Office for Nuclear Regulation

Basis of formal enforcement decision following the MSSS GMI Hydrogen Analyser event in December 2015

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EXECUTIVE SUMMARY

Title

Basis of formal enforcement decision following the MSSS GMI Hydrogen Analyser event in December 2015.

Background

Hydrogen is generated on a continuous basis within Sellafield Limited's (SL's) MSSS compartment silos due to chemical corrosion of the stored Magnox alloy in water. In order to maintain a safe concentration of hydrogen in air, active and passive ventilation systems are installed to manage the evolved hydrogen.

These systems are supported by two diverse hydrogen analyser systems (an ABB type and a GMI type) that monitor the hydrogen concentration and trigger hardwired alarms in the control room if high levels are detected. An alarm response instruction details the actions operators should take place to address the risk presented by the hydrogen.

Within the MSSS, the GMI and ABB hydrogen analysers are designated by SL as Safety Mechanisms (SM, i.e. an item of equipment identified in the safety case with high importance to safety). These SMs provide a diverse, defence in depth capability to monitor the level of hydrogen in the compartments. Some years prior to the event in question, SL had removed the ABB unit on one compartment in the 1st Extension of MSSS.

On 28 December 2015, power supplies were lost to the MSSS 1st Extension. This resulted in the loss of several plant instrumentation systems, including all the hydrogen analysers on the 1st Extension. Power was quickly restored and all the instrumentation reset. The ABB units returned to their normal operating mode automatically. However, during the recovery response, a SL instrument technician found that the GMI units sample pumps, whose function is to take and convey samples of the monitored atmosphere to the detector, had not restarted. He restarted them locally, thus restoring normal levels of protection to the plant.

A second loss of power event then occurred on 30 December 2015, with similar results. On this occasion however, although the ABB units again returned to normal operation automatically, SL did not apply the learning from the previous event and manually restart the GMI sample pumps. Consequently, the atmosphere in the compartment without an ABB unit was not being analysed for hydrogen after the power supplies were restored. SL was unaware of this because of flaws in the design of this equipment. This condition existed until 6 January 2016 when the non-working state of the GMI pumps was identified as part of a planned maintenance activity.

From my review of this event, I conclude that the absence of hydrogen monitoring for seven days on this compartment posed only negligible increased risks to workers in MSSS and the public. This was because the active and passive ventilation systems were never compromised and these ensured that there was no build-up of hydrogen. Specifically, the GMI hydrogen analysers are part of a secondary measure to detect hydrogen if the primary means (which prevents hydrogen accumulation) is not working. In all bar one compartment, hydrogen monitoring was maintained by the ABB system, albeit at reduced defence in depth, and in addition there were also other means of detecting potential significant increases in hydrogen generation, e.g. the silo temperature monitoring system.

Nevertheless, the event highlights shortfalls in compliance against LC 24 (Operating Instructions) and LC 27 (Safety mechanisms, devices and circuits) as well as failings in MSSS's application of disciplined operations, and its application of the site's safety management processes that should have prevented the event.

Basis for Enforcement Decision

Following the event SL convened a Board of Inquiry (BOI), which also considered a related event on the MSSS Original Building ventilation system that occurred a few months later. My

own follow up inquiries and scrutiny of SL's BOI and associated analyses, lead me to conclude that SL failed to comply with LC 24 – Operating Instructions – since SL's instructions for restoring power proved inadequate. I also judge that there was a breach of LC 27 – Safety mechanisms, devices and circuits – in that the hydrogen analysers in the compartment were not suitable or sufficient and did not deliver the safety function required of them in the seven days they were not operating. In addition, I identified contributory failings in MSSS's application of disciplined operations and its application of the site's safety management processes that should have prevented the event.

Though SL's BOI was a reasonable assessment of the event and in general identified most of the root causes, it did not fully extract all the learning from this event and in particular, the wider human and organisational factors.

Applying the principles of ONR's Enforcement Policy Statement via our Enforcement Management Model (EMM) gave an Initial Enforcement Expectation that no regulatory action was required against LC24 and LC27. This was due to the very low additional risks arising from this event and the quality of the improvement plan SL proposed following its BOI and the prompt action taken to make improvements following the event.

However, following consideration of the relevant EMM duty holder and strategic factors, I consider that a regulatory letter should nevertheless be sent. This is primarily due to the history of past incidents and relevant enforcement relating to MSSS ventilation and also the failings in MSSS's application of the site's own safety management processes which should have prevented this event. These aspects are balanced against SL's positive response to the event to address the LC issues and the action plan provided to ONR.

