum equipment, if out-of-roundness, bulges or dents are suspected as a result of transport, handling, field welding or other cause, check the equipment and report any such defects. Procedures for rectification of any damage shall be agreed between the Principal and the Contractor.
16. Field welds shall be non-destructively tested where so specified, and the results recorded.
17. 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. Field-erected equipment shall be hydrostatically tested according to Section (3). Particular attention shall be paid to those parts of equipment which have been modified during construction and erection.
18. A general inspection is required to check personnel hazards (e.g. tripping and headroom) associated with the accessibility of operating equipment. Hazards shall be removed or permanently marked and additional access provided as needed.

5. VESSELS, COLUMNS, REACTORS AND THEIR INTERNALS

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 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 may be stated in the specification.
12. Before final boxing-up, a check on proper installation of internals, correct flange finishes and cleanliness shall be carried out jointly by operational and technical staff.

6. FURNACES

1. Check the proper position and support of radiant and convection bank tubes. Remove any temporary bracing installed for transportation.
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 (for when becoming 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 burner installation, the correct position and shape of burner throats, the correct position of fuel guns in the throats, adjustability of air registers, fuel guns, the correct position and size of peepholes and observation windows. Record the result of the burner position measurement and issue a 'burner protocol' to be filled in the inspection department.
12. Ensure that burner throats and ignition burner are visible from observation windows. Ensure that observation windows are not obstructed by furnace tubes.
13. Inspect the heater access doors. They should move freely and at the angle specified and should not be obstructed.
14. Inspect and test the steam to the furnace, i.e. snuffing steam to fire box and header boxes and steam for soot blowing and burners.
15. Inspect and test the soot blower equipment for correct working within the full range of operation.
16. Check sootblower system and in particular:
    - expansion;
    - purge facilities;
    - self-draining of steam supply piping system;
    - tightness of valves
17. Test the concrete lining of the ducting for voids by tapping with a very light hammer. Inspect the lining for cracks wider than 1.5 mm. These cracks shall be cut out in such a way that a dovetail is obtained for repairs. For further checks on refractory, anchors, etc., see DEP 64.24.32.30-Gen.
18. Carry out a tightness test on air preheaters. Cleaning devices of fixed-type preheaters should be carefully checked. Packing between flanges shall be checked for tightness.
19. Apply a smoke-bomb test as a final check on the tightness of the firebox, ducting, dampers, air preheater etc. During this test the flue gas side shall be kept under pressure with the forced-draught fan.
20. 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 (see Section 3).

21. 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 may be conducted with medium pressure steam, provided that the pressure and temperature do not exceed the furnace design conditions.

    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.

22. Check proper installation of skin thermocouples (if applicable); see Standard drawing S 24.615.

23. Check operation of observation windows and the functioning of the air purge to the windows on the radiant cell.

24. Check that the locking pin of any spring hanger support is removed and the pointer within the operation range. Note the position in the cold, and later in the hot, condition.

7. BOILERS

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. Inspect the burner installation, the correct position and shape of burner throats, the correct position of the fuel guns in the throat, the adjustability of air registers, fuel guns, if applicable and the cleanliness of the fuel gun nozzles. Record the results of the burner position measurements.
12. Inspect and test the soot blower equipment for correct working within the full range of operations. Pay attention to purge facilities and steam shut-off valves.
13. Pressure test the boiler in accordance with the code or regulation under which it is designed. Boiler feed water shall be used as a testing medium (see Section 3).
14. Apply a smoke-bomb test as a final check on the tightness of the firebox, ducting, dampers, etc. During this test the flue gas side is kept under pressure with the forced-draught fan.
15. After starting up the boiler, the set pressure, maximum relief and the reseating pressure of the safety valves shall be checked at working temperature and adjusted if necessary.

8. DESUPERHEATERS - STEAM TEMPERATURE CONTROL EQUIPMENT

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 whether associated valves, instrumentation, and straight lengths of piping upstream and downstream of the injector are in accordance with the specification.
6. Check for proper installation of the low-alloy carbon steel inner tube, if fitted.

9. SHELL-AND-TUBE HEAT EXCHANGERS

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.
9. 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.
10. 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 pressure test not exceeding 110% of the design pressure.
11. Re-tubed replacement bundles shall be subjected to a full pressure test in situ to prove the tightness of the tube-to-tubesheet connections.
12. In cases where the heat exchanger design is based on differential pressure, care should be taken not to overload the tubesheets. Special care shall be taken if bellows are installed.
13. Heat exchangers provided with sheet gaskets which have been idle for more than three months after the date of hydrostatic testing at Manufacturer's works may be opened on a spot-check basis to check for deterioration of the gaskets.

10. AIR-COOLED HEAT EXCHANGERS

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. Damaged fins may be straightened if practicable, otherwise damaged tubes shall be replaced.
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. Bearings of fans and drives shall be inspected for cleanliness and proper lubrication.
7. The correct fan rotation and blade setting shall be checked.
8. Sections of heat exchangers of the air-cooled type are normally tested at the Manufacturer's works. After assembly the sections shall be tested together with the associated piping in accordance with the relevant codes.
9. It is essential to remove the test water by air blowing and drying, see (3).
10. In case of automatic adjustable fan blade pitch, check:
    - that the motor capacity is sufficient over the full pitch range;
    - the correct positioning of fan blades in case of air failure.
11. A general check of the construction should include:
    - 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 air flow;
    - 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.
12. 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.

11. GRAPHITE EQUIPMENT

1. Graphite equipment is brittle and soft and can easily be damaged.
   - Carefully avoid mechanical impact and direct contact with metallic edges.
   - Graphite blocks, while they are outside the metallic shell, should be kept on a wooden base covered with corrugated cardboard, rubber mat, or other equally shock-absorbent material. Graphite blocks should be separated from each other by a sheet of corrugated cardboard.
   - A comparatively small dent in the region of the gasket recesses can render a graphite block useless.
2. Check that the graphite equipment has been installed in such way that it is accessible from all directions, thus allowing connecting pipes to be easily attached.
3. Check that the gaskets between the process fluid orifices of the equipment and the connecting piping are resistant to the fluids and process conditions and are in accordance with specified requirements.
4. Check that fastening torques and pressures are limited to those required for fluid tightness. If tightness is not achieved within the allowable torques or pressures specified by the Manufacturer, dismantle and replace the gaskets.
5. Check that the graphite equipment is not used as a support for piping.
6. Check that the connecting piping does not exert any strain, stress or bending moment on the graphite equipment. Ensure that bellows are correctly installed.
7. Check the diameter of the connecting pipework is not less than the corresponding orifices of the graphite equipment.
8. Check that tie rods, where provided, are tensioned.
9. After the piping is connected, check that the position of the tie rod bolts is within the limits as indicated by the Manufacturer to ensure proper spring loads.
10. For carbon tube exchangers avoid changes from vertical to horizontal position and vice versa as much as possible.

12. ATMOSPHERIC STORAGE TANKS

Inspection shall be carried out in accordance with DEP 64.51.01.31-Gen.

13. ATMOSPHERIC TANKS FOR SOLIDS AND SILOS

Inspection shall be carried out in accordance with DEP 64.51.01.31-Gen.

Also:

1. Check for possible flow restrictions resulting from unground welds, especially at outlets. Check that manhole flush plates are in position. Check for any impediment to the free passage of solids and for proper alignment of flanged connections.
2. Check the inner surfaces for cleanliness and removal of debris.
3. Due to the large variety of above-ground storage facilities, further inspections shall depend on individual circumstances and be subject to agreement by the Principal.

