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Reference 4302109

Hazardous Installations
Directorate

Chemical, Explosives and
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HM Principal Inspector of Health &
Safety
Mr. Greg Haywood

For the attention of [REDACTED] Operations and Maintenance Manager, Northern Systems and Plants

28th July 2015

Dear [REDACTED]

PROCESS SAFETY INSPECTION AT MOSSMORRAN 3RD & 4TH JUNE 2015

HEALTH & SAFETY AT WORK ETC ACT 1974

CONTROL OF MAJOR ACCIDENT HAZARDS REGULATIONS 2015

I am writing to confirm the outcome of the process safety inspection on 3rd and 4th June 2015 carried out by [REDACTED] Process Safety Specialist Inspector, with assistance from [REDACTED] Human Factors Specialist Inspector. We discussed the findings of the inspection with [REDACTED] and others.

The inspection followed up on outstanding actions legal on occupied buildings and the propane treaters from previous inspections and looked at the fire risk assessment for the establishment and the operational checks of the gasoline tanks' secondary rim seals which were to be introduced in late 2013.

A number of recommendations are contained within the accompanying report which will be followed up at subsequent inspections, however only one legal action was identified requiring information to be provided under COMAH 2015 Regulation 5(2).

ACTION LEGAL SHELL/MM/PS/030615/1

Following the failure of the primary rim seal on gasoline tanks T3401 and T3402 the company undertook a risk assessment and raised a deviation to enable it to continue to operate these tanks until August 2015. At the inspection on 3rd June 2015 the company informed the Competent Authority (CA) that it had initiated a review of this deviation which it hoped would allow it to continue to operate both these tanks until 2017 at which time the primary rim seals would be replaced. In compliance with

the Competent Authority

Regulation 5(2) of the Control of Major Accident Hazards Regulations 2015 the company should provide to the CA a copy of the revised deviation and risk assessment. This action legal must be completed by **31 August 2015**.

Information to employees

As required by Section 28 of the Health and Safety at Work etc Act 1974, I am required to provide information to the employees concerning the visit. I am therefore enclosing a copy of the letter which should be passed to the employees' representatives.

Yours faithfully, on behalf of the Competent Authority,

[Redacted signature]

[Redacted name]

HM Inspector of Health & Safety

CC by email: [Redacted] NSP Asset Manager; [Redacted] Plant Installation Manager; [Redacted]
[Redacted], Technical Safety; [Redacted] Process Engineering; [Redacted] NSP HSE Adviser; [Redacted]
[Redacted] SEPA; [Redacted] Energy Division

COMAH Competent Authority Inspection Report

SITE DETAILS		
Name of Company: Shell UK Limited		Address of Company: Mossmorran Fractionation Plant, FNGL, Cowdenbeath
Inspection Title: Occupied buildings and fire precautions		
Service order No: 4302109	Site ID: 1023054	
Inspection Date: 3 and 4 June 2015	Case No: 4063731	
Visiting Inspector(s): [REDACTED]	Discipline: HSE Process Safety Specialist Inspector	Unit & Team: CEMHD 6A
[REDACTED]	HSE Regulatory Inspector	CEMHD 1A
[REDACTED]	HSE Human Factors Specialist Inspector	CEMHD 3I

SUPPORTING INFORMATION	
Intervention Report (discipline): <i>See note 2 to enable drop down menus</i>	ITKY09_1_08 - Process Safety
Keyword: Keywords relevant to topics being considered <i>Please select appropriate key word(s) from drop down menu</i>	Strong Leadership ITKY09_2_01 - Process safety management
	Containment
	Mitigating the consequences of MAH
Main persons seen: [REDACTED]	Position: FNGL Plant Manager
[REDACTED]	HSE Manager

[REDACTED]	Technical Authority – Technical Safety
[REDACTED]	H&S Officer
[REDACTED]	Technical Authority – Process Engineering
[REDACTED]	Technical Safety Engineer
[REDACTED]	Operations Manager
[REDACTED]	HSE
[REDACTED]	Technical Authority – Control & Automation
[REDACTED]	Area Technician
[REDACTED]	Area Technician

Relevant documentation seen

1. Company letter to Competent Authority dated 22 January 2015 containing responses to actions legal Shell/MM/PS/270814/1, 2 and 3.
2. TN242: Mossmorran Occupied Buildings Technical Note, Revision 2, October 2014.
3. Deviation Control Form, T-3401/2 Primary Seals, reference 516129, dated 14/08/2013, valid to 23/08/2015.
4. Company letter to the Competent Authority dated 31 March 2015 in response to mechanical action legal 2, ref.SVC4281632.
5. Company letter to the Competent Authority dated 31 March 2015 in response to mechanical action legal 3, ref.SVC4281632.
6. Fire Fighting Review of Fife NGL Plant, Revision 3, March 2013.
7. Operating procedure number 1/1234 'Isolation and Controlled Oxidation of Propane Treaters' dated August 2012.
8. Shell Technical Note, Process Safety Risk Assessment, Propane Treaters Oxidation Procedure, revision R2 dated 11/03/2015.

Inspection Summary:

The inspection followed up on outstanding actions legal on occupied buildings and the propane treaters from previous inspections and looked at the fire risk assessment for the establishment and the operational checks of the gasoline tanks' secondary rim seals which were to be introduced in late 2013.

It was found that 2 out of the 3 actions legal on occupied buildings could be closed out. The remaining action legal, which relates to the occupied buildings risk assessment itself, remains open and the company is providing the outstanding information as a matter of priority.

A walk-through of the daily operator checks on the gasoline tanks was undertaken and this was found to be satisfactory. It was established, however, that the company had, in error, not implemented the 3 monthly EEMUA 159 checks that it had previously advised the Competent Authority (CA) that it had done in late 2013.

