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NATIONAL IRANIAN OIL REFINING & DISTRIBUTION COMPANY
NATIONAL IRANIAN OIL ENGINEERING
& CONSTRUCTION COMPANY

NIOEC SP

NIOEC SPECIFICATION FOR FIELD PRESSURE TESTING

FIRST EDITION

JULY, 2005

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IN THE NAME OF GOD**FOREWORD**

By their very nature, technical standard specifications are continuously subject to modifications and revisions. To strengthen their merit and usefulness, continuous improvements, addendum, deletion of disparate information and consequently provision of updated revisions are to be made in order to ascertain that such standard specifications meet the current requirements, inclusive of Iranian Petroleum Standards (IPS) and the recognized and acceptable national and international standards, as well as the optimal codes and practices based on the accumulated in-house know-how and plant knowledge and experiences.

However, in reality, due to several reasons, not to mention the complexity of the matter, the ultimate goal of continuous direct embedment of the required changes on the relevant standard specifications may be far reaching. Therefore, in the interim periods between the officially issued revisions, the required changes will appear in other documents related to the engineering and design work of the on going projects.

In response to the initiative of the Design Division of the Engineering and Construction Directorate, and considering that the task of the execution of several important and mega projects for the realization of the new oil refineries, pipelines and oil terminals as well as improvements of the existing facilities, has been assigned to NIOEC, it was decided to update the NIOEC Specifications and to issue new official revisions.

The Design Division of the Engineering and Construction Directorate was itself entrusted to carry out this important task, and as such by forming several special technical committees, working in close co-operation and cohesion and sharing their expertise and knowledge, the updated and revised NIOEC Specifications were successfully prepared and complied.

These Specifications are intended to be used for Oil Refineries, Distribution Depots, Oil Terminals, Pipelines and Pump Stations within NIOEC's projects, and have been proven to be of high value for such purposes. It must however be appreciated that these Specifications represent the minimum requirements and should in no way be interpreted as a restriction on the use of better procedures, engineering and design practices or materials.

We encourage and highly appreciate the users and other clear sighted and experts to send their comments on the Specifications to the Design Deputy of the Engineering and Construction Director of NIOEC for evaluation and consideration.

S. R. KASAEIZADEH


EXECUTIVE DIRECTOR

REVISION INDEX

REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5	REV. PAGE	1	2	3	4	5
1						26						51						76					
2						27						52						77					
3						28						53						78					
4						29						54						79					
5						30						55						80					
6						31						56						81					
7						32						57						82					
8						33						58						83					
9						34						59						84					
10						35						60						85					
11						36						61						86					
12						37						62						87					
13						38						63						88					
14						39						64						89					
15						40						65						90					
16						41						66						91					
17						42						67						92					
18						43						68						93					
19						44						69						94					
20						45						70						95					
21						46						71						96					
22						47						72						97					
23						48						73						98					
24						49						74						99					
25						50						75						100					

NOTES:

- 1) THIS SHEET IS A RECORD OF ALL REVISIONS TO THIS SPECIFICATION.
- 2) REMARKS RELATED TO EACH REVISION SHOW A BRIEF DESCRIPTION. THESE REMARKS SHALL BE INTERPRETED IN CONJUNCTION WITH THE REVISED TEXT MARKED BY REVISION NUMBERS.
- 3) WHEN APPROVED EACH REVISION SHALL BE CONSIDERED AS A PART OF THE ORIGINAL DOCUMENT.
- 4) NUMBER OF PAGES EXCLUDES THIS SHEET AND THE COVER SHEET.

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CONTENTS:	PAGE NO.
1. SCOPE	3
2. REFERENCES	3
3. UNITS	4
4. DEFINITIONS & TRMINOLOGY	4
5. GENERAL REQUIREMENT	4
6. HYDROSTATIC PRESSURE TESTING FOR PLANT PIPING SYSTEM ..	5
6.1 General	5
6.2 Testing Area	6
6.3 Test Equipment	7
6.4 Test Medium	7
6.5 Test Pressures	8
6.6 Nonmetallic Piping-Test Pressure	9
6.7 Test Duration	9
6.8 Test Preparation	9
6.9 Procedure for Hydrostatic Pressure Test	11
6.10 Measures to be Taken after Hydrostatic Testing	12
6.11 Leaking Welds	12
7. PNEUMATIC PRESSURE TESTING	12
7.1 General	12
7.2 Test Equipment	13
7.3 Test Medium	13
7.4 Pneumatic Test Pressure	13
7.5 Precautions to be Taken in Pneumatic Pressure Testing	13
7.6 Pneumatic Testing Procedure	14
8. MANUFACTURING CERTIFICATE FOR FABRICATED PIPING	14
9. PRESSURE TESSTING THROUGH EQUIPMENT	14
9.1 Heaters and Furnaces	14
9.2 Unfired Pressure Vessels	15
9.3 Heat Exchangers	15
9.4 Storage Tanks	16
9.5 Safety and Relief Valves	17
9.6 Pumps, Turbines, Blowers and Compressors	17
9.7 Miscellaneous Equipment	17
10. PRESSURE TESTING OF INSTRUMENTS	17
11. TEST RECORD	18

