Office for Nuclear Regulation

Investigation into a high dose rate during x-ray radiography at the Solvent Recovery Plant.

Project Assessment Report: ONR-SDFW-PAR-17-008
Revision A
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EXECUTIVE SUMMARY

Title

Investigation into a high dose rate during x-ray radiography at the Solvent Recovery Plant.

Background

On the 15 August 2016 a high dose rate was recorded on an Electronic Personal Dosimeter (EPD) whilst carrying out x-ray radiography operations within cell 4 of the Solvent Recovery building at Sellafield. This led to the individual concerned receiving a small radiological dose uptake. The radiation dose to the individual was low when compared against the annual statutory dose limit; however there was the potential for greater doses from this event. There were no consequences to other workers involved in the radiography work or to members of the public

It is considered that the event highlights shortfalls in compliance against the Ionising Radiations Regulations 1999, Regulation 8(1).

Basis for Enforcement Decision

This investigation has concluded that the root cause of the exposure was non-compliance with the SL radiography procedures by the individuals carrying out the work. SL has disciplined the individuals involved. They were initially suspended from carrying out further radiography work, then provided with additional training before being re-assessed to ensure that the individuals were Suitably Qualified and Experienced Persons (SQEP). The individuals have subsequently been allowed by Sellafield Limited (SL) to resume their duties and continue to undertake further radiography on the Sellafield site.

This investigation has also identified a number of other organisational issues which contributed to the degradation of the radiography standards on the Sellafield site. ONR judged that SL's lack of control and supervision of the radiography process constituted a failure of SL to comply with the duty to restrict so far as is reasonably practicable the extent to which employees are exposed to ionising radiation under the Ionising Radiations Regulations 1999 (IRR99) Regulation 8(1).

SL has undertaken both Management Investigation and Board of Inquiry investigations and has proposed a number of recommendations to address the root and contributory causes of the event.

Applying the principles of ONR's Enforcement Policy Statement via the ONR Enforcement Management Model, gave an indicated enforcement action that an Improvement Notice should be served and prosecution considered against SL as well as potential prosecution of the individuals.

After consideration of the relevant strategic factors however, ONR considers that no further action should be taken against the individuals. Whilst there appears to have been a number of failings/omissions by the individuals, ONR considers that prosecution or indeed taking lower level regulatory action would not be in the public interest given that the only person to suffer harm from this event was one individual. In addition, the investigation concluded that the individuals involved have been disciplined, retrained and reassessed for their level of competency to conduct radiography to the required standard to comply with the Ionising Radiations Regulations by SL and hence this compliance gap is considered closed. Following consideration of the relevant EMM strategic factors, ONR considers that a regulatory letter should be served against Sellafield Limited. ONR judges that issuing an improvement notice or initiating a prosecution would not be a proportionate response to this event, when weighing SL's responsibility and failings which contributed to the event against those of the individuals, which ONR considers were the primary cause of the exposure due to the failure to comply with the SL processes. SL has carried out a comprehensive investigation and acknowledged the shortfalls in its management arrangements and is actively addressing them. The issuing of an improvement notice would be unlikely to secure any significant further benefit here.

Conclusions and Recommendations

I recommend that ONR should send a formal regulatory letter to SL. This letter should summarise the findings of the investigation, and set out ONR's expectations regarding SL's actions to ensure that radiography involving x-ray equipment is conducted in accordance with its arrangements and that the associated local rules and procedures are appropriately implemented.

I also recommend that ONR convenes a Holding to Account meeting with Sellafield Limited, on the basis that the enforcement decision has been reduced from the indicated enforcement expectation.

I recommend that no formal regulatory action should be taken against the individuals directly involved in the event.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
EMM	Enforcement Management Model
EPD	Electronic Personal Dosimeter
EPS	Enforcement Policy Statement
HSE	Health and Safety Executive
IRR	Ionising Radiations Regulations 1999
ONR	Office for Nuclear Regulation
SL	Sellafield Limited
SQEP	Suitably Qualified and Experienced Person

TABLE OF CONTENTS

1 INTRODUCTION

1. On the 15 August 2016 a high dose rate was recorded on an Electronic Personal Dosimeter (EPD) whilst carrying out x-ray radiography operations within cell 4 of the Solvent Recovery Building at Sellafield. This led to the individual concerned receiving a small radiological dose uptake. There were no consequences to other workers involved in the radiography work or members of the public.