A number of issues were raised about the content of the deviation raised for the continued operation of the gasoline tanks on one rim seal. In particular, the CA provided feedback on the risk assessment conducted. It was also found that the deviation had not been subject to further review and approval despite the timeline for the replacement of the primary rim seal on T3402 moving from 2014 to 2017. The company informed the CA during the inspection that it had initiated a review of this deviation in light of the CA's findings and an action legal has been established to provide this.

The company has undertaken a fire risk assessment of the gasoline tanks and this was found to be well structured and technically competent. The company agreed that it needed now to widen the scope of this assessment to the rest of the establishment and, in due course, to the other COMAH establishments forming part of Shell NSP.

The company is in the midst of implementing a new fire and gas detection system at the establishment. This project has taken some time to roll out and its scope has changed. The CA should continue to monitor progress with this project since fire and gas detection is a key mitigation measure for an establishment of this type.

A walk-through of steps 1 and 9 of the newly developed controlled oxidation procedure was undertaken jointly with Human Factors (HF). Whilst it was found that the area technician in question had a good knowledge of the plant the current procedure does not deal adequately with key issues around communication and control. HF will pursue this matter further by examination of the human failure analysis for this activity. No further action from process safety is proposed.

The company has completed a process safety risk assessment of the controlled oxidation procedure. However, what was actually required was a risk assessment of the plant and processes used to undertake the activity for controlled oxidation. No further action is proposed provided the current operational procedure is subjected to competent human failure analysis. The process safety action legal relating to this assessment is closed.

Report author: [REDACTED]

Date drafts: 2 July 2015

Final: 24 July 2015

Location: Glasgow

Purpose of visit:

The main purpose of this inspection was:

- to follow up on action legal in respect of occupied buildings risk assessment;
- to verify procedure for controlled oxidation of molecular sieves;
- to understand company's approach to fire risk assessment and, time permitting, verify sampled fire precautions;
- to obtain an update on the fire and gas detection project; and
- to discuss and verify the interim measures taken whilst operating on one rim seal on the gasoline tanks.

Planned intervention X Enforcement compliance check

Factual observations, findings and discussion:*Occupied Buildings Risk Assessment (OBRA)*

1. The previous PS led inspection in August 2014 established three actions legal for occupied buildings – refer to paragraphs 76 to 84 of the Competent Authority (CA) inspection report^d for details. The company provided a response to these actions legal on 22 January 2015¹.
2. Action legal Shell/MM/PS/270814/2 was concerned with possible scaling issues on the drawing used by the company to determine the location of temporary occupied buildings on-site. In their response the company explains that the fire pond is located in the drawing as if it were closer to the plant than it actually is but that the rest the drawing, which shows the main plant, is to scale. Given that the scaling issue was not apparent to either Shell or the HSE when looking at the drawing at the previous inspection I would advise that the company to make this matter clearer in the drawing perhaps by way of a note so as to avoid any confusion in the future. **The company has provided an adequate explanation for the scaling problem found with the drawing during the inspection and confirmed that the rest of the drawing is accurate. As a result of their response action legal Shell/MM/PS/270814/2 can be closed.**
3. Action legal Shell/MM/PS/270814/3 required the company to confirm whether two portable buildings which were located in an area fenced off from the main plant which is being used as a contractors compound and also as a laydown area for materials were occupied (Note: it was not possible to determine this during the inspection as the gate to this area was locked and the portable buildings were too far from the fence line). The action legal also required the company to confirm that if occupied that the location of these portable buildings is acceptable with respect to any risk to persons inside from fire and explosion major accident hazards (MAHs) from the main plant. In response to this action legal the company confirmed that the two unprotected portable buildings are indeed occupied. It has also confirmed that they are located in a region where the maximum individual explosion risk is around 1.0E-07/year. **As the company has located these unprotected portable buildings in accordance with its procedure for the siting of temporary**

buildings and given that the maximum individual risk to those within them is in the broadly acceptable region action legal Shell/MM/PS/270814/3 can be closed.

4. Action legal Shell/MM/PS/270814/1 required the company to review, and where necessary, revise its OBRA after several issues were identified with that assessment during the last inspection. In response to this action legal the company undertook the required review and provided a copy of the revised OBRA² to the CA. Prior to this inspection I reviewed this document and I provided the regulatory inspector with a memo containing my assessment – refer to Appendix A. After discussing my assessment with the regulatory inspector it was agreed that the memo would be provided to the company to allow them to address the issues contained within it in time for this inspection.
5. At the inspection I was advised by Technical Safety that they had reviewed the memo and that they had made some revisions to the OBRA. I had a discussion with them regarding these revisions. The key findings from this discussion are set out below:
 - (a) There is still a lack of clarity as to what explosion resistance has been used in the modelling for some of the buildings included in the assessment e.g. the Administration Building and the Gatehouse. I was advised that the Shell Shepherd model permits the modeller to use standard buildings with pre-defined explosion resistance or to define bespoke criterion but Technical Safety were not able to confirm what had been done in this case. It was agreed that the company needed to confirm what has been modelled for each building on-site. It was also agreed that where explosion resistance has been assumed for any building which was not originally designed to provide such protection at all, or to the level assumed for the purposes of the model, then the company needs to demonstrate why the explosion resistance selected is appropriate;
 - (b) I had some discussion around whether the Control Room could be impacted by a jet fire from the process modules as the wording in the final paragraph in section 2.2 of the OBRA is unclear on this matter. Technical Safety thought this was not the case but they wanted to do a further check and verify. Should the Control be impacted by a jet fire the company will need to take competent advice (e.g. from a buildings structural engineer or similar) as to how the building will respond to such an event in order to complete their assessment of the risk to those within that building during such an event;
 - (c) I also had a discussion around how the Control Room would respond in the event of the thermal radiation effects from a jet fire from the process modules. Technical Safety had provided some further information on this aspect in their revision to the OBRA but there is still a lack of clarity around how long the building can survive the predicted thermal radiation levels during such an event and in how the temperature inside the building will rise and affect those

contained within it. As I had explained in paragraph 7 of my memo, the company will need to take competent advice on how the Control Room will respond to such thermal radiation levels, understand how this will affect persons inside and undertake some sensitivity analysis around that, should it be determined that the risk to persons is significantly affected by the time to take mitigation e.g. through emergency shut-down/emergency de-pressurisation (ESD/EDP). Depending upon the outcome of this assessment the company will need to demonstrate that their proposed measures (such as ESD/EDP) will reduce the risk to persons from the effects of thermal radiation arising from MAHs to as low as is reasonably practicable (ALARP);