CONTENTS:**PAGE NO.**

12. APPENDIX 1 (Guide for piping pressure test activities and compilation of Pressure test package documents)	19
12.0 Scope	19
12.1 Documentation	19
12.2 Preparation of Test Package	19
12.3 Test Scheduling	20
12.4 Line Checking	20
12.5 Preparation for Line Check and Hydrotest	22
12.6 Line Cleaning	22
12.7 Pressure Test	22
12.8 Post Test Activities & Restoration	24
<u>12.9 Final Test Package Documents</u>	<u>24</u>
 ATTACH. A Type of Pressure Testing	 25
ATTACH. B(1/2) Piping Test Package (TP) Flow Chart	26
ATTACH. B(2/2) Detail Work Flow for A/G. Test Package Document Handling/ Line Checking/ Pressure Test/ Post Test	27
ATTACH. C Test Package Documents (Sample File)	28
ATTACH. D Recommended Pressure Gauge Range	44

1. SCOPE

This Specification covers the minimum requirements of field pressure test to be carried out on plant piping system, equipment (Heaters and furnaces, unfired pressure vessels, Heat exchangers, storage tanks) and instruments, upon completion of construction work and before commissioning.

The test is required in order to prove the strength of system, its tightness (absence of leaks) and the integrity of weldments and materials.

2. REFERENCES

Throughout this Specification the following dated and undated standards/ codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this Specification.

For undated references, the latest edition of the referenced document (including any supplements and amendments) applies. For dated references, the edition cited applies.

The applicability of changes in dated references that occur after the cited date shall mutually be agreed upon by NIOEC and the Vendor/Contractor.

ASME (AMERICAN SOCIETY OF MECHANICAL ENGINEERING)

ASME B 31.3 – 2004	“Process Piping”
ASME B 31.1	“Power Piping”
ASME B 31.5	“Refrigeration Piping”
ASME B 16.5	“Steel Pipe flanges and flanged fittings”

API (AMERICAN PETROLEUM INSTITUTE)

API 650	“Welded steel tanks for oil storage”
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NIOEC-SP (NIOEC SPECIFICATIONS)

NIOEC-SP-00-02	“NIOEC Specification for site Preparation-Earth Work and Sewers”
NIOEC-SP-41-03	“NIOEC Specification for Pressure Vessels”
NIOEC-SP-44-01	“NIOEC Specification for Shell & Tube Heat Exchanger”
NIOEC-SP-45-03	“NIOEC Specification for Fired Heaters”
NIOEC-SP-50-07	“NIOEC Specification for Cleaning and Protection of Piping”
NIOEC-SP-50-17	“NIOEC Specification for Protection of Under Ground Steel Pipe”

NIOEC STANDARD DRAWINGS

NIOEC-SD-5044-1/1	“Hydro Static Test Blind”
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IPS (Iranian Petroleum Standards)

IPS-E-GN-100	“Engineering Standards for Units”
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[IPS-C-IN-100](#)

“Construction and Inspection Standard for General
Instrument and Testing of Instrument and
Instrument System”

3. UNITS

International system of units (SI) shall be used in accordance with [NIOEC-SP-00-10](#), unless otherwise specified.

4. DEFINITIONS AND TERMINOLOGY

4.1 Employer: Means National Iranian Oil Engineering and Construction Company (NIOEC).

4.2 Contractor: Means EP contractor or EPC contractor.

4.3 Construction contractor: Construction Contractor is the party which carries out all as part of construction and/or commissioning for the project.

4.4 Inspector: The Inspector is a person/persons or a body appointed in writing by the Engineer for the inspection and testing.

