

[REDACTED]

Investigation into Nuclear Safety Event 57122
HMS [REDACTED] Tank Exposure during [REDACTED] Trial.

[REDACTED]
Health Physics Afloat Manager

[REDACTED]

[REDACTED]

[REDACTED]

1. Investigation team

Health Physics Afloat Manager – [REDACTED]

2. References

- a. NP 5115(A): [REDACTED]
- b. NOP 402(A): Establishing and maintaining an exclusion zone and controlled radiation areas onboard submarines (HMNB Clyde Faslane).
- c. HMNB Clyde RPSOs: Radiation Protection Standing Orders.
- d. BR3030(2): Radiation protection practices onboard nuclear submarines all ships.
- e. BRd 9465: Fleet naval nuclear authorisation and radiological control manual.
- f. IRR-99: Ionising radiations regulations 1999.
- g. JSP 375: MOD Health and safety handbook.
- h. RA000-1248: HMNB Clyde's Risk Assessment to clean and inspect DCT [REDACTED]

3. Individuals Interviewed

Mr [REDACTED] (RA111)

Mr [REDACTED] (RA111)

[REDACTED] (HPAF)

[REDACTED] (SSHP)

Monitoring Control Office Team Leaders (MCO TL)

[REDACTED] (SSBN Ship Manager)

Ship's Staff (SS) were not interviewed at time of writing the initial report due to the vessel sailing immediately after the investigation was initiated. On 16 Jan 13 a meeting was held with representatives from HMNB Clyde Assurance Department, Vessel, COMFASFLOT, PAG, Base RPA, Base RSO and Health Physics Afloat. The findings from this meeting have been included within this report.

4. Event Summary

4.1 Background

Towards the end of Base Maintenance Period (BMP) 01, HMS [REDACTED] was carrying out a planned [REDACTED] trial¹, in conjunction with defect rectification on the [REDACTED] tank; the latter required 24 hour support from base staff. Both of these separate tasks were to be completed prior to the vessel departing HMNB Clyde.

On 16 and 17 Aug 12, work progressed within the [REDACTED] tank whilst the reactor was operating [REDACTED] for prolonged periods. Three radiation surveys were carried between 16 and 17 th Aug12 leading to the assumption that doserates at the worksite were below [REDACTED] and therefore no controlled area was established. A further radiation survey at 21.20 on 17 Aug 12 identified a maximum dose rate of [REDACTED] within the [REDACTED] tank, whilst the [REDACTED] was [REDACTED]. Immediate actions involved withdrawing all personnel from the area and informing the MCO TL. No further tank entries were permitted until the [REDACTED] trial concluded.

¹ HMS [REDACTED] Nuclear Logic BMP 01 – Issue 4.

[REDACTED]

[REDACTED]

Although there was a delay in forwarding this information to the Duty Health Physics Officer and Health Physics Afloat Manager, an initial meeting was arranged at the earliest opportunity on 22 Aug 12 to discuss this incident. Attendees included the BRPA, BRSO, COMFASFLOT, Assurance Department, HPAF and SSHP. This meeting led to HMNB Clyde raising NSER-57122.

4.2 Current administrative controls

4.2.1 [REDACTED] Trial:

This procedure is carried out in accordance with Reference A. Although this procedure is not accompanied with a Radiological Protection Measures (RPM) document, specific radiation protection (RP) precautions are listed within the procedure. The precautions include keeping personal radiation doses ALARP, the requirement for radiation surveys to be carried out on the jetty and casing at regular intervals when the [REDACTED] and restricting access by establishing controlled radiation areas (as required when radiation dose rates exceed $2.5 \mu\text{Sv hr}^{-1}$).

Whilst operating in [REDACTED] Reference B enforces stringent access control into the exclusion zone², where all personnel (excluding ship's company) are issued with accident dosimetry³ and provided with a comprehensive brief detailing any controlled radiation areas onboard. Reference B also directs ship's staff health physics (SSHP) and Engineering Support Health Physics (ESHP) to carry out radiation surveys and to establish controlled radiation areas (as required). There is no RPM issued with this procedure; RP precautions / actions are listed as steps within the NOP that are required to be signed for on completion.

References C to F are listed as additional standing orders that are applicable to both the [REDACTED] trial and the enforcement of the exclusion zone. Contained within these references are specific actions that must be implemented in order to satisfy the RP requirements of a vessel operating at an Authorised Site, in addition to the mandated statutory requirements of Reference F.

