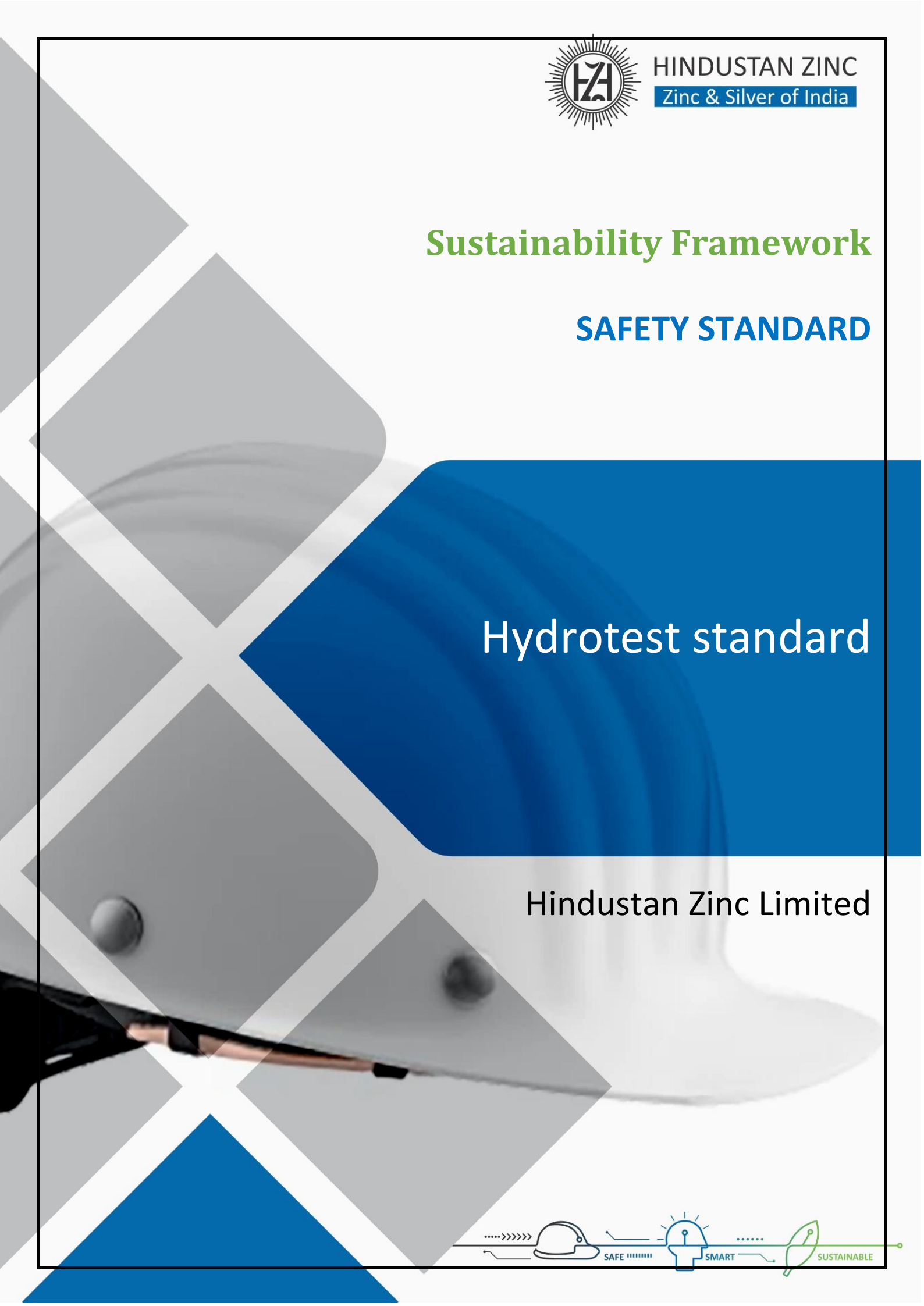
HINDUSTAN ZINC
Zinc & Silver of India

Sustainability Framework

SAFETY STANDARD

Hydrotest standard

Hindustan Zinc Limited



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Name	Mr. Mohammad Parvez Chairman – Hydrotest Safety	Mr C Chandru Chairman - SRP Sub Committee
Sign.		
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Table Of Content

1.0 Title

Hydro Test for all pressure vessel, pipe lines and metallic tank prior to being placed into service, after repair / alteration or for any frequency based legal compliance.

2.0 Purpose

2.1 This procedure gives the requirements for the hydrostatic testing of metallic pressure vessels, pipe lines and storage tanks prior to being placed into service or after repair and/or alteration requiring a new hydro test for any frequency based legal compliance.

2.2 This procedure does not cover pneumatic testing or a combination pneumatic/hydrostatic test of equipment, due to the additional safety precautions necessary to conduct such a test. Pressure testing using gas, steam or air as the pressurizing medium (pneumatic testing) is potentially very dangerous due to the stored energy contained in the test medium and shall only be carried out when the use of hydraulic testing is not possible or recommended by any code / specification.

2.3 This procedure only applies to hydrostatic testing at HZL and is not intended to cover hydrostatic testing at a fabrication or repair workshop.

2.4 Hydrostatic testing is required by:

2.4.1 Factories Rules of Rajasthan States.

2.4.2 Indian Boiler Regulations.

2.4.3 API 620 and 650 for all new equipment before being placed into service.

2.4.4 API 510 and 653 for any vessels and tanks which:

i. have seen major repairs or alterations to the primary pressure containment shell or heads, and

ii. are re-rated to a higher pressure, or

iii. are shut down and taken out of service for maintenance and must be leak tested prior to being placed into service.

iv. HZL Plant procedures which may require critical equipment to be periodically tested to ensure continued integrity.

3.0 Scope

The standard is applicable across the HZL sites to carry out Hydrostatic Test.

