Improving API 1104 for the Twenty-second Edition

Something to consider during your subcommittee meetings
Introduction

- API 1104 contains quite a bit of ambiguity
  - For welding procedure qualification in particular
    - e.g., contains no guidance on what to specify on a welding procedure specification (WPS) in relation to what was used to make the test weld
- Two schools of thought on this
  - Allows flexibility for the user
  - Creates confusion during audits
- Regulatory oversight has increased significantly in recent years
  - Some operators have reported significant issues as the result of this ambiguity and differences in opinion it creates with regard to the true intent of some of the requirements in API 1104
    - Violations of § 192.225 and § 195.214 (Welding Procedures) are often cited in notice of probable violations (NOPVs)
- Is it time to reduce this ambiguity in the next edition of API 1104?
  - Twenty-second edition nominally scheduled for 2019
Increase in Regulatory Oversight

- From [http://www.phmsa.dot.gov/pipeline/inspections](http://www.phmsa.dot.gov/pipeline/inspections) - Pipeline Inspections 101
  - “PHMSA's 139 federal inspection and enforcement staff and over 300 state inspectors are responsible for regulating nearly 3,000 companies that operate 2.6 million miles of pipelines, 118 liquefied natural gas plants, and 6,970 hazardous liquid breakout tanks.”
  - “For 2015, we are authorized an additional 98 inspection and enforcement positions.”

- From Gery Bauman
  - Number of inspector days (Federal) spent on new pipeline construction activities
    - 2013 – 1126
    - 2014 – 1145
    - 2015 – 2146
    - 2016 – increase is expected
  - ~20% of new Federal inspector time will be spent on new pipeline construction activities
§ 192.225 and § 195.214

- § 192.225 Welding procedures.
  - (a) Welding must be performed by a qualified welder in accordance with welding procedures qualified under section 5 of API 1104 (incorporated by reference, see § 192.7) or section IX of the ASME Boiler and Pressure Vessel Code “Welding and Brazing Qualifications” (incorporated by reference, see § 192.7) to produce welds meeting the requirements of this subpart. The quality of the test welds used to qualify welding procedures shall be determined by destructive testing in accordance with the applicable welding standard(s).
  - (b) Each welding procedure must be recorded in detail, including the results of the qualifying tests. This record must be retained and followed whenever the procedure is used.

- Seminar language in § 195.214
  - “...must be recorded in detail...” above and “...details of each qualified procedure shall be recorded...” in 5.2 of API 1104 are often a source of controversy
Background

- The API 1104 committee receives many requests for interpretation.
- The intent for some requirements in API 1104 is contained in the interpretations database.
  - e.g., database contains a number of interpretations that address what to specify on a WPS with regard to what was used to make the test weld.
- Interpretations database was a primary resource in the development of the PRCI guidance document for API 1104.
  - But, guidance document is not part of API 1104, is not sanctioned by API, and its existence is unknown to most users of API 1104.
Specification Information vs. Essential Variables

- Specification information that is not an essential variable can be changed without the need for requalification
  - Simply revise the WPS to show the revised range
- A change to an essential variable outside the range qualified requires that the procedure be requalified

- Travel speed is an essential variable for procedure qualification
Previous Request for Interpretation and Response

- **Question**
  - “Paragraph 5.4.2.12 states that "A change in the range for speed of travel constitutes an essential variable." and requires that the procedure be requalified if this range is changed. How is the range of travel speed for each pass established?
  - A) By measuring the travel speed of each pass during procedure qualification and listing the exact speeds employed by the welder for each pass.
  - B) By establishing a reasonable range of travel speeds based on experience and/or experimentation at the filler metal manufacturers recommended amperage and voltage ranges and welding the procedure qualification coupon within that specified range.
  - C) By some other method (Please explain).”

