T&Q Pipeline Safety Seminar

High Grade Pipe and Construction Issues

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High Grade Pipe Materials & Inspection Observations

1. Positive Observations
2. Pipe Manufacturing Findings
3. Quality Materials
4. Quality Assurance / Inspection
5. Problem Identification – In Service Pipelines
6. Conclusions
Positive Observations (Data Driven)

- Parallel construction – existing pipelines and power lines
  - Few incidents
- Pipeline Safety Cooperation
  - Operators worked with PHMSA to ensure pipeline safety
- MAOP Rule/Special Permit
  - Finding low yield strength pipe
- DCVG Surveys
  - Used on many recent projects
  - Finding coating and pipe damage
- Workshops
  - API & INGAA
Pipe Manufacturing Findings
Pipe Manufacturing

- Quality Issues – pipe (remains under investigation)
  - Chemical composition
  - Low and variable yield strength
  - Laminations and Inclusions
  - Pipe bevel ends – high/low
Pipe Manufacturing

- Low Yield Strength
  - Yield Strength <62Ksi for X70 pipe
  - Maximum ID: 109% of normal
  - Not an isolated project concern

- Out of Spec Chemical Composition
Pipe Manufacturing

- Low yield strength pipe; 56Ksi to 62Ksi for X70 pipe
Pipe Manufacturing

- Laminations and Inclusions
Pipe Manufacturing

• Pipe bevel ends – high/low and flat spots
Pipe Manufacturing

- Pipe bevel ends – high/low
Pipe Manufacturing
Pipe End Conditions - High Low
Pipe Manufacturing - Attendant Problems
X-70 and X-80 Pipe Grades

- More susceptible to hydrogen cracking than lower pipe grades
- Hydrogen is present in the coating of all E XX10 electrodes
- Three conditions must be present in the weld to initiate hydrogen cracking:
  - Source of hydrogen,
  - Micro-structure susceptible to the effects of hydrogen, and
  - Stresses in the weld.
Quality Materials
Possible Causes

- Factors found to contribute to low and variable yield strength pipe
  - Wrong heat chemistry from steel supplier
  - Pipe test locations for yield/ultimate tensile strengths at steel and pipe mills
  - Plate/coil ordered under strength based on the type pipe rolling process
  - Incorrect plate/coil rolling process
  - Improper plate/coil cooling rates
  - Plate/coil switch at pipe mill
Pipe Manufacturing – API 5L

- Section 6.1 – Chemical Properties
- Section 9.3 – Testing of Mechanical Properties -
  - Is one test per heat adequate for high grade microalloyed steel?
  - Should additional requirements be included in API 5L based upon type steel grade, plate or coil?
- Section 9.10 – Retests
Pipe Manufacturing - API 5L

- **Section 9.11.3 - Diameter – Tolerances for Pipe Ends**
  
  - 44th Edition - Tolerances for pipe ends of large diameter pipe such as 36” and 42” (pipe >24” to 56”) has a tolerance of +/-63 mils on welded pipe.
  
  - 43th Edition - Tolerances for pipe ends of large diameter pipe such as 36” and 42” (pipe >24” to 56”) has a tolerance of -1/32” to +3/32” on welded pipe.
Pipe Manufacturing – API 1104

- **Section 7.2 – Alignment**
  - The alignment of abutting ends shall minimize the offset between surfaces.
  - For pipe ends of the same nominal thickness, the offset should not exceed 1/8”.
  - Mechanized welding units cannot space high/low variations around the pipe.
Quality Assurance / Inspection
Pipe Manufacturing - Inspection

- API Monogram Certification
- Steel Supplier/Manufacturer
- Pipe Mill
- Purchaser
Pipe Manufacturing - Inspection

- Did the “rolling mill/purchaser” set up procedures to properly monitor and test the incoming coil/plate for mechanical and chemistry properties?
- Was inspection used by the “purchaser” at the steel mill and pipe rolling mill?
- Are there problems with the API 5L standard for high grades/microalloyed steel?
Problem Identification
In Service Pipelines
Problem Identification
Low Yield Strength Pipe

- 100% SMYS Hydrotest of in place/in service pipe
- Running of Deformation Tools after Hydrotest
  - calibrated to find expanded pipe
Deformation Tool - expanded pipe

3.4% Expansion Tested to 104% SMYS
Conclusions

- Pipe Manufacturing
- Coating
- Welding
- Construction
Broader Construction Findings
Construction Issues

- Worker, Inspector and General Public Safety
- Welding
- Best Practices
Worker, Inspector and General Public Safety

