ENGINEERING STANDARD

FOR

START-UP SEQUENCE AND GENERAL

COMMISSIONING PROCEDURES

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APPENDICES:

0. INTRODUCTION

The Standard Practice Manuals titled as "Fundamental Requirements for the Project Design and Engineering" is intended for convenience of use and pattern of follow-up and also a guidance.

These Standard Engineering Practice Manuals, also indicate the check points to be considered by the process engineers for assurance of fulfillment of prerequisitions at any stage in the implementation of process plant projects.

It should be noted that these Iranian Petroleum Standards (IPS), as Practice Manuals do not profess to cover all stages involved in every process project, but they reflect the stages that exist in general in process projects of oil, gas and petrochemical industries of Iran.

These preparation stages describe the following three main phases which can be distinguished in every project and include, but not be limited to:

Phase I): Feasibility Studies, Process Evaluation and the Basic Design Stages (containing six Standards).
Phase II): Detailed Design, Engineering and Procurement Stages (containing three Standards).
Phase III): Start-up Sequence and General Commissioning Procedures (containing two Standards).

The process engineering standards of this group include the following 11 Standards:

STANDARD CODE	STANDARD TITLE
I) Manuals of Phase I (Numbers 1-6)	
IPS-E-PR-150	"Basic Design Package and Recommended Practice for Feasibility Studies"
IPS-E-PR-170	"Process Flow Diagram"
IPS-E-PR-190	"Layout and Spacing"
IPS-E-PR-200	"Basic Engineering Design Data"
IPS-E-PR-230	"Piping & Instrumentation Diagrams (P & IDs)"
IPS-E-PR-250	"Performance Guarantee"
II) Manuals of Phase II (Numbers 7-9)	
IPS-E-PR-260	"Detailed Design, Engineering and Procurement"
IPS-E-PR-300	"Plant Technical and Equipment Manuals (Engineering Dossiers)"
IPS-E-PR-308	"Numbering System"
III) Manuals of Phase III (Numbers 10-11)	
IPS-E-PR-280	"Start-up Sequence and General Commissioning Procedures"
IPS-E-PR-290	"Plant Operating Manuals"

This Engineering Standard Specification covers:

"START-UP SEQUENCE AND GENERAL COMMISSIONING PROCEDURES"

1. SCOPE

This Engineering Standard Specification covers minimum process requirements for plant start-up sequences and general commissioning procedures for Non-Licensed Units or facilities. For Licensed Units, instructions given by the Licenser shall be followed.

Although, the start-up sequences and commissioning procedures differ to some extent from process to process, the basic philosophy and general aspects shall conform to the concepts of this Standard.

However, considering the general commissioning and all activities to be performed prior initial start-up as outlined in this Standard, feed introduction to the Unit shall be according to the stepwise start-up procedure provided by the Contractor in the Unit Operating Manual.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant.

API (AMERICAN PETROLEUM INSTITUTE)

API Std. 650, Latest Edition, "Welded Steel Tanks for Oil Storage", English Edition, November 1988

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERS)

ASME Code, Section VIII

IPS (IRANIAN PETROLEUM STANDARDS)

IPS-C-PI-350 "Plant Piping System Pressure Testing"
IPS-E-PR-308 "Numbering System"

3. DEFINITIONS AND TERMINOLOGY

Company or Employer/Owner

Refers to one of the related affiliated companies of the petroleum industries of Iran such as National Iranian Oil Company (NIOC), National Iranian Gas Company (NIGC), National Petrochemical Company (NPC), etc., as parts of the Ministry of Petroleum.

Contractor

Refers to the persons, firm or company whose tender has been accepted by the "Employer", and includes the Contractor's personnel representative, successors and permitted assignees.

Licenser or Licensor

Refers to a company duly organized and existing under the laws of the said company's country and as referred to in the preamble to the contract.

Project

Refers to the equipment, machinery and materials to be procured by the "Contractor" and the works and/or all activities to be performed and rendered by the "Contractor" in accordance with the terms and conditions of the contract documents.

Unit or Units

Refer to one or all process, offsite and/or utility Units and facilities as applicable to form a complete operable refinery/and or plant.

4. SYMBOLS AND ABBREVIATIONS

SYMBOL/ABBREVIATION	DESCRIPTION
DN	Diameter Nominal, in (mm).
LPG	Liquefied Petroleum Gas.
NIGC	National Iranian Gas Company.
NIOC	National Iranian Oil Company.
NPC	National Petrochemical Company.
OGP	Oil, Gas and Petrochemical.
ppm (by mass)	Parts per million, in (mg/kg).
PSV	Pressure Safety/Relief Valves.
SSU	Saybolt Universal Seconds.

5. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

6. GENERAL REQUIREMENTS

6.1 Commissioning shall start from the point at which steps are taken to bring the Unit/facility up to operating pressure and temperature and to cut in the feed. It shall be complete when the Unit/facility is operating at design capacity and producing products to specification.

6.2 For a project involving a number of process Units and offsite facilities, it shall be agreed between the Contractor and Company in the earliest stages of a project the sequence of the commissioning of the Units. It shall be necessary to commission utilities and some of the Units in advance of others, because of their interdependence from a process point of view.

6.3 The responsibilities of the Contractor and Company during commissioning stage should be clarified for the provision of labor, operators, specialists and service engineers, and also for the correction of faulty equipment, etc.

6.4 The general requirements outlined in this Standard for testing of equipment/lines shall be followed. The detail procedures for testing of equipment and lines and other precommissioning steps are not included in this Standard and shall be prepared in accordance with the Company's Engineering Standards by the Contractor and submitted to the Company for approval. However, on completion of testing, vessels, equipment and piping should be vented and drained, and where necessary cleaned and dried to the satisfaction of the Company.

Spades, blanks and other equipment installed for testing shall be removed on completion of testing. Wherever a flange joint is broken after testing, e.g.,on heat exchangers, pipework, fired heaters and at machinery, then the joint rings or gaskets must be renewed. Particular attention must be given to heat exchangers employing solid metal or filled gaskets, and great care should be taken to ensure that all gaskets renewed after testing of heat exchangers and are correctly fitted before tightening flanges.

Where required, valves are to be repacked with the appropriate grade of material.

Any temporary bolting which has been used shall be replaced and any temporary fittings which may have been installed to limit travel, e.g., in expansion joints and pipe hangers, shall be removed.

6.5 Prior to commissioning, each item of equipment should have its name, flowsheet number and identification number painted and/or stamped on it according to the Company's Specifications. For numbering system reference is made to IPS-E-PR-308, "Numbering System".

7. PREPARATION PRIOR TO INITIAL START-UP

The procedures described in this Section shall be carried out at the completion of construction and before initial operation of the Unit. Appropriate phases should be repeated after any major repair, alteration, or replacement during subsequent shutdowns. The phases of preparation for initial start-up shall be according to the following steps:

- Operational checkout list.
- Hydrostatic testing.
- Final inspection of vessels.
- Flushing of lines.
- Instruments.
- Acid cleaning of compressor lines.
- Breaking in pumps.
- Breaking in compressors.
- Dry-out and boil-out.
- Catalyst loading.
- Tightness test.