4.2.2 [REDACTED] tank entry:

All tank entries onboard Submarines, whilst alongside at HMNB Clyde, are coordinated by an Authorised Person (Confined Spaces) (AP(CS)) in accordance with Reference G.

The risks associated with this work package were captured within Reference H. The risk assessment does not list radiation as specific hazard; it is assumed that any radiation hazard is captured under the generic risk, which is titled "Working Onboard Vessels". Although this risk captures a magnitude of potential risk associated with working onboard a nuclear powered submarine, the existing control measures specified in Reference H ensure that any hazards are captured by:

- i. The Submarine's Health and Safety brief, which is given by the Quartermaster.
- ii. The local work site safety brief provided by the SS sponsor.

The information within the risk assessment was used by the AP(CS) to produce the Standing Instruction (SI). Similar to the risk assessment, the SI does not specifically consider radiation hazards or the reactor status. The SI specifies who can access the tank, including Babcock personnel and SS (and any external contractors, where necessary).

Prior to each entry into the [REDACTED] tank, the validity of the risk assessment and SI were considered by those entering the tank, to ensure that the status of any pre-identified risk had not

² Exclusion zones, which consist of inside the submarine, are areas within which people would be at greatest risk in the unlikely event of a reactor emergency. Special arrangements are put in place for exclusion zones, including the provision of accident dosimetry.

³ Accident dosimetry is issued to all non-ship's company personnel entering an exclusion zone. It is not an acceptable substitute for occupational (approved) dosimetry; occupational dosimetry is issued to all radiation workers at HMNB Clyde.

[REDACTED]

[REDACTED]

changed and that no new risks were present. This did happen prior to each tank entry; the narrative further explains the actions taken by SS based on the dose rates recorded on the radiation surveys.

5. Investigation

5.1 Narrative

The details of reactor plant operating history and the exposure times from the numerous tank entries, from 15 Aug 12 to 18 Aug 12, are contained within Annex A. The following is a synopsis of the incident produced from the accounts from those involved and the records obtained from the submarine. Due to the vessel sailing immediately after this incident was identified, not all personnel that had a direct involvement have been interviewed at the time of writing this report.

Prior to the [REDACTED] trial commencing, work had been progressing to rectify an OPDEF on the [REDACTED] system. During the testing phase of this rectification, the [REDACTED] tank was found to be leaking.

For ease of identifying key actions during this incident, each day will be reviewed in turn.

5.1.1 15 Aug 12:

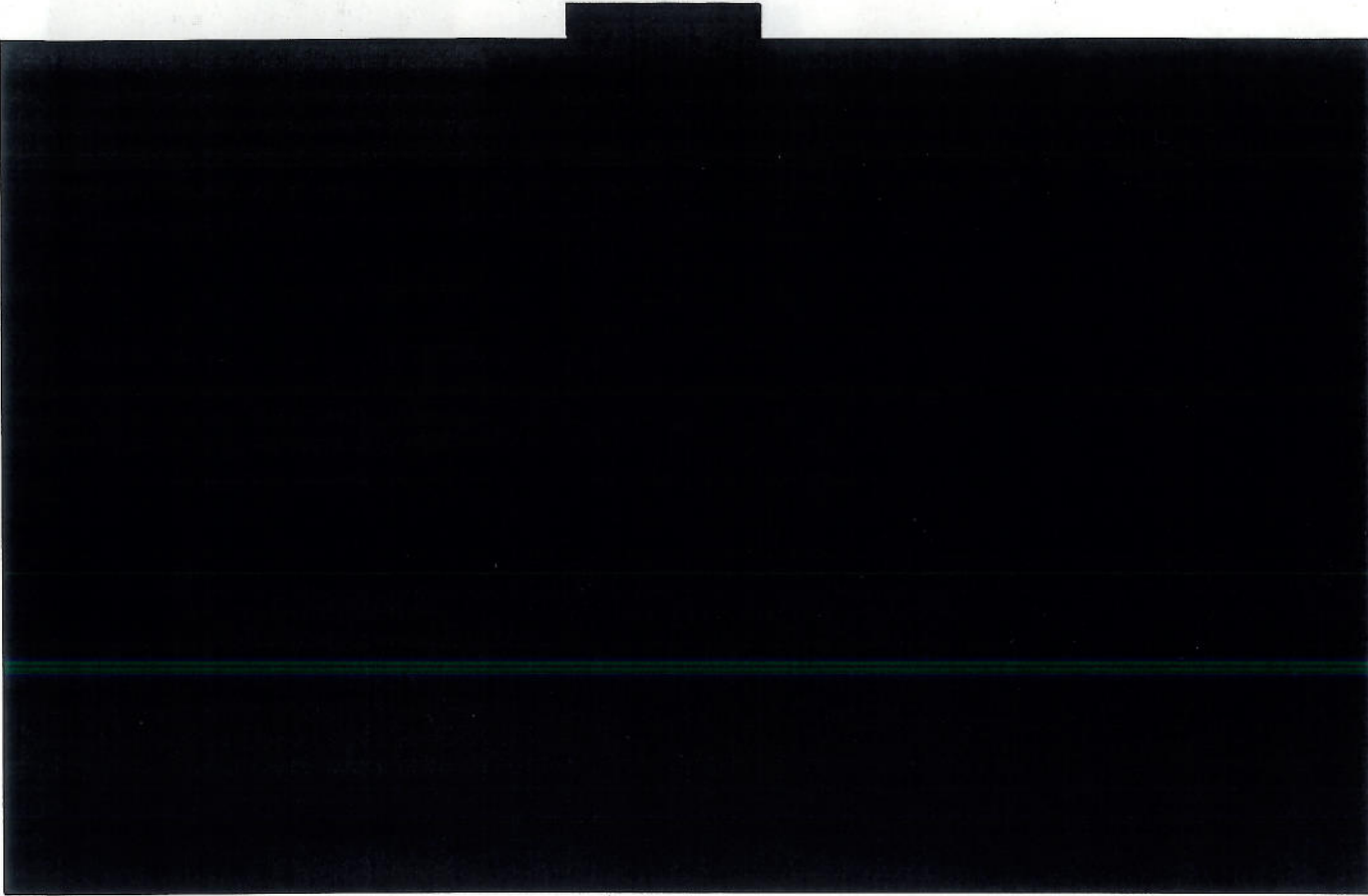
The reactor remained at [REDACTED] reliable radiation surveys at this [REDACTED] indicate that all dose rates within the [REDACTED] tank were below [REDACTED]

Accident dosimetry was issued to each individual entering the exclusion zone; these have been reported as being kept in the pocket of each individual throughout their time within the exclusion zone. The base staff do not recall their safety briefs (from the QM and onboard-sponsor) including the status of the reactor or any controlled radiation areas onboard. This statement applies for the following 3 days.

5.1.2 16 Aug 12

Prior to the night-shift entering the [REDACTED] tank, their team leader (TL) had noted a controlled radiation area warning sign [REDACTED] the dose rate on the sign was [REDACTED] which applied only to the area immediately behind the sign up to [REDACTED]. The controlled radiation area did not extend as far outboard as the [REDACTED] tank hatches – the deck area [REDACTED] designated as a controlled area is shown by the red line in the figure below.

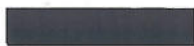
[REDACTED]



Following consultation with his colleague, the TL was made aware that the [redacted] tank formed part of the [redacted]. On contacting the SS engineers, SSHP and the MCO TL to discuss the potential elevated dose rates within the [redacted] tank, the base staff TL was advised that transiting the area [redacted] to the worksite was permitted and that electronic dosimetry was not required. This decision was made on the assumption that the dose rates would be less than [redacted] inside the [redacted] tank, as the dose rates at the [redacted] tank access hatch were less than [redacted] (Radiation survey CA065/12 refers); the figure above shows that this assumption does not account for the entire tank, as there was a controlled area established [redacted]. As a result of acknowledging an elevated dose rate within [redacted] whilst the reactor was operating at [redacted] power level, SSHP, in conjunction with the base staff TL, agreed that a radiation survey of the [redacted] tank would be carried out at the shift change-over times (0800 and 2000) and at any change in reactor power level; the latter is in agreement with the requirements of Reference B.

