NRCREP Resource

From: Findlan, Shane [sfindlan@epri.com]
Sent: Tuesday, September 29, 2009 3:05 PM
To: NRCREP Resource
Cc: Hixon, Jeffrey; RILEY, Jim; Frederick, Greg; McCracken, Steve
Subject: Comments on Draft Regulatory Guides (DG-1221, DG-1222, DG-1224)
Attachments: DRAFT REGULATORY GUIDE DG White Paper - 090727.doc

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Hello,
My name is Shane Findlan, with the Electric Power Research Institute, and I am forwarding the following comments from our welding group members regarding the draft welding-related regulatory guides. These comments are included below and in the attached white paper (for DG-1222, Preheat for Low-Alloy Steels).

Draft Regulatory Guide 1.50 (DG-1222)
Preheat for Low-Alloy Steels
The concern is with is the post-weld preheat maintenance requirement. This is something new and would require a weld program revision at DAEC. Currently this is only applicable to some P#s in B31.1. Scott Presler FP&L, Duane Arnold
RG-1.50 should be revised in accordance with the EPRI WRTC (RRAC) efforts and findings in the way of PWHT and pre heat requirements. Ron Clow XE Nuclear
The main change is the inclusion of a post weld hydrogen bakeout and an associated soak time if preheat maintenance is not done.

(Assuming a WPS is qualified in accordance with Section IX and Section III as specified by the Reg. Guide)
Comments are as follows:

· Part B, 3rd paragraph) When discussing welding fluxes what welding processes are being discussed?
· Part B, 3rd paragraph) Are Low hydrogen SMAW electrodes which have been tested to have low levels (H4) of hydrogen and properly controlled before welding included in the description "welding fluxes"?

· Part C, item 2.) With proper use of low hydrogen processes and welding filler material, if employed, should negate the need for hydrogen bakeout and soak as the predominant source for hydrogen is controlled to a low level. Please explain why the use of low hydrogen processes and filler materials as one of the main ways to control hydrogen are not discussed as a mitigation technique.

· Part C, item 2.), If PWHT is to be done and low hydrogen processes and/or low hydrogen filler materials used, the associated soak and preheat maintenance should not be required as the small amount of hydrogen will diffuse at the PWHT temperature.

Nick Mohr Duke Energy
Comment 1: In Section C2 of the regulatory position, there is only one exception when the preheat temperature doesn't need to be maintained before the final PWHT. That exception is only when a hydrogen bake out is performed. However, in cases where a low hydrogen welding process is used (i.e., GTAW or GMAW with solid wire), there shouldn't be any significant amounts of hydrogen in the weld or HAZ. In these cases, it should be allowed to slowly cool the weld to room temperature prior to the final PWHT. Another example would be in the case where a sufficient weld deposit has been applied (i.e., 3/8" or 25% of the groove is filled) and the weld is allowed to slowly cool to room temperature. In both of the latter cases, if welding has not been completed (due to end of shift), then the welds can be inspected prior to resuming any welding and the required preheat applied.

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Add = M. Bayssie (mmb1)

Comment 2: In Section C4, it is not clear whether the weld is acceptable if the soundness is verified by an acceptable examination procedure. This sentence can be reworded for better clarification.

Alex Gutierrez PG&E

The wording in 2 requires a hydrogen bake out of all CrMo welds for 4 hours.

The wording in 4 states if we don't do steps 1-3 we need to an "acceptable" soundness examination. Soundness usually equals volumetric. Since underbead cracking is what is specifically mentioned surface exams are likely out.

The real concern is the 4 hour post bake out. We have done a lot of work (EPRI, ASME Code, others) to get unneeded PWHT and post-bake out of our Codes and here it is reintroduced at a lower temperature without any cited value.

Neal Chapman Entergy

Also, please see attached white paper related to DG-1222/Regulatory Guide 1.50, prepared on behalf of EPRI by Phil Flenner who is a member of ASME B31.1 and Section IX Code Committees:

<<DRAFT REGULATORY GUIDE DG White Paper - 090727.doc>>

The comments below are for Draft Regulatory Guide, DG-1224:

Draft Regulatory Guide 1.44 (DG-1224)
Control of the Processing and Use of Stainless Steel

Comment 1: The last paragraph in Section C6, can be more specific regarding the need to control welding practices to avoid excessive sensitization of the HAZ. Does this only apply when welding on materials with > .03 carbon? Also, what exactly are the welding practices (heat input and interpass temperature) that need to be controlled? The last paragraph of the discussion section specifically mentions heat input and interpass temperature. The discussion section and regulatory position section should be consistent.