- (d) The current OBRA advises that during a significant fire event in the process modules, such as a jet fire, that those within the Control Room should stay there due to concerns around the risk of fatality from thermal radiation exposure during any attempt to evacuate that building. It also advises that those within the Warehouse should evacuate that building due to concerns around the level of protection it provides them against thermal radiation hazards. Based on my discussions with personnel on plant, and later with the site HSE officer for the site, the current internal emergency plan requires that anyone not involved in the emergency response evacuates to muster. We discussed the content of the revised OBRA and agreed that once the effects on the Control Room from a jet fire have been clarified (refer to the previous two sub-paragraphs) the company may need to review, and where necessary revise, its internal emergency plan;
- (e) I discussed the assessment made on flammable gas concentrations and enquired about the hazard ranges to the Warehouse. Given my discussions it does indeed seem unlikely that this building will be affected by flammable vapours at or above the lower explosion limit (LEL) but the company agreed to clarify this within the OBRA. For example, it would be useful if the OBRA provided a plot to LFL and UFL which shows the position of occupied buildings in relation to these hazard ranges; and
- (f) Finally, I confirmed how the company had used potential loss of life (PLL) to calculate the costs of reasonably practicable risk reduction measures in Table 13 of the revised OBRA. Since Table 13 shows the costs for maximum reduction in PLL I explained that this data could be used to support any demonstration that building relocation is not reasonably practicable. In terms of the measure (anti-shatter film) taken forward by the company it needs to explain more fully why this measure, and no others, has been selected – refer also to paragraph 14 in my memo. The company agreed to review, and where necessary revise, its ALARP demonstration making better use of the data contained within the assessment to support any decisions taken.

6. **Given that a number of issues with respect to the establishment's OBRA still have to be addressed, or addressed adequately, action legal Shell/MM/PS/270814/1 has not been completed and remains open.** I explained to the company the HSE's enforcement position in relation to actions legal which have not been complied with and I had a discussion with them as to why they had failed to provide the information required. It was agreed that the company would provide a timeline to provide the information required in order to close out this action legal as a matter of priority. Note: item (d) above discusses the potential need to revise the site's internal emergency plan. It is included here for completeness and the need for any revision is dependent upon the outcome of the finalised OBRA. Item (d) does not need to be addressed as part of this action legal.

Gasoline tanks – background following failure of the primary rim seal

7. At a previous mechanical led inspection the CA became aware that the primary rim seals on both gasoline tanks (T-3401/2) at the establishment had failed. These discussions have been largely around why the primary seals have failed and on how the integrity issues for these tanks can be managed until such time as the primary seals can be replaced.
8. During these discussions the CA has been provided with a copy of a deviation control form³ which was raised in August 2013. This assessment was required because of the company's need to continue to operate these tanks on their secondary seals alone which is a deviation against the Shell performance standard for tanks of this design.
9. The company has also written^{4,5} to the CA in response to actions legal 2 and 3 which were established following a mechanical led inspection on 3 & 4 December 2014. In responding to action legal 2 the company advise, amongst other things, that additional operator checks are to be performed on the remaining secondary rim seal. In response to action legal 3 the company advise that one of their own actions (action 6) is to establish 3 monthly EEMUA 159 operational checks as part of the SAP routine.
10. I was provided with copies of the company's deviation control form and responses to actions legal and asked to give my opinion as to the adequacy of the risk assessment conducted and of the value, in terms of risk reduction or mitigation, from the additional operator checks described.

Gasoline tanks – additional operator checks following failure of the primary rim seal

11. The deviation control form³ states that the company proposes 'to introduce frequent operator checks of tank (sic) seals during normal inspection routines to check the seal has not collapsed'. The risk assessment associated with the deviation states that 'In addition, although not currently undertaken, the site are proposing to introduce regular/frequent operator checks of the tank seals during routine checks to ensure that the integrity of the seals is not being compromised'. Finally, in responding to action legal 2 the company advises that '...the plant operators have been briefed on the importance of monitoring the tank secondary seal system, and

as such they carry out their own monitoring of the tank seals as part of their normal duties'.

