Piping Inspections

For Beginners

By ZAQ

QA/QC Piping inspections

- Piping Hand notes for beginners

Note:

These slides are only to get prepare beginners for interviews.

ITP – Inspection & Test Plan

Contents of ITP: Defines

- Description of the item to be inspected
- Applicable specification, Procedure, Method Statement
- Acceptance criteria (acceptance according to ASME/API/ specification procedures/drawing/third party/welding procedures, etc

QA/QC Documentation

- QA/QC forms for each inspection
- Responsibilities of Sub contractor, main contractor, and Client

Note: W-witness, H- Hold point, R-random, I-inspection, S-surveillance.

Note: Each approved QA/QC form to be filled by the QC and attached to the AFI/RFI for inspection.

What is AFI? Application for inspection

What is RFI? Request for inspection

To be filled by the sub contractor and submits to the main contractor, after review the main contractor will submits AFI / RFI to the client.

Piping

QC inspection activities as per ITP

- Material receiving inspection

-Piping size, material verification

-Mill certificates

-Physical damages

-Damage report if any damage found

-Preservation of material in ware house.

Basic welding inspection

- Welding specifications:

Procedure Qualification Record (PQR) ASME Section IX welding and brazing qualification.
ASME B- 31.3 (Process Piping)
Welding Procedures Specifications (WPS) ASME Section IX
ASME B-31.3 (Process Piping) Refineries and chemical industries.

- Welding Consumable certificates, storage and issuing procedures.

ASME?
American Society Of Mechanical Engineers.
ASTM?
American Society of Testing & materials.
API?
American Petroleum Institute.
AWS?
American welding society.
AWWA?
American water works association.
ANSI?
American National Standard Institute
AISI?
American Iron & Steel Institute.

Basic Welding Inspection

- Welder Qualification Records (PQR)

ASME Section IX (Procedure Qualification Record)

- List of Welder Qualification Record
- Welder Rejection Rate Record
- Each System Welding Records, Weld summary, Weld Map, Radiography requirements, NDT completion.
- Calibration of Oven, welding machines etc (as per project specification / procedures

Non Destructive Testing

- PIPING
- NDT Personnel's Qualification Records. ASME Section V
- NDT Procedures Qualification Approvals

ASME 31 Codes for Pressure Piping

- ASME B31.1 – Power Piping
- ASME B31.2 - Fuel Gas piping
- ASME B31.3 – Process piping
- ASME B31.4 - Pipeline transportation system for liquid hydrocarbon & other liquid.
- ASME B31.5 – Refrigeration Piping
- ASME B31.8 - Gas Transmission & distribution piping system.
- ASME B31.9 – Building Services Piping
- ASME B31.11 Slurry Transportation piping system.

Different Sections of ASME Codes

- ASME Section I : Rules for construction of power boiler.
- ASME Section II: Materials

Part A - Ferrous materials

Part B –Non-Ferrous materials

Part C- Specification for electrodes & filler wire

Part D- Properties.

Different Sections of ASME Codes

- ASME Sec –IV Rules for construction of Heating Boiler
- ASME Sec- V Non-destructive examination
- ASME Sec- VI Recommended rules for care & operation of heating boiler
- ASME Sec- VII Recommended guidelines for care of power boiler.
- ASME Sec- VIII Rules for construction of pressure vessels. (Dev I & II)
- ASME Sec- IX Welding & Brazing qualification.

Materials

Pipe Materials:

ASTM codes for the following materials

Carbon Steel: ASTM A53, Gr. A/B,

A 106 Gr. A/B/C, ASTM A333 Gr.1/Gr.6

Alloy Steel: ASTM A 335 Gr.P1/P2/P5/P7/P11/P12/P22

Stainless Steel: ASTM A312 TP304 & L /TP304H/TP308/TP310/TP316/TP316L/TP316H/ TP317/TP321/TP321H/TP347/TP347H/TP348/T P348H.

Nickel Steel: ASTM A333Gr.3/Gr.8

Shop Fabrication Inspections

- Prior to welding

-Piping material verification by color code (as per project requirement)

-Material Traceability, Heat Number

-Welding Consumables Records

Welding Inspection Piping

- Pipe Fit-up inspection as per WPS
- Pre Heating (ASME Section IX / WPS) if required
- Pipe Spool identification as per drawing.
- Root Pass inspection as per WPS
- Visual Inspection of completed weld

Welding Inspection Piping

- Orifice Flange weld internal smoothness
- Post Weld Heat Treatment (PWHT) as per Project specification / Procedures
- Hardness test if require (WPS)
- Applicable NDT RT, UT, PT, MT (Third party)
- Positive Material Identification (PMI)
- Reinforcement pad pneumatic test, wipe hole procedure.
- Weld Summary Report, and review all the above reports

What are the common defects in Welding?

- Lack of Penetration
- Lack of fusion
- Undercut
- Slag inclusion
- Porosity
- Crack
- Faulty Weld size & profile
- Distortion

Welding Defects

- **Lack of Penetration:** Defect occurs a the root of the joint when the weld metal fails to reach it or weld metal fails to fuse completely in the root faces of the joint.