1.1 PURPOSE

2. This report has been produced to record the findings of the Office for Nuclear Regulation's (ONR's) investigation of the incident. The report also details the enforcement decisions taken by ONR in accordance with the ONR's Enforcement Policy Statement (EPS) (Ref. 1), guided by application of the Enforcement Management Model (EMM) (Ref. 2).

1.2 BACKGROUND

3. The Sellafield Inspection Certificate Group (ICG) radiography team were requested to carry out x-ray radiography of 10 legacy wooden crates stored in cell 4 of the Solvent recovery building.

4. The x-ray radiography work requires a team of radiographers to position an x-ray generator and imaging plate around the crates and take x-ray images of the contents of the crates. The potential dose rates from the x-ray generator are in the order of Sieverts per minute and as such strict controls are required to ensure that the x-ray generator cannot be energised whilst any person is in the vicinity of the generator or imaging plate.

5. On the morning of 15 August 2016 a team of radiographers comprising 1 radiological team leader (STL) and 2 radiographers (Rad1 and Rad2) carried out x-ray radiography within Cell 4. Cell 4 contained 10 crates each containing contaminated filters. The maximum gamma radiation dose rates measured with a RO-20 Ion Chamber Survey Meter were no greater than 2.5 milli Sieverts per hour (mSv/hr) in contact with 9 of the crates. One crate (Crate Number 8) had a maximum contact dose rate of 20 mSv/hr. The radiographers were accompanied by the Person Organising Work, acting as escort to the visiting radiography team, and a Health Physics Monitor who was present in order to carry out personal contamination monitoring checks on the radiographers each time they exited Cell 4 (a C3 contamination controlled area).

6. At approximately 09:56 hours, while located in Cell 4, Rad2's Electronic Personal Dosimeter went into alarm and he promptly exited the cell. Subsequent analysis of the dosimeter revealed that it had been exposed to a gamma dose rate of 37.5 mSv/hr, and indicated that an equivalent whole body dose exposure of 86 micro Sieverts had been accrued. At the time of the EPD going into alarm, all the other team members were located at the control point, away from cell 4 and from which, there was no view of the interior of the cell.

2 LICENSEE'S RESPONSE TO THE INCIDENT

7. On return of the EPD to the SL Sentinel system it was "red flagged" and a subsequent event report was raised. A management investigation was carried out by SL to determine the cause of the high dose rate alarm. This identified root causes and contributory factors and proposed a number of recommendations (Ref. 3). Although there was no significant dose received by the individual as a result of the actual event, SL recognised that there was the potential for a dose which could have exceeded the statutory Ionising Radiations Regulations 1999 (IRR) dose limits (Ref. 9).

8. Subsequently, SL carried out a Board of Inquiry investigation (Ref. 4) which looked into the event in more detail and proposed a number of recommendations to address the root

and contributory causes. These recommendations are being actioned and tracked through the SL Atlas system.

9. SL disciplined the individuals involved. They were initially suspended from work and then subsequently provided with additional training before being reassessed to ensure they were competent to conduct radiography operations at Sellafield site. SL has deemed that they are now Suitably Qualified and Experienced Persons (SQEP) and has allowed them to resume their duties and to undertake further radiography on the SL site.

3 ONR'S ASSESSMENT OF THE INCIDENT

10. The decision was taken by ONR to formally investigate the incident which included interviews with a number of witnesses who were involved in the event and other relevant SL staff (Ref. 5).

11. The potential sources of the exposure initially considered in the investigation were: a) radiation from the radioactive material in Cell 4; b) radiation from some transient source external to the cell; and c) the x-ray set being energised while Rad2 was present within Cell 4.

12. The ONR Investigation concluded that the maximum dose rate of 37.5 mSv/hr could not have occurred due to proximity to the crates regardless of the configuration of them or Rad2's position in the cell relative to them. Potential sources external to the cell were dismissed as not being credible due to the shielding provided by the cell walls. ONR found that the dose rate of 37.5 mSv/hr was however, consistent with levels of backscattered radiation from an energised x-ray set of this power, and ONR therefore concluded that this was the only credible source of the dose rate measured on Rad2's EPD. ONR's investigation did not identify the event or sequence of events that led to the x-ray set being energised while Rad2 was present in Cell 4

13. The Operator Instructions (Ref. 6) and Risk Assessment (Ref. 7), provided to ONR by SL, specified the following requirements, provided within systems of work, to restrict the exposure of employees and other persons:

    - [Operator Instructions Step 3.2] - Prior to exposure ALL personnel shall retire to the control point.
    - [Operator Instructions Step 3.4] - Operators deploying DDR flat panel or film must have generator key in their possession at all times.
    - [Risk Assessment Part 6 Agreed Level of Supervision] - ICG Radiographers are SQEP to carry out radiography operations under their own supervision. Team Leader RPS will visit the work area to ensure that all instructions are complied with.