14. PIPING

1. Check that the materials of all pipe and fittings comply with the specified requirements, see also (2.2).
2. Check the wall thickness of pipes and all fittings, especially the crutch of tee pieces.
3. Check whether bolting, gaskets, flanges, and flange finish are all in accordance with the specifications.
4. Check that the forces and movements on equipment nozzles are within acceptable limits. This is particularly important for rotating equipment and glass-lined equipment.
5. Check that the installation of any cast iron or glass-lined piping has been carried out correctly without imposing any strain.
6. Check that drains are at the lowest points and vents are at the highest points. Steam lines connected to hot process lines shall be provided with a drain or vent and a valve as close as possible to the process lines.
7. Before pressure testing, check that piping systems are properly supported with adequate expansion allowance provided, where specified. Check fixed points if applicable.
8. Check that uninsulated lines for a hot product have been safely protected at locations where personnel can come into contact with these lines.
9. Check that insulation is properly fitted to avoid ingress of water.
10. Check whether globe valves and check valves have been installed correctly for the direction of flow.
11. Check the pipework transitions from aboveground to underground installations for flexibility and protection against ingress of water.
12. Check that welded nipples are properly installed. Threaded nipples shall be inspected for engagement. Check that they have not been seal-welded.
13. Copper piping connected to ferrous metals, lined or unlined, shall be provided with insulating gaskets to prevent galvanic action.
14. Newly constructed piping systems shall be pressure-tested in accordance with the code governing their design.
15. To limit the number of test circuits, associated equipment may be included. However, the test pressure shall then be limited to that of the item in the circuit with the lowest test pressure, taking account of differences in elevation.
16. Piping systems which have been replaced for maintenance or plant change purpose shall normally be pressure tested. Where this cannot be done, the Principal or, if so required, the local authorities shall indicate what alternative test methods shall be applied.
17. Check for proper slope where required (e.g. flare lines).
18. Radiographic examination and stress relief of welds is not a substitute for pressure testing. It may sometimes be permitted by agreement with the Principal to radiograph and stress relieve the final closing circumferential field weld, provided that the piping material has been previously pressure-tested.
19. When large-diameter process piping cannot be tested hydrostatically because the supports are not designed to withstand the additional loading, every effort shall be made to test prefabricated sections (as large as practical) hydrostatically prior to installation. The final welds after installation of the prefabricated sections shall be made under close supervision.
20. Pressure testing (see (3)) may be performed on fully painted piping spools (including welds) provided that:

    - the welds consist of at least two layers (i.e. root pass and at least one fill pass) for stainless steels and at least three layers (i.e. root pass and at least two fill passes)

for other materials, and have been made in accordance with a qualified welding procedure; and

- the test is not a sensitive leak test as specified in ASME B31.3; and
- the piping spool has been fully inspected (visual examination, non-destructive examination and positive material identification where specified) and released for pressure test.

21. As an appreciable period of time may elapse between the introduction of water for testing and the piping being finally commissioned, the test water shall be removed from the piping systems to prevent corrosion, see (3).

22. If the system is to be left idle longer than one month it shall be preserved in accordance with DEP 70.10.70.11-Gen.

15. VALVES

1. Compare the type, pressure class and material of the valve with the design and specification requirements.
2. Check the valve installation for correct direction of flow, particularly for globe and check valves.

   NOTE: The flow direction of gate and ball valves could differ from the direction for pressure sealing in the closed position.
3. End covers of valves shall only be removed immediately before installation and it shall be checked that the valve is clean.
4. Check the proper torque of the handwheel or mechanical actuator.
5. Check proper lubrication of handwheel bearings, spindles and actuator gearboxes.
6. Check free-running of any chainwheel drive.
7. Check correct installation, commissioning and testing of any electric, mechanical or hydraulic actuator.
8. Check correct position and operation of limit switches, if fitted.
9. Check proper lubrication and adjustment of taper plug valves.
10. Check whether full handle stroke/turn is possible.
11. Check the position of gate and ball valves with vertical holes in low temperature service (see DEP 31.38.01.11-Gen. 8.1.2.3.).

16. SAFETY/RELIEF VALVES

1. General points:
   - Careful handling of safety/relief valves in transit is important. Rough handling can change the pressure setting or deform the pressure relief valve parts so that they will not operate properly.
   - Flanges shall be protected to prevent damage to gasket facings and ingress of foreign material.
   - Relief valves should be treated as delicate instruments.
   - Corrosion inhibitor or protection shall not be applied to valve internals, since these may influence the opening pressure.
2. Compare the type, pressure class, set pressure and materials of the valve with the design and specification requirements.
3. Check the cleanliness of valve internals.
4. Before installation, all safety/relief valves shall be tested at site to check that the set pressure is correct and the valve is in good working order. The test bench used for site testing of safety relief valves shall have a minimum buffer volume of 0.5 m^3.

   For valves in which a security ring ("government ring") is installed, the height, set pressure and date shall be recorded.
5. Check that all safety/relief valves have been installed in the specified orientation.
6. Check that the line size leading to the inlet of the safety/relief valve is at least of the same size or larger than the inlet flange size of the safety/relief valve.
7. Where the valve has been installed to relieve directly to atmosphere, the outlet line shall be vertical. Check that the outlet line has been provided with a drain hole at the lowest point, is adequately supported and is free of debris or other obstructions.
8. Check the flexibility of gas or liquid outlet lines, e.g. in a closed system, for both hot and cold conditions.
9. Check that supports are adequate to carry the reaction forces and prevent excessive vibration.
10. Check that there is no unacceptable misalignment of inlet and outlet piping connections prior to installing the valve.
11. Check that the piping is clean and free from mill scale prior to installing the valve.
12. If a block valve has been fitted between the equipment and the safety/relief valve, or if an interlocking system between safety/relief valves has been provided, check that the locking devices have been properly installed in accordance with DEP 80.46.30.11-Gen. In the case of vented bonnets, make sure that the plug or cap inserted for protection during transport has been removed.
13. If fluid may be discharged at high temperature, the set pressure shall be adjusted for testing at room temperature in accordance with Manufacturer's data.
14. Depending on the make of the valve, improper positioning of the rings may lead to a considerable reduction of the valve capacity (even down to 30% of the rated capacity). Therefore, it is essential to check and make sure that the rings are properly adjusted in accordance with Manufacturer's instructions.
15. Testing and checking of safety/relief valves shall be witnessed by a representative of the Principal.
16. Bellows of e.g. balanced type relief valves shall be checked by applying a slight overpressure via the bonnet vent hole.

17. RUBBER AND GRE/GRP-LINED EQUIPMENT

1. Inspection shall be carried out by qualified specialists.
2. The Manufacturer's test report and installation instructions shall be followed.
3. Check that every flange is protected by a cover plate. These cover plates shall only be removed just before installation.
4. Lined flange facings shall be checked visually for surface defects such as cracks, blisters, scratches, etc.
5. The type of gasket fitted shall be checked for compliance with the specification.
6. The equipment shall be checked for stress-free installation of piping and supports.
7. The presence of soft packing material between the support and equipment shall be checked.
8. Bolt tension shall be checked against Manufacturer's specified values.
9. Filler rings shall be used for raised face steel flanges.

18. ROTATING EQUIPMENT

Rotating equipment shall be installed in accordance with DEP 31.29.00.10-Gen.