7.1 Operational Check-Out

a) Check line by line against flowsheet and locate all items.

b) Identify the location of instruments.

c) Indicate the location of all critical valves including valves at critical vent and drain locations.

d) Check control valves, valves, and globe valves to see that they are installed properly with respect to flow through their respective lines. Special attention must be given to check valves regarding their direction of flow.

e) Review all piping and instrument connections for steam tracing.

f) Check that the following facilities have been installed so that the plant can be commissioned and put on stream:

- Start-up bypass lines.
- Purge connections.
- Steam-out connections.
- Drains.
- Temporary jumpovers.
- Blinds.
- Check valves.
- Filters and Strainers.
- Bleeders.
- Etc.

g) Check pumps and compressors for start-up.

h) Check sewer system for operability.

i) Check blowdown systems.

j) Check heater for burner installation, refractories, stack damper controls, burner refractories, etc.

7.2 Hydrostatic Testing

7.2.1 Hydrostatic pressure testing of the Unit shall be performed to prove strength of the materials and weld integrity after completion of the construction. The tests shall be made on new or repaired equipment and pipings. The initial testing is ordinarily done by the Contractor in the course of erection.

7.2.2 Detail procedure for testing the equipment and lines shall be prepared by the Contractor and submitted to the Company for approval. In addition to the specifications outlined herein, the requirements specified in IPS-C-PI-350, "Plant Piping System Pressure Testing" shall be strictly followed unless otherwise specified in this Standard.

7.2.3 Fresh water containing a corrosion inhibitor which meets the Company's approval shall be used for hydrostatic test purpose unless otherwise specified in this Standard. In systems where residual moisture can not be tolerated, e.g., in SO_2, acid, ammonia and LPG service, and where certain catalysts are used, oil is the preferred test medium. If the water has to be used, the system should afterwards be dried out with hot air. Special attention should be given to the points where water may be trapped, such as in valve bodies or low points.

7.2.4 If for any reason it is not practical to carry out a hydraulic test, a pneumatic or partially pneumatic test may be substituted subject to prior agreement with the Company. Full details, including proposed safety precautions, will be required. The following are usually excluded from hydrostatic testing, and are usually tested with compressed air and soap suds:

a) Instrument air lines (test with dry air only, if possible).
b) Air lines to air-operated valves (test with dry air only).
c) Very large (usually over DN 600 or 24 inches) gas or steam overhead lines.
d) Pressure parts of instruments in gas or vapor service.

7.2.5 When austenitic or austenitic acid clad or lined equipment and piping are tested, the test fluid chloride ion content shall meet the following conditions:

a) If the piping and equipment metal temperature never exceeds 50°C during commissioning, operation or non-operation, water containing up to 30 ppm (by mass) chlorides ion shall be used. The chlorides ion content might be increased up to 150 ppm (by mass) if the equipment or piping can be thoroughly washed out using water containing less than 30 ppm (by mass) chlorides ion as soon as testing is complete if allowed by the Company. In any case, the water must be drained and the equipment thoroughly dried immediately thereafter.

b) If the piping and equipment metal temperature exceeds 50°C during commissioning, operation or non-operation, the piping shall be tested using condensate water, demineralized water or oil with minimum flash point of 50°C.

7.2.6 The testing medium should not adversely affect the material of the equipment or any process fluid for which the system has been designed. Reference should be made to the applicable codes in the case of pressure vessels to determine the minimum ambient and fluid temperatures at which testing may be carried out. If it is desired to test vessels, tanks or piping at temperatures below 16°C, attention shall be made to the danger of brittle fracture occurring in carbon steels and ferritic alloy steels unless the materials have adequate notch ductility properties. For any equipment or piping, water should not be used for testing, when either the water temperature or the ambient temperature is below 5°C. Hydrostatic testing at temperatures below this value may be carried out using gas oil, kerosene or antifreeze solution at appropriate strength, provided that, the fluid used to be agreed with the Company. When flammable liquids including gas oil or kerosene are to be used, appropriate safety measures must be observed and a work permit shall be required.

7.2.7 Sea water shall not be used for the testing of equipment and lines on process Units and steam generating plants. Proposals for the use of sea water for the testing of storage tanks and offsite lines shall receive Company's approval.

7.2.8 During the hydrostatic test pressure with water the system loss should not exceed 2% of the test pressure per hour unless otherwise specified. Evidence of water at valves, flanges, etc. will indicate the leaking areas to be repaired if the system fails the test. All welds and piping must be inspected for defects by looking for wet spots, therefore they should be tested before they are insulated.

7.2.9 If piping is tested pneumatically, the test pressure shall be 110% of the design pressure. Any pneumatic test shall be increased gradually in steps, allowing sufficient time for the piping to equalize strains during the test. All joints welded, flanged or screwed shall be swabbed with soap solution during these tests, for detection of leakage.

7.2.10 Vents or other connections shall be opened to eliminate air from lines which are to receive hydrostatic test. Lines shall be thoroughly purged of air before hydrostatic test pressure is applied. Vents shall be open when systems are drained so not to create buckling from a vacuum effect.

7.2.11 Relief valves must be removed or blinded prior to hydrostatic testing.

7.2.12 After completion of hydrostatic testing, all temporary blanks and blinds shall be removed and all lines completely drained. Valves, orifice plates, expansion joints and short pieces of piping which have been removed shall be reinstalled with proper and undamaged gaskets in place. Valves which were closed solely for hydrostatic testing shall be opened. After lines have been drained with vents open, temporary piping supports shall be removed so that insulation and painting may be completed.

7.2.13 Extreme care shall be taken in field testing of heater and furnace tubes, which are normally field fabricated and must be hydrostatically tested. Where possible, piping and heater tubes shall be tested together.

Heater tubes shall be tested to manufacturer's recommended test pressure. Test shall be coordinated with heater erection Contractor.

7.2.14 Vessels constructed in accordance with ASME Code Section VIII will not require individual pressure tests at site except in the following cases:

a) Vessels whose condition, resulting from transport, storage, handling, or for any other cause is suspect in the opinion of the Company.
b) Vessels which have had any site modification which in the opinion of the Company necessitate a site pressure test.

7.2.15 With the exception of the relief valves, all valves and fittings should be installed on the vessels and included in the test. Relief valves must be removed or otherwise isolated.

On satisfactory completion of a pressure test the vessel should be drained completely, any blinds inserted for test purposes removed and these joints remade to the satisfaction of the Company.

7.2.16 At the conclusion of the test, the system must be drained. If pumps have been included, they must each be drained and refilled with oil to prevent rust forming in the seals. If fractionating columns are included, the water must be displaced with sweet gas, nitrogen, or an inert atmosphere rather than air to avoid corrosion and sticking of the valves on the fractionating trays.

7.2.17 Provided manufacturers test certificates are available, only the following pressure tests should be carried out on heat exchangers except as required by Paragraph 7.2.18.

a) On floating head shell and tube type exchangers, on tube side with bolted bonnets removed.
b) On tube-in-tube types, on both sides in conjunction with associated pipework.
c) On air-cooled types, the bundles are to be isolated and tested separately from associated pipework.