In regard to disciplined operations, I note the commitment of MSSS plant management to delivering improvements in this area and ONR's ongoing longer term intervention in relation to this topic. As such I consider the learning from this event should form part of ONR's existing intervention rather than be regulated separately.

Conclusions and Recommendations

I conclude that there was no harm from radiation to either workers or members of the public as a result of this event and I am satisfied that the additional risks arising from it were very low.

I also conclude that there is no need for separate ONR consideration of the MSSS Original Building ventilation system event. I am satisfied that the common elements that need to be taken forward have been identified and incorporated into SL's action plan and there are no remaining factors unique to this second event that warrant formal enforcement.

I do not believe that any further benefit would be achieved in applying formal enforcement following the identified breaches in LCs 24 and 27 because SL has already closed the specific compliance gaps by updating the relevant MSSS operating instructions and ensuring the GMI Hydrogen analyser safety mechanisms are in good working order.

I have determined that the EMM to this event yields an initial enforcement expectation of no enforcement action. However, when duty holder and strategic factors are also taken into account, I consider enforcement action is merited. Specifically, ONR should seek to regulate the improvements in MSSS's conduct of operations and application of the site's safety management processes so that the shortfalls identified through this event (by SL and ONR) are addressed, as well as seeking improvements in SL's corporate processes for investigating incidents and events.

These matters should be set out in a regulatory enforcement letter and progress then monitored through our Regulatory Issues process. Disciplined operations aspects arising from this event should however be regulated through ONR's existing initiatives ongoing in this area.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
ATLAS	SL Event/Condition Reporting System
BCI	Basic Cause Investigation
BSM	Basket Safety Measure
CDM	Conservative Decision Making
DAP	Duly Authorised Person
DAR	Design Assessment Review
EMM	Enforcement Management Model
EPS	Enforcement Policy Statement
GMI	Gas Measurement Instruments Limited
HAZAN	HAZard ANalysis
HF	Human Factors
HSE	Health and Safety Executive
IN	Improvement Notice
LC	Licence Condition
LTPR	Long Term Periodic Review
OCC	Operational Clearance Certificate
OI	Operating Instruction
OR	Operating Rule
ONR	Office for Nuclear Regulation
PI	Performance Improvement
PMP	Plant Modification Proposal
SHR	System Health Report
SM	Safety Mechanism
SL	Sellafield Limited
MSSS	Magnox Swarf Storage Silo

TABLE OF CONTENTS

1 INTRODUCTION

1. This report details ONR's basis for the formal enforcement decision taken in response to an event leading to the failure of a Safety Mechanism (SM) to deliver its designated safety function at Sellafield Ltd's (SL's) Magnox Swarf Storage Silo (MSSS) in December 2015.

2. SL, the licensee for the Sellafield site, is responsible for the safe operation of the site, and for undertaking operations in accordance with its formal arrangements to ensure compliance with all site Licence Conditions (LC) and other relevant health and safety legislation.

2 SCOPE

3. This report considers the failure of a Gas Measurement Instruments (GMI) Hydrogen Analyser, a Safety Mechanism (SM) (providing hydrogen concentration monitoring) within the MSSS 1st Extension that was identified on 6 January 2016. The report includes a review of the adequacy of SL's internal investigations into that event, the corrective actions identified, the findings from ONR's subsequent fact-finding investigations and a number of separate information-gathering meetings with representatives of the licensee.

3 PURPOSE

4. The purpose of this report is to review this event, its associated root and contributory causes, the proposed corrective actions identified by the licensee and, in light of these, consider whether any formal enforcement action is merited, based on application of ONR's Enforcement Management Model (EMM).

5. This report draws on, and refers to, ONR's specialist fact finding investigations into the event which are reported in full in Ref 1 and ONR's fact finding meeting with SL (Ref 6). It also takes account of a related event involving the MSSS Original Building ventilation system that occurred in March 2016 (Ref 10), aspects of which are relevant to the event being considered here (Ref 5).

4 BACKGROUND AND OVERVIEW OF THE EVENT

6. Hydrogen is generated on a continuous basis within SL's MSSS compartment silos due to chemical corrosion of the stored Magnox alloy in water. In order to maintain a safe concentration of hydrogen in air, a ventilation system draws the air across the compartment ullages to dilute the evolved hydrogen.

