INTERPLANT STANDARD - STEEL INDUSTRY		
IPSS	**INSPECTION OF UTILITY PIPE LINES**	**IPSS:1-06-038-17** ***(First Revision)***
	Corresponding IS does not exist	Formally – IPSS:1-06-038-01

0. FOREWORD

0.1 This Inter Plant Standard has been prepared by the Standards Committee on Pipes, Fittings, Valves and Piping Layout, IPSS 1:6 with the active participation of the representatives of all the steel plants, reputed consultants, was adopted in April 2001 and first revised in July 2017.

0.2 Interplant Standards for steel industry primarily aim at achieving rationalization and unification of inspection of utility of pipe lines used in steel plant. For exercising effective control on inspection, it is advisable to follow strictly the procedure mentioned in this standard and it is not desirable to make any deviations.

0.3 This Inter Plant Standard covers visual inspection; inspection of fittings; mounting & special tests as required.

1. SCOPE

1.1 This interplant standard covers the guidelines for inspection of utility pipe lines in service in Steel Plants. Recommended procedure for visual inspection, pressure tests, special tests and inspection of fittings and mountings is covered in this standard for the guidance of pipe line maintenance, repair planning and record keeping of utility service pipe lines in operations.

1.2 The standard does not cover tests on new pipe lines under construction/yet to be commissioned since they are governed by respective clauses of the design/statutory code/indent specification followed for them.

2. VARIOUS FLOW MEDIA

2.1 In an Integrated Steel Plant, the pipe lines convey various utilities from the source to the point of use. The size, layout and configuration varies with respect to application site conditions and are typical to a particular plant.

The various medium conveyed are :

a) **Fuel gases** - BF gas, CO gas, LD gas, Mixed gas, Acetylene, Synthesis gas, LPG/ Propane, CBM gas.

b) **Other Gases - Hydrogen**

c) **Air/Air products** – Compressed air, oxygen, nitrogen, argon.

d) **Steam** – High pressure, medium pressure, low pressure, process steam/condensate steam.

e) **Fuel oil** – Furnace oil, CTF, LSHS (low sulphur heavy stock) HSD, LDO

f) **Water** – Process/ Industrial water, make up water, drinking water, filtered water, chilled water, DM water, Boiler feed water, soft water.,

g) **Slurry & waste water**.

The flow quantity, operating pressure, operating temperature, allowable pressure and temperature drops vary depending upon the process requirement of each consumer/shop.

3. PIPING MATERIALS

3.1 Varies from one application to another. However, most common piping material for the utility pipe lines in steel industry are :

a) MS/CS pipes of resistance welded/spiral welded construction for transfer of gaseous medium and water system.

b) CS seamless steel pipes for steam, Oxygen application, high pressure Nitrogen and Fuel oil.

c) GI pipes for drinking and sanitation water system.

d) CI pipes for water system.

e) SS/MS rubber lined for DM water/chemicals.

3.2 Piping materials like PVC, HDPE etc, though find use in steel industry; they are not covered under the scope of this specification since their applications are limited to special areas/services.

4. PIPELINE FITTINGS, MOUNTING AND SPECIAL APPURTENANCES

4.1 The following are the most commonly used fittings and mountings on utilities piping systems :

a) Isolation devices – Valves, U seals/water seals, Isolation goggles plates/slipper plates.

b) Expansion joints – Compensators, Dismantling joints, Expansion loops.

c) Drainage system – Condensate drain pots in gas lines, Steam traps in steam lines, Traps/drain lines/seal pots in air lines, Drain lines in fuel oil lines.

d) Vent/purge in system – Vent lines in gas & fuel oil system, Steam/nitrogen purging points, Air release valves in water lines.

e) Safety system – Explosion flaps/rupture disc, Flash back arrestors in acetylene/ LPG/ Propane etc lines, Safety links in oxygen and fuel gas line flanges, Man hole/inspection holes, Pipeline earthing system, Safety Valves.

4.2 Special features in the pipe line system may include :

a) Flow measuring devices

b) Pressure, temperature and flow control systems

c) Safety relief valves

d) Quick shut off valves.