14. From the ONR investigation it was evident that:

    - Rad2 could not have been carrying the x-ray control key while deploying the imaging plate at the time of the exposure, thereby failing to comply with the requirement of Step 3.4 of the radiography operator instruction.
    - Rad1, in position at the control panel, failed to prevent an exposure occurring as Rad2 had not retired to the Control Point thereby failing to secure compliance with Step 3.2 of the Operating Instruction.
    - The STL was present at the Control Point at the time of exposure and failed to ensure that the instructions in steps 3.2 and 3.4 were complied with, thereby failing to provide the supervisory requirement to ensure that all instructions were complied with, when present at the workface.

SL Employees

15. The resulting radiation exposure to Rad2 resulted in a dose equivalent of approximately 86 micro Sieverts. When compared with the annual statutory worker dose limit of 20 milli Sieverts per year this represents a small proportion of that statutory dose limit. However there was the potential for this exposure to be more significant and potentially in excess of the statutory dose limits.

16. The investigation concluded that the root cause of the exposure was non-compliance with the SL radiography procedures by the individuals. More specifically the evidence showed that the individuals had deviated from SL's expected x-ray radiography procedures with regards to the following:

- Key control – the key to energise the x-ray generator should be in the possession of the person adjusting the imaging plate to ensure that the unit cannot be energised whilst that person is in the vicinity of the imaging plate or x-ray generator.
- Line of sight of personnel – all personnel should be visible in the control point prior to energising the x-ray generator to ensure that no one can receive a dose in the vicinity of the x-ray generator.

SL Management Arrangements

17. The investigation identified a number of other organisational shortfalls which contributed to the degradation of the radiography standards at the Sellafield site (these concur with those identified in SL's own investigation (Refs. 3 & 4). These are:

- The work pack for the task (pre-job brief, risk assessments, operating instructions) was found to be missing key documents and was not completed in accordance with IRR99 or SL guidance.
- There was no evidence of management oversight of the radiography procedures and there was a general lack of supervision for radiological operations involving mobile x-ray equipment.
- The SL radiography team had not imbedded learning from a similar previous event (BN1208A1189) involving a breach of radiography procedures that had been subject of an SL amber briefing.

Incident Response by SL

18. ONR is generally content that SL managed the response to the situation in an appropriate manner. However any such event will result in a number of learning opportunities and SL has identified a number of these in its own investigations.

4 IDENTIFICATION OF BREACHES

SL Employees

19. It is the judgement of ONR that the individuals deviation from SL's x-ray radiography procedures constituted a failure to cooperate with SL .This constituted, in each individuals case, a breach of the Health and Safety at Work Act (Ref. 8) section 7 which requires that:

> "It shall be the duty of every employee while at work—
>
> (a) to take reasonable care for the health and safety of himself and of other persons who may be affected by his acts or omissions at work; and
>
> (b) as regards any duty or requirement imposed on his employer or any other person by or under any of the relevant statutory provisions, to co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with"

SL Management Arrangements

20. ONR found shortfalls that indicated a lack of control and supervision of radiography by SL involving mobile x-ray equipment existed at the Sellafield site at the time of the event. These are set out below :

- Inadequate control and supervision of the preparation for the task in that the work pack for the task was incomplete and pre-job tasks had not been completed in line with SL guidance.
- There was no evidence of management oversight of the radiography procedures and a general lack of supervision for radiological operations involving mobile x-ray equipment at the Solvent Recovery Building Cell 4.
- SL ICG radiography management failed to ensure that learning from a similar radiography event had been embedded into its radiography processes.

21. ONR judged that, as a result of SL's failure to provide suitable and sufficient control and supervision it failed to comply with its duty to restrict so far as is reasonably practicable the extent to which employees are exposed to ionising radiation under IRR99 Regulation 8(1), which requires that:

> "Every radiation employer shall, in relation to any work with ionising radiation that he undertakes, take all necessary steps to restrict so far as is reasonably practicable the extent to which his employees and other persons are exposed to ionising radiation."