Comment 2: In the second to last paragraph of the discussion section, it mentions performing the qualification tests on material with the minimum and maximum thicknesses anticipated. Wouldn't the worst case be the material with the minimum thickness (due to slow cooling rate)? The maximum thickness would provide the fastest cooling rate and best chance of preventing sensitization. Based on this, testing should only be required using the minimum thickness material anticipated.

Alex Gutierrez PG&E

The comments below are for Draft Regulatory Guide, DG-1221:

Draft Regulatory Guide 1.43 (DG-1221)
Control of Stainless Steel Weld Cladding on Low Alloy Steel

Comment 1: In the discussion section, paragraph 9, a better description is needed for the alternative bend test. Should the maximum tensile stress be applied to the fusion line area and HAZ? The way it is currently written, the face of the bend specimen would be the weld-bead overlap area which can be consider to be weld metal. However, the expected cracking is in the base metal HAZ.

Comment 2: What about the option of making multiple cross-sections (minimum of 3) in the through-thickness direction either transverse to the weld or parallel to the weld. This way the weld, HAZ and base metal can be viewed.

Comment 3: Why is the acceptance criteria being applied to both test methods (polishing method and bend test). Cracks identified in the bend test method may be generated due to the tensile loading.

Comment 4: In Section C.2.e, the acceptance criteria is applied for any 1-inch length. In the case of the polished surface test, should the acceptance criteria be over an area?

Alex Gutierrez PG&E

Thank you for the opportunity to provide comments and feel free to contact me if there are any questions.

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COMMENTS - DRAFT REGULATORY GUIDE DG-1222
(Proposed Revision 1 of Regulatory Guide 1.50, dated May, 1973)

"Control of Preheat Temperature for Welding of Low-Alloy Steel" June, 2009

The following comments are intended to provide input and suggested revisions to the Draft Regulatory Guide DG-1222.

COMMENTS

1. No definition is given for the term "Low-Alloy Steel." The Keys to Metals database defines low alloy steels as follows:

   "Low-alloy steels constitute a category of ferrous materials that exhibit mechanical properties superior to plain carbon steels as the result of additions of alloying elements such as nickel, chromium, and molybdenum. Total alloy content can range from 2.07% up to levels just below that of stainless steels, which contain a minimum of 10% Cr."

   For the purpose of ASME Codes therefore, low alloy steels may typically be considered as applying to the materials in P Nos. 3, 4, 5A, 5B, 5C, and 15E. (Note: P No. 15E is a new P No. designation for Grade 91 materials; formerly categorized as P No. 5B, Group 2 prior to the 2009 Addenda to the ASME Codes.) It is suggested that the Draft Regulatory Guide DG-1222 include a definition of low alloy steels as those included in P Nos. 3, 4, 5A, 5B, 5C, and 15E. The P No. 15E is suggested since the 2009 Addenda will likely be issued prior to the issue of Revision 1 to RG 1.50.

2. In the 3rd paragraph under "**Procedure Qualifications**" under Section B "**DISCUSSION**", the statement is made that "Prolonged time at the preheating temperature can prevent or interrupt local hardening and assist in reducing the adverse effects of a potential hydrogen gradient." This statement is misleading in that it is technically inaccurate to state that "Prolonged time at the preheating temperature can prevent or interrupt local hardening". Research at EPRI has shown that the local hardening on carbon and low alloy steels can be reduced with the use of the recommended preheat during welding but some hardening will still occur with each welding pass (subsequent welding passes will further reduce the local hardness). The statement however included the information that "Prolonged time at the preheating temperature ... can assist to reduce the adverse effects of a potential hydrogen gradient" which is technically correct. The following revision to the draft proposed sentence is suggested:

   Section B "**DISCUSSION**", Procedure Qualification, 3rd Paragraph

   "Prolonged time at the preheating temperature can ~~prevent or interrupt local hardening and~~ assist in reducing the adverse effects of a potential hydrogen gradient. Preheating at the recommended temperatures can also reduce the local hardening by reducing the cooling rate during welding."