7. Protection against failure of effective ventilation is assisted by two diverse hydrogen analyser systems (an ABB type and a GMI type) that trigger respective hardwired alarms in the control room if the hydrogen concentration reaches 0.25%. An alarm response instruction details the actions operators should then take to remove the risk presented by the hydrogen.

8. SL categorises equipment that delivers safety functions at this level of importance as a SM. SL's requirement for the probability of failure of a SM on demand is 1E-2 per year.

9. The GMI hydrogen analysers rely on pumps to provide a sample of the air from the ullage. Any failure of one of these pumps to provide an effective sample is detected by a Perperl and Fuchs inductive flow sensor. A low flow triggers a hardwired alarm in the control room for response by an operator as detailed in the alarm response instruction.

10. On 28 December 2015, power was lost to the MSSS 1st Extension as a result of a failure of the Uninterruptable Power Supply (UPS) system, resulting in the loss of several plant instrument systems including all of the hydrogen analysers on the 1st Extension. Power was quickly restored and all the instruments reset. During the plant's

response to the loss of power, the GMI hydrogen analyser pumps were found to be off (as a result of the power failure) and were manually restarted locally.

11. However, on 30 December 2015, the UPS power was again lost to the 1st Extension. This resulted in the 1st Extension hydrogen analysers failing again. On restoration of the UPS power, the ABB type analysers returned to normal operation automatically. The alarms on the GMI type hydrogen analysers were reset from the MSSS control room and were thought to be in-service. However, the GMI pumps were not on this occasion restarted locally and so compartment air was not in reality being monitored by the GMI hydrogen analysers. The discovery of this failed SM was made as a result of routine maintenance being carried out on the 6 January 2016 and the GMI hydrogen analyser pumps were then restarted.

12. Since the ABB analyser on one compartment within the 1st Extension had been removed from service in 2013, the failure to restart the GMI hydrogen analyser pumps meant there was no hydrogen monitoring in this compartment during the period 30 December 2015 to 6 January 2016. Monitoring for hydrogen continued to be provided however, to the other 1st Extension compartments by the ABB monitors.

5 LICENSEE'S RESPONSE TO THE EVENT

13. Following this event SL initiated a Basic Cause Investigation (BCI) (Ref 2). It was also reported to ONR in an ONR INF 1 form (Ref 3) and subsequent ONR INF 1 60 day follow up report (Ref 4). SL rated this event as INES Level 1 (anomaly) under the IAEA's International Nuclear Event Scale. This was because there were only minor problems with a defence in depth safety component and no impact on people or the environment. Importantly, there remained significant defence in depth to ensure that MSSS remained safe throughout the period where there was no hydrogen monitoring of the compartment. The initial BCI was subsequently upgraded to a Board of Inquiry (BOI) by SL (Ref 5). This was in recognition of the need for a higher level of investigation because there had been similar previous events in MSSS concerning the ABB and GMI hydrogen analysers and SL's past improvement actions had proven insufficient to prevent this event occurring.

14. The BOI terms of reference were later widened by SL to include an investigation and assessment of a second event relating to MSSS hydrogen control. This second event, on 5 March 2016 (Reference 10), arose when steam condensate entered the Original Building ventilation ductwork via a passing steam valve, collected in a lute and so restricted the ventilation flow. The BOI therefore sought to establish if there were any common causes of failure between the event being investigated and the March event to indicate systematic failures in the operation of the MSSS facility. This second event was also rated as INES Level 1 (anomaly) under the IAEA scheme.

15. SL's BOI investigation found the 30 December event arose as a combination of two main causes, relating to plant and people, as follows:

- SL did not take suitable and sufficient action to address the risks posed by degraded plant and equipment. MSSS failed to address the known vulnerabilities of the ABB and GMI analysers or the UPS in time to avoid this event.
- Ineffective learning from experience both within MSSS and from elsewhere on Sellafield site meant that MSSS failed to learn from its preceding event on the 28 December and did not amend its operating instructions to prompt the same response on the 30 December. Moreover, MSSS did not learn from other previous similar events on the plant relating to hydrogen analysers. Additionally, application of learning from elsewhere on the site regarding problems with the type of flowmeters used in the GMI analysers could also have prevented this event.