5 REGULATORY ENFORCEMENT DECISIONS

22. In evaluating what regulatory enforcement action should be taken as a result of the above breaches consideration has been given to the principles set out in the Enforcement Policy Statement (Ref. 1), ONR guidance on the use of the EMM (Ref. 10) and the use of the EMM Operational Version 3.2. (Ref. 2). For enforcement decisions made under IRR99, there is additional guidance (OC130/11) on how to apply the EMM (Ref. 11). The results of the ONR evaluation can be seen in the Enforcement Assessment Record (EMM1) (Ref.12).

23. This event had the potential to expose, at the most, a small number of individuals and it was therefore considered that the use of EMM table 2.1 for single/small number of casualties was appropriate.

24. It was determined that, in this case, the benchmark risk from an x-ray radiation generator is serious personnel injury (exposure to radiation giving rise to the potential for serious health effects) with a nil/negligible likelihood.

25. The actual exposure to the individual was a dose equivalent of approximately 86 micro Sieverts. When compared with the annual statutory worker dose limit of 20 milli Sieverts per year this represents a small proportion of that statutory dose limit. However there was the potential for this uptake to be in excess of the statutory dose limits and very much greater than the ALARP level. ONR judged that the potential consequences of very much greater than ALARP levels should be used in this enforcement decision.

26. Application of these values resulted in a risk gap of EXTREME and an EMM initial enforcement expectation, prior to taking other factors in account, that an Improvement Notice be issued and a prosecution considered. These other factors are considered in the following paragraphs.

27. The investigation identified a number of shortfalls as result of individual non-compliance and wider organisation and process shortcomings. When considering the potential for enforcement action, ONR considered it appropriate to determine whether enforcement was appropriate against the individuals and SL separately.

SL Employees – Strategic factors

28. Following consideration of the Strategic Factors listed in the EMM, it was determined that the following two strategic factors are relevant:

- Does the Indicated Action Coincide With Public Interest?
    i. It is consider that whilst there appears to have been a number of failings/omissions by the individuals, it is considered that prosecution or indeed taking lower level regulatory action would not be in the public interest given that the only person to suffer harm from this event is one individual. In addition, the investigation concluded that the individuals involved have been disciplined, retrained and reassessed for their level of SQEP by SL and it is not in the public interest to bring further enforcement action upon them as individuals.

- Have the principles and expectations of the Enforcement Policy been met?
    i. The investigation did not identify reckless violations, rather it suggested degraded standards possibly due to complacency and omission of some activities which had potentially become accepted practice amongst a number of SL radiographers. ONR judged that these factors mean that a prosecution would not be a proportionate response to the event in the absence of harm to any other person other than one individual himself.

29. In conclusion, following the application of strategic factors, ONR considered that no further formal regulatory action should be taken against the individuals.

SL Management Arrangements – Duty holder factors

30. The initial enforcement action was to serve an improvement notice against SL, with consideration of a prosecution. In accordance with ONR guidance the following duty holder factors were considered:

- Relevant incident history – SL has had a similar radiography event. It failed to imbed the learning from it in the radiography team. ONR has already taken this into account in the judgement that there was a lack of control and supervision of radiography involving mobile x-ray equipment.
- Previous enforcement action – There has been no recent relevant enforcement action with respect to IRR99 regulations involving radiography at SL.
- Economic advantage deliberately sought – There was no evidence of economic advantage being sought by SL
- Level of actual harm – The radiation exposure to the individual concerned was very low and substantially below statutory dose limits.
- Inspection history – ONR judged SL's overall inspection history to be reasonable with inspection ratings have been in the average range for the Sellafield site.
- Standard of general conditions – ONR determined that the majority of issues are adequately addressed with only minor omissions and hence it considered that overall, general conditions are reasonable.

31. ONR therefore concluded that no applicable duty holder factors modified the initial enforcement expectation.

SL Management Arrangements – Strategic factors

32. The indicated enforcement action was to serve an improvement notice against SL, with consideration of a prosecution. In accordance with ONR guidance the following strategic holder factors were considered relevant:

- Does the Indicated Action Coincide With Public Interest?

i. ONR's regulatory strategy for the Sellafield site is to focus the SL senior management on the key 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 notice based on the present event would raise the importance of this matter beyond the level the event merits and would potentially distract SL from the aforementioned national priority.