4.5 Engineer: The Engineer is a person or a body appointed in writing by the Employer.

4.6 Owner Representative: Refiner representative introduced in writing to the Engineer.

5. GENERAL REQUIREMENTS

5.1 In addition to the requirements specified in this NIOEC Specification, piping systems shall be tested in accordance with the provisions of ASME code as follows:

- a) For process and general utility services ASME B.31.3.
- b) For piping within the scope of steam generation ASME B.31.1.
- c) For refrigeration piping system ASME B.31.5.

5.2 For field pressure testing of pressure vessel, heat exchangers, heaters, storage tanks and underground piping systems, in addition to the stated requirements in related sections of this NIOEC Specification, referenced codes & standards as specified, and manufacturer's recommendation shall be considered.

5.3 Care shall be taken to ensure that the following equipment is not subjected to field pressure test:

- a) Pumps, turbines and compressors.
- b) Rupture discs, safety valves, flame arrestors, filter elements.
- c) Instruments, including gage glasses and pressure gages.
- d) Equipment where the internal lining may be damaged by the test medium.
- e) Equipment such as filters and driers where the content could be damaged or contaminated.
- f) Vessels and exchangers which have hydrostatic test pressure less than the line test pressure.

6. HYDROSTATIC PRESSURE TESTING FOR PALNT PIPING SYSTEM

6.1 General

6.1.1 Before commencing pressure test, the construction contractor shall be provided with the following latest approved for construction document for review and compilation of test package documents and execution of the test, who shall then prepare a detailed test procedure and submit to Contractor / Employer for approval.

- a) Pressure test flow diagram.
- b) Test block list.
- c) Field pressure testing (this NIOEC Specification).
- d) Any other information as necessary.

Note: As a guide, procedure for pressure test activities of plant piping systems (including preparation of test package documents, TP flowchart, line checking, line cleaning, hydrotest, post test activities and restoration, final test package documents) in line with this NIOEC Specification is given in APPENDIX 1.

6.1.2 For convenience, vessels may be tested simultaneously with connected piping provided that requirements as stated in 6.1.3 & 6.1.4 below are met. Vessels shall not be tested with the piping when the following conditions exist:

- a) Large vessels which would overload the foundation or support if filled with water.
- b) Large vessels requiring too much water to fill.
- c) Vessels with internals which would be damaged by water.
- d) Vessels which are extremely difficult to drain or vent.

6.1.3 Where the test pressure of piping attached to a vessel is the same as or less than the test pressure for the vessel, the piping may be tested with the vessel at the piping test pressure.

6.1.4 Where the test pressure of the piping exceeds the vessel test pressure, and it is not considered practicable to isolate the piping from the vessel, the piping and the vessel may be tested together at the vessel test pressure, provided that employer, with the consent of owner, approves and the vessel test pressure is not less than 77% of the piping test pressure calculated by equation 1. (See 6.5.1)

6.1.5 If a portion of a piping system can not be hydrostatically tested because the presence of water is objectionable, a notation shall be made on the pressure test flow sheets indicating that hydrostatic testing by water is prohibited.

6.1.6 Underground lines inside plot limits shall be completely tested, inspected, drained and approved before backfilling of the lines are carried out.(See [NIOEC-SP-50-17](#) and [NIOEC-SP-00-02](#))

6.1.7 Cast iron piping with spigot and socket joints shall be intermittently covered, leaving the joints clear and all the bends securely anchored before testing.

- 6.1.8** Vents shall be provided at all high points in the piping system and drains shall be provided at all low points.
- 6.1.9** Fabrication and welding shall be complete prior to system testing.
- 6.1.10** Welding cleanup, nondestructive examination, stress-relieving, and other heat treatments shall be completed before pressure testing is performed.
- 6.1.11** Insulation shall not be applied over welded or mechanical joints and connections. Screws or welds shall not be painted before pressure testing.
- 6.1.12** Testing shall be performed by qualified personnel of construction contractor who are thoroughly familiar with all equipment and test procedures.
- 6.1.13** Pressure testing shall be performed in presence of the Employer inspector.
- 6.1.14** Pressure testing should be performed when the weather condition is suitable for inspection.
- 6.1.15** Pressure relief and thermal expansion relief valves shall be excluded from the general pressure tests. Blinds shall be installed immediately adjacent to their inlet and outlet (if required) flanges during tests. Relief valve test gags may be used in place of blinds. Screwed relief valves shall be removed and the connections temporarily plugged or capped during the tests.
- 6.1.16** Lines containing check valves shall have the source of pressure located in the piping upstream of the check valve so that pressure is applied under the seat. If this is not possible, the check valve flapper shall be removed or jacked up.
- 6.1.17** Seats of valves shall not be subjected to a pressure in excess of the maximum cold working pressure of the valve.
- 6.1.18** Short pieces of piping which must be removed to permit installation of blind or blank, should be tested separately.
- 6.1.19** Pipe supports and anchors should be fitted prior to pressure testing. In certain cases temporary or additional supporting of pipe work may be required due to weight of the testing medium.
- 6.1.20** For permanent flanged joints, permanent service gaskets shall be used. For temporary flanged joints, test gasket shall be used. Record of such temporary gaskets, shall be maintained.