- Safety is extremely important.
- Heavy loads and large equipment can present special risks
- Do not place yourself in harms way
- Make eye contact with heavy equipment operators
- Wear PPE and safety vests
- Be extremely cautious about entering the area between the pipe and ditch, standing next to the ditch and entering the ditch to observe welding
Safety - Where are you standing?
Pipe on skids can move and fall. You want to park where!
New Construction-Safety First

- Know where you are with respect to the equipment around you.
- Make sure to look around and take stock of what is going on.
- Review what is going on & what could go wrong?
- Is the ground around the bell hole cracked?
- Are they using a shoring box when they need to?
- Are they trying to save time & cut corners vs. working efficiently?
- Is the equipment in good shape, breaking down, damaging the pipe?
- Do the company inspectors have the correct inspection equipment?
- Are procedures available?
Welding Issues
Welding Procedure Development

- API 1104 main body, Appendix A or ASME (Appendix B?)
- List of Rules – Essential variables – other variables (non-essential variables)
- Recently Identified Problems (IP)
  - Did not state all required variables
  - Did not qualify sufficient procedures for project
  - Failed test coupons
  - Special issues API 1104 Appendix A (next slide)
API 1104 Appendix A

To use Appendix A must have:

- Stress analysis, ECA or Engineering Critical Assessment
- AUT error determination
- Written welding procedure with weld testing results
- Identified Problems
  - No stress analysis
  - No AUT error determination
  - Insufficient Charpy tests or CTOD tests that “bust out”
  - Testing lab issue - CTOD test locations are different in the 20th edition
  - Failed bend, nick, or tensile test results
  - No radiographs of qualification welds
  - Using the example calculation in Appendix A is not acceptable
Projects with failed welds that were not detected by NDT
Repair Weld Cracking Issues
Solutions

- In a high strength pipeline weld use low hydrogen welding process (GMAW – FCAW - E XX18)
- Allow time at temperature to allow hydrogen to diffuse from the weld (higher preheat temperatures, preheat maintenance, avoid weld interruption)
- Follow welding procedures
- Welding inspection
- Delay NDT to allow for the possibility of delayed hydrogen cracking to be detected
- Verify NDT technician’s KSA and actual actions
Preheat

• Heating the weld joint before welding
• Temperature of the weld joint immediately before the arc is struck. (Arc start temperature)
• Procedures can state Infrared thermometer, Contact Pyrometer, or Temperature Indicating Crayon
• Range of preheat values found in the welding procedure
Use of Temperature Indicating Crayon

- Temperature indicating crayons (Tempilstik) are specially formulated to change color and melt at a specific temperature.

- On a cold pipe surface upon heating, the mark changes color and melts at the specific temperature.

- Used on a hot surface the crayon only indicates the temperature is greater than the specified temperature on the crayon if the crayon melts.

- Applying the crayon on an area adjacent to a weld joint and then heating with a propane torch directed on the mark will give a false temperature indication. In this case the flame heats the crayon mark faster than the pipe. The pipe will not be up to the required temperature.

- On a hot surface the crayon should be used after heating and two different temperature crayons may be necessary to determine the preheat is within the welding procedure.
Temperature Indicating Crayons

- The crayon holder specifies the melt temperature
Preheat

- In the event of inadequate preheat; document occurrence and notify inspector and operator.
High Mechanized Defect Rate

PHMSA Concerns:

- Having defects not an issue.
- Defect repair, NDT and tracking is an issue.
- Industry experience usually shows
  - 2 – 10% defect rate on mechanized welding
  - 2 – 5% on manual welding
  - less than 2% - examine NDT – are operators procedures adequate? – are radiographic and ultrasonic procedures good? – are NDT technicians following procedures? - are the NDT technicians proficient?
Radiographic Requirement

- Both Parts 192 and 195 require a certain percentage (based on location or class location) of welds be nondestructively tested and that a percentage of a welders daily work product must be nondestructively tested.

- If the radiographs’ image quality indicators are not acceptable, then there may be insufficient numbers of radiographs to meet the percentage and/or daily requirements of the applicable code.

- Use of API 1104 Appendix A requires essentially 100% NDT - AUT
§ 192.235 Preparation for welding.

Before beginning any welding, the welding surfaces must be clean and free of any material that may be detrimental to the weld, and the pipe or component must be aligned to provide the most favorable condition for depositing the root bead. This alignment must be preserved while the root bead is being deposited.

