Minutes

3rd meeting of the HSE/Industry Pressure Drum Working Group

HSL Sheffield 16 June 2004

1.0 Attendance

Graeme Hughes	HSE HID CTG5	GH
Janet Joel	HSL	JJ
James Hobbs	HSL	JH
John Roberts	Ineosfluor	JR
Chris Mulliss	Rhodia	CM
Michael Dean	Air Products	MD
Tim Heumann	Ineoschlor	TH
John Billows	A-Gas	JB
Gary Brown	Ineosfluor	GB
Geoff Rogers	Lloyds QA	GR

1.1 Apologies

Roy Irani	BOC	RI
Jim Reid	Jackson and Kaye	JRd
Charles Pullar	Thames Water	CP
David Holt	Calor	DH
John Davey	Harpe	JD

2.0 Results of last meeting

GH said that the last two meetings had been talking shops where a specification for inspection at time of fill for pressure drums and comments on the CEN draft for periodic examination of pressure drums had been discussed. From these two meetings a specification had been posted on the HSE website and Bsi were taking forward the periodic examination comments. No minutes had been produced for either meeting.

GH said that he would be attending the next PVE3/7 meeting to see what progress was being made with the working groups comments. Andrew Jackson had attended the last meeting and the Working Group thanked him for passing on their thoughts to Bsi.

3.0 ImechE seminar 25 May 2004

JR had received feed back from those present who had expressed concerns that Ineosfluor drums may not be safe. GH said that Ineosfluor were not mentioned by him in the presentation but TH said that one picture with A22 on the drum would lead directly back to Ineosfluor. GH stated that it was not his intention to portray the message that these drums were unsafe but that more needed to be done to ensure their ongoing integrity for the coming years.

GH had only received positive feedback and others present had nothing to report.

4.0 TNT Equivalence

GH gave an overview of the TNT equivalence of pressure drums and said that a typical drum would give 5kg of TNT in a burst situation. He said that he had found one warehouse full of pressure drums and so had looked at what would happen in a fire. Initial calculations show that a drum could reach burst pressure at just 100c. JR said that he has carried out a risk assessment on this and that he will work with HSE to look into ways of preventing possible fire scenarios. JR said that BCGA had literature that gave guidance on the safe storage of drums and that this could be used as a basis for any HSE guidance.

JR said that there had been an incident where one drum had its ends reversed but a second had travelled through a wall. This was in a significant fire. Most drums are stored outside and are normally only inside for use. CM said that this was limited to just one or two drums at a time.

GH said that he was going to do a small research project to get a report on the potential effects of a pressure drum in a fire. This work would be carried out by HSL in consultation with GH and JB. The importance of the final report would be the opportunity to present the findings to the UN working group on gases to try to ensure such drums are protected by a PRD or have some other form of protection from fire engulfment. **Action 3-1 GH/JB**

5.0 Research – Ineosflour drums

JJ gave a presentation on the work that she has so far carried out on the first Ineoesfluor pressure drum. The drum has been cleaned off and had an external MPI examination with no indications. The ends have been cut off to see the structure of the welds and microsections have been examined. The longitudinal seam section showed a slight misalignment. The end welds show the set up which appears to give a sharp discontinuity towards the weld cap. GH question if this could be a fatigue initiation site.

The material microstructure shows many imperfection and JJ said that this was much higher than steels she would see today. The tensile strength was judged to be 430N/mm2 from the hardness values found. One end however showed much higher hardness values – 492N/mm2 and JJ said she would investigate this further.

JJ has carried out a thickness survey with readings of 6.1 to 7mm – the specification gives 7.1 to 8.1mm. Micrometer checks give 6.63 to 6.53mm.

JJ had carried out thickness calculations based on the ICI formula – this gives a minimum shell thickness of 6.6mm. Therefore the drum is now thinner than that allowed by the formula. JR said that due to zinc spraying there would not be a corrosion allowance. JR pointed to shot blasting as a possible cause for this loss of thickness.

JJ said that the next steps would be an MPI examination inside the drum and a thickness survey of the drum ends. She also needs to carry out some tensile testing and a series of charpy tests across the weld. **Action 3-2 JJ**

This will be repeated on the drum supplied to HSL by CM. JR said that if CM gives him the serial number then he will try to find the original data sheet.

JR said that he will have some ADR calculations for the drum and that he will supply these to JJ. **Action 3-3 JR**

GB asked about the corrosion. JJ said that this was internal and was brown in colour and extensive. She said that the drum had been supplied open so any surface corrossion could have taken place at a late stage.

GB asked if there were any other defects – such as dents. JJ said that there was and that the significance of these would be assessed. **Action 3-4 JJ**

JR said that these drum typically see two trips a year so this was not a huge amount of handling. Dents were assessed against the Ineosfluor guide so JJ should use this as an initial assessment. JR said that the original design was assessed for drop tests.

JJ said that this drum was manufactured in 1963 – CM said that he had found one made in 1928.

6.0 Research – Calculation methods

JH gave a presentation on the stresses that could be generated by the misalignment of a pressure drum longitudinal seam. He has used an API and BS7910 approach to carry out the assessment. He reported a misalignment of 11 degrees. He assumed a 0.8mm internal crack at 30 bar pressure.