5. PIPE LINE SUPPORTING SYSTEMS

5.1 Utility pipelines are generally laid over head, supported on steel/concrete trestles, towers, pipe line bridges etc.

In order to secure and maintain the pipe line alignment during operation, the supports are provided at designed intervals. The types of supports are:

- Anchor supports at fixed points
- Sliding/roller/guide supports

- Hanger supports
- Spring supports

5.2 Trunk lines for process/make up water system, fire hydrant system, drinking water system are generally laid under-ground. Anchor blocks are provided to prevent dislocation due to thrust during operation.

6. CORROSION PREVENTION/INSULATION

6.1 To protect the above ground pipelines and supporting structure from ambient corrosion, they are painted as per relevant BIS/IPSS standards. Suitable colour codes are followed for identification of the flow medium.

6.2 Steam/condensate/chilled waterlines are provided with thermal insulation and cladding to prevent loss/gain of heat from/to the fluid.

6.3 Underground MS pipe lines are provided with anti-corrosive coating/wrapping. Under highly corrosive soil conditions, cathodic protection is provided.

7. INSPECTION OF PIPE LINES IN SERVICE

7.1 Periodic inspection of the pipe lines in service is necessary to :

- Avoid loss of energy/utility through leakages.
- Avoid conditions leading to gas leakage hazard and fire hazard.
- Avoid sudden failure of pipe lines/fittings/supporting structure.
- Meet statutory requirements.
- Maintain the records of the condition for planning replacement, shutdowns, etc.

7.2 Inspection of the pipe lines in service covers the following aspects :

a) Visual inspection
b) Inspection of fittings, mountings and specials
c) Special tests

8. VISUAL INSPECTION

8.1 It is recommended that the entire pipe line system of the plant should undergo thorough visual inspection at a regular interval so as to cover the entire system of a particular medium within 3 months.

8.2 The schedule for inspection shall be finalized by the concerned engineering at the start of the financial year so that adequate sections of

the pipe lines are covered on daily basis to meet the requirements of clause no. 8.1.

8.3 The visual inspection shall cover

i) Leakage through flange joints, sockets, glands, pipe body etc.
ii) Condition of the external surface of the pipe line.
iii) Condition of the pipe line supports and structures.
iv) Status of the painting, identification marks.
v) Approachability and maintainability in the critical areas.
vi) Condition of thermal insulation and cladding.
vii) Operation of traps on steam and compressed air lines.
viii) Operation of air release valves.
ix) Operation of electrical, pneumatic, hydraulic actuators.

8.4 Leakage observations :

8.4.1 Leakage from the operating pipe lines occur from the flanged joints, sockets, valve glands, traps, damaged pipe segments, etc.

8.4.2 Leakage result in loss of the conveyed medium, gas and fire hazard and if unattended for prolonged duration, may result in breakdown of the system.

8.4.3 Leakage in the fuel gas lines like BF gas, CO gas, LD gas, Mixed gas etc. shall be inspected taking gas safety precautions.

Portable carbon-monoxide detectors shall be used to identify the areas of leakage. The source of leakage, extent and possibility of stoppage of the leakage on line shall be examined for each pipe segment.

While working near the source of leakage, the inspecting personnel shall wear gas masks and use PPEs to protect themselves from gas poisoning.

8.4.4 Leakage from the non-toxic fluid system shall be inspected by visual observations of the suspected leakage points. Normally the leakages from high pressure system are characterized by hissing sound and can therefore be easily identified.

8.4.5 Leakages from the oil system are apparent from the dripping, sagging insulation at the source of leak.

8.4.6 Leakage from the steam lines are variable for saturated steam systems and can be identified by visual observation. Leakage from high pressure steam system can be detected from the whistling sound near the source of leakage.

While inspecting the steam leakages, the inspecting personnel shall take care not to come in contact to the direct lines of the leakage stream and shall take adequate care to protect them against scalding and steam burns.