- SL's BOI considered the contributory causes of the event to be:
    - The 2013 decision to remove the ABB hydrogen analyser from service in the compartment without first addressing the risk posed by the reduction in defence in depth and therefore not applying suitable risk mitigation measures to reduce the risks to ALARP.
    - The application of SL management of safety processes that should have prevented the event either failed or were ineffective, e.g. the Long Term Periodic Review process, the Plant Modification Process (PMP), Design Assessment Reports, Technical Basis of Maintenance and System Health Reports, disciplined operations and maintenance in MSSS.
    - The management of the MSSS safety case requirements relating to hydrogen SM substitution.
    - Resetting the no-flow alarms incorrectly signals that the pumps have restarted and sample air flow is adequate
    - The insufficiency of two MSSS emergency instructions ("Action to be taken in the event of loss of electrical supplies" and "Actions to be taken in the event of loss of services").

16. SL also considered that the December 30 event had several common contributory factors with the March MSSS Original Building ventilation event. These were failings in the application of SL's disciplined operations and maintenance processes and, the application of the PMP process.

17. To address these shortfalls, SL has produced a consolidated action plan that outlines the actions that MSSS and the site need to address (Ref 5). These are in addition to actions arising from current ONR interventions in MSSS to influence so-called conduct of operations methodology improvements as part of wider work being progressed by ONR at Sellafield. (Reference 12) This work is currently on-going and the licensee has explained that the output from this event will form part of its wider improvement plans.

6 ONR'S ASSESSMENT OF THE EVENT

18. I reviewed SL's investigation into the event and commissioned specialist fact-finding investigations carried out by an ONR Control and Instrumentation specialist inspector (Ref 1). I also held a number of follow-up meetings with members of SL's staff who were conducting the BOI and developing the SL plan of remedial actions (Ref 6). This has been important to develop a good understanding of the work SL will be undertaking to prevent any reoccurrence.

19. Nevertheless, from my review I consider the event highlights shortfalls in compliance against site Licence Conditions and was a reduction of defence in depth. Evidence in relation to this is set out below, with a fuller description of the event and wider causal factors identified within ONR's specialist fact-finding report (Ref 1). This report has been shared with SL to promote a common understanding of the event and to facilitate learning in relation to the wider contributing factors.

20. SL's investigation found that there was a failure of the design substantiation of the GMI hydrogen analysers which allows the alarm to be reset without re-establishing the flow through the rotameter and hence the analyser. This gave a false indication that the GMI hydrogen analysers were healthy and was a direct cause of the failure to initiate a restart of the sample pumps.

21. I concur with this and note that my examination of SL's existing substantiation material for GMI and ABB hydrogen analysers indicates that SL has known for some time that the GMI hydrogen analysers (and associated UPS) fell short of appropriate standards (Ref 1). SL has acknowledged that on multiple occasions, the shortfalls in the substantiation of both the GMI analysers and the associated UPS were raised with the

Plant Health Committee through submitted System Health Reports. SL further recognises that it accepted the risk of the degraded assets on the basis that the work to replace the equipment with fully substantiated assets was recorded in its NACCI (asset care) system, but it did not assess or mitigate the risk that these degraded assets represented. Furthermore, SL acknowledges that its decision to subsequently cancel the hydrogen analysers' replacement in effect accepted this degraded status without the identification and implementation of suitable risk mitigation. SL agrees that improvements to the GMI and ABB hydrogen analysers may have mitigated or avoided this event. I agree with SL's synopsis.

22. SL also recognises that events in THORP in 2005 had identified that the rotameters in use in MSSS had well known failure modes but that the learning from these events had not been acknowledged in any operational documentation or assessments in MSSS. Had SL applied this site-wide learning then the modification to the rotameters would have been made in MSSS. This would have prevented the resetting of the no-flow alarms and the incorrect signal that the pumps had restarted and that the sample air flow was adequate. It is likely that this would then have prevented the December 2015 event.

23. Based on the above, I consider that SL breached LC 27 – Safety mechanisms, devices and circuits. This is because the GMI hydrogen analyser in the compartment in question was not, during the period 30 December to 6 January, suitable and sufficient nor in good working condition and consequently failed to deliver its safety function.

24. SL's investigation also examined the safety case and operational documentation relating to the GMI and ABB hydrogen analyser SMs and found there to be a need to review and address shortfalls so that MSSS risks are managed to be as low as reasonably practical. In particular, SL's investigation found that an Alarm Response Instruction relevant to this event instructs the MSSS control room operators to use MSSS's Emergency Guidance Instruction entitled "Action to be taken in the event of loss of electrical supplies" in these circumstances. This instruction was followed in both the events of the 28 and 30 December and SL has confirmed this from the control room logs. However, these instructions did not prompt the operators to restart the sample pumps on the GMI analysers and this was a significant contributor to SL's failure to identify the actual state of the safety mechanism on 30 December. I agree with these conclusions and also consider that, had the instructions included this prompt, this event would not have occurred.