7.2.18 In the case of tubular exchangers whose condition, resulting from transport or other causes is suspect in the opinion of the Company, a pressure test on the shell side at 1« times the maximum allowable pressure should be carried

out. Tests may be carried out individually or on groups of exchangers having similar operating conditions. Test pressure for shell and tube and air-cooled types should be not less than the maximum operating pressure in the tubes. For tube-in-tube types, the test pressure should be as for the associated pipework.

After completion of test all equipment must be thoroughly drained and if necessary, dried out to prevent scaling of tubes before commissioning.

After completion of test all bonnets and covers should be replaced, temporary blanks removed and all joints remade to the satisfaction of the Company. All compressed asbestos fibre joints should be renewed.

7.2.19 All tanks shall have bottoms, shells and roofs tested in accordance with API 650, latest edition. Shells shall be tested by filling tanks with water. Vacuum testing shall be used for all tank bottoms and roofs.

7.2.20 The blow off (set) and blow down (re-set) pressure of all relief valves should be set to the satisfaction of the Company. After approval of the Company, a seal to be fixed to each valve. The Company's inspector shall check each valve after it has been re-installed to ensure that its seal is intact.

Inlet lines to relief valves should be cleared before the valves are finally installed.

In case where the valve exhausts to a pressure system, the downstream side should be tested to a pressure equal to the test pressure rating of the outlet system.

7.2.21 Flame arrestors and other miscellaneous equipment that does not have test pressure indicated shall be isolated from the test.

7.2.22 Certain types of instruments with their connecting process lead pipelines shall be tested at the same pressure as the main pipelines or the equipment to which they are connected. Such instruments normally include the following types:

- Displacer type level instruments.
- Gage glasses.
- Rotameters.
- Control valves.
- Flow meter pots.

Other types of instruments shall not be tested at line pressure, but shall have process lead lines tested to the first block valve or valves nearest the instrument. Care shall be taken that this equipment is protected by removal, or by blocking the instrument lead line and disconnecting or venting the instruments. These types will normally include the following:

- Analyzers.
- Diaphragm Type Level Instruments.
- Differential Pressure Type Flow Instruments.
- In-Line Type Flow Switches.
- Direct Connected Regulators.
- Open-Float Type Level Indicators and Alarm Switches.
- Positive Displacement Type Flow Meters.
- Pressure Indicators Recorders and Transmitters.
- Pressure Switches.
- Pressure-Balanced Control Valves.
- Pressure Gages.
- Turbine Type Flow Sensors.

Special precautions shall be taken to insure that instruments and instrument lead lines to be tested are vented and completely filled before testing, and are thoroughly drained after test.

7.3 Final Inspection of Vessels

Before the final bolting of coverplates and manheads, vessel interiors should be inspected for cleanliness, completeness, and proper installation of internal equipment. Inspection list shall include at least the following items where applicable:

a) Tray installation; satisfactory testing (where required).
b) Internal drawoff piping.
c) Catalyst supports and screens.
d) Internal distributors.
e) Liquid entrainment separators.
f) Internal risers and vortex breakers.
g) Thermowell location and length.
h) Level instruments, location and range, internal float, external displacement and differential pressure type.
i) Internal cement lining.

7.4 Flushing of Lines

All fluid handling equipment particularly piping, should be thoroughly cleaned of scale and the internal debris which accumulates during construction. This is accomplished by blowing or washing with air, steam, water and other suitable medium.

Some utility systems, such as water and high pressure steam, may be satisfactorily cleaned with their normal media, introduced through normal channels. Other systems must, or preferably should, be flushed with foreign media, admitted via temporary hose or pipe connections. Thus, flushing may be accomplished on exhaust steam lines with high pressure steam or air, and on fuel oil lines with steam, followed by air. The best way to clean a typical utility or auxiliary system is to flush the supply main from source to end at first and making an end outlet by breaking a flange or fitting if necessary, than flush each lateral header in the same manner; and finally, flush the branch which take off from the headers. In some instances if required the weld-cap on the end of each header could be cut off and re-welded after the line has been flushed.

Flowmeter and restriction orifices should not be installed until lines are clean. Any orifices installed, before cleaning should be removed. All connections to instruments should be closed off during flushing, or disconnected at the instrument and flushed. Instrument air lines must be blown with special thoroughness using clean dry air.

7.4.1 Steam piping

- Before blowing a steam line for cleaning, an open end for a free passage of the steam and debris shall be provided. If the open end is a temporary provision, be certain the end is tied down to prevent possible whipping caused by high velocity flow. All drains must be open and the line free of water. Valving to steam traps shall be closed and the traps shall remain out of service until the line cleaning is completed. Prior to starting stream flow all safety precautions shall be taken. The area should be cleaned and guarded to prevent injury to personnel. Steam shall slowly be introduced from the source and the line heated gradually.

- The steam flow rate shall be limited to the condensate drainage flow rate. Condensate must not be permitted to accumulate in order to avoid water hammer. As the piping heats and the condensate diminishes, the steam rate shall be increased. As the line heats, observe its expansion and determine that there is no binding or distortion. After the piping is thoroughly heated, the steam rate shall be increased to provide a hard blow. After blowing, the line shall be permitted to cool and contract, then the preceding blowing to be repeated. The cleaning procedure should be repeated three times and unobstructed.

7.4.2 Process and utility lines

a) Process, utility and auxiliary oil systems shall mainly be washed with water. Any line not accessible to water, or lines which would trap water in such a way that it could not be drained, may be blown out with air. Most of the process and auxiliary lines may be flushed through established circuits from vessels filled with water for the purpose. Machinery auxiliary lines preferably should be flushed by oil.

To the maximum extent, the lines connected may be flushed with water contained within vessels after hydrostatic testing. A single filling of a vessel may not provide sufficient water to flush all lines for which it is the reservoir, in which case a continuous or intermittent flow of water into the vessel should be maintained.

b) When washing exit lines of a vessel, it should be noted that, the vessel is adequately vented to prevent a vacuum condition. Inadequate venting of vessels not designed for vacuum service could rupture them.

c) In any system, to the maximum extent possible, flushing should be made downward, or horizontally, and out at low points. The low point discharge opening may be temporary openings made by disconnecting flanges or fittings. Normal drains may be used for flushing outlets, provided they are equal to line size or nearly so. For best results, there should be no restriction of the outlet or at any other point in a line undergoing cleaning.

d) Too many circuits or openings shall not be flushed simultaneously.

e) Some lines, such as buried pump suction lines, must be flushed through a temporary spool-piece and line-sized valve flanged to one-end, and pointed to a safe location (not to the pump suction). Compressed air is introduced to the other end and pressure allowed to build. When the valve is suddenly opened, the sudden release of pressure will effectively clean the line. Flushing shall be done through all vents, drains and other side connections, by-passes and their main channels alternatively.

f) Flushing line debris into equipment where it may become trapped or lodged shall be avoided.

g) All control valves should be blocked off and bypassed until the major part of the foreign matter has been removed from their systems. Then remove the bottom plate of the control valve or, if the valve is closed, remove the valve itself from the line, and flush through the opening thus created. Finally, replace the plate or valve and flush through the valve in normal alignment (if the valve is opened or can be opened).

h) Flowmeter and restriction orifices should not be installed until lines are clean. Any orifices installed before cleaning should be removed.

i) All connections at pumps and drivers must be closed off or disconnected while the lines running thereto are thoroughly flushed. This applies to the main pump suction and discharge lines, drive and exhaust steam, jacket cooling water, gland oil, and other auxiliaries.