8.4.7 Leakage from the water lines are clearly visible for the over ground pipe lines and pipe lines through tunnels. Leakages from the underground pipe lines manifest in leakage water finding way to soil surface basement/tunnel. Further inspection in such cases shall be carried out by exposing the pipe by excavation.

8.5 Visual inspection of physical condition

8.5.1 Pipe surface

The surface condition of the pipe lines shall be thoroughly inspected for surface corrosion, pitting marks, physical damage etc. In case of excessive corrosion, major physical damage of the pipe line is susceptible to breakdown. The inspector shall make clear mention of such areas in his Inspection Report.

8.5.2 Anchors & supports

Visual inspection of the pipe line shall also include inspection of anchor points, freeness of the sliding, guide & roller supports, and condition of lubrication, deflection of the hanger, spring supports and signs of any dislocation / mis-alignment of the pipe line.

In case the inspector finds that the pipe line has been thrown out of alignment, he shall make clear mention of the affected section in the Inspection Report, so that detailed survey/corrective actions can be initiated.

8.5.3 Supporting structures

The condition of the pipe line supporting trestles, towers, bridges and other structural members mentioned shall be inspected for corrosion, rusting and crust formation. The inspection of structure shall also include inspection of approach ladders, platforms and railings. The cases of unsafe structural condition like excessive surface corrosion, damage to members, tilting/distortion of the members, loss of verticality, unsafe deck plate/railing condition shall be clearly recorded in the Inspection Reports.

8.5.4 Insulation

In case of insulated pipe lines, the inspection of the insulation condition shall include physical condition of the cladding surface, signs of fluid dripping, soggy/loose insulation material and total loss of insulation leaving the pipe surface exposed.

8.5.5 Painting

Visual inspection of the pipe line painting shall cover condition of paint, visibility of identification colour/ bands, correctness of the colour code followed, condition of flow direction marks and general condition of the paints of the structures.

9. **INSPECTION OF FITTINGS, MOUNTINGS & SPECIALS -** Inspection of the piping system shall also cover the inspection/testing of the condition of fittings & mountings such as

- Isolation valves
- Water seals
- Drain pots in gas lines, drains in other lines
- Compensators, expansion joints
- Explosion flaps, rupture discs
- Purging & venting points
- Steam/compressed air traps

9.1 Isolating devices

Gate valves

9.1.1 Gate valves installed in utility lines serve as primary shut off/isolation devices for carrying out maintenance work on the down stream system. The inspection of valves in service shall cover :

- Checking of leakage through glands/flanges
- Condition of the lubrication of valve spindle and stem nut housing.
- Condition of the valve body
- Freeness of spindle movement.
- Checking of stem-nut and its bearings condition during the shutdown.

9.1.2 In case the main valve is provided with pressure equalization by-pass valve, the by-pass valve shall also be checked for the above condition.

9.1.3 Valves at strategic locations need to be holding leak proof for complete isolation of the system. It is recommended that such exercise shall be carried out during available shut down & under protocol. It is necessary to operate such valves from full open to full close condition to check their holding status.

It is advisable to use Rising Spindle gate valve for easy maintenance. In case of non-rising spindle valves the number of rotation & direction of rotation shall be recorded and also displayed near the operating platform. Record of the critical valves failing the hold test shall be maintained so that replacement / suitable corrective actions viz. cleaning if disc seating groove etc. is planned at the earliest.

9.1.4 Water seals

Water seals are commonly used as isolation devices in low pressure gas system. Under the normal operating condition, water seal functions as vessel where dust, condensate, tarry material get deposited over the period of operation.

9.1.4.1 Routine inspection of water seals shall cover :

- Physical checking of the external body condition
- Checking the operatability of water inlet, drain and over flow valves
- Checking the condition of man-holes/inspection holes and other mountings
- Checking the availability of water.

9.1.4.2 Dependability of box type water seal during shut down squarely rests on the condition of the internal baffle plates/pipe. The internals cannot be readily inspected from outside during routine inspection. It is therefore, recommended that such water seals at strategic location be subjected to inspection for their isolating capability. Such an exercise shall be carried out during shutdown under protocol and records maintained.