For each type of equipment a checklist shall be drawn up of any checks required in addition to, or as verification of, the checks described in DEP 31.29.00.10-Gen. which are to be performed prior to commissioning.

A number of general items that have to be checked/verified prior to commissioning are listed below, and more specific checks for particular rotating equipment are listed in sections (19) through (33).

1. All Manufacturer's commissioning/operating instructions shall be adhered to.
2. Pressure-retaining parts of rotating equipment which have been tested in the shop shall not be retested. However, after any pressure-retaining part has been reparied by welding, it shall be retested in accordance with the requirements as described in (3).
3. Check that the line-up and instrumentation are in accordance with the relevant design documents, e.g. process and utility piping, lubrication and sealing system, flow direction of warming up bypass, instrumentation and electrical connections.
4. 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, and restraining devices from instruments, safety devices and protective equipment.
5. Check whether special maintenance tools and instruction manuals have been supplied.
6. Compare the nameplate rating with the Equipment Record Card and note any variations.
7. Check that the nameplate is attached to the equipment in accordance with the specification.
8. Check that the foundation bolts and dowelling are securely tightened and check for free thermal expansion of equipment.
9. Check that the insulation and winterising has been applied in accordance with the specification and precautions taken to prevent the ingress of water.
10. Check the equipment for internal cleanliness before final sealing.
11. Check whether the lubrication system has been properly flushed and is clean. During flushing the bearings/seals shall be bypassed.
12. Check that the quality and grade of the applied lubricants are in accordance with those specified.
13. Check lubrication, filters, strainers and lubricant levels throughout system.
14. Check that the proper mesh size is installed in the suction line strainer/filter of the equipment and that the strainer is fitted correctly. During the initial start-up, commissioning and initial operating phase the strainer shall be covered with a fine mesh gauze. The fine mesh gauze may be removed after the initial operating phase if fouling is within limits. This shall be determined by means of a suitable differential pressure method.
15. During plant/system flushing and pressure testing the rotating equipment shall be positively isolated from the system. Equipment nozzles shall be blinded off in such a way that no flushing or testing liquid can enter.
16. Check process lines leading to and from the equipment to make sure that these have been connected to the equipment in such a way that strain-free operation is assured.
17. Check that the process or steam lines to the equipment are cleaned, flushed or blown out in accordance with the specifications.
18. Check whether adequate drain and venting facilities have been installed.
19. Check the direction of rotation. An arrow, indicating the direction of rotation, should be

an integral part of the equipment (check driver rotation first).

20. Check the shaft alignment between driving and driven unit. Any misalignment radially and axially should not exceed the limits specified by the Manufacturer or DEP 31.29.00.10-Gen. whichever are the more stringent.
21. Check cold setting position of spring hanger after filling the system with liquid. Check easy removal of locking pin and remove lockpins. If easy removal of pin is not possible take adequate corrective action.
22. Check whether coupling is clean and lubricated, if required.
23. Check coupling guard and flexible connections.
24. Check that the applied surface protection system complies with specified requirements.
25. Check that earth bosses are connected and in electrical contact with the equipment.
26. Check whether warm-up line of multi-stage and large simple stage pumps is properly installed to avoid channeling and in line with Manufacturer's recommendations.
27. Check the presence of start-up and insurance spares.

19. CENTRIFUGAL COMPRESSORS

Lube oil/seal oil or sealgas system

- Check that the gaskets fitted are of the correct material and pressure class.
- Fill the system with the correct amount of flushing oil. Start flushing the system after any special instructions of the Manufacturer have been followed (e.g. concerning bearings and/or seals etc.), and continue flushing until API 614 cleanliness criteria have been met.
- After the lubrication and sealing system has been properly flushed, drain the flushing oil. Oil tanks shall be cleaned and inspected after the flushing procedure. Replace filter elements and clean the filters. Remove all the special precautions installed for the system flushing.
- Check precharge pressure of accumulators.
- Fill the lube and seal oil system with the correct amount of oil of the specified grade.
- Check the levels throughout the system (overhead system properly filled/vented).
- Check tightness of the seal system using installed safeguarding system.

Process piping

- Check that piping flanges line up properly with the equipment flanges. For parallelness of flanges see DEP 31.29.00.10-Gen.

The following checks shall be done after completion of the hydrotest and system flushing:

- Check that all process piping in between suction strainer/filter and compressor nozzle is clean (no mill scale etc.). If the line diameter is too small for a proper visual inspection, line sections concerned shall be removed and chemically cleaned and passivated.
- Check whether the start-up strainer/filter is properly constructed and fitted in accordance with Standard Drawing S 38.041.
- The alignment shall be checked during final connection of the process piping to the equipment. Dust blinds shall remain in place up to that time.

Utilities

- Check that the cooling water system has been properly flushed and is clean.
- Verify the change-over function if double coolers are installed.
- For closed cooling water system, check whether the system is properly treated with anti-freeze and corrosion inhibitor.

Safety devices

- Check that the instruments and safety devices are correctly installed and in accordance with instrument data sheets and flow diagrams.
- Check proper functioning of all safety devices.
- Safety devices which cannot be tested when the machine is not running should be checked during the initial run.

Function testing of compressor

1. Prior to initial run:
    - Check that the foundation bolts are securely tightened.
    - Check that the casing can expand with increasing temperature and that the axial and transverse keys are properly located and secured.
    - Check the compressor alignment without any process piping connected. When the alignment is within the Manufacturer's requirements, connect the process piping to the compressor with the alignment clocks still in place. During the tightening of the piping the dial indicators should be watched in order to highlight the cause of any distortion. If the alignment of the compressor after all process piping has been

completely tightened is within Manufacturer's tolerance, data can be recorded and filed and unit can be accepted for further commissioning.

The following should be verified during the final alignment checks:

a) proper pipe supports and pipe anchors installed;

b) locating pin for spring hangers has been removed and check for cold setting;

c) casing hold down bolts properly tightened;

d) casing positioning screws loose.

- Check that the auxiliary lubeoil/seal oil pump cuts in at correct pressure.
- Verify and check all alarm and trip/safety device settings and their proper functioning by simulation of the alarm-trip condition/signal from the sensing device. Simulation of the alarm-safety system from the relay/junction base in the auxiliary room is not allowed as this does not test the field wiring. Verification of alarm/trip device settings which require actual running of the installation shall be done during the initial run (e.g. surge protection system).
- After satisfactory completion of the alarm-safety checks, the compressor can be coupled to the driver provided that the drive safety program including its safety checks under running condition, e.g. overspeed, has been completed.
- If the coupling is a gear coupling, check the following after it has been fitted:

  a) axial float of the coupling, and adjustment in accordance with Manufacturer's instructions;

  b) position and direction of spray of the oil nozzles;

  c) quantity and pressure of lubricating oil at the spray nozzles.
- Check proper installation of coupling guard.

2. Initial operation of compressor

- Sometimes a compressor is used to dry and clean the process installation using air. The molecular weight and the K value of air may differ from those of the process gas in the compressor. It is advisable to contact the Manufacturer if such operation is foreseen or required, as the compressor may have to be operated at reduced speed and pressure; for example, seals may have to be modified temporarily to prevent equipment damage.
- Prior to starting the unit on process gas, it shall be purged with nitrogen.
- Start lube and seal oil systems after purging with nitrogen, but prior to pressurising the unit.
- When lube and seal oil flows, levels, pressure and temperature are found to be satisfactory, start pressurising the compressor with process gas. Stop the unit immediately if abnormalities are observed.
- Check for any gas leakage.
- Start the compressor.
- Check and record vibration levels and leakage regularly, particularly after a change in operating conditions, and confirm they are within specified limits.
- Check and record the oil/gas flows, pressures and temperatures regularly, particularly after a change in operating conditions.
- Once the unit is up to rated conditions, check the surge protection system. Verifying the settings of this protection system may result in surging of the compressor, and therefore shall be carried out by qualified personnel only.
- When satisfactory operation is obtained and all outstanding matters have been dealt with, the unit is ready for the plant performance test.
- Conditions for the test shall be mutually agreed between equipment Manufacturer,

Contractor and Principal.