6.2 Testing Area

- 6.2.1** If possible, test equipment including pumps, gages, recorders, and other items shall be located in the same area.
- 6.2.2** The area shall be continuously monitored by test personnel while testing is being performed so that any change in test procedures or conditions will be noted immediately and corrective action taken as required.

6.3 Test Equipment

The inspector approval shall be obtained prior to use of equipment intended for the execution of the pressure test.

6.3.1 Instruments

The required instruments for each test shall be as follows:

- a) Pressure gage, accurate to within 1% of its range. The range shall be 1.5 to maximum 2 times of test pressure.
- b) Dead weight tester and temperature indicator, if specified, instruments shall be suitably protected from all elements. Prior to testing, they shall be calibrated (preferably on site) and a record of the instrument calibration and identification shall be kept as part of the inspection records. The calibration date and identification should be affixed to the instruments. Calibration shall be done according to IPS-C-IN-100.

6.3.2 Pumps

Construction contractor shall be responsible for the supply of suitable pumps for the testing. As a minimum a high volume centrifugal pump for filling and a variable speed positive displacement reciprocating pump with sufficient discharge head and capacity for the pressurization shall be provided.

The construction contractor shall provide chemical injection pump and means necessary for measuring of the inhibitor (if required) to be added to test water.

6.4 Test Medium

6.4.1 The test fluid normally shall be fresh water and shall not contain suspended solids which may plug small lines. If it is found necessary water filter shall be used equipped with 100 mesh screen to remove 99% of particles which are 140 microns or more in size.

6.4.2 The water shall have a corrosion inhibitor if so specified on the pressure test flow sheets.

6.4.3 If the water temperature is likely to fall to zero degrees Centigrade or below, glycol or another antifreeze approved by the Engineer shall be added.

6.4.4 Carbon and low-alloy steel

Piping manufactured from carbon steel or low-alloy steel may be hydrostatically tested with fresh water. Brackish or sea water may be used provided that prior approval of the Engineer is obtained.

6.4.5 Stainless steels

The chloride content in the water used for the hydrostatic testing of piping manufactured from or containing parts manufactured from austenitic stainless steel (e.g., 18 Cr- 8 Ni or 18 Cr-10 Ni-2 Mo), shall be less than 40PPM., laboratory test report shall be provided.

6.4.6 Duplex stainless steels

The preferred method is to use condensate or demineralized water (up to 2 PPM chloride).

6.4.7 9% Nickel alloy steel

The test water shall be of a neutral PH value, clear and free from sulfides which may otherwise precipitate stress cracking of the equipment.

6.4.8 In systems where residual moisture can not be tolerated, e.g., in SO₂, acid, ammonia and LPG service and where certain catalysts are used, other test medium shall be selected. If flammable liquid is used consideration shall be given to the test environment.

6.5 Test Pressures**6.5.1 General process piping-test pressure**

The hydrostatic test pressure, at any point in a metallic piping system shall be as follows:

- a) Not less than 1.5 times of the design pressure.
- b) For design temperature above the test temperature the minimum test pressure shall be calculated by the following formula, except that the value of S_T/S shall not exceed 6.5:

$$P_T = \frac{1.5 P S_T}{S} \quad (\text{Eq.1})$$

Where:

P_T = Minimum hydrostatic test pressure
 P = Internal design gage pressure
 S_T = Allowable stress at test temperature
 S = Allowable stress at design temperature
(See table A-1 ASME B31.3)

- c) If the test pressure as defined above would produce a stress in excess of the yield strength at test temperature, the test pressure may be reduced to the maximum pressure that will not exceed the yield strength at test temperature. (All code requirements as mentioned in ASME B 31.3 shall be considered)
- d) Where the pipe work being tested contains flanges, the test pressure as determined in paragraph 6.5.1 (b) for piping should be in accordance with section 8 of steel pipe flanged fittings, ASME B 16.5.