9.1.5 Goggle valves/Goggle plates/Slipper plate

Goggle valves/plates shall be inspected to check:

- Physical condition of the blank plate and ring plate with their rubber seals, bonnets (both blank plate and ring can be inspected during shut down only).
- Freeness of the movement in the slide channels (during shut down only).
- Condition of lubrication of the operating mechanisms.
- Condition of hydraulic power pack, oil lines, cylinders, manual over ride and vent valve.
- Condition of sprocket and chain, guide rollers, link chain and pulley.

9.2 Drain/drip pots in gas lines:

9.2.1 Drain/drip pots in the gas lines serve as on line collection devices for condensate from the flowing medium. Drip pots are normally kept in automatic operation by maintaining the water levels in the bow pipes/syphons. Some of the drip pots may, however, be not in automatic operation due to various reasons. Condensate in such cases is required to be removed by manual operation of valves.

9.2.2 A defective / mal-functioning drain pot can be a major source of gas leakage. The recommended frequency of the inspection of drain pots is at least once in 15 days. The inspection shall cover :

- Check and ensure that there is no through leakage from drain valve.
- Check and ensure adequate water in-flow and over flow in tundish/ tunnel
- Check whether the connected valves are holding
- Check whether the condensate removed by the drain pot is causing damage to the adjacent structures and fittings.
- Ensure the drain line is not chocked.

Drain lines for other utilities:

9.2.3 Drain lines are provided in non-toxic pipe lines to periodically drain out of accumulated condensate from the pipe lines manually. Drain lines are provided with valves/traps.

9.2.4 During the inspection, the operation of the drain valves from full close to full open shall be checked. The valves not holding properly can be source of hazard apart from the loss of fluid. Inspection of drains shall also include checking the leakage from glands & flanges. After the inspection of the drain valves, the valve shall be closed on removal of condensate/trap fluid.

Traps:

9.2.5 To remove the condensate accumulation in the steam / compressed air lines, traps are provided at designed intervals depending upon the fluid condition and condensate load.

9.2.6 Inspection of trap shall include checking of :

- the functioning of the trap by visual observation
- through leakages
- isolation valves and by-pass valves condition
- erosion of flanges due to continuous leakages

9.2.7 A single trap shall not be connected to more than one drain point.

- Check that separate steam trap has been used for each drain point.

9.2.8 Intermittent discharge of traps indicates correct functioning.

If the blow of condensate is continuous through the trap

– Check for the size of the trap used. It may be a too small drop (in terms of discharge capacity) – use a longer trap or fix additional trap in parallel or fix a trap suitable for pressure differential system.

9.2.9 If the trap blows Live steam

- Check the following

a) Valve may fail to seat
b) Trap may have lost its prime

9.2.10 If trap fail to discharge condensate, it may be due to

a) Pressure too high – Check pressure reducing valve whether functioning proper or not.
b) Trap orifice may be enlarged by normal wear – Replace the trap.
c) Strainer may be clogged – Clean the Strainer.
d) Broken valve closing the Line – Change the valve.
e) Trap body may be filled with dirt – Install Strainer and clean the trap.
f) Bucket vent in case of inverted bucket trap may be filled with dirt – Clean the dirt by bucket vent scrubbing knife.
g) Valve may be held in closed position by sticky deposit – Knock the trap. If it does not operate, clean the trap by ramming the sticky deposit.

9.3 Expansion Joints :

9.3.1 Compensators - The over-ground pipes are subjected to thermal expansion due to variation in the ambient temperature and the temperature of the flowing media. Expansion joints like bellow type compensators, telescopic pipes etc are provided in the pipe lines to accommodate such expansion. Low pressure gas/utility lines are generally provided with bellow type expansion joints commonly termed as compensators. Numbers of ribs, flange to flange distance varies from one location to another depending upon the pipe line layout.

9.3.2 Inspection of the compensators shall include :

- Checking the physical leakage from the body and flanged joints
- Checking the compensator surfaces for corrosion/physical damage
- Checking whether any black patches are appearing on the surface (black/dark patches indicate accumulation of condensate leading to internal corrosion)
- Checking whether condensate is dripping from the body/flange joints
- Checking the Tie rods, nuts and its lugs.