- After successful completion of the test the unit may be stopped for adjustment of safety devices or inspection of certain parts including start up strainer if the differential pressure is up to 1.5 bar. Whenever the differential pressure across the strainer reaches 1.5 bar, the unit shall be stopped and the strainer cleaned.

  Take an oil sample and check it for presence of water and cleanliness.

  Once it can be safely assumed that the system is clean, the fine mesh shall be removed. The perforated cone, however, remains in place.

  When sufficient operating experience has been gained to indicate that the total system is free of foreign matter (this can take up to several months) the entire screen can be removed. However, in order not to disturb the piping alignment the flange of the conical strainer shall be recovered and reinstalled.

  NOTE: After each plant overhaul a temporary strainer made of perforated plate shall be installed for equipment protection.

20. RECIPROCATING COMPRESSORS/VACUUM PUMPS

1. Check the crankcase and crossheads for cleanliness and make sure the crankcase can be properly vented.
2. Check line-up of luboil system and that it is in accordance with flow diagram.
3. Check that the entire luboil system has been properly flushed and is clean.
4. Check line-up of cooling water system and that it is in accordance with flow diagram.
5. Check that the cooling water system has been properly flushed and is clean.
6. Check line-up of vent and drain system of cylinder stuffing box and cylinder compartment distance pieces, taking into account local safety regulations for disposal of hazardous or toxic gases.
7. Check line-up of purge system to cylinder stuffing-box gland or cylinder compartment distance pieces.
8. Check the barring gear for correct functioning.
9. Check crankshaft deflection before and after coupling-up of driver.
10. Check the suction and discharge valve assembly and valve housing for cleanliness and check valve lift. Check that valves are assembled correctly. If valve unloaders are mounted, check correct functioning and sequence.
11. Check the piston travel clearance at both sides of each cylinder and piston/piston rod run-out.
12. Check cylinder and suction volume bottle for cleanliness.
13. If clearance pockets for capacity control are installed, check proper functioning of this device.
14. Check cleanliness of the piston-rod seals at the cylinder stuffing box and the cylinder compartment distance pieces.
15. If the compressor is driven by means of V-belts, check the correct tension of these belts and the pulley alignment.
16. Check whether the safety devices are properly installed and in accordance with the data sheets and flow diagram. Check that the safety/relief valve is installed and check set pressure.
17. Check that the crankcase contains oil up to the correct level.
18. Check that the lubricator is filled with oil and check proper supply to all lubricated points by rotating the crank by hand.
19. If an intermediate bearing is installed, check that the bearing housing contains oil or grease, and check for correct oil level.
20. If a gearbox is installed, check that it contains oil up to the correct level.
21. Check proper function of cooling water system.
22. If cylinders are cooled by thermosyphon cooling, check that the reservoir and cylinders are filled with glycol and check for correct level in the reservoir.
23. Check the proper functioning of all safety devices. Safety devices which cannot be tested when machine is not running should be checked during the initial run.
24. Initial run (normally without valves)

    1) The molecular weight, suction pressure and K-value of air or nitrogen will most probably differ from those of the process gas. Follow the Manufacturer's recommendations for air or nitrogen operation. The suction should be unrestricted and the discharge temperature should not exceed the maximum as specified by the compressor Manufacturer.

NOTE: Not applicable if valves are not installed

2) Remove suction or discharge valves from each cylinder.

3) Check that the barring gear is in a safe position after the compressor has been barred over for at least one full revolution. If abnormal resistance is encountered during barring, refrain from starting the compressor until the cause of the resistance has been found and remedied. Purge all gas vapour spaces, luboil and seal oil systems with nitrogen before the unit is put into operation.

4) Operate the compressor on a start-stop procedure while the luboil pump operates for about 5 minutes.
After bringing the unit to standstill, check all bearings and other friction parts. If no excessive temperature is observed, and once all nuts have been tightened, start the compressor again and let it run for about 4 hours. Regular observations should be made during this 4-hour run. Check that the suction line is free of liquid, the knock out system is properly installed and the heating system is switched on.

5) After the mechanical run-in period of about 4 hours, the valves should be refitted and the compressor started again. It should be started up in accordance with the specified sequence. Check capacity control system with respect to unloading sequence and cylinder load. Let it run for a prolonged period unless observations indicate the presence of a defect.

6) Check the oil pressures and temperatures of all bearings and seals, and check the proper functioning of the lubricator regularly.

7) Check the gas pressures and temperatures regularly.

8) Check for any gas leakage, vibration of machine and piping.

9) For instrument air compressors check the automatic loading and unloading device, if installed, for smooth operation.

10) Check whether noise exceeds the specified limits.

21. ROTARY TYPE COMPRESSORS

1. Check the bearings and bearing housings for cleanliness.
2. Check that the luboil system is in accordance with the flow diagram.
3. Check that the entire luboil system has been properly flushed and is clean.
4. If a separate seal oil system is installed, check that it is in accordance with the flow diagram.
5. Check that the entire seal oil system has been properly flushed and is clean.
6. Check that the cooling water system is in accordance with the flow diagram.
7. Check that the entire cooling water system has been properly flushed and is clean.
8. If the compressor is driven by means of V-belts, check the tension of these belts and the pulley alignment.
9. Check the suction line for absolute cleanliness. Any dirt or welding scale from the suction line is disastrous for a screw compressor.
10. Check the discharge line for cleanliness and check valve orientation.
11. Check whether safety devices are properly installed and in accordance with data sheets and flow diagram.
12. Check whether a safety/relief valve is installed and check the set pressure.
13. Check that the luboil tank contains oil up to the correct level.
14. Check that the seal oil tank contains oil up to the correct level.
15. Check that the overhead seal oil accumulator contains oil up to the correct level and is properly vented.
16. If a gearbox is installed with its own luboil pump, check that the gearbox contains oil up to the correct level.
17. Check that the auxiliary luboil pump cuts in at the correct oil pressure.
18. Check that the auxiliary seal oil pump cuts in at the correct oil pressure.
19. Check the proper functioning of all safety devices.
20. Safety devices which cannot be tested when the machine is not running should be checked during the initial run.
21. Check the loading/unloading system.
22. Check the direction of rotation before coupling-up.
23. Check overspeed/underspeed protection.
24. Before the initial run verify manually the free rotation of the unit.
25. Initial run (normally on air or nitrogen)

    1) The molecular weight, suction pressure and K-value of air or nitrogen will most probably differ from those of the process gas. Therefore, the compressor may have to be operated at a reduced speed and discharge pressure. Follow the Manufacturer's recommendations for air and nitrogen operation. The suction should be unrestricted and the discharge temperature should not exceed the maximum, as specified by the compressor Manufacturer.

    2) Purge all gas vapour spaces, lubricating oil and seal oil systems with nitrogen before the unit is put into operation. When luboil, and where applicable seal oil, flows and pressures are found to be satisfactory, start the compressor and allow the compressor to attain full speed. Shut down and check for excessive bearing temperature.

