

# **Minutes of First Meeting of the HSE Gas Cylinder Research Steering Committee**

**15 January 2002**

**HSL Sheffield.**

## **1.0 Attendance**

Roy Irani (RI)	BOC
Steve Elliott (SE)	BCGA
Andy Webb (AW)	Air Products
Andy Jackson (AJ)	Jackson & Kaye
Peter Bates (PB)	Gas Container Services
Roy Mellick (RM)	Messer
Barrie Shepherd (BS)	MBEL
Janet Joel (JJ)	HSL
Oliver Crichton (OC)	HSL
Graeme Hughes (GH)	HSE

Apology received via BCGA for Mr Ojake of Energas who wishes to remain papers only at this time.

## **2.0 Election of Chairman and Secretary**

RI was unanimously elected as the committee chairman and GH volunteered to act as secretary.

## **3.0 Proposed Research**

GH gave a presentation on the background to the need for addition HSE sponsored research. A copy of the presentation is attached to these minutes.

## **4.0 NDT Research by MBEL**

BS gave a presentation on the capabilities of MBEL with particular emphasis on development of NDT procedures. He spoke about a stainless steel project that could detect stress corrosion cracking down to 2mm height using a semi automated belt scanner. He went on to suggest eddy current testing as a rapid detection procedure which could be fully automated. RI expressed concern over the use of eddy currents on magnetic materials but BS said that things have moved on over recent years and that new

saturation methods allowed ferretic materials of up to 20 mm thick to be inspected. One advantage of an eddy current method is that orientation is not critical as it is with ultrasonic methods. An application was discussed using a rotating head where pipes could be inspected at a rate of 20m/minute, 3 to 12 mm thick and up to 110 mm diameter. BS stated that this type of equipment could detect 5% wall thickness loss.

BS went on to outline his view of a possible joint sponsored project for non invasive inspection of gas cylinders. He sited the following as the most important outcomes of such a project :

- Reliability
- Speed of inspection
- Cost effectiveness
- Automatic
- Ease of use
- Not tied to one inspection supplier

BS spoke about other MBEL group sponsored projects the most relevant of which was the recommended practice for Non Invasive Inspection.

BS outlined the approach to be taken in two phases. Phase one would review potential NDT methods, source cylinders with defects, run feasibility trials which may include a combination of ultrasonics, electromagnetic and laser shearography. Phase two would be to build and test an automated system.

Acoustic emission was not included in BS list as this is seen as a sorting technique rather than a measuring technique.

RI was concerned that legislators allow ultrasonics and acoustic emission but it may be some years before other techniques are allowed. The wording in 6.2.1.6.1 (b) of ADR reads '*Internal examination of the receptacle (e.g. by weighing, examination of the internal condition, checks of wall thickness)*'. Note 1 allows the hydraulic pressure test to be replaced by an equivalent method based on ultrasound and Note 2 states '*With the agreement of the testing and certifying body approved by the competent authority of the country of approval, the hydraulic pressure test of cylinders and tubes may be replaced by an equivalent method based on acoustic emission.*' So this would appear to mean that if the aim is to get rid of the hydraulic test the developed procedure must include either a UT or AE element. It may therefore be possible to use electromagnetics to satisfy (b) with a UT head to satisfy Note 1. ADR can be changed in the future if it can be demonstrated that a suitable procedure is available.

BS was asked to look at the methods in use today as background to his proposal.

AJ stated that he had problems with UT in the past, these included set up times which made the economics wrong. He went on to say that visual testing with gauges and hydraulic testing is today's methodology that had served industry well. He did see huge

advantages of not having to hydraulically test cylinders and further advantages with toxics of not having to remove a valve.

AW continued this debate stating that the actual usage of each valve is important. Some valves see only a few operations whereas others are opened and closed very frequently. He saw a need to differentiate between these types as there can be no need to remove a valve that is still like new. This debate looks very similar to that within the Non Invasive Inspection methodology and GH feels that this best practice could form a basis for future gas cylinder risk based inspection.

## **5.0 Facilities at HSL**

JJ spoke about the small scale testing available at Sheffield. She has a fully equipped metallurgical facility, a strong floor and good craneage. She also spoke about a wire rope test machine that could pull up to 400 tonnes.