The [redacted] remained above [redacted] from 0400 to 2359 (and through to 0715 on 17 Aug 12), without any repeat radiation survey carried out until 2345; the dose rates recorded on this survey (CA071/12) commensurate with dose rates recorded when the reactor was [redacted] (CA072/12) and at [redacted] (CA075/12), therefore there is limited confidence in the validity of the data recorded in radiation survey CA071/12. Not only has this demonstrated a lack of compliance with the agreement to survey at shift change-over times and [redacted] changes, but also poor communication and lack of thought process between SSHP and SS engineers; [redacted] therefore the potential for the dose rates within the [redacted] tank to increase should have been considered and identified prior to permitting access. Whereas the two evolutions [redacted] were independent, communication onboard should have identified the potential hazards with this work occurring concurrently.

5.1.3 17 Aug 12



[REDACTED]

The concerns regarding the dose rates discussed on the night-shift (16 Aug 12) were briefed to the section manager (Sec Man). At approx. 0730, the Sec Man consulted the MEO to discuss the potential for elevated dose rates within the [REDACTED] tank. All personnel within the tank were instructed to vacate, until a repeat radiation survey was carried out to assess the dose rates. Radiation survey CA072/12 was carried out at 0900 [REDACTED] which assessed the highest dose to be [REDACTED] this dose rate is within the range expected [REDACTED] when the reactor is shut down. SSHP recorded the [REDACTED] to be [REDACTED] when this survey was carried out, giving a false indication that the results were indicative of a reactor operating [REDACTED]. Acting on this incorrect information, SS and SSHP were content for entries into the [REDACTED] tank to continue whilst the [REDACTED] trial progressed; this was briefed to the base staff TL.

At the night-shift change, a repeat radiation survey (CA074/12) was carried out within the [REDACTED] tank; all dose rates recorded were greater than [REDACTED]. The highest dose rate was recorded at the [REDACTED] worksite [REDACTED]. SSHP immediately reported these findings to the DMEO and base staff TL. No further entries into the tank were permitted until dose rates were less than [REDACTED]. The DMEO relayed this information to the MCO TL. All further tank entries were conducted when the reactor was shut down.

5.1.4 18 Aug 12

In an attempt to ascertain whether base staff had been inadvertently exposed to ionising radiation whilst working within the [REDACTED] tank, the day-shift TL discussed the incident with the MCO TL. Due to lack of information available, the TL was advised to wait until Monday (20 Aug 12) to discuss this further.

5.1.5 Initial actions by base staff

The HPAF CPOMA was notified of this incident on 20 Aug 12 (approx. 0700), by the MCO TL. An outline of the incident was also briefed at the SFM morning meeting. The following actions were taken by HPAF CPOMA:

1. Request for copies of all radiation surveys carried out by SSHP that related to this incident.
2. Request for a detailed list of all personnel that entered the [REDACTED] tank during the period outlined above, from [REDACTED].
3. Discussion held with the RPS onboard the submarine to determine what RP controls were in force during the [REDACTED] trial.

The HPAF Manager was alerted to this incident on 21 Aug 12. SSHP LMA was subsequently interviewed (the remainder of the department were unavailable all day due to [REDACTED] to review the radiation surveys and to discuss the RP measures taken onboard to restrict the exposure of the base staff working within the [REDACTED] tank. All information was subsequently collated and discussed with the BRSO. As a matter of urgency, the meeting referred to in para 4.1 was scheduled. Consequentially, the following actions were raised:

1. All accident dosimetry to be landed and dispatched to Dstl, Institute of Naval Medicine, for urgent analysis.
 2. HMNB Clyde to initiate an investigation.
 3. SS to land copies of the nuclear log sheet (S2029(8)), engineer officer of the watch log (S2029(23)), radiation survey report (S1951 A) and contractor log, for the period of the [REDACTED] trial.
 4. SS to raise NRP event.
- [REDACTED]

- [REDACTED]
5. RADPOL(SM) NCHQ is to be notified of this incident.
 6. All personnel that were identified as being inadvertently exposed to ionising radiation, whilst working within the [REDACTED] tank, are to be notified immediately (via line management and HP representative). Estimated doses are to be calculated once investigation is complete.
 7. DNSR to be notified accordingly.