- Have the principles and expectations of the Enforcement Policy been met?

i. ONR considers that issuing an improvement notice or initiating a prosecution would not be a proportionate response to this event, when weighing SL's responsibility and failings which contributed to the event against those of the individuals which ONR considers were the primary cause of the exposure due to the failure to comply with the SL processes. SL has carried out a comprehensive investigation and acknowledged the shortfalls in its management arrangements and is actively addressing them. The issuing of an improvement notice would be unlikely to secure any significant net benefit but would result in the diversion of significant SL and ONR resource to this area which would not represent a targeted use of ONR resources.

33. In conclusion, through application of strategic factors in accordance with the EMM I consider that modification of the indicated enforcement action of an Improvement Notice to a formal regulatory letter is appropriate. The letter should include recognition of the work that SL has already undertaken since 15 August 2016 to address the shortfall in compliance with IRR Reg 8(1) that this incident has highlighted. The letter should set out ONR's expectations regarding the actions that SL are expected to undertake to ensure that radiography involving x-ray equipment complies with the SL processes.

6 CONCLUSIONS

34. No one received a radiation dose except one individual involved as a result of this event.

35. The radiation dose to the individual was low when compared against the annual statutory dose limit; however it should be noted that there was the potential for a greater dose from this event.

36. ONR's investigation concluded that the root cause of the exposure was the non-compliance of the individuals with SL's radiography procedures. Through the application of strategic factors (Public Interest and meeting the principles of the Enforcement Policy), it is considered that no further formal regulatory action should be taken against the individuals involved in the event.

37. ONR's investigation also identified a number of other organisation shortfalls which contributed to the degradation of radiography standards on the SL site. ONR judged that SL's lack of control and supervision of radiography processes resulted in its failure to comply with its duty to restrict so far as is reasonably practicable the extent to which employees are exposed to ionising radiation under IRR99 Regulation 8(1).

7 RECOMMENDATIONS

38. I recommend that ONR should send a formal regulatory letter to SL. This letter should summarise the findings of the investigation, and set out ONR's expectations regarding the actions that SL are expected to undertake to ensure that radiography involving x-ray equipment complies with the SL processes.

39. I recommend that no regulatory action should be taken against the individuals directly involved in the event.

40. In accordance with the Sellafield Compliance, Intelligence and Enforcement Strategy, I also recommend that ONR convenes a Holding to Account meeting with Sellafield Limited, on the basis that the enforcement decision has been reduced from the indicated enforcement action.

8 REFERENCES

Ref.1 - ONR Enforcement Policy Statement ONR-ENF-POL-001 Revision 0 – HOW2

Ref. 2 – Enforcement Management Model (EMM) Operational version 3.2 – HOW2

Ref. 3 – Sellafield – EPDs went into alarm during x-ray radiography operations – Sellafield Ltd Management Investigation Report BN1608A1695 – 14th November 2016 – TRIM 2017/188830

Ref. 4 - Sellafield – 2 Radiographers EPD alarmed whilst working in cell 4 – Sellafield Ltd Board of Inquiry Report BN1608A1695 – 6th April 2017 – TRIM 2017/188830

Ref. 5 – [OFFICIAL SENSITIVE] ONR Combined Investigation and Prosecution Report - Butex Investigation – TRIM 2017/261188

Ref. 6 – Sellafield – ICG Radiography X-ray Inspections Operations on Sellafield Site - Operator Instructions ICG/INSPECTION/OI/015 Issue 1 – April 2016 - TRIM 2017/166594

Ref. 7 – Sellafield – Carry out Radiography on Crates in B*** - Risk Assessment RA/RAD/001 /B***/2016 Issue 1 – 8th March 2016 - TRIM 2017/166586

Ref. 8 – Health and Safety at Work etc Act 1974

Ref. 9 - Ionising Radiations Regulations 1999

Ref. 10 – The Use of the Enforcement Management Model in ONR – NS-ENF-GD-002 Rev 6 – HOW2

Ref. 11 - OC 130/11 - Enforcement management model (EMM): application to ionising radiations – HSE Website

Ref. 12 – EMM1 – SL Butex Radiography Event – 29th June 2017 – TRIM 2017/251706