The flushing outlet point should be as near the pump or drivers as conveniently possible. Generally this will require disconnection of a flange or fitting. Where this is done on the pump (or driver) side of the block valve, cover the open pump connection if necessary to prevent entry of the flushing flow. In the main discharge lines containing a check valve immediately adjacent to the pump (generally the case with centrifugal pumps), a flush outlet may be made by removing the check valve coverplate, provided the flapper or disc remains in place to seal off the pump itself.

Where it is desirable to flush through a check valve, the flapper must be removed and the cover replaced.

j) All connections to instruments should be closed off during flushing, or disconnected at the instrument and flushed. Instrument air lines must be blown with special thoroughness.

Steam traps until the lines are fairly clean should be bypassed. Check the operation of traps after they have been opened to the flow, and remove for inspection and cleaning those which are not working properly.

k) Disconnect heater burners until the fuel gas line to them is clean; then reconnect them and blow through the burner and pilot.

l) At the conclusion of flushing any system, it shall carefully be checked to see that normal alignments are restored, temporary connections are broken, and temporary breaks reconnected, check valve flappers and/or cover-plates replaced, and orifices installed, etc. In the case of lines which will receive further cleaning during subsequent pump break-in, this instruction may be qualified in part.

When flushing of process lines is finished, drain water from the system as completely as possible. Provide ample top venting during the draining operation, or whenever the level is being lowered in a vessel, to avoid pulling a vacuum on the equipment. Blow lines with air to effect further water removal.

The basic utility systems such as steam, water and air should be put in normal working order after they have been cleaned so that supplies will be available for further operations.

7.5 Instruments

In general the instruments should be checked against the design data as well as to be checked for installation, calibration and operation as per the following list:

a) Installation check

a.1) The instrument is properly installed and accessible for operation and maintenance.
a.2) All wiring is checked out.
a.3) All loop checks is completed. The loop check procedure shall be prepared by the Contractor/Vendor and shall be submitted to the Company for approval.

b) Calibration check

b.1) The instrument is calibrated for operation.
b.2) Orifice plates are installed after hydrotest and line flushing.
b.3) The proper charts are installed on all recorders.

c) Operation check

c.1) Power is supplied to all instruments.
c.2) All alarms are test actuated and interlock systems checked.
c.3) Instruments, connecting piping, and pneumatic tubing are checked for leaks.

7.6 Acid Cleaning of Compressor Lines

Mill scale, dirt, heavy greases, and other foreign materials that could enter the compressor and result in operating and maintenance problems must be removed from the compressor system as required in the Piping & Instrumentation Diagrams (P & IDs). The following items must be acid cleaned:

a) All make-up gas piping including spill-back lines.
b) Make-up compressor suction lines and drums. Suction drums may be acid cleaned where practical.
c) Make-up gas coolers and intercoolers.
d) Fuel gas lines to gas turbine burners.

The procedure to be followed should be supplied by the cleaning Contractor, who must accept the responsibility of proposing and carrying out an acceptable and proven procedure for the entire cleaning operation. The general outline for a typical acid-cleaning operation is presented in Appendix A.

7.7 Breaking-In Pumps

New pumps should be given a preliminary run, with strainers in their suction lines, in order to test mechanical performance and reveal any defects before attempting to start up the Unit. This preliminary circulation also serves as a supplemental cleaning operation, instrument and control valve check, a leak check, and allows a general performance test of the lines and equipment involved in the flow. Flow meter orifices should be installed.

Pumps not equipped with permanent strainers or strainer holders should be furnished with temporary basket type screens inserted in the nearest accessible suction flange. This pump "run-in" is usually done by circulating water through the Unit, which requires temporary piping. Before starting pumps, go through the following check-list:

a) Check driver rotation.

b) If turbine drivers, check the turbine overspeed trip and governor for operation with the turbine disconnected from pump.

c) Be sure there is a bleeder on the pump so that the case can be filled with liquid before starting. Being Asphalt plant pump or rotary type their priming shall be done according to the manufacturer's instructions.

d) Check lube oil in bearing housing of both pump and driver.

e) Check out pump cooling water and seal oil systems where applicable.

f) If pumps are run in on a fluid other than that for which the pump was specified, it may be necessary to throttle the pump discharge to keep from over-loading the driver.

g) Be sure mechanical seals or packing is installed.

For reciprocating pumps the following should be checked:

h) On power pumps, check driver rotation and lube oil in gearbox.

i) Check oil level and operation of piston rod lubricators.

j) On direct-acting steam pumps, check out steam piping and cylinder drains. Warm up steam end before starting pump.

Before starting a centrifugal pump, rotate it by hand to make sure that it turns freely. This is a good practice always, but it is especially important during the first few starts. If the pump is at all tight, it should be dismantled and inspected for grit in the packing box, or inadequate clearance in rotors or bearings.

If the pump is free, open its suction valve wide and vent the casing to ensure that it fills with liquid. Leave the discharge valve closed or open it very slightly.

The pump is now ready for starting, assuming that its suction and discharge circuits are properly aligned and that its driver is also in readiness.

Once it has been put in rotation, a centrifugal pump must be quickly brought up to normal speed-or at least to a speed which develops substantial discharge pressure, as read on the local gage-in order to provide internal lubrication of the rotor.

The pump discharge valve should remain in its initial closed or throttled position until the pump comes up to speed and establishes full discharge pressure. The valve may then be opened gradually until the desired liquid flow is obtained, or until an automatic valve assumes control; in the latter instance, the manual valve is then opened wide.

If the pump does not quickly develop a discharge pressure close to its normal value, try venting the pump while it is running. If this does not help, stop the pump and vent it freely before starting again.

In case of persistent loss of suction (low or fluctuating discharge pressure), look for closed or throttled valves, plugged strainer or other restrictions in the suction line. If a difficulty of this sort is not located, the system must be examined for sufficient net suction head.

A reciprocating pump is started with its suction and discharge valves wide open.

Rotary pumps installed in the plant must be started strictly according to the manufacturer's instructions.

All pumps should be watched closely during preliminary circulation, and particularly when first started. If bearings or packing boxes begin to overheat (usually this means hot to the touch) or give other evidence of trouble, such as noisy bearings, shut the pumps down for inspection.

To ensure against overloading, electricians should measure current with "Tong"-type ammeters.

Pumping rates should be kept as high as possible for thoroughness of line flushing. The collection of solids on the strainer screen restricts suction line flow, and may eventually lead to loss of suction.

A pump should be stopped after running for several hours or whenever it shows signs of losing suction, for removal, inspection and cleaning of the strainer. The strainer is then replaced, the pump started, and the process repeated until the strainer shows itself clean. Standby pumps should be run alternately with their counterparts. It will be found helpful to keep a record for each pump of running time, screen inspections and condition, and final disposition of strainer.

Following the run-in period, the pump should be isolated, drained, and filled with oil to protect the mechanical seal against rusting.

7.8 Breaking-In Compressors

Compressors and drivers of all types must be properly installed and operated for "run-in" similarly to pumps to assure their satisfactory service.