OC spoke about the larger scale facilities available at Buxton. They can carry out hydraulic testing up to 650 bar and pneumatic testing up to 275 bar. The compressor is 0.9 cum/minute with a large 275 bar storage tank. Buxton is a 600 acre site and is approved for up to 25 kg TNT explosions. A 100m exclusion zone is easily achieved.

OC also spoke about work on diesel tank behaviour in a 40 mph crash. HSL had used very high-speed video (4500 FPS) and the tank failure was easily followed through the impact to the cloud of fine diesel droplets and finally the fireball. GH suggested that members may be interested in testing an ADR tractor unit with a car collision at 40 mph to see if a fireball resulted that could engulf the DGs being carried.

**Action 1. All**

RI asked about hydrogen testing facilities at HSL. OC said that nothing was available at this time. Group was concerned that no research was available on 300 bar hydrogen and also it was not clear on how fuel tanks for cars at 700 bar had been tested.

RI further stated that there was a gross difference in testing regimes between UK and USA and that the ISO TC58 WG7 were working on the compatibility document ISO1114-4. Previous experience showed embrittlement problems with high strength steel but now manufacturers and users want to start moving back to these materials for hydrogen. A fracture mechanics methodology is used to justify this and the question is – is the UK approach any safer than the US approach or are we over conservative. GH will put a file together on this and submit it to Bill Geary at HSL for a formal project proposal.

**Action 2. GH**

## **6.0 View of Gas Supply Companies**

AW stated that they were please to see HSE take an interest in gas cylinder research and fully supported the work. He went on to say that the cost of an incident is dramatic with

far reaching consequences. He asked that UK legislation for gas cylinders be toughened up and he was not adverse to the idea of regulating gas filling plants.

## **7.0 View of Competent Persons**

PB said that the work was fully supported and he saw a definite need to improve safety. The independent test houses see the 'dirtier' end of the market and need to protect themselves from the shoddy practices of some of their customers. PB questioned the end product of this research, would it be to toughen up legislation. GH responded that he hoped to see a Best Practice Document addressing the issues surrounding the filling and testing of carbon dioxide cylinders.

AJ was keen to see the development of better testing that was fast, reliable and economical and that had limited false calls i.e. rejected defective cylinders only. The initial need was to replace the current testing practices but it was seen that an inspection at time of fill would be the ultimate outcome.

RI reminded the group of the ISO work on examination of current retest intervals and reject criteria and suggested that some aspects of the proposed work could feed in to the ISO committee.

It was stated that the German Authorities impose an internal inspection before filling any CO2 cylinder.

AW said that mixed gas was not in common use on the continent and AJ added that in the UK we only have about 10 years experience of using mixed gas.

The group was disappointed with the HSC statement that the competent person regime in CDGCPL2 would continue until 2006. The feeling within BCGA is that the regime is failing the industry and should be removed in 2003 which is the next opportunity. GH said that he would put together his case for regulating competent persons and send it to Rose Court for their consideration.

**Action 3. GH**

## **8.0 Proposed Research**

### **8.01 300 Bar Cylinders**

GH reported that HSE had no funding for this part of the project. IR suggested that this was the way ahead and was very important to the group. GH proposed that there could be a case for a joint funded project and asked JJ to put forward a proposal to all members

**Action 4. JJ**

AW said that he would bring this research to the notice of EIGA at the next working group meeting and see if any funding could come from them.

**Action 5. AW**

## 8.02 Corrosion Matrix

The need for a full set of dry cylinders was questioned and it was agreed to limit this to two cylinders only –using CO<sub>2</sub> from ammonia production with one cylinder made from tube and the other from plate/billet.

RI suggested that for good research results we should duplicate all tests with one cylinder made from tube and the other from either plate or billet. This was agreed and an action on JJ to update the matrix.

**Action 6. JJ**

It was agreed that all cylinders should be made to the same standard and that they must meet the requirements of CDGCPL2. It was decided to use BSEN1964 as the basis of design. Mixed gas cylinders will have a fill pressure of 200 bar and test of 345 bar. Carbon dioxide cylinders will have a test pressure of 250 bar and a 0.75 fill ratio. All cylinders should be of CM steel with a diameter of 140 mm. JJ was asked to order the tube cylinders from PB and the plate/billet cylinders from AJ. PB indicated that he might have a problem with the required diameter, if this is the case then all orders should be placed on AJ.