12. I met with the Operations Manager to verify: (1) what briefings had been provided to operations staff; and (2) to confirm his understanding of the requirements of the newly proposed routine and 3 monthly EEMUA 159 operational checks which the company has referred to.
13. It was explained to me that all operations staff performing routine checks of the gasoline tanks had been made aware of the need to pay particular attention to the any evidence of secondary rim seal failure in light of the failure of the primary seal.
14. In terms of routine checks I was advised that the area technicians perform a daily visit to the roof of the gasoline tanks to check for pooling of water, signs of any physical damage/deterioration in the seal arrangement, roof or tank walls and/or signs of any escaping vapour. It was confirmed that these checks do not involve going down onto the roof but comprise of a visual check (aided to some extent by smell and sound) from the perimeter walkway on the top of the tank. Given the nature of the checks it was agreed that these are very much about detecting issues which have the potential to be significant as any defect or abnormality would have to be seen from the walkway and interpreted as such by the area technician. We also agreed that the ability to look closely at the alignment of the roof to the tank walls and also the rim seal skirt (which is the only visible part of the seal arrangement) was affected also by how far the roof was from the walkway which depends upon the quantity of petrol in the tank. The Operations Manager confirmed that there was no procedure setting out the content of the daily checks.
15. In terms of the 3 monthly EEMUA 159 checks I was initially advised by the Operations Manager that a schedule of operator checks had been created based on that standard and implemented through SAP. I asked to be provided with a copy of this check list in order that I could observe a walk-through of it with an area technician on plant. After some difficulty in locating this work instruction I was advised that this check list had not in fact been developed and that in error the risk assessment from the deviation control form had been put into SAP as the work instruction.
16. Given that this deviation dates from August 2013 and given too that the company has advised the CA that it has reinforced the need for operations staff to pay particular attention to the state of the remaining rim seal and raises the question why this error has been allowed to continue. I asked to see the record of the checks in SAP and I noted that at one stage an area technician makes a remark to the effect that the work instruction doesn't contain any instructions. Despite this remark nothing was done to correct this error.
17. It was agreed that the company needs to review what further operational checks would be appropriate as per EEMUA 159. The CA may wish to follow this matter up at a future intervention.
18. I visited the plant and met with an area technician to undertake a walk-through of the daily operational checks. He advised me that due to his shift rota he had not yet

been required to perform the 3 monthly EEMUA 159 check although I established later in the inspection that the work instruction for these checks hadn't been implemented anyway. I asked him about whether he had been given any recent awareness training of the need to pay particular attention to the rim seal. He said that he had and, indeed, he was able to give me a good description of the importance of conducting checks of that area.

19. I visited the walkway on the top of both gasoline tanks, T3401 and T3402, with the area technician. T3401 was running low with the level of the floating roof at a height of around 4m (taken from the reading on the control room panel prior to going out onto plant). T3402 was running fairly full at 19m.
20. I was told by the area technician that it was a requirement that he wear a personal gas monitor when visiting the walkway. Shell procedures allowed visitors such as myself to not carry a gas monitor provided we were accompanied at all times by someone who was wearing such a device. I asked what would happen should his gas detector alarm and was advised that he would remove himself from the roof immediately and inform his supervisor.
21. The area technician went on to explain in some detail what he was looking for whilst on the roof which essentially comprised of looking to see for areas where water may be pooling, areas where the rim seal skirt may have come away from the tank wall, other areas of physical damage to the tank and any evidence of petrol vapour. The area technician agreed that the roof height was an important factor in being able to see any signs of wear or damage. Having visited both tanks it's clear to me that it's much harder to see how the skirt of the rim seal is aligned to the tank wall when the roof was at 4m than it was when the roof was up at 19m..
22. Having visited the plant I am content that the area technician I met with had a good understanding of what to look out for in terms of the rim seal and of the importance of undertaking this task. It's important that routine checks of the roof are conducted not only in relation to the rim seal but also to check for pooling water which may cause buoyancy problems with the roof. Since the checking of the rim seal now forms part of an existing, and important, routine check the area technician is not putting themselves at any increased personal safety by ensuring that a visual check of the rim seal skirt is included in this daily schedule.
23. Upon completion of the plant visit I had a further discussion with the Operations Manager and also with the Technical Authority (TA) Process Engineering in relation to my findings. I agreed with them that these checks help to reinforce the importance of ensuring that the roof and rim seal are checked for any signs of failure in so far as one can detect rim seal failure through a visual check of the rim seal skirt from the walkway. I also agree that provided these checks are done, and done competently (refer to my previous remarks on the 3 monthly EEMUA 159 checks) that they may provide warning that a failure has occurred. Clearly, however, the detail of what can be seen from the walkway depends largely on the height of the roof.
24. The company has previously advised that it has also instituted repairs to the secondary seal and increased rim seal inspections by suitably qualified integrity

engineers to every 6 months. I have taken some advice from an HSE mechanical colleague on how often a tank of this type may have its rim seals inspected in this way and understand that a 6 month frequency is a higher frequency than for a tank in good condition.

25. In relation to the question asked of me around the value of the operational checks (paragraph 10) I take the view having now seen the daily check that whilst it will have some benefit (see paragraph 23) it is not likely to contribute significantly to the assessment of risk as a mitigation measure. In my opinion, the work undertaken to repair the secondary rim seal, if done competently, in conjunction with 6 monthly integrity checks are the key measures taken by the company to reduce/mitigate against the risk of failure of the secondary rim seal whilst the tanks await replacement of their primary seals.

Gasoline tanks – deviation control process following failure of the primary rim seal

26. As mentioned in paragraph 8, the company raised a deviation control form³ in August 2013 once it became clear that the primary seals had failed on both gasoline tanks.
27. The deviation control form contains a risk assessment which I was advised had been conducted by the team responsible for the deviation. This team comprised of representatives from operations, process engineering, process safety and integrity disciplines. Once finalised the completed deviation control form was circulated around relevant personnel for approval including TA's for Process Engineering, Technical Safety and Inspection.
28. I had intended to discuss the content of the risk assessment with the TA Process Engineering on the basis that I had been advised that he had authored this document. When it became apparent that he had not written it I discussed instead why he had made the comments he had made in the deviation control form and what he thought of the attached risk assessment – refer to paragraphs 30 to 36 for further detail.
29. The following observations are relevant to how the company approaches this kind of assessment in the future:
- (a) The introductory paragraph makes reference to the 'high unlikely scenario' that there is coincidental failure of both seals. This is echoed to some extent in the third paragraph where the team remarks that there have been no reported failures of rim seals in T3401 and T3402 although this mechanism for a release of hydrocarbons is stated in the safety report. It's not clear why the team has made these remarks and whether this has been taken into account given that the primary seal on both tanks has already failed and the purpose of the deviation is to assess whether continued operation is acceptable;
 - (b) The first paragraph also refers to residual risk of 'credible' hazards but it doesn't explain what this means. Anyone reading this

assessment should seek clarification on what is considered by the team to be credible and, in so doing, satisfy itself that what has been ruled out as being not credible is appropriate;