6.5.2 Refrigeration service-test pressure

Refrigerant piping shall be tested in accordance with the provisions of ASME B31.5 "Refrigeration Piping" and be successfully dried out accordingly, or other measures approved by the Engineer shall be applied against freezing.

Note:

However no oxygen or any combustible gas or combustible mixture of gases shall be used for testing within the system. Water should not, if possible, be used for testing of refrigerant piping, but if used, it must be completely removed as described in paragraph 6.10.5.

6.5.3 Vacuum service-test pressure

Lines in vacuum service shall be tested at a minimum internal pressure of 200 kPa (29 psi) unless limited to a lower pressure by design and/or construction.

6.5.4 Utilities service-test pressure

The test pressure for service air and water piping shall be 1½ times the design pressure or 700 kPa (100 psi) for steel piping, whichever is higher. Flanged cast iron piping shall be tested to 1½ times the design Pressure + Maximum static head of pipe content during operation; but in no case more than the following test pressures:

<u>Size (Dia.)</u>	<u>Class 125 Flange</u>	<u>Class 250 Flange</u>
DN 25-300 (NPS 1-12)	1700 KP (250 psi)	3500 KP (500 psi)
DN 350-600 (NPS 14-24)	1400 KP (200 psi)	2800 KP (400 psi)
DN 750 (NPS 30 & LARGER)	700 KP (100 psi)	1400 KP (200 psi)

6.5.5 Jacketed lines-test pressure

In jacketed lines the jacket shall be tested in accordance with paragraph 6.5.1 on the basis of jacket design pressure. The internal line shall be tested on basis of external or internal design pressure whichever is greater, unless limited by the engineering design conditions. Limitations shall be noted on the pressure test flow diagram.

6.6 Nonmetallic Piping-Test Pressure

The hydrostatic test pressure at any point in a nonmetallic piping system shall be not less than 1.5 times the design pressure, but shall not exceed 1.5 times the maximum rated pressure of the lowest rated component in the system.

6.7 Test Duration

The test pressure shall be maintained for an adequate time (not less than one hour) to detect small and slow seepage leaks and to permit a thorough inspection.

6.8 Test Preparation

6.8.1 For hydrostatic testing, all pipe supports shall be in position and completed before testing is undertaken.

6.8.2 All piping intended for other than liquid service shall be adequately supported by temporary supports if necessary, particularly on lines using spring or counterweight supports. Large adjacent lines shall not be tested simultaneously where the weight of the combined test water load may overload the structure of supports.

6.8.3 If blind flanges are necessary, the flanges shall be indicated on the pressure test flow diagrams.

6.8.4 All lines should be cleared of debris by flushing with water or blowing with steam or air. Precautions should be taken to ensure that debris is not flushed into associated vessels, equipment or "dead ends".

- 6.8.5** The construction contractor of test shall consider temporary gaskets when making connections that will be broken for testing or reassembly after testing.
- 6.8.6** Ball valves and gate valves shall be completely open during the test.
- 6.8.7** The construction contractor shall take care to avoid contaminating valve seats with foreign particles.
- 6.8.8** Lines containing check valves shall have the pressure source located on the upstream side. If impossible, the check valves shall be removed from the line or blocked open.
- 6.8.9** Lines which have spring hangers or are counterweight supported shall be temporarily blocked up during testing in order to sustain the weight of the test fluid. Sometimes spring hangers are provided with stops for carrying the test load and need not be blocked up.
- 6.8.10** All orifice plates shall be removed before the test.
- 6.8.11** Equipment that is not to be included in the test shall be isolated by blinds or shall be disconnected from the piping.
- 6.8.12** Control valves shall remain in the line for testing. Those which are normally closed shall be opened by clean dry air. The valves shall not be jacked or forced open.
- 6.8.13** Pressure control valves with internal passages between the process fluid and the diaphragm shall be isolated from the test. External connections shall be disconnected or blocked during the test. The diaphragm pressure shall be bled off.
- 6.8.14** Expansion joints of the sliding sleeve or bellows type should be provided with temporary means to limit lateral movement.
- 6.8.15** Expansion joints, instruments, filters and similar equipment for which the maximum permissible cold test pressure is considerably lower than the maximum hydrostatic test pressure permissible for the other components of the system shall be removed or blanked off from the line before testing. Such equipment should be inspected during the commissioning with due regard to the pressure limitation.
- 6.8.16** Plugs shall be removed from tell-tale holes in compensating rings and reinforcement pads around branches (nozzles) and the holes left open during hydrostatic testing and observed for any leakage.
- 6.8.17** Prior to commencement of the test a thorough check shall be made to ensure all fittings, flanges, plugs, etc., are in place. All flanges and flanged fittings shall be bolted and bolts properly torqued.
- 6.8.18** Testing of more than one individual section simultaneously may be carried out by connecting the sections with suitable jumper lines. The materials used