5.2 Training and Competence

The senior medical branch rating has been appointed, by his Commanding Officer (CO), as the Radiation Protection Supervisor (RPS) for all controlled radiation areas onboard the Submarine. Although a trainee carried out radiation survey CA072/12, the RPS has endorsed this survey. Also appointed by the CO, the Medical Officer was fully qualified in his role as the RSO; the RSO's involvement was minimal, as he was undertaking his hand-over with the new Medical Officer.

All other personnel directly involved with this incident are considered to be suitably experienced and qualified to meet their individual roles and responsibilities.

5.3 Documentation

From the perspective of restricting exposure to the ionising radiation from the [REDACTED] trial, References A to E provide instructions to achieve this, which include the requirement for radiation surveys and issue of personal dosimetry. This is a result of the prior risk assessment (and subsequent local rules, where required) for all accessible compartments [REDACTED] including [REDACTED].

Neither References A or B make specific comment on ensuring that compartments and tanks [REDACTED] are checked clear of all non-essential personnel prior to operating the reactor at [REDACTED]. Historic data is evidence that areas [REDACTED] need to be designated as controlled radiation areas when the reactor is operating at [REDACTED]. Although the references may be open to individual interpretation, this does not detract from the delegated duties and responsibilities of the RPS and EOOW in ensuring the safety of all personnel.

The documentation governing work within confined spaces does not specifically consider the radiation hazard as a risk on its own; this risk is encapsulated within the general risks associated with work on a submarine.

6. Root Causes

Poor communication has contributed greatly to this incident. This has been supplemented by a lack of understanding of the magnitude of the hazards present when operating a reactor at [REDACTED]. Although radiation surveys were carried out to identify dose rates within [REDACTED] compartments [REDACTED] failure to accurately capture the reactor PL at the time of the survey resulted in dose rates being interpreted incorrectly and subsequent failure in applying the appropriate RP controls mandated in the References to restrict exposure; dose rates recorded when the reactor was [REDACTED] but believed to be at [REDACTED] were subsequently used to permit continued access into the [REDACTED] tank.

Furthermore, the controlling documentation for entry into the [REDACTED] tank has failed to specifically consider any potential radiation hazard. Arguably this could have been factored into the generic risks associated with submarines, however given the [REDACTED] of the [REDACTED] tank [REDACTED] it would be prudent to list this as a specific risk. Inclusion of this risk would have

⁴ BRd 9465, Chapter 41 – Generic Fleet Prior Risk Assessments.

[REDACTED]

[REDACTED]

highlighted at an early stage that a potential for [REDACTED] dose rates within the tank did exist. Reflecting this information on the SI would have drawn greater attention to radiation hazards; conventionally, the focus remains on atmospheric hazards.

7. Conclusions

It is apparent that the following control measures have failed to sufficiently highlight the interrelation between the [REDACTED] trial and the [REDACTED] tank work to those who needed to know:

- i. PAG plant state A meeting.
- ii. Base morning brief.
- iii. Onboard plan of today/tomorrow.
- iv. Nuclear procedures.
- v. Standing Instruction.
- vi. Submarine safety information board.
- vii. Quartermaster's H&S brief.
- viii. Local Ship's staff H&S brief.
- ix. Point of work risk assessment.

The following conclusions have been drawn from this investigation:

1. The base staff working within the [REDACTED] tank were inadvertently exposed to ionising radiation, at levels of up to [REDACTED]. From the available survey information, estimated doses have been calculated and are listed at Annex B. The maximum individual exposure is estimated at [REDACTED] and the estimated total exposure for all personnel is 1.16 mSv. The submarine was not critical at any other time (other than the periods mentioned above) whilst work progressed within the [REDACTED] tank. It is therefore highly unlikely that any other inadvertent exposures occurred.
2. Preventative immediate actions by SS ensured no further inadvertent exposures occurred after the elevated dose rates were recorded at 2120hrs on 17 Aug 12.
3. The exclusion zone and local safety briefs were not concise and failed to inform the base staff that the reactor was operating at [REDACTED]. As the base staff visit the SM on a frequent basis during a BMP, their local safety briefs by the sponsor were reported to be cursory or non-existent. This was identified during the interview of those involved. The onus is placed upon both the sponsor and individuals working on the submarine to ensure that an adequate brief is delivered and received.
4. The base staff reported that they were issued with accident dosimetry for each entry into the exclusion zone. As some of the exclusion zone entry log sheets could not be located, it is not possible to relate the dosimetry to an individual⁵. All accident dosimetry has been analysed and the recorded doses are reported as being below the detectable threshold of 0.02 mSv.
5. SS failed to identify the need to carry out radiation surveys within the [REDACTED] tank on 15 and 16 Aug 12. [REDACTED] the need to assess the magnitude of the dose rates within the tank should have been identified at an early stage. Applying the same controls within this tank, as are applied to other compartments [REDACTED] would have immediately identified the requirement to designate the tank as a controlled radiation area when operating at [REDACTED]. This in turn would have prevented the inadvertent exposure.