- **Answer**
  - “The Company establishes the range that they feel is appropriate and one way is as you have suggested in B.”
Response to a Similar (Long Lost) Request for Interpretation

- “There are different approaches to welding procedure qualification:
  - a) The Company may choose to qualify using a “typical” welding speed range and list a wider range in the welding procedure specification to allow for different electrode sizes, voltages and amperages that might be used for different pipe diameters and wall thicknesses.
  - b) The Company may choose to qualify using a very wide range of travel speed (e.g. explore the usable travel speeds) and then list a tighter range in the welding procedure specification to get more average production welds.
  - c) The Company may choose to shift just the high end or low end of the travel speed range depending on the Company’s relative concern for low or high heat input.
  - d) The Company may choose to write two specifications from a single test weld, one with a wide range and one with a narrow range, to use for specific applications.

- All of these approaches to procedure qualification are allowed by API 1104. The Company sets the travel speed range listed in the welding procedure specification as they feel appropriate.”
- Do these interpretation responses represent the intention of the committee?
- A certain degree of flexibility is required in API 1104
  - Some pipelines are more high risk than others
  - API 1104 needs to be “scalable”
- If so, what can we do to convey the intent of the committee in the standard?
- What improvements can we make to reduce ambiguity?
  - e.g., travel speed is an essential variable for procedure qualification, yet ironically, what API 1104 provides as an example procedure qualification record (PQR) does not even have a place to record travel speed
  - Figure 2 – Sample Coupon Test Report
- The lack of guidance on what to specify on a WPS with regard to what was used to make the test weld, combined with the ability to specify a very wide range (and the thought of increased regulatory oversight) encourages users to specify very wide ranges
  - May be allowed
  - May prevent welding outside the “qualified range”
  - May not be technically sound for some applications

- Other examples of issues resulting from ambiguity?

- Ideas for improvements for Twenty-first Edition?
Another Example of Ambiguity

- Changes to an essential variable outside the range qualified requires that the procedure be requalified
  - “A welding procedure shall be reestablished as a new welding procedure specification and shall be completely requalified when any of the essential variables listed in 5.4.2 are changed.”

- What does “completely requalified” mean?
  - Presumably it involves making and testing a new test weld, but why?
- If the new range could have been specified initially (based on the original test weld), why require that a new test weld be made?
- Can I write a new WPS based on an old existing test weld?

- What significance does the concept of an essential variable have if the company can specify anything they think is appropriate, regardless of what was used to make the test weld?
Wall thickness ranges
- A procedure qualifies on 0.188 in. thick can be used to weld on 0.750 in. thick, but a procedure for 0.750 in. thick cannot be used to weld on 0.751 in. thick?

Type and removal of lineup clamp
- Common to use no line up clamp but to specify either internal or external

Time between passes
- Time between the root pass and hot pass is an essential variable for procedure qualification, yet Figure 2 does not even have a place to record it

Travel speed is an essential variable for procedure qualification...
- ...but amps and volts are not (can be changed to any value without requalification
  - Main body of API 1104 does not consider the concept of heat input, which takes into account the collective effect of amps, volts, and travel speed of the resulting thermal cycle of the weld
  - Is it time to recognize heat input as optional essential variable to travel speed?
Cap height

- Section 7 says “At no point shall the crown surface fall below the outside surface of the pipe, nor should it be raised above the parent metal by more than 1/16 in. (1.6 mm).”
- Figure 1 suggests 1/32 to 1/16 in. – does this need to be reassessed?
- Why limit cap height to 1/16 in.?

Preheat temperature

- 5.3.2.13 only says the preheat temperature at the “start of the weld” shall be specified. What is the “start of the weld”? Does that mean the start of the root bead only, each weld bead, the start of each layer of weld metal, or?
- Is it time to recognize both preheat temperature and interpass temperature?
Mechanisms for providing guidance

- Clarify the requirement in the standard itself
  - Leave as-is for less-critical applications?
  - Supplemental essential variables and tighter allowable ranges for more-critical applications (e.g., for when toughness requirements exist)?
- Provide guidance note(s) after the requirement
- Provide guidance in a commentary section or companion document
**More Opportunities for Improvement**

- 5.3.2.13 only says the preheat temperature at the “start of the weld” shall be specified
  - What is the “start of the weld”?  
  - Does that mean the start of the root bead only, each weld bead, the start of each layer of weld metal, or?
- Is it time to introduce “interpass temperature”
- Is it time to remove antiquated language (e.g., weld pass instead of weld bead)
- Section 5.1 refers to hardness, yet hardness testing is not specified for production welds