  If incorrect size of electrode is used, low welding current, & Faulty fit-up and inaccurate joint preparation.
- **Lack of Fusion:** lack of fusion is defined as a condition were boundaries of un-fused metal exist between the weld metal and base metal or between the adjacent layers of weld metals.

  This occurs mainly due to presence of scale, dirt, oxide, slag and other non metallic substance which prevents the weld to reach melting temperature.

  Improper deslagging between the weld pass.

Welding Defects

- Undercut: This defect appears as a continuous or discontinuous groove at the toes of a weld pass and is located on the base metal or in the fusion face of a multi pass weld. It occurs prominently on the edge of a fillet weld deposited in the horizontal position.

Cause

1. Excessive welding current
2. Very high speed of arc travel
3. Wrong electrode angle

Can rectified by filling the undercut groove with a weld pass.

Welding Defects

- **Slag inclusion:** Improper cleaning of slag between the deposition of successive passes.

  Presence of heavy mill scale, loose rust, dirt, grit and other substances present on the surface of base metal.

Note: To avoid slag inclusion, clean the slag thoroughly between the weld pass. Keep the joint surface and bare filler wire perfectly clean, avoid undercut and gaps between weld pass and use proper welding consumables.

Welding Defects

- **Porosity: What is porosity?**
- The presence of gas pores in a weld caused by entrapment of gas during solidification is termed as porosity.

Cause of Porosity?

1. Chemically imperfect welding consumables.

2. Faulty composition of base material or electrode

3. Presence of oil, grease, moisture and mill scale on the weld surface.

4. Excessive moisture in the electrode coating or submerged arc flux.

5. Inadequate gas shielding or impure gas in a gas – shielded process.

6. Low welding current or very long an arc.

7. Quick-freezing of weld deposit.

Weld Defects

Crack:

What is Crack? Fracture of metal is called crack, there are two types of cracks: cold crack & Hot crack.

Cold crack usually occur in HAZ of the base metal when this zone becomes hard and brittle due to rapid cooling after the weld metal has been deposited and sufficient hydrogen has been absorbed by the weld metal form the arc atmosphere.

Precaution: Use of low carbon equivalent materials, Higher heat input during welding, preheating, use of low hydrogen electrode.

Weld Defect

- Faulty weld size and Profile:

  A weld is considered faulty if it has lack of reinforcement, excessive reinforcement or irregular profile.

Distortion: Due to weldment is locally heated, the temperature distribution in the weldment is not uniform and changes take place as welding processes, Typically, the wd metal and the base metal heat affected zone immediately adjacent to it are at a temperature substantially above that of the unaffected base metal.

Distortion is cause when the heated weld region contacts non uniformly, causing shrinkage in one part of the weld to exert eccentric forces on the weld cross section. The distortion may appear in butt joints as both longitudinal and transverse shrinkage or contraction, and as angular change (rotation) when the face of the weld shrinks more than the root.

Distortion in fillet welds, is similar to that in butt welds: transverse and longitudinal shrinkage as well as angular distortion results from the unbalanced nature of the stresses in the welds.

PWHT

- What is mean by PWHT?

"Post weld heat treatment"

- Why it is required?

This is done to remove residual stress left in the joint which may cause brittle fracture

Blasting and Painting

Released for blasting and painting at painting yard after spool fabrication:

Blasting: Profile to be check according to the approved procedure

Primer: Thickness (DFT) dry film thickness to be check (DFT Gauge Elcometer)

After completion of Primer, First, Second, and Final coat, DFT to be check according to the project specification.

Material handling: Proper protection / care to be taken at the time of transporting to construction site.

Valves / Pipe Fittings

- Flanges are classified based on facing as:-

Flat face (F/F)

Raised face (R/F)

Tongue and groove (T/G)

Male and female (M/F)

Ring Type joint (RTJ)

- Flanges are classified based on face finish as:

1) Smooth Finish
2) Serrated finish.

The smooth finish flange is provided when metallic gasket is provided and serrated finish flange is provided were non metallic gasket is provided.

Gaskets

- Gaskets are classified as

1 Full face

2 Spiral wound metallic

3 Ring type

4 Metal jacketed

5 Inside bolt circle.

The most commonly used material for gasket is Compressed Asbestos Fibre.

The recommended gasket for high temp and high pressure is Spiral wound Metallic Gasket.

Valves

Function of Valve:

- Isolation:

Gate, Ball, Plug, Piston, Diaphragm, Butterfly, Pinch valve.

- Regulation:

Globe , Needle, Butterfly, Diaphragm, Piston, Pinch

- Non- Return:

Check Valve

- Special Purpose

Multi-port, Flush bottom, Float, Foot, Line blind, Knife gate valve.

- The check valves are self-operated and all the other valve types comes under operated valves.