9.3.3 Expansion loops – Expansion loops (horizontal/vertical) are provided in the steam lines to ensure adequate flexibility. Vertical loops are supported at the lowest point by spring supports to take care of vertical forces.
In certain designs, specially designed expansion bellows are provided to reduce the size of the expansion loop.

9.3.4 Inspection of the expansion loops should cover checking the signs of any mis-alignment and distortion of spring supports. In a properly designed and erected pipe line, loops do not get disturbed frequently. Frequency of inspection once in a year is enough.

9.4 Explosion flaps & Rupture discs

9.4.1 Explosion flaps/rupture discs are provided on the pipe lines to release excessive pressure in the event of explosion/surge.

The explosion flaps may be spring loaded type, or counter weight type. Rupture discs have specially designed diaphram which rupture in the event of excessive pressure build up.

9.4.2 The inspection of explosion flaps and rupture discs shall cover :

- Checking whether the diaphragm is in tact or is showing signs of pitting/corrosion which warrant immediate replacement.
- Checking whether the cover with counter weight is properly sitting on the disc.
- Checking the physical condition of springs and studs.

Inspection of these on the trunk lines shall be carried out at least once in 6 months and invariably after each instances of pressure surge. However, the rupture discs/explosion flaps near the furnaces/working area inside shop, shall be inspected once in every month.

9.5 Purging & venting points

9.5.1 Purging points – Purging points are provided on the gas line to enable flushing out of the toxic media for obtaining safe condition for working during shutdown.

The purging medium may either be steam or nitrogen. Inspection of the purging points should cover:

- Checking the condition of purge in points and valves
- Availability of purging medium at adequate pressure
- To ensure that back flow of toxic medium in purging line is prevented.

9.5.2 Vent points – Vent points serve as release points for de-pressurization/outlet during purging operation. Inspection of vents shall cover :

- Checking that the vent valves are holding tight and that there is no leakage
- Checking the condition of the vent pipe including internal chockage and rain water protector at the outlet, tie ropes.

9.6 Pipe line Instrumentation

9.6.1 Pipe lines are generally provided with following instrumentation for monitoring purpose :

- Orifice/flow meters for flow measurement
- Flow/Pressure Control valves
- Safety relief valves
- Quick shut off valves
- Local gauges.
- On-line CO monitors

9.6.2 Regular inspection of above is necessary for keeping the system under control and safe. Routine inspection of these shall be carried out at least once in 3 months. The inspection shall cover :

- Checking the validity of calibration of flow meters/orifices, on-line CO monitors.
- Checking the set points vis-à-vis actual output obtained for flow control and pressure Control valves
- Checking the set points of pressure relief valves
- Checking whether any leakage is taking place through improperly set safety valve or due to pressure build up on the down stream side because of upstream side valves are not holding
- Checking the operation of quick shut off valves
- Checking the condition and calibration of local gauges like pressure gauge, temperature gauge etc.

10. **SPECIAL TESTS -** Special tests on pipe lines shall include :

- Ultrasonic thickness measurement
- Thermo-vision test for assessment of internal deposits
- Pressure drop survey
- Load flow analysis
- Residual life assessment (RLA)

10.1 Ultrasonic thickness measurement

10.1.1 Thickness measurement of the pipe lines shall be carried out with the help of portable ultrasonic thickness measuring instruments. The frequent of measurement shall be (a) for fuel gas line & corrosive area once in 2 years and (b) for other medium as per ambient condition/statutory regulation as applicable.

10.1.2 Schedule for thickness measurement for each utility pipe line shall be drawn covering the entire pipe line network.

10.1.3 The number of points where thickness measurement is to be carried out on a pipe line section shall be pre-decided and the surface at the selected location shall be properly cleaned of the dirt, dust, deposits and paint so that accurate thickness measurement is possible. The number of spots along the periphery at a given location shall be minimum 3 nos. along the circumference of the pipe (minimum 2 nos. at the bottom half).