4.0 References

- HZL MIQA Standard -HZL/CPSM/MIQA/STD/001
- HZL MIQA Manual Rev 00
- PESO Rule 2002 Amended 2018
- Indian Boiler Regulation
- Factory rule as per Rajasthan State
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- HZL Drawing for pressure vessel and process tank.
- Deferral procedure as per HZL MIQA Manual
- HZL “Confined Space Entry Standard”.
- HZL “PTW” & “LOTO: safety standard
- API 570 – Piping Inspection Code
- API 653- Tank Inspection
- HZL Business Excellence Procedure no 1.4.1 Rev 0 (Shaft Alignment Procedure)
- API 510- Pressure Vessel Maintenance Code - Maintenance Inspection, Rating, Repair and Alteration
- API 620- Design and Construction of Large, Welded, Low Pressure Storage Tanks
- API 650- Welded Steel Tanks for Oil Storage
- API 653- Tank Inspection, Repair, Alteration, and Reconstruction
- API RP 1110- Pressure testing of liquid petroleum
- API RP 572 - Inspection of Pressure Vessels o Vessel Inspection Code API 510 (latest edition) American Petroleum Institute Publishing
- Services, 1220 L Street, N.W., Washington, D.C. 20005 o Recommended Practice No. SNT-TC-1A (latest edition) American Society for on Destructive Testing, 1711 Arlingate Lane, Columbus, OH 43228
- American National Standards Institute (ANSI)
- ANSI/NB-23: Guidelines for in-service inspection of boilers \
- American Society of Mechanical Engineers (ASME)
- Boiler and Pressure Vessel Code - Section 1-Power Boilers, Section VIII-Pressure Vessels and Section X.
- ASME B 31.1 (exclude B-31.11): Standards of Pressure Piping
- ASME VIII, Div.1: Design and Fabrication of Pressure Vessel
- MSS SP (4): Pressure testing of steel valves. o Boiler and Pressure Vessel Code, Section V (latest edition) American Society of Mechanical Engineers
- National Board of Boiler and Pressure Vessel Inspectors
- National Board Inspection Code
- GAD of pressure vessel / tank
- Previous test records of hydrotesting of pressure vessel / tank / piping

5.0 Management Responsibilities

Line management across the HZL has the responsibility to implement this standard whenever applicable.

6.0 Definitions / Acronyms

PESO - Petroleum & Explosives Safety Organization

API - American Petroleum Institute

ASME - American Society of Mechanical Engineers

JSA - Job Safety Analysis

IBR - Indian Boiler Regulation

PSV - Pressure Safety Valve

PRV - Pressure Relief Valve

ASNT - American Society for Non-Destructive Testing

HSE - Health Safety & Environment

NDT - Non-Destructive Testing

MSDS - Material Safety Data Sheet

TPI - Third Part Inspector

PPM - Parts per million

MAWP - Maximum Allowable Working Pressure

MSS SP - Manufacturing Standard

NBIC - National Board Inspection Code

7.0 Minimum Competency Requirements & Accountability:

Sl. No.	Role	Min. Qualification	Min. relevant experience (yrs.)	Mandatory HSE Trg. details	Competency required	Remarks
1	Fitter	ITI/ 5 years industrial experience	5	Safety Training Validity, Training on process hazards, Emergency response and HZL Safety Standards	Training & evaluation on this procedure	Nil
2	Helper	5 years industrial experience	5	Safety Training Validity, Training on process hazards, Emergency response and HZL Safety Standards	Training & evaluation on this procedure	Nil
3	Supervisor	Diploma/ B. Tech (Mech Engg)	5	Safety Training Validity, Training on process hazards, Emergency response and HZL Safety	1. Training & evaluation on this procedure 2. Awarene	Will supervise the work as per this procedure

				Standards	ss on relevant sections of IBR / Rajastha n Factory Rule
4	Mechan ical Mainten ance Engine er	B.E./B.T ech (Mech Engg)	5		
5	Third Party Inspect or (Non-Regulat ory)	BE (Mech) with SNT-TC-1A certificati on / ASME B 31.1 / ASME VIII Div. 1/ ASME Boiler & Pressure Vessel Code / API 510/ API 572 / API /653 as			
6	Third party Inspectors for regulatory		B.E (Mech Engg) Competent Person as per IBR / PESO / Rajasthan Factory Rules		

Mechanical Head is accountable for safe planning and execution of this procedure and the Competent persons (as per above) are responsible to supervise this inspection and testing activity.

8.0 Prerequisites

Process safety hazards associated with inspection and testing activity and the precautions to be taken.

Required PPEs are **Safety PPEs (√/As Applicable)**

SAFETY HELMET	√	COTTON REFLECTIVE	√	SAFETY GLASSES	√
SAFETY SHOES	√	COTTON HAND GLOVES	√	EAR PLUG/ AR MUFF	√
GAS MASK		COTTON DANGRI		DUST MASK	√
BALACLAVA				KEVLAR HAND GLOVES	

Refer the MSDS for the hazardous substance if there is any exposure to the substance during inspection & testing activity.

Hydrostatic testing is potentially hazardous due to stored energy. Personnel may be injured during testing by unexpected bursting of the vessel wall, connection blanks flying off or supports failing under load. (engineering in charge should confirm the HT pressure of each system based on allowable code calculations)

For these reasons as a minimum the following safety precautions must be taken before and/or during any hydrostatic test:

• To meet regulatory requirements, a Competent person as per Govt. shall supervise, conduct and certify the testing of pressure vessel or tank which is under the jurisdiction of the regulating authority. In all other cases, the Competent person shall be a qualified engineer certified as per

- API 510, 572, 575, 650, 653 as applicable.
- For any hydrotesting requirement arising from repairs or alterations, ensure that there is a valid and approved management of change decision where required by the *HZL Procedure for Management of Change-Technical/Facilities,* or where required by the HZL *MIQA Manual (Repairs & Alterations).*
- Only for non-regulatory testing, if field alterations or repairs, process incompatibility,

equipment size, or equipment configuration prevent the performance of a hydrostatic test, a "Hydrostatic Test Waiver" specifying an alternate non-destructive test method (like radiography, shear-wave ultrasonic thickness testing, or fit up and root pass inspection must be completed and approved by the Authorized Competent Person or ASME / API inspector. Further, such hydrostatic test waiver shall be subjected to a decision as per *HZL Management of Inspection, Testing, and Preventive Maintenance (ITPM Deferral) & Deviations procedure* (Unit Head/Project Head).

• Hydrostatic Testing of Pressure Vessels, Pipe lines and Tanks, is carried out using a liquid, usually water, as the pressurizing medium as it is the least dangerous method. For details of test fluid for hydrotesting, refer Annexure-1 *Test Fluid.*

• Refer Annexure-2 *Test Criteria* for determining criteria for specifying the test pressure and other criteria for hydrotesting.

• Ensure JSA is available and being communicated prior to commencing Hydrostatic test activity.

• Use hard barricading around the equipment to prevent unauthorized access.

• Blank off all connected piping and instruments and lock out all connected equipment.

• All the pipes, fittings, pressure gauges, pressure relief valve, gaskets, manual bleed valve shall be higher rating than the hydrostatic pressure, generally it should be 1.2 to 1.4 times higher than the hydrostatic pressure. (Piping system is based on PMS (Piping material specification) and VMS (Valve material specification), similarly the nozzle selections are based on ASME or related calculations. The HT temporary manifolds shall minimum meet the PMS requirements.