in the fabrication of these jumpers shall be of the same quality as the system under test, as a minimum. Threaded piping shall be minimized on jumper lines.

6.8.19 Instrument piping at orifice flanges shall be removed or a drain or vent shall be opened to ensure that the instrument does not become pressurized because of a leaking valve.

6.8.20 Mounted instrumentation shall be isolated from the system during testing.

6.8.21 The supply connection size shall ensure filling of the system within a reasonable time, and it shall have a flanged valve.

6.8.22 A valve shall be used for depressurizing, for which a globe valve is preferred.

6.9 Procedure for Hydrostatic Pressure Test

6.9.1 Pressure test sections shall be chosen by the construction contractor, based on the submitted approved pressure test flow diagram, test block list and testing as much piping as possible at one time without exceeding the allowable test pressure of the weakest element in the system.

6.9.2 Vents and other connections that can serve as vents shall be open during filling so that all air is vented prior to the application of test pressure to the system.

6.9.3 Test pressures shall be taken at the lowest point of a line or test system.

6.9.4 During hydrostatic testing, care must be exercised to limit the applied pressure to the particular portion of the system designated on the field pressure test flow diagram.

6.9.5 Care must also be taken to avoid overloading any parts of supporting structures.

6.9.6 Where conditions require a test pressure to be maintained for a period of time, during which the test medium in the system might be subject to thermal expansion, provision shall be made for the relief of excess pressure due thereto. (By either installation of a proper relief valve or discharging excess pressure.)

6.9.7 Test pressure shall not be applied against any closed valve unless the maximum allowable working pressure (MAWP) of the valve exceeds the test pressure.

6.9.8 If the test pressure is the same upstream and downstream of a control valve, the block and by-pass valves shall be left open, with the control valve open or closed (whichever is most convenient).

6.9.9 If the test pressure is different at upstream and downstream of a control valve, the test on the upstream portion shall be made with the upstream block valve and control valve open, downstream block valve and by-pass valve open and blinded off.

6.9.10 All plain test blanks required for field testing shall be provided and/or made in the field according to NOEC-SD-50-01.

6.10 Measures to be Taken after Hydrostatic Testing

- 6.10.1 After hydrostatic testing is completed and approved by the inspector, the system shall be depressurized.
- 6.10.2 After depressurizing, lines and equipment shall be completely drained. The equipment should be cleaned, if necessary (in the opinion of the inspector).
- 6.10.3 While draining, the system shall be vented to avoid a vacuum.
- 6.10.4 Special attention shall be given to points where water may be trapped such as valve bodies or low points.
- 6.10.5 Systems shall be dried after draining. The drying process may be accomplished by blowing warm compressed air through the system or by another method approved by the Engineer.
- 6.10.6 All temporary blanks and blinds shall be removed. 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. Temporary piping supports shall be removed so that insulation and painting may be completed.

6.11 Leaking Welds

Welds or portions of welds that leak during hydrostatic test shall be cut out, rewelded, radio graphed and line shall be hydrostatically tested again at the construction contractor's, expense.

7. PNEUMATIC PRESSURE TESTING

7.1 General

With prior approval by the Engineer pneumatic testing may be substituted for hydrostatic testing if the following conditions apply. Pneumatic test should be specified in pressure test flow sheet when it is substituted for hydrostatic testing.

- a) When special supports or other special arrangements would be required on large, low-pressure lines.
- b) When hydrostatic tests are uneconomical or impractical.
- c) When the possibility exists that piping, insulation, refractory material, or attached equipment might be damaged by water.
- d) When even a small amount of water left in a system, such as a refrigerant system, could be injurious.