**Action 7. JJ**

The corroding fluids were discussed at length. RI suggested that hard water should be used for the wet cylinders as it is more acidic and will give the worst case. AJ agreed to contact the Brewers association to obtain sufficient samples of coca cola syrup, the most acidic beer or lager, tonic water extract and a common cleaning fluid, preferably containing hypochlorites. JJ reported that the water in Sheffield was soft so could AJ also find sufficient hard water.

**Action 8. AJ**

RI reported that BOC in Derby used carbon dioxide from Norsk Hydro which comes from ammonia production. All cylinders on the matrix that require either mixed gas or CO<sub>2</sub> from ammonia process will be filled at BOC Derby. JJ asked that a gas analysis be supplied to her at the time of filling.

**Action 9. RI**

RI asked that all cylinders be stencilled 'FOR RESEARCH PURPOSES ONLY' and that a BOC shipping label and test tag be fitted to each cylinder.

**Action 10. JJ**

It was agreed that there should be a minimum time period between putting the corrosive fluid into the cylinder, fitting the valve, filling with gas and putting the cylinder in a safe place in Buxton. This needed a detailed risk assessment but it must be noted that earlier research shows a corrosion rate of 1mm/month or 0.033mm/day so it was widely agreed that if the full operation could be completed in one day there should be no measurable increase in overall risk levels.

RI requested that GH write a letter to BOC and Messer giving permission to fill contaminated cylinders.

**Action 11. GH**

RM stated that Messer could supply CO<sub>2</sub> from a distillery process in Edinburgh. JJ had concerns over the time restrictions. After the meeting she asked GH if it would be possible to obtain the CO<sub>2</sub> closer to the Buxton area. Could RM please look into this and report back to GH as soon as possible.

**Action 12. RM**

RI asked that BOC be given one weeks notice before cylinders need to be filled to allow him to prepare the filling station and prepare exact filling instructions – these would need to include the fact that one litre of fluid was in each cylinder before start of fill.

**Action 13. JJ**

There was discussion on the merits of testing each cylinder either vertically or horizontally. The HSE approach had been to lay each cylinder on its side to give the maximum contact length. RI suggested that in his experience the fluid accumulated near the cylinder centre and that it was important to corrode the base where high stresses occur. It was agreed to lay the cylinders with the neck raised to about 20 degree angle thereby ensuring a large contact area that would include part of the base. OC was asked to design the storage with this in mind.

**Action 14. OC**

There was concern that HSL would fit the cylinder valves correctly, using the torques specified in BS5430 Part 1. OC stated that there was a calibrated torque wrench at Buxton that would be suitable but that no cylinder clamp was available. It was agreed that a chain clamp could be used on this occasion to assist in the torquing operation and OC should ensure that he has suitable equipment to hand before any corrosives are added to the cylinders.

**Action 15. OC**

It was agreed that the normal cylinder valve shrouds would hinder the experiment and make connections slow and difficult. After fitting of the cylinder valves each cylinder should be capped prior to transport.

**Action 16. OC**

OC stated that the number of storage containers would need to be increased to accommodate the duplication.

**Action 17. OC**

### **8.03 NDT**

RI invited BS to visit the BOC test house at Chester-le-Street on 01/02/02 to see how BOC uses NDT and to help BS appreciate some of the problems of gas cylinder inspection.

Follow this meeting BS will produce a proposal for a group sponsored project and circulate to all committee members.

**Action 18. BS**

### **8.04 Continuation of Chesterfield work**

GH stated that this had been seen as a stand alone project with cylinders supplied by member companies. RI suggested that a better approach would be to use cylinders from the corrosion tests. These could then go through the BOC NDT and then fatigue or burst

or section as agreed once the corrosion damage had been categorised. JJ was asked to update the project specification to reflect this change. **Action 19. JJ**

RI high lighted the difficulties that would be faced by the BOC NDT department if 160 mm diameter cylinders were used. BOC do not have a 160mm diameter reference cylinder and would need to have one made by Chesterfields at a cost of approx £1000. For this reason it was agreed that all cylinders used would be 140 mm diameter. See 8.2.