• Use HT 10.9 bolts only for flanges fittings.

• Ensure all blanks and plugs are secure by checking for loose bolting or threads, Inspect the threads before use or replace the damage fittings before the test. After tightening min two threads shall be out. Gaskets shall be as per the PMS. (Spiral wound gasket (SPWD) shall not be reused in any case)

• Protect all equipment against overpressure.

• Ensure the Vessel, Piping system or Tank is free from dirt, debris and any foreign substance. To ensure the foreign material and debris inside the pressure part, it should be flushed before performing hydro test.

• Identify any hazardous chemicals that may remain in the Vessel, tank & Piping systems and flush the system before performing hydro test. Wear the required personal protective equipment as applicable.

• Ensure the person operating the pressure source is in a safe position away from the equipment in case of a sudden failure, not insight of line of fire. Neither the tester nor anyone

else should be underneath a large tank or column during the test because of danger of collapse; if close viewing is needed, use a remote viewing device.

• Ensure all personnel conducting the test are wearing suitable and mandatory personal protective equipment.

• •Repair all known cracks or wall thickness below minimums prior to the hydrostatic test.

• • Ensure to perform NDT (DPT/MPT/UT/RT) of all repaired and welded joints before performing hydro test.

• • System test pack need to be created for each case. The file shall contain the applicable drawings and stage wise inspection details including NDT, physical and other inspection details with full positive tracing to the material used. In case of piping, line history sheet is a must. As recommended by EIC, the items like in line instrument etc. can be dropped with suitable blind or caps as defined in the PMS. Hydrostatic test medium shall be clearly specified with chloride content depending on the metallurgy.

• Manifold provided with end caps suitable for the system pressure testing shall be prepared. It is recommended that all joints in a test manifold are of welded type and should be subject to 100% non-destructive examination by MPI and

Radiography. Pressure relief valve of adequate capacity to relieve the system of any overpressure. A manual bleed valve for emergency bleeding and depressurization of the piping system, should the relief valve fail. A pressure gauge, pressure recorder and temperature recorder connection. The pressure gauge should be calibrated preferably within 4 weeks of the test being carried out. The hydrotest pressure should preferably fall within 35-75% of the full range of pressure gauge. A connection to connect the hydrotest pump to the manifold.

• A connection to connect the test manifold to the low point of the piping system for filling and pressurization. All valves and fittings on the manifold shall be of the next higher rating. The strength of the test manifold should be validated by testing the manifold between 1.2 to 1.4 times of its rated system test pressure.

• A pretest check shall be made to ensure that support “contact” has been achieved at all support locations. This includes temporary supports provided only for hydrotest. The temporary supports should be designed (specially for large bore heavy piping) to ensure they are able to sustain the hydrostatic loads. Scaffolding shall not be used as temporary support in any case. Removal of temporary support should be done only after the test is complete and the lines are fully drained.

• All lines shall be checked to ensure the entire system can be completely drained after testing. Vents or other high point connections shall be opened to displace air from lines once the water filling starts during the hydrostatic test.

• All joints including structural attachments shall be left uninsulated/primed and exposed during hydrostatic testing.

• All equipment which are to be excluded from the test shall be either disconnected from the system or positively isolated using spectacle blinds or blind flanges.

• Expansion joints, bellows and spring supports shall be provided with temporary restraints or stops to prevent excessive travel or deformation under the hydrostatic test loads.

• In-line valves should be in fully open position during the hydrostatic leak test.

• Orifice plates, spray nozzles and similar restrictions should normally be installed after completion of tests.

• All temporary gaskets are to be changed with permanent ones and signed off.

• Prefabricated spacers and spool pieces shall be fabricated and supplied to the correct test pressure rating by the contractor for replacing in-line instrumentation during plant testing and flushing, except for equipment such as control valves, with butt welding ends (which will be installed initially without internals and provided with a blind flange).

• Special attention shall be given to the provision of spacers and spool pieces required for equipment packages.

• • Use the larger vent nozzle with respect to drain nozzle possible when draining the equipment after the pressure has been brought to atmospheric to prevent a possible vacuum from building up inside the equipment and causing a collapse. This is especially important for API type storage tanks.

• • Ensure all plant safety procedures are observed / followed.

• • Ensure permit system is in place with safety personnel

• • Follow check list as per Annexure – 6.

9.0 Tools & Test Equipment Required and Spare parts

• Hydro Test Skid set as per attached Annexure - 5.

• • Hydrostatic pressure pump-manual or powered (For pressure vessels only).

• • Test blanks or blind flanges with HT bolts and gaskets for all nozzles and manways.

• • Calibrated test gauge with shutoff valve and a range of 1.5 to 4 times test pressure. The gauges should have a current calibration date per site procedure. (Calibration certificate must be present)

• • Blanks and blind flanges for isolating the equipment should have TC.

10.0 General Guidelines

Testing shall only be performed under the direct supervision of a Responsible Person. All personnel involved with testing shall be

aware of, and trained in, the procedures to be implemented, and familiar with the hazards and risks associated with the activity.

Equipment when brought up to test pressure shall not be approached for close examination until the pressure remains stable and a reasonable duration has elapsed. The pressure at which equipment can be safely tested, and subsequently may be approached for close examination shall be specified in the test procedures.

The test medium must be compatible with the equipment materials e.g. if austenitic stainless-steel materials are being tested, the water shall preferably be distilled or de-mineralized and contain less than 50 PPM (unless otherwise specified) of chloride ions.

The testing of carbon steels and certain ferrite alloys shall not be undertaken at low temperatures otherwise brittle fractures may occur. For further details, the Inspection Practices Manual and Site Inspection Engineer may be consulted. The maximum and minimum temperatures permitted during the test must be determined prior to work commencing.

Equipment shall not be subjected to any form of shock loading such as hammer testing during pressure testing operations. Test equipment must be in sound condition, properly installed / supported and connected, and must be of the correct pressure rating for the job.

Only calibrated pressure gauges must be fitted to equipment under test to ensure accurate measurement of the test pressure during the test. Prior to pressuring, the equipment to be tested

must be thoroughly examined e.g. for isolation, drains closed, vents open/shut as required etc. Prior to testing, drawings shall be made available showing the limits of the test, Mechanical Clearance and all other Non-Destructive testing shall be completed.