25. Based on this, I consider that SL breached LC 24 – Operating Instructions. This is because following the loss of electrical power, which I consider is a foreseeable event likely to occur from time to time at MSSS plant, the Operating instructions did not include all the instructions necessary in the interests of safety. Specifically, instructions to restart the GMI analyser sample pumps were omitted. SL therefore failed to ensure all operations which may affect safety are carried out in accordance with written operating instructions and, further, that these operating instructions included any instructions necessary in the interests of safety.

26. I consider that the event also shows shortfalls in SL's ability to learn from experience. For example, the need to restart the GMI analyser pumps following a power failure was identified by an SL instrument mechanic who was investigating a high hydrogen level alarm on another MSSS compartment on 28 December. He observed that the pumps were stopped and he restarted the pumps, bringing the GMI analysers back on line. This was however, not recorded in the control room logs, nor in the handover between shifts. Had the learning from this off-normal event been applied, and the relevant operating instruction revised or red-lined, it is likely that the event of 30 December would have been avoided. Further, the learning from a similar loss of power event in 2006 relating to the hydrogen analysers should have resulted in actions being placed to improve the relevant Emergency Guidance Instruction that would have prevented the GMI analyser pumps failing to be restarted.

27. Based on this, I also consider there were shortfalls in operational standards relating to log-keeping and Condition Reporting and, following on from this, also in relation to shift handovers. These however, do not amount to breaches of legal requirements.

28. Though I concur with the shortfalls identified by SL, I consider that there are limitations in SL's action plan to address these. For example, it is not clear that SL has got to all the root causes of the above apparent failures to learn from experience and why the off-normal condition identified by the instrument mechanic was not reported in the logs and at handover. Further it is not clear why a Condition Report for this off-normal event was not completed, or what supervision was in place for the instrument mechanic's investigation. Further, SL has not applied learning from events in other site facilities using similar rotameters that have been found to fail in an unrevealed fashion. It is my view that the plant and SLstaff were not learning adequately from experience to improve their safety performance. This may indicate a failing in the practical application of SL's Performance Improvement (PI) process in MSSS.

29. SL's investigation also found that MSSS's application of the site's management of safety processes that should have prevented this event occurring, such as the LTPR (non-substantiation of GMI and ABB hydrogen analysers), PMP (long term reliance on one GMI analyser in one compartment), PI (failure to apply LFE from THORP), Asset Care (failure to address System Health Report findings regarding GMI analysers) and DAR (failed to identify the potential for GMI analysers to fail in an unrevealed fashion) processes were all factors contributing to this event. This finding may well have broader implications for MSSS and the site. Furthermore, in its BOI review, SL has noted that in several cases the shortfalls in these processes included poor decision-making and lack of understanding of their safety significance at managerial levels in MSSS. I agree that these aspects also contributed to this event.

30. Furthermore, SL recognises that over-complexity in the MSSS safety case may also have contributed to this event. In particular, there appears to be no clear golden thread from the safety case through to supporting operational documentation, and there is therefore important learning for SL here in relation to the clarity of its safety cases and their translation into operational practice, e.g. in the quality of the resultant operating instructions.

31. From my review, I conclude however, that there was no direct risk from radiation to either workers or members of the public as a result of this event and I am satisfied that the risks arising from it were very low. This reflects the fact that during the period of the event there was no plant occurrence which would have initiated any increase in hydrogen generation (by disturbing the Magnox swarf) and any hydrogen that might have occurred would have been addressed by the plant's ventilation systems (which remained in operation throughout, one of which is a passive system installed on the plant in recent years as an additional defence in depth measure). Moreover, hydrogen monitoring was available in all bar one of the compartments in MSSS throughout the event, albeit at reduced defence in depth. There were also other means of detecting any increases in hydrogen generation available to the plant operators such as the silo temperature monitoring system. I note that this system showed no increase in temperature over the period of concern.

32. Overall therefore, I consider that this was an avoidable event with two root causes and a number of further contributory causes. Whilst I broadly agree with the factors that SL has identified, I consider that SL's investigation was insufficient to fully extract all the learning from the event and in particular, the wider human and organisational factors that led to an ineffective application of SL's safety management processes which should have prevented this event occurring. These resulted in the above-noted shortfalls in operational standards. From my review of this event, I consider that the risks it posed to MSSS workers and the public were very low. Nevertheless, maintaining high operational standards is an important part of MSSS's multiple safety barriers and I therefore support SL's commitment to undertake further work to better

understand these aspects. I also note that my own investigations found the following factors to have been influential: a lack of clarity in setting standards and expectations, poor understanding and implementation of the safety case and its hazard management strategies, and poor oversight of operational standards. I have shared my fact-finding report (Ref 1) with SL and will be looking to ensure these matters are adequately addressed as part of SL's Improvement Plan.