(c) Paragraph one states that the assessment's objective is to demonstrate that the residual risk is ALARP and yet it only describes what is and never examines what further measures could be taken and how these may affect risk reduction. As a consequence despite the stated intention the assessment fails to make this demonstration; and

(d) Finally, the team confidently state that following any rim seal failure the release of gasoline vapour will be small/minor. This assertion should be substantiated by providing some assessment as to how much hydrocarbon vapour could be lost and its impact given the likely failure mechanisms of the secondary seal. For example, did the team take advice on whether the seal can fail catastrophically or is it more likely to fail in short sections around its circumference? By setting out such an assessment one can support what is currently no more than an assertion that there is no MAH potential following secondary seal failure and provide the necessary underpinning for the assessment of ALARP to follow.

30. In granting his approval in August 2013 the TA Process Engineering made comments on the deviation control form which appear to have informed this decision. This included, amongst other things, a statement that he understood that T3402 was to have its primary seal replaced in 2014 and that if possible T3401's primary seal replacement, which at that time was scheduled for 2017/18, should be brought forward to follow on from T3402. These comments were made on the basis that he believed that the business risk was slightly greater than had been assessed by the team.

31. I discussed these comments with the TA Process Engineering and he emphasised to me that his comments related to his assessment of a slightly higher business risk rather to any safety risk. I had some discussion with him around his views on the attached risk assessment and was advised that he felt it was acceptable. Indeed, he reminded me that if he hadn't he would not have approved the deviation.

32. I asked the company for clarification as to when the decision was taken to undertake both primary seal replacements in 2017 and was advised that this was around December 2013.

33. I discussed with the company why the deviation process did not trigger a review when the date for replacing T3402's primary seal was changed from 2014 to 2017 especially given that the TA Process Engineering's decision was based on an understanding that T3402 would be done in 2014 and T3401 in 2017/18. I was advised that the deviation process didn't require a review because the deviation had been approved to August 2015 which is the maximum period allowed. In my opinion this approach cannot be considered to be appropriate given that a key timeline in the project had changed. I was advised by the TA Process Engineering that in this

particular case he was made aware of the change in timeline at some point after giving his approval but that his decision to approve had not changed.

34. Whilst in this particular case the company has asserted that the safety implications following a failure of the remaining rim seal are small/minor (see my comments in paragraph 29(d)) the decision around what is reasonably practicable in terms of primary seal replacement should have been revisited at the point when the timeline was changed, i.e. in December 2013, and not left until August 2015 when the deviation was due to expire. I would also argue that any assessment of what is reasonably practicable should take into account the actual duration it is proposed to operate the tanks in this manner and that it should not be constrained by the 3 year timeline which is set by the deviation control process.
35. I discussed this matter with the Plant Manager and was advised by him that he had initiated an immediate review of this deviation in light of our findings. The company should address the comments made in paragraph 29 of this report to ensure that it produces a suitable and sufficient risk assessment and ALARP demonstration as part of this review.
36. In terms of the deviation review the TA Process Engineering advised that he would need to be provided with sufficient information to support any decision around whether a deviation could be approved until 2017.
37. The company should provide a copy of the revised deviation and the accompanying risk assessment once the review has been completed.

[ACTION LEGAL SHELL/MM/PS/030615/1]

I have recommended that the CA follow up this deviation review at a future intervention.

Fire risk assessment

38. I had a discussion with Technical Safety in relation to fire risk assessment at the site.
39. Initially, I was presented with a plan to review existing information and to talk to relevant staff via workshops to facilitate the review and revision of a fire risk assessment at St Fergus. Whilst this is to be welcomed I explained that I was interested in the fire risk assessment for this establishment. After a little discussion it was agreed that we could have a discussion later around the assessment which was prepared for the plant in March 2013 in order to that I could provide some feedback.
40. I was provided with a copy of a fire fighting review for the Fife NGL Plant which had been prepared by Technical Safety in March 2013⁶. This assessment was in response to an HSE Improvement Notice that required Shell to undertake such an assessment in 2008 following an incident involving the gasoline tanks at the plant in 2007.
41. The assessment uses IP19^c to provide a framework to develop a fire and explosion

hazard management (FEHM) strategy and it sets out this strategy for the gasoline tanks.

42. I was taken through the key elements of the review and I provided my feedback that it was well structured and technically competent. The document can be improved by making the linkages clearer to the MAH assessment in the safety report so that it provides a detailed fire risk assessment based on already defined MAH scenarios.
43. It was agreed that the company should proceed now and widen the scope of its fire risk assessment to the whole establishment starting with completing a site-wide FEHM strategy based on defined MAH. **As the company are already proposing to undertake this review I am content to leave this matter with them and recommend that this be revisited at the next inspection.**

Fire and gas detection project

44. I was provided with an update on the fire and gas detection project at the establishment. The company is in the midst of upgrading its fire and gas detection systems at St Fergus and Mossmorran. Currently, Braefoot Bay is not included in the scope of this project.
45. It was explained to me that the safety report quantitative risk assessment (QRA) had been used to examine the frequency of losses of containment and that this had informed to a large extent where detection may be needed. Broadly speaking any area where the release frequency was $> 1 \times 10^{-3}/\text{yr}$ were considered and other areas such as the gasoline and LPG tanks where inventories of flammable substances were high.
46. The original design intention was to have a system which would alarm at a low set point, 20% LEL, and alarm and take executive action (based on a voting system) at a high set point of 40% LEL. It was explained to me that due to a communication error in the project process this would be implemented now at St Fergus but not at Mossmorran. I was advised, however, that preparatory work to enable executive action to be taken at Mossmorran would be undertaken but that in order to take full advantage of this, and realise the original design intention of the project, a separate project would need to be approved.
47. In terms of implementation at this establishment I was told that Module 3 was nearly complete. Module 2 would be undertaken in Q3 2015 and Module 1 in Q4 2016.
48. From my limited understanding of this project I gather it has had a bit of a chequered history. It is a positive step that the company is taking to improve its fire and gas detection system but given the length of time it has taken to reach this point and given also that this is a key mitigation measure for this type of establishment the CA should continue to monitor this project closely.
49. At some point the FEHM strategy for the establishment will need to be updated to reflect the new fire and gas detection system – see also paragraph 43.
50. In addition to updating the fire risk assessment for the establishment the internal and

external emergency plans may require updating and the safety report revised.