<u>Applicable for both Smelter & Mines</u>

Every pressure vessel or plant in service shall be thoroughly examined by a competent person:

- **Externally, once in every period of 6 months (Thickness)**
- **Internally, once in every period of twelve months (Thickness)**
- **If by reason of the construction of a pressure vessel or plant, a thorough internal examination is not possible this examination may be replaced by a hydrostatic test which shall be carried out once in every period of two years:**

Provided that for a pressure vessel or plant in continuous process which cannot be

frequently opened, the period of internal examination may be extended to four years; hydrostatically tested once in every period of four years , provided systematic non-destructive test like ultrasonic test for metal thickness other defects of all parts DP, the failure of which might lead to eventual rupture of the pressure vessel or plant shall be carried out) to be taken every year after the Hydo test due date (2 years) .Within 4 years Hydrotest of any pressure vessel & internal examination must carried out.

The hydrostatic pressure to be carried out for the purpose of this rule shall be 1.25 times the design pressure or 1.5 times the maximum permissible working pressure whichever is less:

11.0 Inspection & Testing Steps

11.1 Strategy

Include failure modes and tests that can detect the failure modes. Mention the frequency of testing (*refer the ITPM tables in HZL MIQA Manual Appendices)*

Purpose (regulatory test / barrier function test / failure mode detection)	**Failure mode / damage (if test is for failure mode detection)**	**Basis for test (regulation / code / standard / OEM / reference / FSIPP /**	**Testing strategy (time based / condition based / risk based)**	**Frequency of testing**	**Test type (offline / online)**	**Inspection & Test details**
Regulatory per PESO	Not applicable	Rule 126 of The Petroleum Rules, 2002	Condition based	Prior to commissioning of new tank; Upon repair of tank	Offline	Refer Rule 126 of Petroleum Rules, 2002
Regulatory as per IBR	Rajasthan Boiler Rules 1954 (including latest amendment),		Time Based	Prior to commissioning of boiler, every year and upon	Offline	Chapter IX of Indian Boiler Regulation 1950

	Indian Boiler Regulation 1950		repair whichever is earlier		
Regulatory as per Factories Rules	Rajasthan Factory Rule 1951 (including latest amendment)	Time Based	Prior to commissioning of pressure vessel, four year and upon repair	Offline	Rule no. 58 (7) of Rajasthan Factory Rule 1951

11.2 Hydrostatic test general procedures

A specific hydrostatic test procedure must be written for each application but in general the following guidelines should be followed in developing specific procedures in addition to the safety precautions enumerated in Section 8. A general safety and procedure checklist are given in Annexure - 6 and a Hydrostatic Test Report is given in Annexure – 4

Testing at or below equipment MAWP-The equipment's existing overpressure protective device may be used

Filling of vessel / tank / pipe lines

• Flushing by fresh water / potable water shall be carried out for all piping / equipment in prior to hydro-testing to clean all dirt & construction debris or other foreign matters if any till achieving requisite water parameters.

• In general, the vessel, tank, piping or piping system must be filled with water or alternative test fluid and all air vented before the hydrostatic test. A high point vent nozzle(s) must be used to vent all air. It is preferable to fill the tank or vessel using the lowest available nozzle such that there will be less turbulence in filling the equipment which could entrain air which must then be vented. If a top nozzle must be used, adequate time must be added to the test to enable entrained air to escape through the vents. If not vented, this trapped air may make it difficult to attain the final test pressure. In addition, the test fluid should be pumped or flow by gravity into the test equipment and must never be pneumatically pressurized during filling operations. Before filling is started, all vents must be open and a method to monitor the filling progress initiated, for example, by viewing through an open nozzle or manhole, or through use of a level gauge etc. Filling should be conducted at a controlled rate to minimize turbulence and the rate should be substantially reduced when the equipment is nearly full to prevent excessive spillage of test fluid from open vents.

Test setup

- Where vessels, tanks and heat exchangers are to be pressurized, the application of the test pressure must be in a controlled manner. To achieve this, manual or powered test pump with gauge and drain valve shall be used. It is essential that excessive pressure not be applied during the test. Consider two different cases:
- • Testing above equipment's MAWP-There are these alternatives:
- 1. Use a manually (hand operated) powered or a carefully controlled pneumatically driven pump, with test pressure carefully monitored and recorded.
- 2. Use a pressure relief valve / rupture disc set at hydrostatic test pressure x 1.05.
- 3. Note that for testing above MAWP if pressure exceeds 1.05 x test pressure even momentarily then there must be a fitness-for-service (FFS) evaluation by third party before the equipment is returned to service
- Use of a higher-pressure source of fluid supply such as a water supply header with a pressure regulator is not acceptable due to the possibility of instrument failure. The pump piping to the equipment shall be equipped with a valve downstream of the pump and the pressure gauge shall have its own shutoff valve. In addition, a pressure gauge located at the high point of the equipment shall be installed to monitor the test pressure. This gauge must be easily visible and have a range from 1.5 to 4 times the expected test pressure. High point vents with valves should be provided. For atmospheric tanks to be filled to the roof or top angle only, the roof manhole should be opened, or the largest roof nozzle opened, for venting and monitoring of the liquid level in the tank.

For atmospheric tanks with side overflows, the overflow may be shut if the liquid level in the tank does not exceed the top angle or top tangent line during the test. For such tanks a secure way of monitoring the liquid level must be in place to ensure this level is not exceeded.

Application of pressure

After the vessel, pipe lines or tank, is filled the supply liquid valve is closed and positively disconnected. With someone monitoring the pressure gauges, the test pump is operated slowly to bring the pressure in the equipment to first 25% and then to 50% of the design pressure and a gross check for leaks observed. If there are no leaks the pressure is raised to the design pressure and the equipment is again checked for leaks. Finally, if there are no leaks at the design pressure, the pressure is raised to the test pressure and held a maximum of 30 minutes with reference to REG-379 IBR 1950) unless otherwise specified. If the pressure holds steady for test pressure for test duration, then it may be lowered to the design pressure and checked for leaks again. If during the hydrostatic test any weld leak is observed then the test must be stopped, the equipment shall be drained, and the weld repaired before a new hydrostatic test is held. If flanges are observed to be leaking, the pressure should be lowered to atmospheric pressure. Then they shall be retightened to stop the leak and the pressure raised to the final pressure. The equipment must complete the hydrostatic test without any leaks during the hold period. For flat bottom tanks, the liquid level shall be slowly raised to the

desired level including the use of standpipes to simulate small internal pressures in low-pressure tanks. For low pressure and atmospheric tanks, the leak checks may be made at the end of the hold period at the full test liquid level in the tank.

