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Neil Gallon, ROSEN.

8th October 2020

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"INTEGRITY MANAGEMENT OF HYDROGEN TRANSPORTATION PIPELINES "

Neil Gallon

8th October 2020

About Me

- **Neil Gallon**
- **Neil is the Principal Materials and Welding Engineer at ROSEN.**
- He graduated from Cambridge with a degree in Materials Science and Metallurgy, and has spent almost 20 years in various technical roles within manufacturing, working for British Steel in its various guises including in the Hartlepool pipe mill, and also for offshore flexible pipe and valve manufacturers. For the past 3 years he has been working in the consulting engineering industry, looking at various aspects of materials engineering, welding and corrosion. He is a professional member of the IoM3, and also an International / European Welding Engineer

- This presentation will illustrate a comprehensive integrity management approach supporting pipeline operators with the conversion of their existing natural gas grids and operations for transporting hydrogen. It will summarise the potential threats, and the changes or additions to current integrity management (and potentially operating) practices needed to monitor these new threats.

Q&A

Selection of Questions to **Neil Gallon**, ROSEN

Post-Presentation 08/10/2020

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Thanks for an excellent presentation, are there any industry guidance on optimum materials selection for pure H2 or H2-Hydrocarbon mix? Of course we would be using existing infrastructure, anyway.
- **A.** Suggest that you refer to ASME B31.12 2019 Hydrogen Piping and Pipelines, see also AIGA guidance AIGA 033/14 Hydrogen Pipeline Systems.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** An excellent presentation. Thank you Neil. You seem to be indicating that a baseline ILI is essential, what then would be the likely future ILI freq. compared to Non H2 pipelines. Are guidelines already established ?
- **A.** Future freq. is dependent on the actual threats identified but expected lower frequency overall.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** In the existing codes for H2 transport pipelines is the same 250HV limit used, as NACE MR0175, or is the HV limit relaxed due to the less severe charging conditions?
- **A.** This is taken from other industry guidelines and is quite conservative.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Effect of hydrogen on toughness is worse at lower strain rates, charpy and DWTT used for pipeline steels are high strain rate tests. how can these tests be adapted/interpreted for hydrogen service?
- **A.** It is very difficult to define best test, there are multiple factors / considerations. This remains an open discussion presently.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Fracture toughness data give the test pressures during testing but not time spent in a hydrogen atmosphere prior to testing. Given that hydrogen embrittlement is a diffusion controlled mechanism, is this data relevant to long exposure times? Would fracture toughness vs exposure times be required? This also applies to FCGR, UTS etc.
- **A.** The general consensus is that in gaseous H2 conditions, there are 2 modes that contribute to cracking, soaking + internal diffusion. These are different mechanisms to standard H2 issues.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Very good presentation! Please can you clarify a bit more why some of the cracking mechanisms mentioned are a concern for hydrogen transport when they are mostly based on atomic hydrogen as opposed to hydrogen gas?.....
- A. The amount of available H2, which is dependent on the Op. parameters, Temp. Press. etc.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Thanks for a great presentation. HTHA has been noted at lower temperatures than stated on the Nelson curves. Can the threat be safely ruled out, as you suggested?
- **A.** Gas transmission pipelines typically operate at temperatures =< 70 deg. C and maximum pressures ~100 bar, I'm not aware of any evidence of HTHA under these kind of conditions but if there is anything out there would be interested to hear more.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Could blending hydrogen into natural gas pipelines be used as a means to transport hydrogen through higher-strength pipelines which might otherwise be considered unsuitable?
- **A.** Safe limits are not yet defined in documentation but 10-20% is generally considered a safe range.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Very good presentation! Please can you clarify a bit more why some of the cracking mechanisms mentioned are a concern for hydrogen transport when they are mostly based on atomic hydrogen as opposed to hydrogen gas?..
- **A.** According to Sieverts' law molecular hydrogen will dissociate at the surface of the steel pipeline and atomic (or ionic) hydrogen will be absorbed into the lattice.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Hello Neil. Thank-you for an interesting presentation. we are discussing lining long pipelines against hydrogen with some operators, are there any studies which have been published on this subject?
- **A.** Design guidelines recommend lining as a potential mitigation but they don’t allow any additional allowance in terms of stress levels etc. for lined pipelines, probably due to the difficulties in ensuring 100% effectiveness of the liner.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Excellent presentation. Have you experience in assessing integrity threats from hydrogen as a CCS contaminant from blue hydrogen generation, e.g. hydrogen partial pressures of the order of a few bar?
- **A.** Yes even quite low levels H2 can have impacts, but O2.+ CO + Nat gas, are competing contaminants and they are beneficial ones.

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- **Q.** If a pipeline, or pipeline section, is identified as unsuitable, are there ever practical remediation methods possible, or does the section of pipe always have to be removed and replaced?
- **A.** This really depends on exactly why has it been deemed unsuitable, once known further guidance can be given.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Does gas transport temperature provide any form of mitigation for hydrogen transport?...not really most Op Temp. ambient / not much effect?
- **A.** Answer is pretty much as above, for the types of temperatures usually involved the variation between e.g. ambient and 50 deg. C is minimal.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Any differences in degradation in gas and liquid state of fluid? any comments on inhibitors protection?
- **A.** Talking purely about gas phase so conventional inhibitors not really appropriate. Some additives (e.g. oxygen) can mitigate against the effects by preventing absorption in the first place but operators are way about mixing oxygen and combustible gases.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Great presentation Neil; has anyone looked at the impact of sulphide films or black powder on hydrogen uptake?
- **A.** No not to date that I am aware of so far.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Thanks for the presentation, Neil. Any thoughts on the limits of the TD/1 approach of 0.3 design factor for type R areas (leak befiore rupture) for hydrogen blends?
- **A.** TD/1 is currently out for review to incorporate hydrogen, I will review properly and respond there.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** For management of existing known defects (e.g., from your base line inspection when the line is transporting natural gas), how does the performance of your ILI tools compare when the pipeline is then used to transport hydrogen? Thanks
- **A.** A different ILI tool design is required specific to H2 operations and/or known internal conditions. Test magnets need to be protected etc. plus speed variations required according to local conditions and testing req's.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

- **Q.** Thanks for the presentation, Neil. Any thoughts on the limits of the IGEM/TD/1 approach of 0.3 design factor for type R areas (leak before rupture) for hydrogen blends?
- **A.** TD/1 is currently out for review to incorporate hydrogen, I will review properly and respond there.

Questions and Answers – MCF / ICorr Joint Event Aberdeen – Oct.2020

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