Valves

- Valves are classified based on end connections: (end connection mean, valve attached to equipment or the piping)
- Screwed ends, Socket ends, Flanged ends, Butt weld ends, wafer type ends, buttress ends.
- Type of Check Valves: Lift check valve & Swing check valve

Pipe Line Check

- Piping Line Checking Prior to Hydro Testing.
  HT package contains the following:
- Latest Revised Isometrics & P & Id
- Isometric drawing list
- RT/NDT completion record, NDT summary
- Welding Completion record, Weld summary
- Line check to be done according to Isometric, material to be check as per bill of materials (BOM) mentioned on the each Isometric drawing.
- Internal cleaning of pipe line, record.
- Supports / details Supports drawings
- Valve list, Type of Valves, Valve Orientation, Valve operational and maintenance access, Flanges Rating,
- Vent and Drains to be provided as per drawing
- Provision for high point and low point pressure gauge.

Pipe line check

- During line checking, the incomplete works to be noted in the punch list as per the categories “A” “B: “C”, inspector has to prepare the punch list, each and every incomplete items to be written in the punch list.
- Punch “A” to be complete before hydro test
- Punch “B” to be complete after HT
- Punch “C” to be complete at the time of Mechanical Completion Check
- Punch “D” (Document) to be complete before turnover.

Pipe line check

- Release for Hydro Testing after clearing all “A” punch items.
- Re check the NDT completion prior to release for Hydro testing.]
- Hydro test manifold to be tested separately to at least 1.2 times the system pressure
- All lines to be checked and ensure the entire system can be drained after hydro test.
- Re check the system is properly supported / additional temporary supports, if required.
- Spring supports to be locked in position for the test using the pre-set pins or plates or by blocking the spring.
- Orifice plates and restriction orifices that interfere with the filling, filter elements, venting, or draining of the lines to be removed.
- All the valves to be open in the test limits.
- Verify air vents and drain are installed and welded.

Hydro Test

- Water to be filled from the lowest point, to avoid air pockets.
- Air in the system to be vented through the high points vents, that shall be kept open until the test medium flows from the outlet / high point.
- Pressurized the line, when its reaches to the test pressure, check all welding, flanges, threaded joints

Hydro Test Pressures

Hold at the pressure for 30 minutes, and check the leaks.

(Test pressure to be 1.5 times of design pressure:

Minimum test pressure=1.5 X Internal design pressure X Allowable stress at test temperature / Allowable stress as design temperature)

Reduce the pressure and drain the water.

Reinstatement of items as per list

Pre commissioning:

Air blowing / Flushing the line after hydro test

What is psi?

Pound per square inch

One bar is equal to 14.5 psi

Machinery Installation & Inspection and Test Plan

- It is common practice that equipment installation in any project follows the similar standards and codes, but the main concern is inspection that are planned in the ITP (Inspection and test plan. We define inspection characteristics in the inspection plan, to describe what is to be inspected and how the inspection is to take place. This process describes the options for defining quantitative characteristics such as setting standards, and defining key inspection points. Any inspection which is very important

  As some are planned as random witness, surveillance and documents are very helpful. These types of inspections which create conflicts at the later stage with other disciplines and sometimes process, operation and maintenance can be resolved by proper Inspection and Test Plan.

  If such inspections are done properly than we can minimize the conflicts & errors and can complete the project on time with improved performances which yields quality production.

  Always a good ITP will definitely result in good quality work, so never compromise on ITP preparation, review and approval.

Quality is everybody's responsibility…Quality is not an act, its an habit..

What are the major responsibilities of a project engineer?

- Site Project Engineer is responsible for the overall activities and execution as per the construction package, agreed schedule and within budget, also responsible for project monitoring and periodic reporting to the site project superintendent / Section head
- Including reviewing documents to ensure that all construction activities are performed as per approved construction package, schedule and within budget.
- All coordination within affiliate departments (safety, materials, contracts, planning and quality control)
- He is responsible for the entire field construction works, and to ensure that the construction contractor's work permit receiver is qualified and certified by the safety department.

What are the major responsibilities of a project engineer? Continued

- Involve and assist the contractor to arrange ID cards for mobilization.
- Ensure timely availability of project material at site.
- Participate in walk thru with the management team.
- Provide timely technical clarification, design issues review and resolution and material approvals as needed.
- Lead construction kick-off meeting for any new activity, and understand with the contractor their action plan and schedule.
- Endorse contractor intermediate and final invoices.
- Categorize punch list with the help from project team
- Identify the major out of scope items.
- Responsible to process the change orders and get them approved as per authority schedule.

What are the major responsibilities of a project engineer? continued

- Prepare a system / equipment commissioning acceptance certificate.
- Fill out ***Transfer of care, Custody and Control*** (*TCCC)* form and review the documentation.
- Review of *ITB* (*Intend to Bid*) and integrate all the discipline for review and ensure the project specification, requirement is met and in line with Licensor recommendation and met all the local regulation.
- Monitor project execution to ensure all the activities are performed as per schedule and expedite the process in case of delay, communicate through letters in case of delays and investigate the causes and concerns.

What are the major responsibilities of a project engineer? continued

- Ensure quality is implemented fully.
- Conduct Audit, supporting Insurance agency with adequate documents required by them.
- Preparation of monthly, weekly project reports. Finalization of *MOM* (*Minutes of meeting*)
- Monitor and updating of curve and bars based on physical progress.
- Handling small scale modification projects.
- Reporting directly to project director/construction manager/ project manager.
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