Draining of vessel / tank / pipe lines

At the end of the hydrostatic test and leak examination, the pressure in the vessel, piping system or tank is released using the vent valve gradually. When the top gauge reads zero pressure the vent valves should be opened fully to release any residual pressure in the equipment not indicated by the gauge. Once the equipment is fully vented, the main drain valve may be opened, and the liquid contents drained to an approved location. Care should be taken that the vents are enough to prevent any vacuum from building up in the equipment due to the drain flow being larger than the vents can accommodate. Thus, the vent nozzle(s) should always have a larger area than any drain nozzle. After pipe lines / tank or vessel is fully drained, the use of hot air or nitrogen or hand drying may be necessary to completely dry out the equipment before being placed into service, especially if the test fluid will react with the process fluid or cause corrosion in the equipment. Some equipment, e.g. stainless steel, requires mopping down to ensure complete removal of water. In case of piping system use hot air, nitrogen and compressed air (oil free dry air if called for by the customer specification) / cardboard blasting may be necessary to completely dry out before being placed into service, especially if the test fluid will react with the process fluid or cause corrosion

11.3 Steps

Step	Action
1	**VERIFY** that Isolation of the system has been completed under Permit to Work, and that the pressure vessel / tank and associated piping has been emptied for the test.
2	**CONFIRM** the LOTO has been applied
3	**REMOVE** the applicable valves, piping as per the plant line break procedure.
4	**VERIFY** that the instruments and equipment (hydrotesting apparatus including pressure gauge) used for hydrotest are having valid test / calibration and record the test / calibration certificate number and validity date.
5	Review the test procedure in section 14.2 along with specific hydrostatic test procedures for the specific test to be conducted. The test procedure should be on the Hydrostatic Test Report form (Annexure - 4).
6	Follow the steps in Annexure - 6, “Hydro Test Checklist” and complete the checklist as work progresses.
7	Document the work by completing the “Recorded Work part of the “Hydrostatic Test form (Annexure - 4), sign and date the form as the Examiner, and provide it to the Authorized Inspector.
8	**SAFELY DRAIN** the pressure vessel / tank / pipe line to safe location in relevant plant drain.

9	**VERIFY** that the pressure vessel / tank / pipe line has been tested successfully with a valid inspection and test record, and that any anomalies have been rectified and recorded as completed.
10	**REMOVE** all test equipment and any temporary blanks, covers and inspect the location to clear any debris.
11	**CONNECT** the applicable valves, piping and make sure to reinstall all drain, vent, tracing, insulation, supports, etc.
12	**VERIFY** the current conditions (Field Operator to verify the pressure vessel / tank and associated piping is properly lined up and ready to take into process operation).
13	**COMPLETE** the post - test & inspection documentation.

End of Procedure Steps

12.0 Acceptance Criteria

The equipment shall withstand the hydrostatic pressure test for hold time as specified in the test procedure at a test pressure as specified in clause no. 19.1

13.0 Post – test Actions

The hydrotest report shall be reviewed and signed off by the Authorized Competent person (either by regulation or by code as applicable).

In case the hydrotest has been unsuccessful, isolate the pressure vessel / tank / pipe lines and perform RCFA to identify the causes of failure. After closing out the deficiencies, repeat the hydrotest for successful acceptance of results. Handover to operations only after successful hydrotest results are obtained

14.0 Post – task Documentation

- Raise notifications to close out the deficiencies, if any.
- Also refer relevant section(s) on Test & Inspection Documentation of HZL MIQA Manual.
- The result of every hydrotest of pressure vessel shall be recorded suitably and signed and dated by the competent person who is conducting the hydrotest).
- Record of hydro test to be updated in SAP system as applicable
- Chapter IX of Indian Boiler Regulation 1950.
- Rajasthan Factory Rule 1951 (including latest amendment)- Rule no 58 (7) of Rajasthan Factory Rule 1951
- For storage tanks under jurisdiction of PESO, the result of every hydrotest of tank shall be recorded in tank test certificate (refer Rule 126 of The Petroleum Rules 2002).

Standard Renewal Process

This standard shall be reviewed and revised as necessary and, at a minimum, not later than two years from the date of the last revision.

15.0 Annexure 1: Test Fluid

Hydrostatic testing requires that the pipe lines / vessel / tank be filled with an appropriate liquid. This liquid is general clean, low chloride water but may be other liquids if the presence of water would adversely affect the future use of the equipment or is incompatible with the materials of construction or process fluids. The water may also be treated with additives such as fluorescent dyes or surface tension reducers to aid in the location of leaks during the test.

For detailed requirements for water quality check and for additional details regarding water, corrosion problems, and alternative liquids, check with process technology team. However, the general requirements for test water quality are given below.

Water quality

Water used for a hydrostatic test if left in equipment can cause significant problems. In cold climates, distortion and rupture may be caused by freezing of the water. The water may promote general corrosion or microbiological corrosion. Residues of chloride left on the surface may lead to stress corrosion cracking. Consequently, it is essential to ensure all water is drained and the equipment thoroughly dried immediately after testing, or at least within 72 hours of test completion.

Whenever possible, good quality water should be used for Hydrostatic test. Good quality water encompasses demineralized water, steam condensate, or potable (drinking) water containing less than 50 ppm chloride. Even when good quality water is used, it should be drained from the equipment and the equipment effectively dried so that long-term damage, such as microbiological corrosion does not occur.

The following considerations are required when selecting water for Hydrostatic test:

- • Water quality. Table 1 and Table 2 below summarize risks associated with different types of water and equipment.
- • Equipment type. Heat exchanger shell sides, coils and jackets on equipment always require the minimum essential level of water quality, i.e., clean potable water with less than 50 ppm chloride, or better.
- • Exposure length. Where microbiological corrosion is a factor, equipment should be drained and dried within 72 hours of testing.
- • Water removal. After draining, equipment should be dried using warm air or nitrogen at a maximum temperature of 49°C, (Exceptions shall be approved by concerned authority). With stainless steel equipment, mopping down is required to assure complete removal of water.

• • Material of construction. For carbon steel, and stainless steel/aluminium use Table 1 and Table 2, respectively for guidance. For other materials of construction, consult a materials engineer.