       Start the compressor again and let it run for a period of about 4 hours.

3) Check the oil pressures and temperatures of the bearings and seals regularly.

4) Check and record the gas pressures and temperatures regularly. Check the interstage cooling and knock-out facilities.

5) Check for any gas leakage.

6) Check and record vibration.

7) For instrument air compressors check the automatic loading and unloading devices, if installed, for smooth operation.

8) Make a hot check of the coupling alignment as soon as the machine has come to a standstill following a running period of some hours at design temperature.

9) Check whether noise exceeds specified limits.

22. BLOWERS/FANS

1. Check the bearing and bearing housings for cleanliness, and where bearings are oil-lubricated, check that the lubricating rings have adequate free movement.
2. If bearings are oil-lubricated, check the correct position of the constant-level oiler, if applicable.
3. Check that the bearing housings contain oil up to the correct level or are properly greased. Check the presence of correct regreasing facilities.
4. Through the inspection cover on the casing, check the radial and axial clearance between the impeller and the inlet cone. While rotating by hand, check correct bearing position and dowels.
5. Check and flush cooling water lines.
6. Initial run
    1) Check the temperatures and pressures regularly.
    2) Check and record excessive vibration.
    3) Check whether noise exceeds specified limits.
    4) Check the correct position and function of inlet guide vanes if installed.
    5) Check cooling and purging facilities on the shaft sealing area.
    6) Check the housing drain facilities.
7. For ID and FD fans for furnaces and boilers:
    - Check proper functioning of inlet guide vanes. Record their movement degrees (degrees) versus instrument output. Make sure that the operating mechanism is strong enough and has less than 5 - 20 degrees hysteresis.
    - Make sure that greasing facilities are installed.
    - Make sure that an adjustable minimum and maximum stroke stop is installed.

23. CENTRIFUGAL PUMPS

In addition to the general points, see (18), the following particular points are also of importance:

Lubrication

- Check the proper functioning of the lubricating rings and/or lubrication system.
- Check the correct position and level of the constant-level oiler.
- Check that the bearing housing contains oil up to the correct level or is properly greased. If oil-mist lubrication is applied, check that the system is lined up correctly and is clean.
- Check presence of proper regreasing facilities.

Sealing

- Check that soft packing rings in the stuffing box are of correct material and the packing and gland are properly installed.
- Check the location and connections of the lantern ring and check whether proper seal liquid is used, if applicable.
- Check that the type of mechanical seal and its material are in accordance with specification.
- Check whether the seal piping arrangement is correctly installed in accordance with the specified API plan.

Utilities

Safety devices

Function testing

1. Prior to initial run
   - Check the free axial movement of the gear coupling spacer, if applicable.
   - Check the free movement of pump rotor/electric motor.
2. Initial run (on water or flushing liquid) if applicable
   - Where necessary, supply cooling water, start the luboil unit and seal liquid supply.
   - Check N_2 partial pressure in accumulators if applicable.
   - Open the suction valve and vent the pump casing and seal chamber.
   - Start the pump with the discharge valve cracked open and check the shut-off head. Open the discharge valve gradually and check the power consumption (ammeter) at the same time.
   - Check the mechanical performance of the pump on the duty point, e.g. bearing temperature, vibration levels.
3. Final start-up on product
   - If a bypass or equalizing line is installed for warming-up purposes, open the valve in this line and warm up the pump for a sufficient length of time.
   - Start the pump as for water.
   - Check and record vibration. If vibrations are excessive make a hot check of the coupling alignment, if necessary.
   - Check whether noise levels exceed the specified limits.

NOTES:
1. Ensure that vacuum pumps are not started when full of liquid.
2. For high speed pumps, follow the start-up procedure of the Manufacturer.
3. Multi-stage pumps with balancing disc should always operate at the specified differential head and design process conditions. Low discharge heads could destroy the balancing disks.

24. RECIPROCATING PUMPS

Lubrication

- If forced-feed lubrication is applied, check the line-up of the luboil system.
- Check that the crankcase contains oil up to the correct level.
- If applicable, check that the lubricator contains oil up to the correct level and check for proper oil supply to all lubricated points by rotating the crank by hand.
- If a gearbox is installed, check that it contains oil up to the correct level or is properly greased.
- Check the correct position and level of the constant-level oiler.
  Check that the bearing housing contains oil up to the correct level or grease.
  If oil-mist lubrication is applied, check that the system is lined up correctly and is clean.

Sealing

- Check whether soft packing rings in the stuffing box are of correct material and the packing and gland are properly installed.
- Check the location and connections of the lantern ring and check whether proper seal liquid is used, if applicable.

Utilities

- If a bladder type pulsation damper is installed, check that the nitrogen precharge pressure is as specified.

Safety device

- Check whether a safety/relief valve is installed and check the set pressure.

Function testing

1. Prior to initial run
   - Check the free axial movement of the gear coupling spacer, if applicable.
   - Check free movement of pump rotor/electric motor.
   - Check the suction and discharge valve assembly and valve housings for cleanliness and check whether the valves are correctly assembled.
   - If the pump is driven by means of V-belts, check the tension of these belts and check pulley alignment.
   - If the pump is steam-driven, check that the steam supply and exhaust lines have been connected to the equipment so that strain-free operation is assured. Check flange bolts, gaskets and pipe supports.
   - Check the valve gear and re-adjust where necessary.
2. Initial run (on product or flushing liquid)
   - Check any specific Manufacturer instructions. If stroke adjusting devices are installed the Manufacturer's handling instructions shall be followed. (In principle the start-up should be at a minimum capacity).
   - Supply the specified utilities, e.g. steam, cooling water.
   - Supply, if applicable, steam to heating jackets.
   - Start the luboil unit and seal liquid supply.
   - Open the suction and discharge valves.
   - Start the pump.
   - Check the mechanical performance of the pump and its lubrication.

     Check and record vibration of pump and piping.
   - Check whether noise exceeds specified limits.

- Check and record the mechanical performance of the pump at the duty point, e.g. bearing temperature, vibration levels.

3. Final start-up on product

   - If a bypass or equalizing line is installed for warming-up purposes, open the valve in this line and warm-up the pump for a sufficient length of time.
   - Start the pump.
   - Check and record vibration. In case of excessive vibrations make a hot check of the coupling alignment, if necessary.
   - Check whether noise exceeds specified limits.

25. ROTARY POSITIVE-DISPLACEMENT PUMPS

Lubrication

- Check the bearings and the bearing housings for cleanliness and ensure that lubricating rings have adequate free movement.
- Check the correct position and level of the constant-level oiler.
- Check that the bearing housing contains oil up to the correct level or is properly greased. If oil-mist lubrication is applied, check that the system is lined up correctly and is clean.

Sealing

- Check that soft packing rings in the stuffing box are of correct material and the packing and gland are properly installed.
- Check the location and connections of the lantern ring and check whether proper seal liquid is used, if applicable.
- Check that the type of mechanical seal and its material are in accordance with specification.
- Check that the seal piping arrangement is correctly installed in accordance with the specified API plan.

Utilities

Safety device

- Check whether a safety/relief valve is installed and check the set pressure.

Function testing

1. Prior to initial run
   - Check the suction line and filters for absolute cleanliness.
   - Check the free axial movement of the gear coupling spacer, if applicable.
   - Check the free movement of pump rotor/electric motor.
   - Check shaft coupling, bolting and bolt-securing devices.
2. Initial run (on flushing liquid or product)
   - Supply the required utilities.
   - Start the oil lubrication and seal flush/quench system.
   - Start the pump with the suction and discharge valves open.