- Sometimes called “Hinging”
- 1 Hydrotest failure on attributed to hinging
Arc Burns

- Arc burns are not acceptable on high pressure gas pipelines and liquid pipelines.
- The following slides show that arc burns can happen during internal back welding.
Many operators are choosing Alternative Acceptance Standard For Girth Welds

Fracture mechanics analysis used to determine the acceptance standard instead of the traditional method of empirical criteria for workmanship (API 1104, Section 9)
API 1104 Appendix A

Essential Variables

- “Any change in the essential variables specified below shall require requalification of the welding procedure....”

- “b. a change in the grade or manufacturer of the pipe material or a basic change in the chemical composition or processing by a single manufacturer.”

- Requalification was not performed.
Pipe Manufacturers

- 3 plate manufacturers of 0.617” WT (Mittal, Saltzgitter, VoestAlpine).
- VoestAlpine was not addressed in the welding procedure qualification
- Pipes were supplied to the welding crews and welded in random order
The Challenge

- Procedures aren’t being followed - there is a disconnect between the operators’ engineering/design group and field practitioners.

- Many operators are now choosing Appendix A acceptance criteria to keep up with the volume of new construction and preference for automated welding. Are all the required variables being checked?

- PHMSA is working on a standard for interpretation and enforcement.
Best Practices
New Construction

- Good Dirt
- Level
- Straight Shot
- No rocks
- Good Trench
New Construction

- Good Trench
- With Proper Egress
New Construction

- Uh Oh! Found a rock.
New Construction

- Documentation!
- How large of a rock can be left in backfill?
- Ask the inspector.
- Check the procedures.
New Construction

- Crossing other utilities safely.
- Rock Shield where applicable.
New Construction-Trenching/ Stringing

- Steep terrain.
- Be Careful.
New Construction

- Might need rock shield in this area?
- Note stationing and ask for records in office if you are not there when backfilling occurs.
- Did you see a padding machine on this job?
- Do they use sifter buckets?
- Is the mesh in the bucket the proper size?
New Construction-Coating & Jeeping

- There. Fixed it with a patch stick! Just dripped it on big time. Has to be well coated now!
- Is this ok?
- Why?
- Why Not?
New Construction

- When do you look for holidays?
- A lot of Contractors allow for Pre-jeeping.
- Code requires to inspect the coating just before lowering in.
New Construction-Jeeping

- Is the equipment in good condition?
- Ask inspector questions.
- Check procedures.
- Watch how the crew repairs holidays.
- Patch stick is for holidays $\leq$ pin hole holidays.
- 2 part epoxy for larger holidays.
New Construction-Fitting Pipe to the ditch

- Be observant while driving around.
- What happenned to the coating on this pipe?
- Ask inspector.
New Construction-Bending

- Check the equipment.
- Is it in good repair?
- Does it need work?
- Is it damaging the pipe?
New Construction-Damaged Pipe

- Dents
- Wrinkles
New Construction

- Foam installed after lowering in = trench breakers.
- Installed on slopes
- Protects trench from washouts.
- Correct spacing?
- Ask the inspector.
- Check procedures.
New Construction

- Fittings-Piggable?
- Short Pups
- How small can a pup be?
- Ask the inspector.
- Check the procedures.
- Why the different coating color? ARO vs. FBE
- Shrink sleeves on welds
New Construction

Sand Bags for Pipe Support
New Construction

- Power Lines
- Is pipe grounded?
- Can booms reach power lines?
New Construction

- Length of Unsupported Spans
- Are there enough Side Booms?
- Ask inspector.
- Check Procedures.
New Construction-Padding/ Backfill

- Use all your senses.
- Is the padding getting all the way around the pipe?
- Is it deep enough over the pipe before the dozer completes the job?
- Ask Inspector/Check Procedures
New Construction-Padding/ Backfill

- Coating Damage
- Response = that is what CP is for! – Not!
- Easier to fix prior to burial
- Post Construction DCVG Survey Required
New Construction

- You are inspecting for problems that might cause a failure in 1 year (dent w/metal loss);
- 5 years – rock impingement/shielding CP
- 20-50 years – corrosion leak/rupture
Inspection Tips

- Notify Operator contact. Be considerate.
- Construction is unique; the opportunity to inspect is limited.
- Naturally an adversarial relationship.
- Be professional and courteous.
- Know plans and procedures.
- Observe.
- Ask questions then listen.
- Take notes.
- Take photographs.
- Report and document.
- Do not direct contractor or employee’s actions.
- Direct contractor questions to the inspection company (take note of occurrence; ask yourself why is the workman asking you questions about construction procedures or practices).
Thanks!

Questions?

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