Table 1. Water quality guidance for carbon steel equipment

Water Type	Equipment Types	Corrosion Risk level	Actions
Demineralized water or steam condensate	All	Acceptable	Drain and dry within 72 hours
Clean potable water with <50 ppm chloride	All	Acceptable, minimum essential level of water quality	Drain and dry within 72 hours
River	Storage tanks, vessels	Moderate	Flush with demineralized water or steam condensate, drain and dry within 72 hours
Brackish or sea water	Storage tanks	High	Consult materials engineer

Table 2. Water quality guidance for stainless steel and aluminium equipment

Water Type	Equipment Types	Corrosion Risk Level	Actions
Demineralized water or steam condensate	All	Acceptable	Drain and dry within 72 hours
Clean potable water with <50 ppm (unless	All	Acceptable, minimum essential level of	Drain and dry within 72 hours

otherwise specified) chloride		water quality	
River	Storage tanks	Moderate to high	Flush with demineralized water or steam condensate, drain and dry within 72 hours
Brackish or sea water	None	High	Consult materials engineer

16.0 Annexure 2: Test Criteria

16.1 Test Pressure

For regulatory testing, refer the respective regulations for specification of the hydrotest pressure. As per applicable regulatory authorities. (MMR/Factory rules/IBR)

For **non-regulatory testing**, for new pressure vessels including heat exchangers stamped to the ASME Code, the hydrostatic test pressure is generally 1.25 (1.25 for Section VIII, Division 2 or 1.1 for Section X) times the MAWP times the stress ratio at test temperature to design temperature. This pressure is usually measured at the top of the vessel in the installed position, or if the test is done in horizontal position or the test gage must be located at the bottom of the vessel for convenience, the additional pressure due hydrostatic head is added to the test pressure. When vessels are being pressurized, the test pressure shall be obtained gradually. For pressure vessels that have been repaired, or altered, the test pressure should equal the original hydrostatic test pressure. For vessels being placed back into service after routine maintenance, the test pressure need only equal the design pressure. For pressure vessels being tested above the MAWP, after the initial hold period, the test pressure may be reduced to the design pressure and the vessel inspected for leaks at flanged joints or welds. In no case shall a leak test be conducted at greater than the design pressure. Tests pressures on heat exchangers are applied to one side only with the other side drained and open. For shell side pressure tests, it is desirable to remove the bonnets or channels, if possible, to assist in checking for leaks of tube-to- tube sheet joints.

16.2 Metallic Tanks

For API type flat bottom tanks, the tanks are filled to the top angle only at atmospheric pressure. For tanks with floating roofs the tank is filled to the design liquid level only. If the tank is designed for small internal pressures, the test liquid may be filled only into the roof area such that the liquid height above the top angle equals the design internal pressure. This prevents any pressure in the roof from lifting the shell and “oil canning” the bottom of the tank. For tanks with properly designed roofs and bottoms held down by anchor bolts or stiffened by dunnage, the test fluid may be brought to higher levels to simulate the design internal pressure. However, in no case should an API tank be tested at more than the design pressure of the tank.

Non – Metallic Tanks

For flat bottom non-metallic tanks, filling to the top tangent line only is permitted unless the tank is designed for an internal pressure. If the tank is designed for an internal pressure the test liquid may be filled into the upper roof area such that the liquid height above the tangent line equals the design internal pressure. For fiberglass tanks only with properly designed roof and anchored bottoms or dished bottoms, the tank may be filled to the top of the roof to simulate the design internal pressure. An additional test pressure of no more than 1.1 times

the design pressure may be added on top of a filled tank.

16.316.2 Test Temperature

The temperature of the test fluid and the equipment during the test shall be a minimum of 20°C above the minimum design metal temperature but not more than 50°C to minimize the risk of brittle fracture.

16.416.3 Test Conditions

Hydrostatic tests shall be conducted in dry conditions at temperatures above freezing unless special precautions have been taken to prevent the test fluid from freezing and the test temperature is at least 17°C and above the minimum design metal temperature. In no case shall the test be conducted during precipitation in an unprotected outdoor location.

16.516.4 Test Duration

Unless otherwise specified by the test procedure, the maximum hold time at test pressure shall be 30 minutes. For a tank, it shall be maintained full of water for 24 hours or longer to check for foundation settlement under load. For vessels, and Tanks undergoing acoustic emission testing conducted in conjunction with a hydrostatic test, the test duration is typically longer than 30 minutes as the pressure is gradually brought up to test pressure in stages and measurements taken.

17.0 Annexure 3: Inspection & Testing Training Evaluation

Title: Hydrotesting of _____ PSM critical equipment.

Objective: Technician will be able to safely perform Inspection and Testing of _____PSM critical equipment which is part of _____UIC / process / system / package.

QUALIFICATION:

Examinee: _____Employee#_____ Qualified: Not Qualified:

Comments:

_____
_____ _____Total time for training evaluation: Hrs. Minutes_____

Examiner: _____ Date: _____

REVIEW:

Reviewed by Training Facilitator: _____ Date: _____

Reviewed by Area Supervisor: _____ Date: _____

Scoring Instructions:

a. Check off each item on the Scoring Sheet “yes” or “no” as the Examinee performs the work or explains the hazards, PPE, etc.

b. If examinee does not answer / demonstrate each question a "Not Qualified" score will be given and a re-take period will be determined

c. Make notes that would be helpful in discussing the results of the training evaluation.

Description	**YES**	**NO**
Explain:		
- Precautions & prerequisites required for inspection and testing of XX PSM critical equipment		
- The hazards associated with this inspection and testing activity		

and the required PPEs to protect from hazards

Locate:

- Safe Inspection & Testing Procedure No.
- Required materials, tools & equipment

Demonstrate:

- Safe isolation, removal, disassembly, re-assembly, reinstallation and de-isolation of the XX PSMCE
- Correct performance of inspection & testing of the XX PSMCE as per the laid down procedure
- Proper work practices (such as right tool, correct torqueing, etc.)

18.0 Annexure 4: Hydrostatic Test Report System Description

Business Unit: Equipment Name or System:

Equipment No: Work Order No:

Pipe Code: Fluid Service: Drawing No:

Boundary Description: (Drawings ☐ Are, or ☐ Are Not Attached)

Test Description/Requirements

☐ Hydrostatic ☐ Other _

Test Procedure:	Test Medium:	Test Pressure:	Test Hold Time:
Design Pressure:	Start date & time:	End date & time:	Duration:

Other Requirements:

☐ For tests above the MAWP do not exceed 1.05 times the test pressure

☐ For Leak tests, the Hold Time is the time taken to visually inspect all weld joints

☐ Others: (specify) _____

_

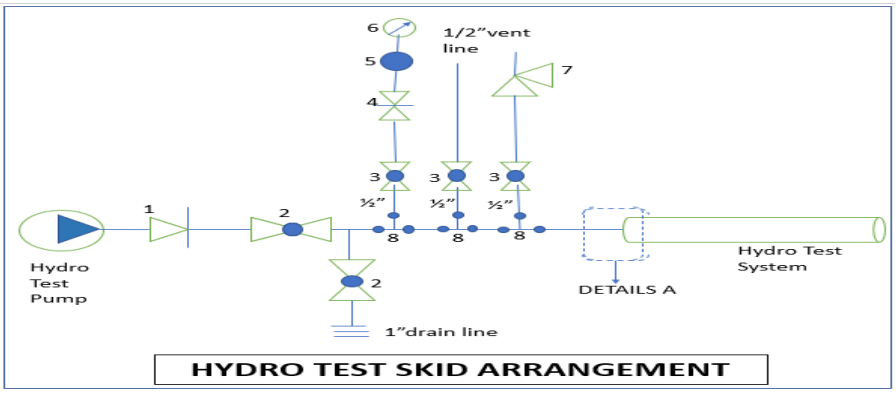
Recorded Data

Pressure Gage No.	Range:	Calibration Validity Date:	Calibration Certificate No.	Pressure Gage No.	Range:	Calibration Validity Date:	Calibration Certificate No.
Time	Test Pressure	Time	Test Pressure	Time	Test Pressure	Time	Test Pressure

Pressure-Temperature Recorder No. Calibration Validity Date: Calibration certificate no. Range:

Comments, Exceptions, Etc.