Controlled oxidation procedure for the propane treaters

51. At the time of my last inspection I recommended that the CA consider a human factors (HF) intervention on the newly developed controlled oxidation procedure prior to the procedure being used which, at that time, was advised to be August 2015. Refer to paragraph 60 in the previous PS led inspection report^d. Following discussion within the CA it was agreed that HF and PS would verify this procedure as part of this inspection.
52. Prior to the inspection I met with my HF colleague, [REDACTED] and reviewed the proposed procedure⁷ for controlled oxidation of the propane treaters. I also explained to her the background behind the need for controlled oxidation and provided an overview of the process safety hazards associated with failing to control the oxidation properly or failing to undertake it at all.
53. [REDACTED] has also reviewed the human factors analysis (HFA) which was subsequently provided for this procedure.
54. Following the review of the procedure and the HFA it was agreed to undertake a walk through on plant of step 1 (regen and bypass the heaters) and step 9 (the controlled addition of oxygen to the treater). These steps were selected on the basis that the company had determined that they contained safety critical steps which could contribute or give rise to MAH.
55. I visited the plant with HF and regulatory and undertook walk through of steps 1 and 9 of the procedure with an area technician.
56. Having visited the plant with the area technician a number of things are clear. Firstly, the area technician we met with is very experienced and knows the plant well. As a result he didn't struggle to find any of the valves, for example, despite none of them being marked on plant and in the procedure. The operating procedure relies on a good knowledge of the plant and I don't have a problem with that provided suitable training and competency assessment is provided to area technicians on that area of the plant and the limited evidence from this walk through would suggest that there isn't a problem with that.
57. What is not been handled well in the procedure are issues around control (especially step order) and communications. For example, there are three people involved in executing step 9 which deals with the controlled addition of oxygen to the treater. These are the vendor (Air Products), the area technician and the control room operator. Each is in possession of key information at each sub-step but it's not clear how these communications are to be handled and what information is required before one can proceed from one step to the next. Is it critical that the vendor steps up from 1% to 3% and so on in the order specified – in fact, is it clear from the procedure that there is indeed an order? Does it matter if the CRO doesn't provide the temperature information to the area technician before the vendor proceeds to the next step? These issues should have been identified and dealt with in the HFA but they haven't been.

58. I'm content with the approach proposed by the company. I've stated before that controlled oxidation as a strategy is reasonable (paragraph 20 of the PS inspection report dated December 2013). I'm also content that given the frequency of this activity, and the likely consequences should it be improperly followed, that it be handled through a largely manual process provided this process, or organisational measure, is suitably assessed and human error is reduced to ALARP. Given my findings from this inspection and advice from my HF colleague I am not satisfied that the current draft procedure is suitably robust but I have agreed that this matter will be progressed by HF through their further examination of the HFA.

Process safety risk assessment of controlled oxidation

59. I have been asked to provide feedback on the process safety risk assessment which has been provided to the CA⁸ post inspection. Refer also to paragraph 69 in my previous inspection report.

60. To a large extent I've given my opinion on the approach taken by the company in paragraph 58 of this report. I have had a look at the technical note provided and would make the follow observations which the company may wish to consider if undertaking an assessment of this kind in the future:

(a) The first thing to note is that the process safety risk assessment should be an assessment of the process proposed rather than the procedure. In other words it should systematically examine how the vessel is to be prepared for controlled oxidation and the oxidation controlled rather than be constrained, as it were, by the proposed procedure. This is because the relevant regulations, COMAH regulation 4 or DSEAR regulation 5, require a systematic assessment of the plant and process (workplace). For example, the current arrangement utilises a vendor skid unit and temporary connections to fixed plant. There are alternatives to this approach though such as having permanent plant provided by the company which, for example, automatically controls the addition of oxygen into the propane treater. Engineered solutions such as controlling the addition of oxygen on, say, temperature and outlet oxygen concentration would eliminate the need for procedural control and its associated human error. In order to make such a demonstration as to whether this is justified or not the process safety risk assessment should examine the causes of fire and explosion and demonstrate why the current equipment and organisational measures (i.e. procedure) reduce the risk to ALARP;

(b) The second aspect I would challenge is around MAH potential. Based on the information provided I don't believe the case for no MAH has been demonstrated. For example, in section 6 the assessment advises that only minor injury may result should there be an attempt to remove the sieve in a circumstance where there has been complete oxidation of the pyrophoric iron. Further information should be provided to justify this assertion and given that a MAH to

persons can include physical injury (as opposed to fatality) there is a question as to whether the right judgement been made. I also note that the company has identified steps in the procedure which it believes are safety critical or steps which if not performed correctly could result in or contribute to a MAH. Given these findings there appears to be a misalignment between the process safety risk assessment and the HFA in terms of the MAH potential from this activity; and

- (c) The assessment doesn't consider steps being carried out in the wrong order or missed completely. What happens if there is too much oxygen introduced at the wrong time? If oxygen were introduced rather than nitrogen would that result in a problem?