10.1.4 Proper records of the measured thickness shall be maintained. The measured thickness shall be compared with the original thickness. In case of fuel gas pipe section when the measured thickness has found to be 60% of the original thickness shall be planned for immediate replacement/cladding. For the other service lines this shall be governed by statutory regulation as applicable/severity of operating condition.

10.2 Thermo-vision Test

10.2.1 Thermo-vision test is carried out using thermo-vision camera. The test is carried out to assess the extend of deposits in the pipe line. However, thermo-vision test requires difference in the temperature of flow media and the deposits so that the profile plotted by the m/c is indicative of the deposits in the pipe line.

10.2.2 The instruction given by the manufacturer of the thermo-vision camera shall be followed for accuracy. The test may be carried out with expert help.

10.3 Pressure drop survey

10.3.1 Periodical pressure drop survey shall be carried for the pipe line system to compare the actual pressure drop with the designed/desired pressure drop.

10.3.2 Pressure survey shall be carried out using calibrated portable pressure gauges/calibrated locally mounted gauges. Suitable points at which pressure is to be measured shall be pre-selected.

10.3.3 Readings during the pressure drop survey shall include :

- Pressure and temperature at the starting point of the pipe line
- Flow in the section
- Pressure and temperature at the pre-selected intermediate points.
- Pressure and temperature at the final point in the piping system.

Above readings shall be taken in a coordinated manner simultaneously.

10.3.4 Actual pressure drop measured for the noted flow shall be compared with the design pressure drop for clean system. Excessive pressure drop in a section indicate possibility of blockage in that particular section. Necessary action for re-checking can be planned for such sections.

10.4 Load flow analysis

10.4.1 Load flow analysis of the piping grid is required to be carried out in case of need for extension/alteration in the configuration utility system enhancement. Theoretical analysis is possible using conventional Hardy Cross method or by using software packages available for this study.

10.4.2 The load flow studies can be conducted on the existing pipe line system taking expert help to identify the problem areas so that the system improvement can be achieved.

10.5 Residual life assessment (RLA)

10.5.1 Critical service pipe lines after long service require assessment of residual life of the system to determine the balance service life at the operating parameters.

10.5.2 RLA study includes metallographic analysis of the parent material of the pipe, ultrasonic thickness measurement and flexibility analysis etc. The studies are to be conducted by expert agencies.

11. RECORD KEEPING

11.1 Inspection record of the pipe lines shall be properly maintained and up-dated on each inspection/corrective action by the concerned engineer.

11.2 Suggested format for maintaining the inspection records is given in **Annexure-I**.

11.3 It is recommended that the details of pipe line grid be entered into PC and data base generated for the Inspection Records Maintenance and Updating.

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ANNEXURE-I

1.	Date of inspection	
2.	Flow medium	
3.	Pipe line section/identification	From _____ To _____
4.	Configuration	Size DN ___Original thk____mm
5.	Location	Underground/t unnel/ overground/ Overhead/ inside shop & yard.
6.	Service condition	Operating Pressure Kg/cm^2/ mmwc Operating Temperature ^oC Normal Flow Rate Nm^3/hr or m^3/hr
7.	Ambient condition	Temperature/ Humidty/ Corrosiveness of atmosphere

8. Physical check :

   i) Leakage points

   ii) Condition of isolating devices (valves, water seals)

   iii) Condition of expansion joints

   iv) Condition of drain pots/points

   v) Condition or purge & vent points

   vi) Condition of safety devices (explosion flaps / Safety valves)

   vii) Pipe line alignment

   viii) Condition of surface & painting

   ix) Condition of other fittings (traps, instruments, etc)

   x) Condition of insulation/cladding

   xi) Condition of pipe saddles & supports

xii) Condition of supporting structure/ Platforms, ladders

xiii) Approachability/supporting area (wild growth, Stagnent water, spillage from drain etc)

9. Special tests

i) Thickness measurement Yes/No - Detailed report to be made & enclosed.

ii) Other special test conducted Yes/No -do-

10. Other observations:

11. Remarks/Recommendations

Inspected by :

Name
Designation

Copy to: All concerned.