The detailed instructions issued by the manufacturer for the installation and operation of the machine must be closely followed. The following checklist should be observed:

a) Check lube and seal oil system on compressor and driver. Circulate "run-in" oil in lube and seal oil system to clean all lines. Heat oil as necessary. "Run-in" oil should be changed. See manufacturer's instructions.

b) On turbine driven machine, check overspeed trip and governor with turbine disconnected.

c) On motor driven centrifugals and turbine driven reciprocating compressor, check gearbox lubrication.

d) Check out suction and discharge piping vent and drain connections, block valves, bypasses and relief valves.

e) On gas engine driven compressors, check out fuel system and starting air system. On turbine driven equipment, check out all the turbine and condensing equipment.

f) Check operation of valve unloaders and clearance pockets on reciprocating machines.

g) Check out intercooler and interstage knock-out drums.

h) Be sure there is no liquid in suction piping and bottles on reciprocating machines before starting compressor.

i) Check out control system and emergency shutdown devices.

j) Both centrifugal and reciprocating compressors may be run in on gas different from that specified for the design of the machine. However, if there is an appreciable difference in gas properties, the manufacturer should be consulted. This is especially true for centrifugal machines.

k) Check both reciprocating and centrifugal machines for adequate instrumentation.

l) Cooling water to oil coolers, intercoolers, and aftercoolers must be made available.

m) If permanent strainers are not installed, temporary strainers at each suction flange must be installed.

Reciprocating compressors are initially operated at no load, with valves removed to check lubrication, piston clearances, and operability of moving parts without undue noise or rubbing.

During the run-in, all controls of the lubricating system must be made to function correctly and satisfactorily. All alarms and safety devices must be verified for proper setting and correct functioning. If the compressor has carbon parts, the run-in period is used to polish and seat the carbon parts before pressure is applied to them.

7.9 Dry-Out and Boil-Out

7.9.1 Heater dry-out

Before a heater is put into service for the first time, it will be necessary to slowly expel the excess moisture from the insulating concrete (setting) by gradually raising its temperature before any appreciable load is put on the heater.

Heater dry-out procedure shall be in accordance with the manufacturer's drying procedure. The heaters served in the reactor section of the Licensed Units shall be dryed-out following the Licensers instructions. However, the typical general procedure utilized can be similar to the procedure presented in Appendix B.

7.9.2 Chemical boil-out of steam generation facilities

Chemical boil-out is desirable as a means of internally cleaning the system parts with a mixture of chemicals and hot water to remove oil and other deposits that may have accumulated during fabrication and erection of the components. It is most important to remove any oil, grease or oily scale from the inside of the pressure parts in order to avoid foaming and priming during subsequent operation.

The boil-out is performed as the final step prior to bringing the Unit on stream. It should be done after all physical inspections and check-out procedures have been performed. Several combination of chemicals may be used to achieve a satisfactory job of cleaning.

Two satisfactory mixtures for chemical boil-out are the following; use of any other types shall receive approval of the manufacturer in advance:

1) A mixture of Soda Ash (Na_2CO_3) and Caustic Soda (NaOH) in equal proportion for a total of 6 kg of chemicals per cubic meter of boiler water.

2) An equal mixture of tri-Sodium Phosphate and Soda Ash for a total of 8 kg of chemicals per cubic meter of boiler water.

These chemicals should be well mixed and thoroughly dissolved in hot water and should be introduced into the steam drum through the chemical feed connection. If a portable pumping system is not available, the chemical solution may be fed directly into the drum through the manway prior to boil-out.

If possible, it is desirable to introduce part of the chemical solution into the feed line leading to the boiler feed water preheat coil in order to obtain some cleaning action in the preheat coil itself.

With the system in readiness and the chemical solutions prepared, the actual boil-out can begin. A typical chemical boil-out sequence presented in Appendix C can be used.

During each blowdown period, the superheater drains should also be opened wide to assure that no condensate has accumulated in the coil or outlet header.

The duration of boil-out will normally vary between twenty-four (24) and seventy-two (72) hours, depending on the type and initial cleanliness of the Unit, as well as the chemical concentration and temperature maintained during boil-out. It is to be expected that twenty-four (24) to thirty-six (36) hours should suffice to prepare the system for satisfactory operation.

Blowdown water condition is one indication of whether the boil-out has achieved satisfactory results. The only conclusive determination of boil-out effectiveness, however, is by a visual internal inspection of the steam drum.

Upon completion of boil-out, the fires should be extinguished and the Unit permitted to cool, after drum pressure has reached zero, open vent and completely drain Unit of chemical solution.

After draining the Unit should be refilled with clean, fresh water to high drum level and flushed through the drum blow-downs, bottom drains, and the steam generation coils.

After flushing open the steam drum for internal inspection to check on the effect of the boil-out. The flushing procedure should remove practically all residual chemicals and any accumulation of sludge.

If the interior of the drum is adequately clean, the boil-out may be considered complete. If cleaning is not adequate the boil-out should be repeated. It must be emphasized that the satisfactory operation of the Unit depends, to a considerable extent, on a complete and thorough job of chemical cleaning.

After chemical cleaning is complete, the following steps should be taken:

1) The gage glasses should be removed, cleaned and reassembled. Care should be taken to be sure that all connections between the drum, gage glasses, and water columns are unobstructed.

Note:

If desired, spare gage glasses may be used during boil-out to be replaced by new glasses prior the normal operation.

2) All manhole and other gaskets which were exposed during inspection, blinding, etc., should be replaced with new operational gaskets.

3) All connections and closures, which were opened after hydrotesting, should be checked and tightened securely. All such connections should be checked carefully, as the boiler is brought on the line for normal operation.

7.9.3 Reactor section dry-out

Before loading the catalyst into the reactors in the Licensed Units, it is necessary that lines and equipment to be dried to remove any traces of water which might have remained from the construction and flushing.

Under most circumstances, free water can be adequately removed by allowing it to drain from the lines, heaters, reactors, exchangers, etc., while blowing through the lines with air. However, the dry-out of the refractory in the charge heaters might be convenient to be performed with the run-in of the recycle gas compressor.

All components existed in the reaction section shall be connected together for their dry-out. Before to begin the dry-out a tightness test may be required.

Following the tightness test, a test under vacuum to be performed. Then a pressurization by nitrogen to be done. The vacuum test to be repeated and the system should be pressurized again with nitrogen. In any case detail dry-out procedure specified by the Licenser shall be followed incorporating the heater refractory dry-out procedure provided by the heater'smanufacturer.

The use of air for dry-out is not allowed because of the possibility of an oxygen/seal oil explosive mixture in the compressor at the elevated temperature.

Nitrogen, inert gas, fuel gas or a mixture of hydrogen and fuel gas can be used as dry-out purpose upon approval of the Licenser. If fuel gas is used, it shall be sweet, light and contains no contaminants which might cause equipment coking or catalyst poisoning.

Being the compressor designed for light H_2-rich recycle gas, the compressor discharge operating conditions will be higher than normal operating ones when using nitrogen or other heavier gases. It may be necessary to reduce the driver (steam turbine) speed to maintain said conditions within normal. Special attention shall be paid to the heaters equipped with a waste heat recovery steam generation section, that shall be protected during the dry-out procedure. All of the reactor internals including the catalyst flow pipes between the reactors should be installed prior to the dry-out operation.