61. Given my views on this activity and how it is being controlled as stated in paragraph 58 of this report I'm content to close out action legal 1 from the PS led inspection on 27 November 2013 on the basis that the procedure is suitably assessed for human error (and that this is being dealt with by HF). The company has, however, asked for feedback on the process safety risk assessment and having provided it I would expect that it considers my advice and reviews, and where necessary revises, this assessment at the next available opportunity.

Main conclusions:

62. The company has provided an adequate explanation for the scaling problem found with the drawing used by it to determine the location of temporary buildings at the site. **As a result of their response action legal Shell/MM/PS/270814/2 can be closed.**
63. The company confirmed that two unprotected portable buildings located in the contractors' compound at the site are occupied. It has also confirmed that they are located in a region where the maximum individual explosion risk is around 1.0E-07/year. **As the company has located these unprotected portable buildings in accordance with its procedure for the siting of temporary buildings and given that the maximum individual risk to those within them is in the broadly acceptable region action legal Shell/MM/PS/270814/3 can be closed.**
64. **The company had not addressed adequately the issues raised from the CA's assessment of the OBRA for the site and action legal Shell/MM/PS/270814/1 had, therefore, not been completed and remains open.** The CA agreed that the company would provide the further information required to it as a matter of priority. Since the inspection the company has provided a revised OBRA which will be reviewed by the CA in due course.
65. The company has failed to implement the 3 monthly EEMUA 159 operator checks on the gasoline tank rim seals despite advising that it had done. The company has agreed to implement further checks should these be appropriate.
66. The company has improved awareness of the need for area technicians to look at

the rim as part of their daily checks for the gasoline tanks.

67. Following the CA's findings at this inspection the company has initiated a review of the deviation it has raised for continued operation of both gasoline tanks at the site. I have provided the company with comments on the adequacy of the risk assessment associated with the current deviation and recommend that it considers these when it undertakes its review. I have also given my opinion that any assessment of what is reasonably practicable should take into account the actual duration it is proposed to operate the tanks in this manner and that it should not be constrained by the 3 year timeline which is set by the deviation control process. An action legal has been established to require the company to provide a copy of the revised deviation and risk assessment.

ACTION LEGAL SHELL/MM/PS/030615/1

68. The company has undertaken a fire risk assessment using IP19 as a framework for the gasoline tanks at its establishment. This assessment is well structured and technically competent and should now be extended to establish the fire and explosion hazard management strategy for the establishment as a whole. The company has agreed to do this and it is recommended that the CA follow this up at a future intervention.

69. The company is in the midst of implementing a new fire and gas detection system at the establishment. This project has taken some time to roll out and its scope has changed. The CA should continue to monitor progress with this project since fire and gas detection is a key mitigation measure for an establishment of this type.

70. I undertook a walk-through of steps 1 and 9 of the newly developed controlled oxidation procedure for the propane treaters with an area technician and HSE HF. Whilst it was found that the area technician in question had a good knowledge of the plant the current procedure does not deal adequately with key issues around communication and control. HF will pursue this matter further by examination of the HFA for this activity. No further action from PS is proposed.

71. The company has completed a PS risk assessment of the controlled oxidation procedure. However, what was actually required was a risk assessment of the plant and processes used to undertake the activity for controlled oxidation. I do not propose any further action to be taken provided the current operational procedure is subjected to competent HFA. **Action legal 1 from PS inspection of 27 November 2013 is closed.**

Actions Legal

ACTION LEGAL SHELL/MM/PS/030615/1

Following the failure of the primary rim seal on gasoline tanks T3401 and T3402 the company undertook a risk assessment and raised a deviation to enable it to continue to operate these tanks until August 2015. At the inspection on 3rd June 2015 the company informed the Competent Authority (CA) that it had initiated a review of this deviation, which

it hoped would allow it to continue to operate both these tanks until 2017 at which time the primary rim seals would be replaced. In compliance with Regulation 5(2) of the Control of Major Accident Hazards Regulations 2015 the company should provide to the CA a copy of the revised deviation and risk assessment. This action legal must be completed by **31 August 2015**.

References

- a. A guide to the Control of Major Accident Hazards Regulations 2015, Draft. Version 19/3/15.
- b. Dangerous Substances and Explosive Atmospheres Regulations 2002 Approved Code of Practice and Guidance, L138, HSE Books, Second Edition, 2013.
- c. Fire Precautions at Petroleum and Bulk Storage Installations, Model Code of Safe Practice Part 19, 3rd edition, November 2012, Energy Institute.
- d. Competent Authority inspection report dated 7 October 2014 for process safety led inspection at Shell Mossmorran on 26 & 27 August 2014, SVC4281632..

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APPENDIX A – COMPETENT AUTHORITY MEMO ON SHELL MOSSMORRAN OBRA

I've taken a look at the revised occupied buildings risk assessment (OBRA). It's improved from the version I looked at previously but there are some issues I would like to follow up on at a future inspection. I've made some comments on the assessment provided – see below. These can form the basis of any discussions with Technical Safety and I suggest we forward these to the company so that they can prepare adequately.

I've structured my comments in line with the sections in the company's OBRA.

Section 1 - Introduction

1. I'm not sure how Table 1 ties in to commentary provided on these buildings in preceding paragraphs. For example, the Admin building appears to be designed to 0.1bar in the narrative on page 1 but Table 1 suggests 1000mbar/250mbar. The text on page 1 also suggests that the Gatehouse may be able to withstand up to 0.1bar (although I'm uncertain as to the degree of verification the company has gone through to support this statement) but Table 1 provides no explosion protection capability. Finally, why is building type B5 not described in legend to Table 1?
2. The document usefully summarises how the company defines occupancy but it doesn't set out the occupancy levels in any occupied building nor the numbers of the fatalities expected within a given building under each major accident hazard (MAH) scenario modelled. I understand that this information may sit in the safety report (SR) but in order to set the context for this assessment and to enable some understanding of how the PLLs are derived (see also paragraph 4) I think it would have been preferable to summarise this information here or at least cross reference to the relevant sections in the SR.
3. I note the remark in the introductory paragraph that the QRA has recently been revised. I'm not sure whether this means that the data which we have access to in the current SR may be out of date with respect to what's contained here. I don't have an issue with that as such since the company is in the midst of its SR review and revision cycle but it would have been more transparent if the company had provided some further information in order to enable me to understand whether the QRA revisions had thrown up anything significant with respect to the risk to persons in occupied buildings.