     Check the mechanical performance of the pump and watch bearing temperature.
   - Check and record vibration.
   - Make a hot check of the coupling alignment, if necessary.
   - Check whether noise exceeds specified limits.

26. MIXERS

Lubrication

- Check the bearings and the bearing housings for cleanliness and ensure that lubricating rings have adequate free movement.
- If the axial bearing is oil-lubricated, check the correct position of constant-level oiler, if applicable.
- Check that axial-bearing housing contains oil up to the correct level or is properly greased.
- If a gearbox is installed, check that it contains oil up to the correct level or is properly greased.
- Check for correct position and level of the constant-level oiler.
- Check that the bearing housing contains oil up to the correct level or is properly greased. If oil-mist lubrication is applied, check that the system is lined up correctly and is clean.

Sealing

- Check that soft packing rings in the stuffing box are of correct material and the packing and gland are properly installed.
- Check the location and connections of the lantern ring and check whether proper seal liquid is used, if applicable.
- Check that the type and material of mechanical seal are in accordance with specification.
- Check that the seal piping arrangement is correctly installed in accordance with the specified API plan.

Utilities

Safety device

- Check whether a safety/relief valve is installed and check the set pressure.

Bottom bearing

- Manufacturer's drawings, instructions etc. shall be consulted.
- Check dimentsions and materials used for sleeve and bushing.
- Check flush system
- Check whether bearing can be operated with test liquid.
- Use clean feed lines and clean vessel and bearing before initial start.

Function testing

1. Prior to initial run

- Check the inlet lines and filters for absolute cleanliness.
- Check the general condition of the stirrer for damage damage which might have occurred during transport.
- Mark parts such as seal cartridges, bushes and sleeves of bearing. In the event of a failure or problem (e.g. wear in the bottom bearing) this information can be helpful in tracing the cause.

During this stage the electric drive is still uncoupled from the main and the main switch is locked.

- Check the alignment and bolts of different parts of the drive.
- Check the alignment criteria for the coupling shaft between gear box and main shaft, after installation. Limits should be given by vendor.
- Check wether the shaft can be rotated by hand without obstruction.

- Mark positions on mixer set-up and vessel for vibration and shock pulse measurements (3 directions on drive, gear box, bearings, mechanical seal, top nozzle of vessel, bottom of the vessel and construction).
- Alignment of the main shaft to be checked by measuring the run-out at three different heights along the shaft by means of a gauge.
- Check the position of the main shaft relative to the middle of the vessel at the same positions as for the run-out measurements.
- Has the operating procedure for the mechanical seal been added to the plant operating manual?

After this stage the vessel shall be cleaned and all inlets to the vessel must be flushed or the lines must be cleaned later without drainage into the vessel. Take photographs of the different parts of vessel and mixer set-up, both inside and outside.

2. Initial run

From this point on the manhole is open for visual observations during tests at ambient conditions. No construction work near the manhole is permitted. Glasses, helmets and tools must likewise be kept away from the manhole. The presence of the vendor is preferred at this stage.

a. Run the motor uncoupled for 3 hours (check whether this is allowed!).
   - Check directional rotation of the motor in relation to the proper pumping action of the impellers.
   - Measurement of absorbed power (kW, volts, amperage, cos ∅). Check in the control room.
   - Measure stirrer speed with tachometer and check in control room.
   - Carry out vibration and shock pulse measurements at marked positions.
   - Carry out noise measurements near drive, gear box, mechanical seal and bottom of vessel.

b. Connect drive to the gearbox and run for 2 hours in an empty vessel. (If applicable: check whether bottom bearing needs to be submerged).
   - Accurate measurement of absorbed power (kW, volt-amps, cos ∅).
   - Measure stirrer speed with tachometer and check in control room.
   - Carry out vibration and shock pulse measurement at marked positions.
   - Carry out noise measurements near drive, gear box, mechanical seal and bottom of vessel.
   - Check proper functioning of the seal unit (leakage, pressure and temperature).
   - Observe deflections of the main shaft via top man hole.

c. Charge vessel with a measured quantity of clean water to the operating level with the stirrer at stand still. Check which liquid can be used for initial run with regard to both the material and drive rating of the unit.

   Test run with water level with the top tangent line for 12 hours. During the test the following shall be monitored:
   - Absorbed power.
   - Stirrer speed (if variable speed, vary at least twice from minimum to maximum and check with tachometer and in control room).
   - Temperature of drive, bearings (drive and gearbox) and seal.
   - Proper function of seal unit.
   - Movement ("wobbling") of pedestal (indicative of low frequency vibration).
   - Observe deflections of the main shaft.

- Observe noises around mixer set-up.

At the start, halfway point and end of the test run, carry out:

- Vibration and shock pulse measurements at marked positions. Vibrations shall not exceed the maximum given by vendor before installation.
- Noise measurements near drive, gear box, mechanical seal and bottom of reactor.

Empty and clean vessel.

27. ROTARY FILTERS

1. Manufacturer's instructions, drawings, etc., shall be consulted for any additional checking not mentioned below.
2. Check that the quality and grade of the applied lubricants are in accordance with the specification.
3. Check filter tank expansion facilities.
4. Check the filter tank for cleanliness after filter cloth is installed and check for damage of packing between hood and tank before tank is closed.
5. Check the hood hydraulic lifting device for leakage and proper functioning.
6. When the hood is lifted, check the assembly of safety bars.
7. Check the drum for proper installation of grids and check the dividing strips for sharp edges or burrs.
8. Check the drum for proper installation of wire fasteners and movement of adjustable fasteners. Check the wire guide grooves at the drum ends for correct angle and smooth finish.
9. When tank is filled with water, carry out pressure test of drum at approximately 0.35 bar (ga) and check for leakage.
10. Flush trailing and leading pipe after pressure test and check for cleanliness.
11. Check the drum-shaft journals for cleanliness and proper location of luboil supply holes.
12. Check whether soft packing rings in the stuffing box are of correct material and whether packing, lantern ring and gland are properly installed.
13. Check that valve head and wear plate surfaces are perfectly clean. Apply grease to surfaces while valve head is being installed.
14. Check the bearing bushing in the valve head for cleanliness and check that oil supply holes to the bearing and to the circumferential grooves in valve head are clean.
15. During installation of the valve head, check the correct pressure of springs and check the sealing bellows for damage.
16. Check straightness of the conveyer shaft by turning the conveyer by hand.
17. Check the setting of deflector blades after filter cloth has been installed.
18. Check the outer and intermediate bearings of scroll shaft for cleanliness.
19. Check whether soft packing rings in the stuffing boxes of scroll shaft are of correct material and whether packing, lantern ring and gland are properly installed.
20. Check the tightness of bolts of conveyer flanges.
21. Check whether luboil or grease system is correctly installed and all connections are tight. Check for cleanliness. Check for proper supply of luboil or grease to all lubricating points when lubricator is operated.
22. Check whether the electric drum drive motor and speed variator are rigidly supported.
23. Check the drum drive coupling alignment and that slip coupling and limit switch are correctly adjusted.
24. Check for cleanliness of worm wheel, worm and worm shaft bearings.
25. When the speed variator has been filled with oil and the luboil system is operated, check the proper functioning of speed variator, and the correct direction and free rotation of drum.
26. Check whether geared scroll drive electric motor is rigidly supported and check the coupling alignment.