3. The last paragraph under "**Procedure Qualifications**" under Section B "**DISCUSSION**", concerns the specification of an interpass temperature. While it is true that the interpass temperature does potentially affect impact toughness properties, a requirement to apply the specific control of the interpass temperature when toughness is not required to be controlled is often unnecessary and an excessive requirement that will add costs during any welding operation on these materials. The requirements of ASME Section IX, "Welding and Brazing Qualifications" adequately control the interpass temperature by qualification. The rules require the qualified welding procedures thus qualified to be followed when impact toughness is a requirement of the construction code. The following revision to the draft proposed paragraph is suggested:

Section B "**DISCUSSION**", Procedure Qualification, Last Paragraph

"In addition to the minimum preheat temperature, a maximum interpass temperature must ~~should~~ be specified per the requirements of ASME Section IX if toughness is a requirement of the construction Code or the design. ~~If the weld metal transforms at too high a temperature, the required mechanical properties for the metal may not be met. The maximum interpass temperature varies for different steels, as does the minimum preheat temperature, and~~ For other low alloy steels, a maximum interpass temperature, if required, should be selected on the basis of such influencing factors as the chemical composition of the steel."

4. Under Section C "**REGULATORY POSITION**", the statement is made in item 1 that "The procedure qualification should require the following:" This is not the purpose of a procedure qualification per the rules of ASME Section IX. The procedure qualification record only provides a documentation of the actual required parameters used during the welding of the qualification coupon and the procedure qualification is an activity rather than a statement of the requirements. To be correct, it is the welding procedure specification (WPS) where the requirements for welding are specified.

   Under Section C "**REGULATORY POSITION**", the statement is made in 1a that "A minimum preheat and a maximum interpass temperature should be specified." As stated above, a maximum interpass temperature is not always necessary for some low alloy steels.

   Also, the statement is made in 1b that "The welding procedure should be qualified at the minimum preheat temperature." ASME Section IX, essential variable QW406.1, specifies that the minimum preheat temperature shall be specified in the WPS and that it cannot be decreased more than 55°C (100°F) from the preheat temperature qualified. The proposed draft statement could be interpreted as requiring the preheat temperature qualified as the minimum temperature that could be used or specified within the WPS. This could cause increased costs associated with controlling the minor deviations from the target preheat temperature with no appreciable effect on the weld quality. Since this is already covered in ASME Section IX, this statement is not needed.

   The following revisions to the draft proposed statements are suggested:

Section C "**REGULATORY POSITION**", Item 1

"1. The welding procedure specification (WPS) ~~qualification~~ should specify ~~require~~ the ~~following:~~

~~a.~~ A minimum preheat and a maximum interpass temperature, if required.~~should be specified.~~"

~~b. The welding procedure should be qualified at the minimum preheat temperature.~~"

5. Under Section C "**REGULATORY POSITION**", item 2 states:

"For production welds, the preheat temperature should be maintained until final postweld heat treatment or a hydrogen bakeout is performed between 200 and 400°C (400 and 750°F) for a minimum of four hours after which the component may be slowly cooled to ambient temperature prior to the performance of the final post weld heat treatment. The post weld hydrogen bakeout temperature and soak time should be based on the materials being welded, geometry, and the welding process used."

Similarly to the discussion concerning the need for maximum interpass temperature control, there is little need for hydrogen bakeout for many low alloy materials. It is therefore essential that any controls proposed that may require hydrogen bakeout be applied only to those materials which require it in order to reduce the possibility of hydrogen cracking after welding. Applying this rule to materials and welds which do not need it and which maintaining the preheat until the PWHT is performed would be an extraordinary cost due to time and effort with no appreciable benefit.

There are many factors which influence the need to perform a hydrogen bakeout at the conclusion of a weld if the preheat is not to be maintained. Included is the hardenability of the material, the thickness, the welding process, the welding technique used (heat input and multiple passes) and the moisture content of the flux (if the process involves a flux).

The current Codes provide relatively little restriction based on the imposition of a hydrogen bakeout on low alloy materials. ASME Section III contains nonmandatory preheat rules in Appendix D but there is only a cautionary statement (Para. D-1120) that mentions the need to consider the effect of reducing the preheat below the stated temperature.