7 IDENTIFICATION OF BREACHES

33. As explained in paragraph 25, I consider that SL failed to comply with LC 24 – Operating Instructions – in that it did not ensure that

- "all operations which may affect safety are carried out in accordance with written instructions hereinafter referred to as operating instructions" and,
- "such operating instructions include any instructions necessary in the interest of safety"

34. In addition, as explained in paragraph 23, I consider that SL failed to comply with LC 27 – Safety Mechanisms, devices and circuits – in that it did not ensure that:

- "a plant is not operated, inspected, maintained or tested unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order"

35. I am satisfied however, that although the safety case for MSSS is complicated it is adequate. For example, SL is able to demonstrate the safety of the operation of MSSS and the limits and conditions necessary for safety. I also found evidence that the safety case has been subject to periodic review. Given that a new safety case for MSSS is about to be issued in support of retrievals I do not consider that it would be appropriate or proportionate to pursue improvement to the extant safety case at this time. Nonetheless, I have found failings in MSSS's application of disciplined operations and maintenance, and its application of the site's management of safety processes that should have prevented the event. I judge that these are important and so will be taken into consideration when applying the EMM below.

36. I am further satisfied that there is no need for separate ONR consideration of the March 2016 event in which ventilation flows in the MSSS Original Building became restricted due to a lute filling with condensed steam. This is because SL's combined event BOI and my subsequent fact-finding work have been sufficient to identify the common elements that need to be taken forward and there are no remaining factors unique to this second event that warrant formal enforcement.

8 REGULATORY ENFORCEMENT DECISIONS

37. In evaluating what regulatory enforcement action should be taken as a result of the potential breaches identified above, consideration has been given to the principles set out in the ONR Enforcement Policy Statement ONR-ENF-POL-001 Revision 0 – Dated 1 April 2014, and ONR guidance on the use of the Enforcement Management Model in ONR-NS-ENF-GD-002 Revision 5. The resultant Enforcement Assessment Record (EMM1) can be found at Ref 7.

38. I consider that this event posed negligible increased risks to workers in MSSS and the public in that the actual increase in risk from a hydrogen deflagration was only marginally increased. This was because the active and passive ventilation systems were never compromised and these would have ensured that there was no build-up of hydrogen. The GMI hydrogen analysers are a secondary measure to detect hydrogen if the primary means (which prevents hydrogen accumulation) is not working. In all bar one compartment, hydrogen monitoring was maintained, albeit at reduced defence in depth. In addition there were also other means of detecting any increase in hydrogen generation, e.g. the silo temperature monitoring system. However, in one compartment there was no direct hydrogen monitoring for approximately 7 days.

39. Considering the EMM, I judge that the multiple casualties risk gap table is appropriate in this case due to the fact a fire or large explosion would have the potential to cause an off-site event. As such, I assess the EMM actual and benchmark consequences to be Serious.

40. Since the risk of hydrogen build up can be fully mitigated. I consider that the benchmark likelihood (i.e. where the risk should be) should therefore be Nil/negligible. During the period of this event, the actual risk of a hydrogen build up was however similarly Nil/negligible. This is because there was no plant occurrence which would have challenged the SM, active and passive ventilation systems were available in the compartment throughout the period and other instrumentation was available to provide indication to the operator of an adverse condition.

41. Applying the principles of ONR's Enforcement Policy Statement via our EMM then gives an Initial Enforcement Expectation that no regulatory action is required against apparent breaches in LC24 and LC27 prior to taking other factors into account. This is primarily due to the absence of any significant risk gap. The EMM duty holder and strategic factors are considered below.

Duty Holder Factors

42. This part of the EMM considers if any factors specific to the licensee should either increase or reduce the severity of the Initial Enforcement Expectation.

43. As already noted, SL has had a history of related events relating to GMI analysers both within MSSS (e.g. in 2006 following a loss of power event) and similar monitoring equipment elsewhere on the site (e.g. an event in THORP in 2005). The MSSS LTPR in January 2013 also noted shortfalls in the GMI analysers. These events and findings suggest that the failures of the GMI analysers that occurred in December were foreseeable and should have been addressed. Moreover, the operating instructions should have been updated and the Duly Authorised Persons (DAPs) should have been trained in, and been aware of this potential issue.