19.0 Annexure 5: Hydro Test Skid Arrangement

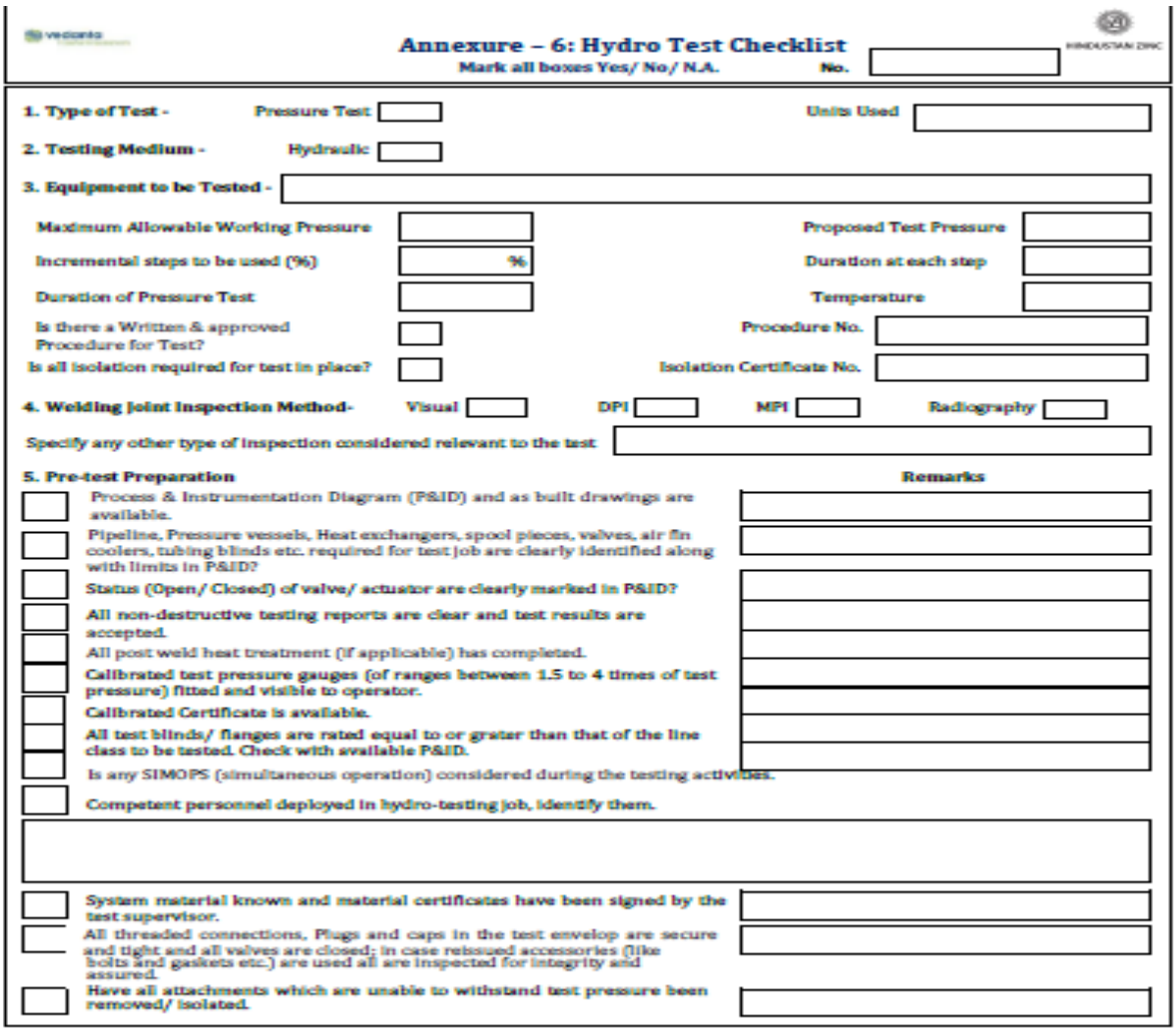


Details A	Note
Thickness of blind plate is 2 times thickness of pipes thickness	All connection to be welded except details A . Details A section Flange joint with proper flange guard accepted HT 10.9 grade bolt , nut with washer
	100% DP testing to be performed for all joints
	All valves are #1500
	All pipes are schedule 80
	Test kid testing pressure upto 200 Kg/cm2

Bill of Quantity for one set of Arrangement: REF. NO.	QTY. (NOS.)	DESCRIPTION
1	1	1" NRV
2	2	1" GLOBE VALVE
3	3	½" GLOBE VALVE
4	1	½" NEEDLE VALVE
5	1	CONDENSING LOOP
6	1	PRESSURE GUAGE

7	1	SAFETY VALVE
8	3	1" * 1/2" REDUCER TEE

20. Hydrotest checklist



Annexure – 6: Hydro Test Checklist

Mark all boxes Yes/ No/ N.A. No.

1. Type of Test - Pressure Test ☐ Units Used
2. Testing Medium - Hydraulic ☐
3. Equipment to be Tested -

Maximum Allowable Working Pressure | Proposed Test Pressure
Incremental steps to be used (%) % | Duration at each step
Duration of Pressure Test | Temperature
Is there a Written & approved Procedure for Test? | Procedure No.
Is all isolation required for test in place? | Isolation Certificate No.