Section 2.1 - VCE

4. Taking the data presented *prima facie* all the buildings at the site appear to have IRPA's for explosion in the tolerable if ALARP region.
5. Table 3 – not sure how the PLL has been calculated as no data is provided on numbers of fatalities. Assuming $PLL = \sum(IRPA \times \text{fatalities})$ then this is essentially the annualised fatality rate for those within each building or the site as a whole depending upon what IRPA one has calculated. Given the context of Table 2, I think the PLL presented is that for explosion only but some explanation in this section would have been an improvement. In relation to the remarks made by the company in the paragraph under Table 3, I'm content that the company use PLL to judge the cost effectiveness of

risk reduction options. They appear to be making a start on this in section 3 of the OBRA although the assessment doesn't really go anywhere – see paragraph 13 for further discussion.

Section 2.2 - Fires

6. It's not clear based on Figure 3 and given what's written in the accompanying text as to whether there is a means of escape from the Control Room in the event of a fire in one (or more) of the process modules – see also paragraph 12. This section also makes reference to the Warehouse being affected by fire but it states that an alternative escape route is available. Escape from both buildings in the event of a significant fire may be something worth verifying during any future emergency response inspection.

7. The modelling for jet fires indicates impingement on the Control Room. The narrative in the OBRA advises that there is little evidence to enable a determination to be made as to the survivability of the Control Room during such an event but it is 'expected' that it would survive long enough to enable the ESD and EDP to be initiated (which the company advise is less than 15 minutes). It's not clear whether the company has obtained competent advice on the likely effects of a jet fire on the Control Room in order to underpin the assumptions it has made in relation to building survivability and on the available time it has to perform an ESD/EDP. Since it appears that the company is placing reliance upon timely ESD/EDP in order to make the necessary demonstrations the company will need to:
 - (a) justify its opinion that the Control Room would survive a jet fire long enough to enable ESD/EDP to occur and provide some sensitivity analysis around that (what I mean by this, how critical is the 15 minute period – can it be 30 minutes or 1 hour or actually if you go past 20 minutes is the building likely to be compromised); and
 - (b) If taking action to ESD/EDP in a timely manner is important, has the company given any consideration to whether it would be reasonably practicable to automatically initiate ESD/EDP in this area rather than to rely, as they currently do, on manual detection and intervention.

8. Table 4 shows that the risk from fire is tolerable if ALARP – I'm not clear on exactly what this table is trying to show, it appears to be solely concerned with jet fires (given the vulnerability data mentioned) and only with the Control Room. It's not clear why the QRA from Shepherd hasn't been used to calculate the IRPA for those within that building with the company taking the approach set out in the assessment instead. It's also not clear on the applicability of using building occupant vulnerability data to jet fires when it has previously been discussed that the company isn't sure in how the building would perform when impacted by a jet fire. It would have been more transparent if the company had set out more clearly why it was using this methodology and for what purpose, how the numbers in Table 4 had been calculated and how sensitive they are to factors such as vulnerability or any other factor given in the equation.

Finally, why hasn't the company presented the IRPA for those in the Warehouse which it states could be affected by thermal radiation from fires?

Section 2.3 - BLEVE

9. There's some commentary in the final paragraph in this section on the assumption in the QRA that people would move away before a BLEVE would occur. That may well be the case for those out on plant but this assessment is concerned with the risks to those within occupied buildings who may or may not be aware of a developing situation on site. As I understand it, however, the assessment indicates that the only building which could be affected by this type of event is the Control Room and this is adequately protected against such an event.

Section 2.4 – Flammable Gas

10. The company states that only the Control Room could be affected by flammable gas releases. Is this really correct – the Warehouse is located fairly close to the Control Room? It would have been preferable if the company had taken the data presented in Table 10 and plotted it so one could see the distance to % LFL/UFL.

Section 2.6 – Total Risk

11. As mentioned in section 2, all buildings are within the tolerable if ALARP region based on calculation of the IRPA which is 'dominated' by explosion risk. The company advises that these require an ALARP demonstration which it goes on to set out in section 3.

Section 3 – ALARP Demonstration

12. First paragraph. This appears to clarify the lack of detail mentioned in paragraph 6 in this memo with respect to the ability of persons to escape (if appropriate) from the Control Room in the event of a fire in one or more of the process modules. This section appears to suggest that there is no available/suitable escape route, is this correct?
13. Section 3 sets out a reasonable means by which the cost effectiveness of risk reduction measures could be assessed – indeed this approach is set out within our guidance - but the assessment doesn't really go anywhere as individual measures are not set out clearly in terms of cost and in terms of their risk reduction potential (expressed as a change in PLL). Unless I have misunderstood Table 13, the company appears to have calculated the cost (C) for a total reduction of PLL for each building to zero for a given ICAF of £10m rather than the cost effectiveness of a given option which would result in a given change in the PLL.
14. The proposal to look at applying film to windows in two of the buildings isn't explained fully. Was that the only option considered, how was the data presented in Table 13 used (if at all). Whilst I accept that it's unlikely that relocation of the buildings, for example, would be reasonable practicable is there anything else which could be done such as moving any equipment from the roofs of the buildings, fixing arrangements within the buildings to protect those inside should the building shake etc.. Appendix 1 in the CIA guidance sets out some other potential options to consider for explosion hazards.

14 April 2015