7.9.4 General notes for dry-out and boil-out

1) The heater refractory dry-out, plant dry-out and chemical boil-out procedures can be combined in the interests of saving time. It is likely, however, that the heat input during either the heater refractory or the Unit dry-out procedures may be excessive for controlled chemical boil-out. Therefore, combining the two or three operations may require a temporary interruption of the drying-out procedure while the flushing operation is completed and the steam generation facilities made completely operational.

2) The drying-out and boil-out periods present an opportune time to check out the operation of auxiliary equipment and instrumentation.

The circulating pumps should be operated in rotation to make certain that there will be no difficulties during final start-up.

7.10 Catalyst Loading

Initial catalyst loading activities shall be performed according to the Licenser's and/or catalyst manufacturer's procedures under supervision of the Licenser's representatives. Full attendance and cooperation of the Licenser's responsible authorities is required.

7.11 Tightness Test

7.11.1 During equipment cleaning, lines have been disconnected, orifice plates and blinds removed and re-installed.

As a consequence, tightness tests shall be required to eliminate leakages due to gaskets which have been damaged, flanges or drains which have been left open.

7.11.2 Tightness test is to be carried out after final installation by air, steam, nitrogen or the proper process fluids.

7.11.3 All joints, flanges, packing glands, etc. must be checked for leaks by means of a sensitive detector, for example by using a soapy solution.

7.11.4 Thermal insulation of flanges shall be done only after the final pressure test of the section is completed.

7.11.5 Air or nitrogen are commonly used for tightness test purpose. Thightness test pressure will depend on the operating pressure of the system under test. Normally shall be 1.2 times the normal operating pressure provided that this does not exceed the set of the PSV existing in the section. And, anyhow, the max. test pressure is normally limited by the available plant or Instrument Air pressure. When operating pressure is considerably higher that of said air, a preliminary tightness test is done with air and final tightness test is done with process fluid during start-up.

7.11.6 The acceptability of the test is given by the pressure drop that can occur in a limited period of time. It is normally accepted that the tightness of a section is reasonably good when said pressure drop is less than 1% in two hours time.

7.11.7 When the Unit, or section, is subject to special conditions of pressure, temperature and type of process fluid, a more tight condition of pressure drop measurement will be given.

7.11.8 Tightness test of sections operating under vacuum

a) When sections of Units are normally operated under vacuum conditions, it is necessary to test for proper tightness.

Being almost impossible to find leaks while the section is under vacuum, the most common way to do the test is to check all flanges, joints, valves packing, pumps seal and any other possible point of leaks by pressurizing the system up to 80% of the lower design pressure of equipment included in the system to be tested or 80% of Pressure Relieve Valves installed. Whichever the lower will govern the pressure test.

b) Once the system or section is at the selected pressure conditions, all joints shall be carefully checked with soapy solution, or equivalent, and even minimum leaks shall be repaired. Then vacuum shall be pulled at the selected value. Stop vacuum pulling devices and check for pressure drop in the selected period of time (normally one hour).

If pressure drop is higher than specified, the system shall be pressurized again and rechecked to find the leaks.

Repair possible leaks and pull again vacuum. The operation shall be repeated until the pressure drop is within given limits.

c) When the system to be vacuum tested is very large it may be convenient to split it in two or more sections by closing isolating valves. Installation of blinds is not recommended.

d) Only when the system does not show any leak from the joints, possible internal leak due to bad-seal of valves may be suspected. In this case it is convenient to blind-off suspect valves.

When suspect bad-sealing valves are welded type it will be necessary to open their cover to inspect internal disc and/or seat for proper smoothness and/or full travel of the wedge into the ring seats.

8. NORMAL START-UP PROCEDURES

8.1 General

Placing the new Unit in operation can be made through several methods depending on the experiences of operational crew.

Due to variety in type of the process and facilities included in the Unit, a standard procedure for start-up can not be established. The procedure and important points outlined in this Standard Specification are general start-up main items which shall be followed by the start-up crew regardless of the type of the process. The detail procedure for placing the Unit in operation shall be provided by the Contractor and/or Licenser where required.

The procedure should be studied carefully before start-up, because several operations described must be done simultaneously and the crew should be prepared to act upon contingencies.

The normal start-up activities can be proceeded when the following main commissioning and precommissioning steps are completed:

- Heater refractory dry-out.
- Line and equipment flushing.
- Rotating equipment run-in.
- All other activities outlined in Clause 7 above.

8.2 Prestart-Up Check List

The procedure describes in general terms, the steps to be followed for placing the Unit on stream. The exact sequence of events depends on the flow scheme of the particular Unit; however, the following steps must be completed before charging feed to the Unit.

- All unnecessary blinds are removed.
- All relief valves are tested and installed.
- All temporary lines have been removed.
- The flare header is purged and in service.
- The sewers are in service.
- The heaters are steamed out.

- The fuel oil and fuel gas lines are in service.
- The pilots are lit in all heaters.
- The orifices are installed and are correct in direction of flow.
- All instruments are ready for service.
- All utilities are in service.
- All drains and vents are closed.
- Control valves and bypasses are blocked in.
- All compressors are blocked in.
- The chemical systems are ready for operation.
- The catalysts have been filled or regenerated.
- The unnecessary connections such as pump out, etc. are closed.
- All fire fighting facilities are ready for operation.

8.3 Make Area Safe

Remove all welding gear from area and all maintenance tools not of a non-sparking nature, clear away all planks and scaffolding. No further work to be done except with work permits and, if necessary, specific welding permits. "No Smoking" signs must be re-installed, if required.

8.4 Utilities Commissioning

All utilities such as various types of steam, condensate, boiler feed water, fuels and plant air, instrument air, nitrogen, and plant water shall be commissioned. Do not put cooling water into exchangers, which are to be left with water side drains and vents open and drained until after steam-out.

8.5 Air Purging and Gas Blanketing of Non-Catalytic Sections

Special attention should be paid that oil or flammable gas never be charged into process lines or vessels indiscriminately. The Unit must be purged before admitting hydrocarbons. Air purging can be performed by nitrogen or inert gas, displacement of air by liquid filling followed by gas blanketing, or steaming out followed by gas blanketing. Air purging by nitrogen normally is dictated to be followed for reactor section in the catalytic Units by the Licenser. For the remainder of the Unit other than the reactor section, steam purging followed by fuel gas blanketing can be used to air free the Unit. The following steps and potential problems or hazards should be taken into consideration during the steam purge:

a) Collapse due to vacuum

Some of the vessels are not designed for vacuum and therefore should not be allowed to stand blocked in with steam due to being developed a vacuum by condensation of the steam. Thus, the vessel must be vented during steaming and immediately followed up with fuel gas purge at the conclusion of the steam out.

b) Flange and gasket leaks

Thermal expansion and stress during warm-up of equipment along with dirty flange faces can cause small leaks at flanges and gasket joints which shall be corrected accordingly.

c) Water hammering

Care must be taken to prevent "Water hammering" when steam purging the Unit. Severe equipment damage can be resulted from water hammering.

d) Block in the cooling water to all coolers and condensers

Shut down fans on fin-fan coolers and condensers. Open high point vents and low point drains on the vessels to be steam purged.

e) Start steam out operation

Start introducing steam into the bottom of the columns, towers, and at low points of the various vessels. It may be necessary to make up additional steam connections to properly purge some piping which may be dead-ended. Thoroughly purge all equipment and associated piping of air. Be sure to open sufficient drains to drain condensate which will accumulate in low spots and receivers. Pumps and instruments shall not be steamed out. Steam out duration shall not be less than 12 hours.

f) Start fuel gas injection

When purging is completed, close all vents and drains start introducing fuel gas into all vessels and cut back the steam flow until it is stopped completely when the systems are pressured. Regulate the fuel gas flow and the reduction of steam so that a vacuum due to condensing steam is not created in any vessel and/or that the refinery/plant fuel gas system pressure is not appreciably reduced. A minimum pressure of 80 kPa [0.8 bar(ga)] in the vessels should be maintained throughout the steaming out and gas purge procedures.