More explicit rules exist in ASME B31.1, Para. 131.6.1 where low alloy materials of P Nos. 3, 4, 5A, and 5B are addressed (there are no P No. 5C materials in B31.1 and P No. 15E (now P No. 5B) will not be addressed until the 2009 addenda). The current Para. 131.6 in B31.1 applies to the interruption of welding (preheat) before the welding is completed but the primary concern is the potential for hydrogen cracking once an adequate weld has been deposited for structural purposes. For P Nos. 3, 4, and 5A, the only requirement is that the weld be slowly cooled to room temperature; no intermediate heat treatment is required. For P No. 5B materials, an intermediate heat treatment is required prior to cooling but is not specified other than being adequate. The current B31.1, Para. 131.6.1 is shown as follows:

Current B31.1-2007 with 2008 Addenda, Para. 131.6.1

131.6 Interruption of Welding

131.6.1 After welding commences, the minimum preheat temperature shall be maintained until any required PWHT is performed on P-Nos. 3, 4, 5A, 5B, and 6, except when all of the following conditions are satisfied.

(*A*) A minimum of at least ⅜ in. thickness of weld is deposited or 25% of the welding groove is filled, whichever is less (the weldment shall be sufficiently supported to prevent overstressing the weld if the weldment is to be moved or otherwise loaded).

(*B*) For P-Nos. 3, 4, and 5A (with a chromium content of 3.0% maximum) materials, the weld is allowed to cool slowly to room temperature.

(*C*) For P-No. 5B (with a chromium content greater than 3.0%) and P-No. 6 materials, the weld is subjected to an adequate intermediate heat treatment with a controlled rate of cooling.

(*D*) After cooling and before welding is resumed, visual examination of the weld shall be performed to assure that no cracks have formed.

(*E*) Required preheat shall be applied before welding is resumed.

ASME B31.1 has processed a recent change to Para. 131.6.1 that is scheduled for publication in the 2009 addenda to the 2007 edition. The revised Para. 131.6 to be published in the 2009 addenda to ASME B31.1-2007 adds a new Para. 131.6.2 which allows the omission of the intermediate heat treatment for the P No. 5B materials provided the process and electrode moisture content meets certain criteria. The approved change to B31.1, Para. 131.6. is shown as follows:

B31.1 Para. 131.6.2 Revision approved for publication in 2009 Addenda.

131.6.2 Intermediate heat treatment for P-5B materials may be omitted entirely when using low-hydrogen electrodes and filler metals classified by the filler metal specification with an optional supplemental diffusible-hydrogen designator of H8 or lower and suitably controlled by maintenance procedures to avoid contamination by hydrogen producing sources. The surface of the base metal prepared for welding shall be free of contaminants.

This change reflects the ability to control hydrogen cracking through use of processes that will not introduce excessive levels of diffusible hydrogen into the weld.

In Ref. [1], the statement, "The use of a 350 Hv hardness criterion implies a significant tolerance to variations in hydrogen content. Cracking tests show that 350 Hv is a safe level even when using rutile coated electrodes." In Ref. [2], it has been shown that the average maximum hardness in the HAZ of typical multipass welds in P No. 1, 3, 4, and 5A materials is below 350 Hv, even on 1.5 in. thick materials.

This discussion reflects the ability to control hydrogen cracking using methods other than the methods that are proposed in the draft regulatory guide, Section C, Item 2. It is therefore suggested that this item be revised as follows:

Section C "**REGULATORY POSITION**", Item 2

"For production welds on low alloy materials that are susceptible, the preheat temperature should be maintained until final postweld heat treatment or other process controls should be used to minimize the potential for hydrogen cracking. Controls such as slow cooling, processes with low hydrogen potential, electrodes with low diffusible hydrogen content, welding multiple pass techniques and heat input controls to minimize potential high hardnesses, or a hydrogen bakeout may be used. If needed, the ~~a~~ hydrogen bakeout should be ~~is~~ performed between 200 and 400°C (400 and 750°F) for a sufficient time to remove the excess hydrogen, ~~minimum of four hours~~ after which the component may be slowly cooled to ambient temperature prior to the performance of the final post weld heat treatment. The post weld hydrogen bakeout temperature and soak time should be based on the materials being welded, geometry, and the welding process used."

REFERENCES

[1] Graville, Brian A., *The Principles of Cold Cracking Control in Welds*, p.127, Dominion Bridge Company, Limited, 1975.
[2] McGehee, A., Flenner, P., *Investigation of Thickness Limits for Post Weld Heat Treatment (PWHT) Exemption*, Interim Report 1011535, Section 3, Electric Power Research Institute, 2005.