27. When the scroll drive motor gearing has been filled with lubricant to the correct level and the luboil system is operated, check for correct direction and free rotation of the scroll.
28. Check whether product lines, inert gas and solvent lines are properly installed and all connections are tight. Special attention should be paid to flexible hoses at valve head, ensuring that no pipe strain is transmitted to the valve head.
29. Check for correct position of spray nozzles and check for cleanliness.
30. Check all pipes leading to the equipment for cleanliness before they are connected.
31. Before installation of the filter cloth, check that the length of the cloth is correct and the cloth is free of mildew. Check by weighing whether sufficient winding wire is available on the spools for a complete winding run. Check for sufficient and correct caulking material.
32. Check whether the wire winding machine is properly supported on its foundation and whether threaded shaft, bearing, wire guides, sprockets and driving chain are properly installed.
33. Apply the filter cloth and caulking material to the drum in accordance with Manufacturer's instructions.
34. Make sure that filter cloth has not been damaged during this procedure and that caulking bars are flush with cloth surface.
35. Carry out the wire winding procedure in accordance with Manufacturer's instructions.
36. Make sure during the winding procedure that the correct wire tension is constantly maintained.
37. Check that the wire cannot be drawn into the caulking at the drum ends.
38. Check the set pressure of relief valves.
39. When installed, check that the line-up of the inert gas supply to the bail-out device connection is in accordance with the applicable drawing.
40. Check all view port connections for tightness.
41. Check that the cold insulation material is properly applied. Check that parts are properly steam-traced.
42. Check that instruments are properly installed and are in accordance with the instrument data sheet.
43. Check the oil grade and level in the lubricator, worm wheel housing, speed variator of drum drive, and geared electric motor of scroll drive.
44. Check the starting sequence of equipment, ensuring that neither scroll drive nor drum drive can be started before the luboil system is operated and that the drum drive cannot be operated before the scroll drive is operated.

28. ROTATING DISC CONTACTORS

Field inspection shall be in accordance with DEP 31.22.01.31-Gen.

29. STEAM TURBINES

Since construction details and auxiliary equipment can vary widely from Manufacturer to Manufacturer, it is important to consult the Manufacturer's instruction manual for any additional checking not mentioned below.

1. Check the schedule of auxiliary and associated equipment for correct calibration and operation.
2. Check that the casing and shaft can expand with increasing temperatures. However, transverse movement of the casing should be prevented. The casing foundation bolts should have adequate clearance under their heads to allow for expansion of the casing.
3. Check bearings and bearing housings for cleanliness. If applicable, check that bearing lubricating rings have adequate movement.
4. Check for correct position of constant-level oiler.
5. Check that the luboil system is in accordance with the flow diagram.
6. Check that the entire luboil system has been properly flushed and is clean.
7. Check that the control oil system is in accordance with the flow diagram.
8. Check that the entire control oil system has been properly flushed and is clean.
9. Check that the cooling water system is in accordance with the flow diagram.
10. Check that the entire cooling water system has been properly flushed and is clean.
11. Check the piping arrangement and shaft seals.
12. Check vent and drain piping.
13. If a gland steam condenser is installed, check for proper line-up of piping and control of sealing steam.
14. Check that the line-up of vacuum equipment is in accordance with the applicable drawings.
15. Check whether safety devices are properly installed and in accordance with data sheets and flow diagram.
16. Check that the safety/relief valve is installed and check the set pressure.
17. Check that bearing housings contain oil up to the correct level.
18. Check that the luboil tanks contain oil up to the correct level.
19. Depending on the type, check that the governor contains oil up to the correct level.
20. Check that auxiliary luboil pump cuts in at correct oil pressure.
21. Check that the line-up of the governing system is in accordance with the applicable drawings. If possible, operate the system and check for proper functioning of relay valves, control valves and main stop valve after correct control oil pressure is obtained. If the main stop valve is operated without oil pressure, check proper functioning manually.
22. Check that the automatic cut-in turbines are properly preheated and that the cut-in device is properly set.
23. Check the proper functioning of all safety devices. Safety devices which cannot be tested when the machine is not running should be checked during the initial run.
24. Check the lever-holding mechanism of the overspeed trip device while the turbine is not running.
25. Initial run
    1) Before running the turbine, check the proper functioning of all steam drains and condensate traps. Consult Manufacturer's instruction manual for start-up

procedure of unit.

Run turbine uncoupled for a few hours and make following checks :

2) Observe steam pressures and temperatures, bearing temperatures and that luboil flow to bearings is adequate.

3) Check the overspeed trip device by increasing the turbine speed to the correct trip speed, 3 times in succession.

4) Check and record vibration levels.

5) For automatic cut-in turbines, check the cut-in device for correct operating condition.

6) For condensing turbines, check the proper functioning of vacuum equipment and whether the required vacuum can be obtained.

7) Check all condensate drains and steam traps for proper operation.

8) Check whether the governor operates over required speed range.

9) Check whether noise exceeds specified limits.

If no abnormalities are observed during the initial run, the turbine can be coupled to the driven machine and the complete unit started up, taking into consideration the process conditions and start-up procedure for the driven machine.

26. Second run

Run the complete unit for a long period, if possible under normal operating conditions, until smooth operation is obtained and no abnormalities are observed. During this test, all observations carried out during previous test, with the exception of the overspeed test, shall be repeated.

The following additional check should be carried out during this test :

1) Check when loading the turbine that the control valves respond and open gradually. If the turbine is equipped with back pressure control valves, check that they respond and function properly.

2) Make a hot check of the coupling alignment as soon as the set has come to a standstill following a running period of some hours at design temperature.

30. GAS TURBINES

Since construction details and auxiliary equipment can vary widely from Manufacturer to Manufacturer, it is important to consult the Manufacturer's instruction manual for any additional checking not mentioned below.

1. Check the equipment supplied against the schedule of auxiliary and associated equipment for correct calibration and settings.
2. Check that the casing, shaft and exhaust duct can expand with increasing temperatures. However, transverse movement of the casing should be prevented. The casing foundation bolts should have adequate clearance under their heads to allow for expansion of the casing.
3. Check that the cooling system is in accordance with the flow diagram.
4. Check that the entire cooling system has been properly cleaned.
5. Check that the entire luboil oil system has been properly flushed and is clean.
6. Check that the entire hydraulic oil system has been properly flushed and is clean.
7. Check that the fuel supply system is in accordance with the flow diagram.
8. Check that the entire fuel supply system has been properly flushed and is clean.
9. Check the correct functioning and setting of gas fuel supply system pressure regulators and isolating/venting valves.
10. Operate the fuel control system statically and check for correct equipment response.
11. After commissioning the compressor washing system, ensure that it operates correctly according to the Manufacturer's manual.
12. Check all air intake bypass doors and mechanized shutters for cleanliness and correct operation.
13. Check whether safety devices are properly installed and in accordance with the data sheets and the flow diagram.
14. Check that the luboil tanks contain oil up to the correct level.
15. Check that the auxiliary luboil pump cuts in at the correct oil pressure.
16. Check that the line-up of the governing system is in accordance with the drawings. If possible, operate the system and check the proper functioning of relay valves, control valves and the main stop valve after correct hydraulic oil pressure is obtained. If the main stop valve is operated without oil pressure, check proper functioning manually.
17. Check the proper functioning of all safety devices. Safety devices which cannot be tested when machine is not running should be checked during the initial run.
18. Check fire protection and gas detection systems for correct operation according to the Manufacturer's manual.
19. Initial run (non-fired)

    All precommissioning runs shall take place under the supervision and responsibility of the Supplier's engineer and in accordance with the Manufacturer's instructions.
20. Second motoring run

    Repeat item 19 but with gas start selected.
21. Commissioning run

    This run is to take place under the supervision and responsibility of the Supplier's engineer and in accordance with the Manufacturer's instructions.
22. Check whether noise exceeds specified limits.
23. Take a vibration frequency analysis for future reference.
24. Take an oil sample.