8.6 Catalytic Units Reactor Section Air Purging and Gas Blanketing

The following procedure is normally applied for the reactor section unless otherwise instructed by the Licenser:

- Evacuate the reactor circuit to the lowest attainable pressure.

- Hold the vacuum for 1-2 hours to check for tightness of the Unit. If a good vacuum can not be held, introduce nitrogen to the system at the discharge of recycle gas compressor and pressure the reactor circuit to a positive pressure and repair all leaks that are discovered. Afterwards, repeat the vacuum test until a good vacuum can be held.

- Introduce nitrogen at the discharge of the recycle gas compressor and pressure the reactor circuit to a positive pressure of 10-35 kPa [0.1-0.35 bar (ga)]. The purge nitrogen should contain less than 100 mol ppm oxygen.

- Pull the vacuum on the system twice more, pressuring each time with nitrogen.

- After pulling the last vacuum, pressure the reactor circuit with nitrogen to at least minimum pressure required for recycle gas compressor operation, but not higher than the allowable percentage of the reactor shop test pressure.

- At the same time that the reactor circuit is evacuated, the compressor suction drums should also be evacuated and purged with nitrogen. Do not pull a vacuum on the compressors, but leave them blocked in. The compressors must be thoroughly purged with nitrogen and maintained under nitrogen pressure before admitting hydrogen into the Unit.

8.7 Heat Exchanger Activation

Water should now be put through the water-cooled exchangers. Vents at high points to be opened for releasing of air. Start one fan on each section of the air-cooled exchangers.

8.8 Vacuum Test

Vacuum test to be performed for the equipment designed for vacuum and to be operated under vacuum conditions such as vacuum column in the Vacuum Distillation Unit. All sections and facilities not designed for vacuum should be blocked off and segregated from the section to be tested for vacuum. Check the system for leakage after vacuum approaches minimum and perform the following activities:

- Block off inlet to the ejector facilities which are producing vacuum and hold for one hour.

- If leakage does not exceed 50 mm per hour, it will be acceptable unless otherwise the system should be investigated for the leakage sources.

8.9 Establish Flow in the Unit

The Unit should be lined up and final check shall be carried out to introduce the feed to the Unit. All safety precautions should be taken into account. The feed to be charged at turn down ratio of the Unit design throughput according to the stepwise start up procedure developed by the Contractor. Hydrocarbons circulation in the coils of reboiler heaters shall be maintained at all times at a flow rate close to the design values in order to avoid coke deposition inside the coils.

8.10 Inhibitor/Chemical Injections

Corrosion inhibitor and/or chemical injection shall be started where required when the temperature and pressure of the system are rising to the values close to operating conditions. The inhibitor and chemical injection rate shall be as indicated by the Contractor/Licenser.

8.11 Adjust Operation to Obtain Quality

On the basis of laboratory tests, operating conditions must be adjusted to meet specifications on the products as well as product yields.

APPENDICES

APPENDIX A
TYPICAL ACID CLEANING PROCEDURE FOR COMPRESSOR LINES

A.1 The Preparation

A.1.1

a) A list of metals, alloys, and non-metallic materials in the sections to be cleaned, including block valve trims, gaskets, valve packings, nuts, exchanger tubing, as well as major equipment and piping must be made.

b) Assurance must be obtained from the cleaning Contractor that the chemicals and chemical solutions used in the operation will not be injurious to these materials.

A.1.2

a) A list must be made of the safe operating pressures of all components in the sections to be cleaned.

b) Assurance must be obtained by the cleaning Contractor that these pressures will not be exceeded (especially if the safety valves in these sections are going to be blinded off; in this case the cleaning Contractor should provide safety valves with his equipment).

A.1.3 Spool pieces must be made and substituted for turbine meters and for any valves that must be protected from any chemical solutions. Valves which are removed should be cleaned separately and their openings sealed off.

A.1.4 Orifice plates must be removed from the lines.

A.1.5 All instrument taps in the system must be disconnected or blocked off. Drain points must be provided in the taps to drain off solution, and all instrument drain valves should be opened.

A.1.6 All externally mounted liquid level instruments, such as displacement type level transmitters and gage glasses, should have all block valves adjacent to the vessel closed and all drain valves opened.

A.1.7 Pressure gages and thermowells should not be in place and their connections should be blocked off.

A.1.8 All piping strainer screens must be removed.

A.1.9 All high points must be provided with vent valves. These vent valves should be opened periodically during the cleaning operations.

A.1.10 Major items of equipment such as compressors, pulsation dampeners, etc., must be blinded off.

A.1.11 Cleaning circulation circuits must be determined. For a three stage make-up compressor system, this might mean four separate circulation circuits, one for each stage and one for the incoming fresh hydrogen line.

(to be continued)

APPENDIX A (continued)

A.2 The Acid-Cleaning Operation

The acid-cleaning operations can be generally divided into the following steps:

A.2.1 Flushing:

All sections should be water flushed to remove all loose dirt, debris, and other foreign material in the lines. It should be noted that process pumps must not be used to circulate any of the flushing, rinsing, or chemical solutions. All transfer and circulating pumps for handling these solutions must be furnished by the chemical cleaning Contractor.

A.2.2 Degreasing:

All sections should be flushed with a degreasing solution (generally an alkaline solution such as a Soda Ash solution) to remove all grease or oil that may have been applied to the lines and vessels as a rust preventative measure. The cleaning Contractor should specify the type and concentration of the solution to be used.

During this and other phases of the operation, the Contractor may want to heat the circulating solutions. In doing so, reboilers or exchangers must not be used as a means of heating them. All heating is to be external to the systems being cleaned and by equipment furnished by the chemical cleaning Contractor.

After this step, all sections should be rinsed with water.

A.2.3 Chemical cleaning:

All sections must be treated with an acid solution to remove all rust and scale from the metal surface. There are several types of cleaning solutions that can be used to do this step (such as inhibited hydrochloric acid or inhibited phosphoric acid); it is the responsibility of the cleaning Contractor to select one which has been proven by experience. A suitable inhibitor must also be chosen to reduce the attack on metal. The Contractor should specify the concentration to be used and the percentage of metal components (such as iron) to be allowed in solution. Afterwards, the acid circulation should be followed by a water rinse.

A.2.4 Neutralizing:

All sections must be flushed with a neutralizing solution (perhaps a Soda Ash solution) to neutralize all traces of acid left in the system. The cleaning Contractor should specify the type and concentration of the solution to be used. After this step, all sections should be rinsed with water.