44. I note that SL also has a history of relevant enforcement being taken against it relating to hydrogen management within MSSS; specifically a misconfiguration event at MSSS in 2010 that resulted in no hydrogen analyser being on line is particularly relevant and led to ONR serving an Improvement Notice.

45. However, I also note that SL has conducted a BOI, using senior experienced staff and has produced a consolidated action list. This clearly sets out the action owners (senior SL managers and subject matter experts) as well as planned delivery dates. The action list also takes into account the findings and subsequent actions arising from the MSSS Original Building ventilation system event in March.

46. I consider that SL has undertaken a reasonable assessment of the event and in general identified most of the root causes, as well as producing a good consolidated action list. It is also already undertaking work to improve its approaches to safety culture, leadership and human performance in MSSS (Ref 9), which I expect will address ONR's concerns regarding the sufficiency of SL's BOI to fully extract all the learning from this event and in particular, the wider human and organisational factors, to prevent any reoccurrence. An ONR Task Sheet (Ref 12) is already in place to address this. SL's actions give confidence that the licensee is being suitably proactive in restoring compliance, irrespective of any enforcement action ONR might choose to take.

47. ONR has also challenged the adequacy of SL's performance in regard to 'conduct of operations' across the Sellafield site more generally. This reflects events which have occurred in several facilities including MSSS. In light of these, in January 2015 ONR wrote to SL (Ref 8) stating that SL appeared to be failing to consistently comply with requirements under LC 24(1) and the Management of Health and Safety at Work Regulations (1999) (Reg 5). In response to this, SL identified and is implementing a

site-wide improvement programme incorporating work to improve its methodologies regarding safety culture, leadership and human performance. This work is on-going and is the subject of regular monitoring and scrutiny by ONR (e.g. as per Ref 12).

48. The SL BOI found specific failings in MSSS's application of disciplined operations and maintenance, and its application of the site's safety management processes that should have prevented the event. I consider that it is important that any enforcement action in relation to this event integrates and links into the wider context of interactions with SL in this area. This is important to determine the most effective strategy and ensure alignment, both at a corporate and facility level, to promote sustained improvement and compliance, as well as to ensure that appropriate levels of SL's leadership are committed to delivery of improvements in relation to operational standards. As such, any action taken by ONR in this regard should be taken forward as part of ONR's existing initiatives in this area.

49. Following the EMM, the history of relevant events and enforcement serves to increase the regulatory response beyond the Initial Enforcement Expectation. After consideration of EMM Duty Holder Factors, given the number and nature of relevant events and findings, I consider that increasing the regulatory response beyond the Initial Enforcement Expectation would be proportionate. In particular, ONR should seek improvements in MSSS's application of disciplined operations and maintenance, and also in its application of the site's safety management processes. I therefore consider that the enforcement expectation, before taking Strategic Factors into account, should be raised to a regulatory enforcement letter.

Strategic Factors

50. Following consideration of the Strategic Factors listed in the EMM, I consider that the following two factors are pertinent:

51. Does the indicated action coincide with the public interest?

- ONR's regulatory strategy for the Sellafield site is to focus the SL senior management on the key strategic matters which are required to deliver key safety improvements, e.g. the national priority to accelerate risk and hazard reduction at the legacy plants. Serving a regulatory enforcement letter seeking improvements in MSSS's application of disciplined operations and maintenance and in regard to applying the site's safety management processes will improve the safe delivery of the hazard and risk reduction programme, both in MSSS and more broadly. As such, the proposed enforcement action is judged to coincide with the public interest.

52. Have the principles and expectations of the Enforcement Policy been met?

- I consider that serving a regulatory enforcement letter would be targeted and proportionate given the importance of carrying out risk and hazard reduction safely at MSSS and in view of the shortfalls identified. Application of the EMM has ensured consistency of the regulatory approach being followed, e.g. not issuing an Improvement Notice as we did in 2010 is justified given the significantly smaller risk gap in the present event. Appropriate standards of accountability and transparency will be achieved through the publishing of this PAR and sharing the report with SL (noting that our fact finding report (Ref 1) has already been shared). As such, the proposed enforcement action is judged to meet the principles and expectations of ONR's Enforcement Policy.