25. Compile a checklist of safety devices to be calibrated. This checklist shall include all test information.

31. DIESEL ENGINES

Since construction details and auxiliary equipment can vary widely from Manufacturer to Manufacturer, it is important to consult Manufacturer's instruction manual for any additional precommissioning checks not mentioned below.

1. Check whether the crankcase, oil pump and lubricating lines have been properly flushed and are clean. Check that the crankcase can be vented.
2. Check the cleanliness of oil filters and oil coolers.
3. Check that the fuel oil system is in accordance with Manufacturer's drawing.
4. Check that the entire fuel oil system has been properly flushed and is clean.
5. Check filter and separators.
6. Check that cooling water lines are installed in accordance with Manufacturer's drawings.
7. Check that the entire cooling water system is properly flushed and is clean.
8. Check the line-up of starting equipment. If an electric starting system is fitted, check electrical installation and battery condition.
9. If an air starting system is fitted, check the line-up of compressor, starting-air vessel, and all pipe connections in accordance with the Manufacturer's instructions.
10. Check that the starting-air vessel is equipped with a safety/relief valve (and check the set pressure) and that the vessel can be drained.
11. Check that an air inlet filter is installed.
12. Check that the oil sump contains oil up to the correct level.
13. Check that the barring functions correctly.
14. If a lubricator is installed, check that it contains oil up to the correct level and check for proper supply to all lubricated points by rotating the crank by hand.
15. Check that the fuel oil tank is filled with fuel oil.
16. Initial run
    1) Consult Manufacturer's instruction manual for start-up procedure of engine.
    2) Regular observations should be made of temperatures, luboil pressure, speed regulation, vibration, etc.
    3) Check whether noise exceeds specified limits.
    4) Make hot check of the coupling alignment, if necessary.

32. ROTARY STOP VALVES

1. Check that seals between rotor axis and side plates are of the specified material.
2. Ensure that the gas purge of seals is functioning, if applicable, before solids are introduced into the valve.
3. Check for correct alignment of the rotor in the housing.
4. Check the system leading to the valve for absolute cleanliness to avoid damage by foreign matter during start-up operation.
5. Check that the chain drive is secure, if applicable.
6. Check for presence of a shear pin, if applicable.
7. Trial run, empty.

33. EXTRUDERS

Since construction details and auxiliary equipment can vary widely from Manufacturer to Manufacturer, it is important to consult the Manufacturer's instruction manual for any additional precommissioning checks not mentioned below.

Extruders may be subdivided into small extruders for laboratories and large extruders for commercial production.

1. Manufacturer's instructions, drawings, etc. shall be consulted.
2. Check for additional precommissioning procedures specified by Principal.
3. Check that the entire lubrication system is clean and correctly installed in accordance with the flow diagram.
4. Check that the quality, grade and levels of lubricants are in accordance with requirements.
5. Check that the entire cooling system is clean and correctly installed in accordance with the flow diagram.
6. Check the equipment alignment and couplings for compliance with specified tolerances.
7. Check the tightness of connections to specified torques.
8. Check whether safety valves are installed and check set pressures.
9. Check that bearing housings are supplied with oil to correct levels are properly greased.
10. Check internals for absolute cleanliness.
11. Check whether safety devices are correctly installed and in accordance with data sheets and flow diagrams.
12. Check for proper functioning of all safety devices. Safety devices which cannot be checked when the equipment is not running should be checked during the initial run.
13. The initial run shall take place under the supervision and responsibility of the Manufacturer in accordance with the Manufacturer's instructions.

34. REFERENCES

In this DEP reference is made to the following publications:

NOTE: Unless specifically designated by date, the latest edition of each publication shall be used, together with any amendments/supplements/revisions thereto.

SHELL STANDARDS

Index to DEP publications and standard specifications	DEP 00.00.05.05-Gen.
Rotating disc contactors	DEP 31.22.01.31-Gen.
Installation of rotating equipment	DEP 31.29.00.10-Gen.
Piping - general requirements	DEP 31.38.01.11-Gen.
Hydrostatic pressure testing of new pipelines	DEP 31.40.40.38-Gen.
Insulating and dense refractory concrete linings	DEP 64.24.32.30-Gen.
Standard vertical tanks - field erection and testing	DEP 64.51.01.31-Gen.
Equipment record cards	DEP 70.10.01.10-Gen.
Preservation of old and new equipment and piping standing idle.	DEP 70.10.70.11-Gen.
Cleaning of equipment	DEP 70.10.80.11-Gen.
Field inspection, maintenance and repair of vertical steel storage tanks	DEP 70.51.10.11-Gen.
Interlocking systems for safety/relief valves	DEP 80.46.30.11-Gen.

STANDARD DRAWINGS

Installation of thermocouple on furnace tubes	S 24.615
Temporary conical suction strainer for compressors	S 38.041

AMERICAN STANDARD

Lubrication, shaft-sealing, and control-oil systems for special-purpose applications	API 614

Issued by: American Petroleum Institute
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1220 L Street Northwest
Washington DC. 20005 USA

Process piping	ASME B31.3

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345 East 47th Street
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USA

APPENDIX 1 RULES FOR EXPANDING FURNACE TUBES INTO RETURN FITTINGS

To determine the extent to which a furnace tube has to be expanded in the return fitting to ensure a sufficiently strong connection, the following practical rules are given from which the required extent of expansion can be calculated.

For a tube wall thickness of 10 mm the extent of the expansion of the inside diameter equals 3 mm plus the difference between the outside diameter of the tube and the inside diameter of the return fitting. This difference must be determined by measuring the actual tube and fitting.

For every millimetre by which the wall thickness is greater than 10 mm, the expansion of the inside diameter is increased by 0.25 mm.

For every 2 mm by which the wall thickness is smaller than 10 mm, the expansion of the inside diameter is reduced by 0.25 mm.

Thus :

Wall thickness of tube	:	10 mm
Extent of expansion of tube diameter	:	3 mm
* Difference between outside diameter of tube and inside diameter of return fittings	:	For new return fittings, from 0.8 to 1 mm
Total extent of expansion	:	3.8 to 4 mm on diameter

The following table gives a summary of the typical difference between the outside diameter of tubes and inside diameter of return fittings for the various wall thicknesses of furnace tubes.

Wall thickness of tube (mm)	Extent of expansion of tube diameter (mm)	* Total extent of expansion on diameter (mm)
6	2.5	3.4 - 3.6
8	2.8	3.6 - 3.8
10	3	3.8 - 4
13	3.8	4.6 - 4.8
16	4.5	5.4 - 5.6

***** Specifications for tubes permit rather wide dimensional tolerances. Therefore, dimensions of tube ends and return fittings should be checked before the tubes are installed.

If the difference between the O.D. of the tube and the I.D. of the return fitting is outside the range 0.8-1 mm, then the actual value shall be recorded and the total extent of expansion shall be increased or reduced accordingly.