A.2.5 Passivating:

In order to form an anti-rust skin, a solution with a passivating agent must be circulated through each section. Afterwards, each system is allowed, to dry. Note that any passivating agent used must meet with the Licenser's approval and must be flushed from the system prior to start-up.

After completing the cleaning operation, the vessels and lines should be inspected to determine the quality of the cleaning. Treated surfaces should be clean, rust-free, and dull gray in color. In-line turbine meters, valves, strainers, and all other equipment which was removed must be installed. Afterwards, the make-up system must be nitrogen purged and left under nitrogen pressure until the start-up.

APPENDIX B
TYPICAL HEATER DRY-OUT PROCEDURE

B.1 General Procedure:

During the initial heater refractory drying out period, it is preferable that no material be flowing through the tubes.

a) Make a temporary installation of thermocouples through the pipe sleeves in the hip section of the heater. The tips of these thermocouples should extend 150 mm (6 inches) beyond the inside of the insulating concrete, but should not contact the tubes.

b) It is preferable to use gaseous fuel (refinery gas or LPG) for drying out the setting. If no gas is available, liquid fuel may be used, but it should be free of sediment and heated as required to give the proper viscosity about 43 mm^2/s or 43 cSt (about 200 SSU) for good atomization and clean combustion.

c) Light one or more burners, as required, in each section of the heater and fire slowly, so that the temperature, as indicated by the hip thermocouples, is increased at a rate of about 14°C (25°F) per hour until it reaches 482°C (900°F). Hold this temperature for 10 hours, or 2 hours per 25.4 mm (per inch) of refractory thickness, whichever applies.

d) While increasing the temperature, the burner operation should be rotated frequently in order to distribute the heat as evenly as possible over the entire length of the setting.

e) After the 10-hour holding period, all burners should be shut off and the heater setting allowed to cool slowly by keeping the air inlet doors and stack damper(s) fully closed.

f) After drying has been accomplished, the temporary hip thermocouples should be removed and the plugs replaced in the pipe sleeves. If the setting has been dried as outlined above, temperature may be subsequently raised or lowered at any desired rate within the design limits of the heater.

B.2 For Gas-Fired Heaters:

a) When Unit is shut down, always blind off the fuel gas supply line because gas may leak through the block valves at the heaters and fill a furnace.

b) Before starting to light any pilot burner, see that all individual burner block valves are closed and steam out firebox to remove any gas accumulation. **Make sure the damper is opened**. Steam out the box until a steady plume of steam can be seen rising out of the stack. Stop steaming and pinch in the damper.

c) When all pilot burners are lit, light each burner individually by opening the gas valve to each burner after the torch is inserted in front of the burner. After a few burners are lit, **it will be necessary to open the damper** to provide enough draft to light the remainder of the burners.

d) Burners should be fired to produce a blue flame with a yellow tip, obtained by regulating the primary and secondary air supply. The heaters should be checked frequently for dirty burners which might give either too long, too short, or a misdirected flame. There must be some excess of air to the burners so that an increase in fuel gas flow will have sufficient air to produce complete combustion.

e) If for any reason the fires in a heater go out:

1) Shut off gas supply immediately by closing the block valves at the fuel gas control valves. Bypass and pilot lines which might be open around the control valves must also be closed.

2) Put snuffing steam in the firebox.

3) Close all individual burner valves.

f) As in all heaters, care should be taken that no flame impingement on the tubes is permitted.

(to be continued)

APPENDIX B (continued)

B.3 For Oil-Fired Heaters:

a) When the Unit is shut down and before entering heaters, always double block the oil supply line on both the supply and return headers and pull the oil guns from the burners as oil may leak through the block valves at the heaters and fill a furnace.

b) Before starting to light any pilot burners, see that all individual oil guns are removed from the burners, and steam out the firebox and header to remove any gas accumulation. Make sure that the dampers are opened slightly.

c) Oil burners without gas pilots should be lighted from a regulation torch. When there is a gas pilot, light it first and then light the oil from the pilot. Have fuel oil circulating through the fuel oil return at normal operating temperature.

d) Burners should be fired to produce a yellow flame with good pattern obtained by regulating the primary and secondary air supply. The furnaces should be checked frequently for dirty burners which might give either too long, too short, or a misdirected flame. There should be some excess air to the burners so that an increase in fuel flow will have sufficient air to produce complete combustion.

e) If for any reason the fires in the furnace go out, then:

1) Shut off the fuel supply immediately. Do this by closing the main block valve in the fuel supply to the furnace. This will take care of any bypass lines which might be open around the control valves. Be sure the check valve on the fuel oil return does not leak allowing fuel to back into the firebox.

2) Put snuffing steam in the firebox.

3) Block in the pilot gas line. Close individual burner valves.

f) As in all heaters, care should be taken that no flame impingement on the tubes is permitted.

B.4 Safe Procedure for Lighting Oil Burners:

a) Push the oil gun forward, and then turn on steam by fully opening the steam block valve and the steam control valve. Close off when the steam is dry.

b) Make sure the oil block valve is closed, then open the steam bypass valve to clean and warm the burner.

c) When condensate has been removed and the steam is dry (dry steam is invisible), close the bypass steam valve.

d) Adjust atomizing steam valve for a small flow of steam.

e) Open oil block valve gradually until the oil starts burning. The oil will ignite from the pilot gas flame or an oil torch. Take care to see that unburned oil is not put into the firebox. Accumulated oil will become hazardous as the firebox heats up.

f) Adjust the atomizing steam valve and oil valve to obtain correct flame pattern. Never let the flame touch the tubes.

APPENDIX C
TYPICAL CHEMICAL BOIL-OUT SEQUENCE

C.1 Fill the system to normal drum level, using the feed-water pump and the regular feed connections. Introduction of some chemical compound into the feed water, as outlined above would be desiderable. The feed water temperature should be limited to approximately 80 to 90°C.

C.2 Make certain that the superheated steam line is closed to the refinery/plant steam system. Open the superheated steam coil outlet vent and drain lines which are open to the atmosphere and leave them partially open during boil-out. This will assure flow through the superheater tubes and avoid any accumulation of condensate.

C.3 Open the vent valve on top of the steam drum.

C.4 Start one of the water circulation pumps to provide flow through the steam generating coils.

C.5 Light fire in the heater. The boil-out procedures can be combined with the heater refractory dry-out or the Unit reactor section dry-out. Bring the heater firebox temperature up at 50°C per hour until the steam drum pressure is established at approximately 3.5 to 7 bars (3.5 to 7 kg/cm²). Care must be taken to maintain a level in the steam drum at this time.

C.6 Flow must be maintained through the boiler feed water preheat coil. Since steam will be venting to atmosphere, this will be accomplished by charging make-up water to maintain the level in the steam drum. If possible, a temporary line should be connected from the discharge of the water circulating pumps to the boiler feed water preheat coil inlet line to provide chemical to clean this section also.

C.7 Approximately once each shift, the Unit should be blown down using the blowdown connections. The water should be dropped to the bottom of the gage glass and then fresh water added to bring the water back to the normal operating level. Chemical solution should be added through the chemical feed connection to maintain the concentration in the boiler water as close to the recommended levels as possible.