JH reported that the vessel failed the assessment. It was beyond the assessment line on the failure assessment diagram (FAD) but near to the plastic end of the scale rather than the brittle end.

JH reported a cyclic fatigue of 10-20bar daily, 0-30 bar weekly and 45 bar every 10 years. The crack would grow from 0.2 to 0.8 mm in 50 years.

JH reported boundary stress analysis results that showed very high stresses at the peak of 415Nmm-2 – this is well above yield. A crack would increase this still further. GR asked if bending stresses had been included. JH said that the bending stress was 1.5 times the membrane stress in this case. **Action 3-5 JH**

JH concluded that peaking had a high effect on the stresses and that a defect of just 0.8mm would cause failure. Fatigue would cause very slow crack growth. JR asked how the elements of the fatigue each contributed to the crack growth and JH said that he would look at lunch time. JB asked for the presentation to be appended to the minutes. This was agreed. JH reported after lunch that the 0-30 bar cycles were the most significant part of the analysis and that the 45 bar hydro test gave the least crack growth per year.

GB asked what the effect was peaking angle was. JH said that for this crack a 9 degree angle falls within the FAD.

JB said that JH reported assumption and asked for clarification. JH said that he had to assume the height of the peak from API approaches – the photograph he had was not sufficient to measure this and hence the assessment approach. JB asked what effect errors in the assumption would have. JH said that the angle is the important part and that this was not critical to the calculation but that he would carry out same sensitivity analysis on this. JH reported after lunch that the sensitivity to peaking angle is a critical aspect of the analysis and he showed an FAD that gave angles of 4 to 5.5 degrees with 5 degrees being well within the assessment line.

GR asked if JH had carried out peak stress analysis to PD5500. He said that his experience showed that in reality there would be plastic deformation that would bring stresses down to near yield. JH will look at this to see what effect this has on the model. **Action 3-6 JH**

JR said that this should be used to lead to better assessment guidance for the inspection and time of fill and the periodic examination. He said this work should be used to lead to better defect criteria.

7.0 End of life guidance principles

A brain storming session was used to identify what ageing could mean to a pressure drum. This highlighted the following;

- Dents
- Cracks – internal - external
- Corrosion
- Peaking
- Welding process
- Features that are necessarily dangerous
- What is the life and why
- Design features
- Reliance on periodic examination
- Rolling life method
- Old materials
- Large bead welds
- 1976 introduction of BS5500
- Bench mark changes to design, welds and materials.
- Rolling hoops and shrouds – crevise corrosion

It was identified that time of fill inspections and periodic examinations could be used to sort out features such as dents, corrosion and external cracks but that the main risk to the drum would be internal cracks that grow due to some fatigue mechanism. It was further agreed that the periodic inspection was not sufficient to find the signs of ageing.

8.0 End of life guidance structure

A second brain storming exercise then concentrated on the features that could lead to an internal fatigue crack and it was agreed that these would form the basis of the guidance that was required.

- Weld profile
- Geometric features
- Material
- State of heat treatment
- Weld quality
- Operating conditions
- Changes of use
- Stitch welding of rolling hoops
- Possible crevise corrosion sites – shrouds, data plates, other water traps etc
- Low temperature

It was agreed that the guidance would have a section on each of the above and that more could be added as the guidance developed. It was further agreed that the 1976 edition of BS5500 would be used as a watershed and if it can be shown that a drum at least meets that standard then little more would be required as this would have controlled shape, materials and welds.

The group was prepared to assume that the defect criteria given in the periodic examination draft standard would not lead to ageing of the pressure drum. GH suggested that JH should look at this aspect and report back to the group on his opinion of the risk of allowable dents and corrosion levels leading to a drum failure. With regards to the dents these should not grow but the corrosion could worsen over the 10 years between examination. **Action 3-7 JH**

9.0 Drafting guidance

GH agreed that the guidance would be published on the HSE website and that therefore GH is best placed to carry out the drafting work. **Action 3-8 GH**

10.0 Carriage Regulations

The Carriage Regulations came into force on 10 May 2004 with no transitions.

JR says that he has a number of drums that he is getting ready for pi marking in July 2005. He has been told by TUV that Article 1. 3 of TPED does not require a re-assessment. GH stated that this interpretation is not correct if use in other EC countries is required. ADR covers transport and allows the contents to be emptied but it would not allow the drums to be refilled for use in another member state or to have a periodic examination in another member state.

The HSE website should be up and running in the next few days and will include a link to the Safe Use of Gas Cylinders INDG308 Rev 1 free leaflet.

11.0 AOB

TH asked if any other groups like this meet in other Countries. GH knew of none.

GB asked if there was a similar body looking at chemical plant issues. GH said that there was an oil refinery interest group but was not aware of a pressure systems group for the chemical industry other than EEMUA. GB said that his company were no longer EEMUA members.

12.0 Date and venue of next meeting

TBA first week in October at Ineoschlor Runcorn **Action 3-9 TH**