53. Neither of these strategic factors changes the conclusion from the previous section that ONR should issue a regulatory enforcement letter. The letter should set out the conclusions from ONR's fact-finding investigations in regard to this event, acknowledge the improvements SL has made to date and inform SL of ONR's expectations as follows:

- SL should provide ONR with a suitably prioritised programme to implement improvements in MSSS's conduct of operations and the plant's application of the site's safety management processes to address the shortfalls identified through this event.
- This programme should include the improvements in these areas that SL has identified through its own BOI process.
- Noting that SL's BOI was insufficient to fully extract all the learning from the event and in particular, the wider human and organisational factors that led to an ineffective application of the site's safety management processes, SL's programme should also include improvements to its corporate processes for investigating incidents and events.

54. ONR should raise one or more Regulatory Issues to monitor SL's progress in resolving these matters and seek updates at appropriate intervals.

9 CONCLUSIONS

55. I conclude that there was no harm from radiation to either workers or members of the public as a result of this event and I am satisfied that the additional risks arising from it were very low.

56. I also conclude that there is no need for separate ONR consideration of the March 2016 event in which ventilation flows in the MSSS Original Building became restricted due to a lute filling with condensed steam. I am satisfied that the common elements that need to be taken forward from this event have been identified and incorporated into SL's action plan deriving from the first event and there are no remaining factors unique to this second event that warrant formal enforcement.

57. I do not believe that any further benefit would be achieved in applying formal enforcement following the identified breaches in LCs 24 and 27 because SL has already closed the specific compliance gaps by updating the relevant MSSS operating instructions and ensuring the GMI Hydrogen analyser safety mechanisms are in good working order.

58. Applying the EMM to this event yields an initial enforcement expectation of no enforcement action. However, when duty holder and strategic factors are also taken into account, I consider enforcement action is merited. Specifically, ONR should seek to regulate the improvements in MSSS's conduct of operations and application of the site's safety management processes so that the shortfalls identified through this event (by SL and ONR) are addressed, as well as seeking improvements in SL's corporate processes for investigating incidents and events.

59. These matters should be set out in a regulatory enforcement letter and progress monitored through the Regulatory Issues process. Conduct of operations aspects arising from this event should be regulated through ONR's existing initiatives ongoing in this area.

10 RECOMMENDATIONS

60. Based on the conclusions of my fact finding investigation and consideration of the EMM, I recommend that ONR should send a regulatory enforcement letter to SL seeking a programme of improvements. The letter should attach this report and highlight the need for improvements in the application of disciplined operations and maintenance at MSSS, MSSS's application of the site's safety management processes and for wider improvements in SL's site-wide processes for investigating incidents and events.

11 REFERENCES

1. ONR Fact Finding Investigation into unrevealed failure of a safety function in Sellafield Limited Magnox Swarf Storage Silo, Trim Ref 2016/258488
2. Sellafield Limited's Basic Cause Investigation into the MSSS GMI Hydrogen Gas Analyser Event, Trim Ref 2016/263953
3. Sellafield Limited's INF 1 report into the MSSS GMI Hydrogen Gas Analyser Event, ONR INF 1 database reference 2016/11.
4. Sellafield Limited's 60 day Follow up INF 1 report into the MSSS GMI Hydrogen Gas Analyser Event, Trim Ref 2016/263955
5. Sellafield Limited's Board of Inquiry Investigation into the MSSS GMI Hydrogen Gas Analyser Event, Trim Ref 2016/185816.
6. ONR-SDFW-CR-16-041 Revision 0 Fact finding meeting on the MSSS Hydrogen Gas monitoring and Ventilation system events, Trim Ref 2016/159102
7. EMM1 Form Relating to the MSSS GMI Hydrogen Gas Analyser Event, Trim Ref 2016/264027
8. Letter SEL77528 – Conduct of Operations at Sellafield - Trim Ref 2015/37330
9. ONR-SDFW-CR-16-222 Revision 0 - Objective 2: Risk and hazard reduction - MSSS L4 Human Factors workscope - Trim Ref 2016/264079
10. Sellafield Limited's 60 day Follow up INF 1 report into the MSSS original building vent duct work restriction event due to steam condensate entering the ductwork via a passing steam valve and collecting in a lute, Trim Ref 2016/289464
11. Email correspondence between the ONR THORP Nominated Site Inspector and SCIE Delivery Leads, Application of the EMM within ONR, January 2016, Trim Ref 2016/51200.
12. ONR Sellafield Programme Task Sheet ONR-SEL-TS-16-19 Rev 0 Leadership and Culture.