### **8.05 Acoustic Emission**

GH reported that the AE work was underway. Physical Acoustics had been contracted to carry out AE on cylinders at Buxton. Half the cylinders would be tested using pneumatic pressure and the second half by hydraulic pressure. The work is to take place wc 11 February. RI stated that the UK would need comments in early march on the proposed ISO standard so it was important to get a preliminary report through as quickly as possible. **Action 20. OC**

### **8.06 Grinding Issue**

GH reported that a contract had been placed on HSL Sheffield to carry out the grind mark modelling. No results were yet available but GH would summarise the work once reports were issued. **Action 21. GH**

### **8.07 Bursting Discs**

GH reported that HSL had a computer modelling technique that could combine fluid forces and material stresses and that by using such a package it may be possible to look at fatigue in bursting discs.

AW suggested that his company could carry out actual fatigue tests on bursting discs. The group as a whole seemed unconcerned that bursting discs failed in service and put it down generally to overfilling.

It was noticeable that around the table each company had a different approach to bursting discs with only PB seeming to appreciate that fatigue may be an issue and renewing discs each examination. Some companies tested the disc to prove that it was intact at that moment, others did nothing until it failed.

GH asked if AW could make the results of fatigue testing available to the group after which this topic could be revisited. **Action 22. AW**

### **8.08 Leak Before Break**

GH reported on his concerns that leaking liquefiable gases could freeze the cylinder material, moving it to below the transition temperature and giving an initial brittle cleavage. RI said that this had been seen before in LPG failures but had not been fully

explained. The group decided that this was a 'nice to know' but that if money was available for research other areas, such as 300 bar cylinders, should get preference.

### **8.09 Aluminium Cylinders**

RI asked why aluminium cylinders had not been included. The group thought that there was no corrosion issue with aluminium in CO<sub>2</sub>. RI stated that he had a cylinder in his office that had been attacked by coca-cola extract in CO<sub>2</sub>.

PB said that luxfer had worked with coca cola some years before and had not found a compatibility problem. He said that there was a report written. GH asked if PB could get a copy of the report and circulate it to the group for discussion at the next meeting.

**Action 23. PB**

### **9.0 Date of Next Meeting**

The next meeting was set for 14.00 on 26 March 2002 at BSI Chiswick.

## Summary of Actions

Action No.	Person	Action	Date to complete
1	All	Discuss within own company merits of testing lorry fuel tanks in 40 mph collision.	26/03/02
2	GH	Put together information on ISO TC58 WG7 work on hydrogen compatibility for Bill Geary HSL	31/01/02
3	GH	Put together information pack on inspection of competent persons for Rose Court	15/02/02
4	JJ	Write joint industry project proposal for 300 bar cylinders and circulate to members.	31/01/02
5	AW	Talk to EIGA members about research proposal for 300 bar cylinders.	26/03/02
6	JJ	Update corrosion matrix	31/01/02
7	JJ	Order cylinders	31/01/02
8	AJ	Source supply of corrodents from matrix	28/02/02
9	RI	Supply gas analysis when filling cylinders	TBA
10	JJ	Mark cylinders for research	Before filling
11	GH	Write to BOC and Messer with permission to fill contaminated cylinders.	Once serial numbers known.
12	RM	Look into closer supply of distillers CO2 and liaise with JJ	15/02/02
13	JJ	Give one weeks notice of filling to BOC and Messer	TBA
14	OC	Design storage to tilt cylinders in container	28/02/02
15	OC	Source equipment to torque cylinder valves.	28/02/02
16	OC	Cap cylinder valves before shipping	TBA
17	OC	Purchase additional storage containers as required.	28/02/02
18	BS	Group sponsored project proposal	26/03/02
19	JJ	Update project proposal to take into account use of cylinders from matrix	31/01/02
20	OC	Issue preliminary report of AE work to allow UK comments on ISO	28/02/02
21	GH	Report progress on grinding project to the committee	26/03/02

<b>22</b>	<b>AW</b>	<b>Report back to the committee results of fatigue testing on bursting discs.</b>	<b>26/03/02</b>
<b>23</b>	<b>PB</b>	<b>Obtain copy of luxfer research paper into coca cola compatibility and circulate to committee.</b>	<b>31/01/02</b>