4. Welding Joint Inspection Method- Visual ☐ DPI ☐ MPI ☐ Radiography ☐

Specify any other type of inspection considered relevant to the test

5. Pre-test Preparation — Remarks

- ☐ Process & Instrumentation Diagram (P&ID) and as built drawings are available.
- ☐ Pipeline, Pressure vessels, Heat exchangers, spool pieces, valves, air fin coolers, tubing blinds etc. required for test job are clearly identified along with limits in P&ID?
- ☐ Status (Open/ Closed) of valve/ actuator are clearly marked in P&ID?
- ☐ All non-destructive testing reports are clear and test results are accepted.
- ☐ All post weld heat treatment (if applicable) has completed.
- ☐ Calibrated test pressure gauges (of ranges between 1.5 to 4 times of test pressure) fitted and visible to operator.
- ☐ Calibrated Certificate is available.
- ☐ All test blinds/ flanges are rated equal to or grater than that of the line class to be tested. Check with available P&ID.
- ☐ Is any SIMOPS (simultaneous operation) considered during the testing activities.
- ☐ Competent personnel deployed in hydro-testing job, identify them.
- ☐ System material known and material certificates have been signed by the test supervisor.
- ☐ All threaded connections, Plugs and caps in the test envelop are secure and tight and all valves are closed; in case reissued accessories (like bolts and gaskets etc.) are used all are inspected for integrity and assured.
- ☐ Have all attachments which are unable to withstand test pressure been removed/ isolated.

☐	Any Piping supports / expansions joints hose are fitted with temporary restraints such as whip check as applicable.	
☐	Piping field test reports are signed by mechanical engineer and welding inspector, in case of new installed.	
☐	The Test section has been isolated from all other sections and all valves in system are open.	
☐	The integrity of all attachments e.g. valves and threaded connections checked and confirmed in compliance.	
☐	All temporary piping test head and other equipment connected to test section have been pre-tested.	
☐	Pressuring equipment is fitted with regulator and relief valve, and in good condition. All relief valves are checked and assured to 1.05 times of test pressure.	
☐	Vent and drain points identified and accessible.	
☐	Are all NRVs in the test envelope installed inline with test medium flow, or locked open.	
☐	The test section has been filled completely and air has been vented off.	
☐	Inline safety valve in equipment to be remove or locked.	
☐	All newly welded joints in the system have been left exposed (not painted, in case for Hazardous / Poisonous fluid services) and are accessible and dry.	
☐	Disposal of Hydro-test water is identified.	
☐	All debris shall be removed from all the pressure parts before testing.	
☐	Access and egress to test site clear of obstructions	
☐	Warning signs 'Pressure Test In Progress' and barriers are erected, PA announcement to be made.	
☐	All necessary personnel at test site have been informed of commencement and duration of test.	
☐	The supervisor operating the pressure equipment has been instructed of the limiting pressure applying to test.	
☐	Barricade area and restrict movement to authorized personnel only.	
☐	If it is non-routine, all controls as per Job Safety Analysis (JSA) in place. Provide JSA No.	
☐	If it is non-routine, additional control specified in Permit in place. Provide Permit No.	
☐	Additional Control as per Rescue Plan in Place. Provide Rescue Plan No.	

☐ Additional Hazard and its control measures

S. No.	Hazards	Control	Controls in place Yes/ No	Remarks
1.				
2.				
3.				
4.				
5.				

6. During Testing — **Remarks**

☐	Ensure no PTW pending in concerned system, all related PTW was closed.	
☐	All the agencies and maintenance department are to be informed about the hydro test schedule.	
☐	The field engineer along with maintenance person to check the total system to ensure that no work is going on and all men are cleared from pressure part vicinity.	

- ☐ Ensure Area barricading to keep personal at a safe distance and elevation, and only authorised person to allow.
- ☐ Ensure availability of pressurisation pump with valid inspection certificate.
- ☐ System flushing to be done before conducting hydro test to ensure removal all the debris from pressure parts.
- ☐ Hazardous chemical that may be remaining in the system have been identified and removed and completely flushed out.
- ☐ Identify and eliminate any extraneous water dripping in boiler area to avoid confusion of water source later during pressure checks.
- ☐ Ensure water temperature in the range of between 20 to 50 degc.
- ☐ Ensure all instruments are isolated if test was done above 1.5times of design working pressure.
- ☐ Maintain minimum flow rate during filling water in system to avoid any stress.
- ☐ After enough water is coming from vent, tightly close vent valve.
- ☐ Start pressuring of system through pressure pump.
- ☐ Ensure rate of rise of pressure is maintained at ≤0.2 to 0.3 mpa/min, in case of boiler rising rate not more than ≤1mpa/min.
- ☐ Hold pressure rising at 25%, 50% of test pressure step by stem and check system thoroughly for any leakage.
- ☐ If found any leakage fully depressurised and drain the system and arrest leakage.
- ☐ After arresting leakage start test procedure again from starting.
- ☐ After reaching 50% of system pressure, ensure no one shall allow to go nearby system.
- ☐ After reaching design working pressure of the system reduce pressure rising rate and set to ≤0.1mpa/min.
- ☐ When final hydrotest pressure is reached, closed the discharge valve of pressuring pump and check for 30minute for holding pressure in System.
- ☐ If pressure was hold and after getting clearance from in charge, start de-pressuring of system through drain point.
- ☐ When system pressure reaches 25% of normal working pressure thoroughly check system again for any seepage/leakage.
- ☐ After getting clearance de-pressurise the system further.
- ☐ After de-pressuring the system open vent and, drain the system.

7. Post-test Requirement

	Remarks
☐ Vents to be used for slow depressurization identified and fit for purpose	
☐ Drains to be used for draining of test medium identified and fit for purpose	
☐ Test medium disposal method clear and in line with site and company environmental requirements	

8. Site Restoration

- ☐ All pressure test equipment removed from site
- ☐ All liquids drained from test envelope
- ☐ All potential trapped pressure areas clear e.g. NRV's
- ☐ All required Inspection activities complete
- ☐ All service test points identified and tagged
- ☐ All isolated or clamped valves re-instated
- ☐ Pipe support spring/hangers correctly adjusted
- ☐ Joint / Flange check list register updated
- ☐ Equipment removed for test can be re-instated
- ☐ Any orifice plates to be re-instated
- ☐ Flange / Joint Tape can be removed
- ☐ Test Equipment Calibration date available
- ☐ All drain valves and vents closed
- ☐ Test Certification sheet(s) completed
- ☐ All clamps, or additional supports removed
- ☐ Pressure Record is available
- ☐ Drying programme complete if applicable
- ☐ Preservation required, if applicable
- ☐ If any Maintenance, record is available
- ☐ Work Permit signed off
- ☐ Insulation / Cladding can be re-instated
- ☐ Excavated pipework can be recovered
- ☐ All barriers and signs removed

8. Lessons Learnt, if any

9. Checked By

Name		**Signature**	
Title		**Date**	
☐ **HZL**		**Name of BP**	
☐ **Business Partner (BP)**		**Project Name**	