⁵ Accident dosimetry is issued by serial number to an individual. This data is only recorded on the exclusion zone entry log.

[REDACTED]

- [REDACTED]
6. The recorded PL on the radiation surveys was incorrect. Radiation survey CA072/12 was carried out with the understanding that the reactor [REDACTED] was at [REDACTED]. The reactor had been [REDACTED] by the time this survey was carried out. The dose rates recorded were therefore indicative of a reactor in this state and not representative of a [REDACTED]. This survey gave a false indication of the dose rates within the [REDACTED] tank, and therefore no ALARP measures were put in place, as it was believed that the tank was not required to be designated as a controlled radiation area. This survey was not repeated until 2120, even though the [REDACTED] and increased in [REDACTED]. This demonstrated a lack of awareness for RP controls by SSHP and repeated poor communication between the Engineers and SSHP.
 7. There is no confidence in the dose rates recorded in survey CA072/12, as they are in keeping with dose rates recorded when the reactor was [REDACTED]. Survey CA072/12 was reported as being carried out when the reactor was operating at a [REDACTED].
 8. The miscommunication about the power levels, albeit of major concern, must not distract from the fact that Babcock employees were within the [REDACTED] tank for more than 24 hours (0400 on 16 Aug 12 to 0715 on 17 Aug 12), with no controlled area established, no approved dosimetry and no other radiological control in place. The TL specifically queried the controls in place, only to be incorrectly reassured that dose rates within the [REDACTED] tank were less than [REDACTED]. There was prolonged and repeated failure of SS to understand and to control the radiological hazard that they were creating.
 9. The requirement to conduct radiation surveys was not met in accordance with References A and B. Due to poor communication between the Engineers and SSHP, there was a lack of appreciation for the RP controls required during the [REDACTED] trial.
 10. The daily / weekly planning meetings held onboard should have prevented any work progressing within the [REDACTED] tank whilst the reactor was scheduled to be operating at a [REDACTED].
 11. Initial actions by the DMEO in alerting the MCO TL were done promptly, gaining appropriate health physics advice from the survey data available. Unfortunately, the potential seriousness of this incident was not relayed to the Duty Health Physics Officer at all, and subsequently, the BRSO was not informed in a timely manner. Base H&S department were not informed of this incident until 24 Aug 12.
 12. Dynamic risk assessments / reviews of the worksite risk assessment and SI were done prior to each tank entry. In doing so, the relevant risks that were listed on the documentation were questioned; however there was not sufficient consideration given to additional (generic) risks, including the radiation hazard.

8. Recommendations

1. Review the documentation associated with working in tanks (confined spaces) onboard submarines. [REDACTED] the potential for a radiation hazard must be specifically considered. (This is also relevant for risk assessments that are written for work that is located [REDACTED].) The AP is not SQEP to carry out an assessment of radiological hazards; however, the relevant confined spaces procedure should require him to prompt SSHP to consider the magnitude of the radiological hazard, if any.
 2. The provision of education and training for Engineering staff (including ship's sponsors for visitors onboard), SSHP and Quartermasters must be undertaken at the next available opportunity. This must include the importance of complying with written procedures and statutory requirements, the issue and control of accident dosimetry (including access lists)
- [REDACTED]

[REDACTED]

and the requirement for applying stringent RP controls whilst operating a reactor [REDACTED] power levels.

3. References A and B (and any other nuclear procedure associated with [REDACTED] operations alongside) are to be reviewed, with consideration given to including a statement for ensuring that all compartments (and tanks – where appropriate) [REDACTED] including the [REDACTED] have been checked clear of all non-essential personnel, prior to [REDACTED] operations. There should be a presumption that entry will not normally be permitted into these compartments and tanks. However, if there is an urgent operational requirement which justifies work within these compartments and tanks, a temporary controlled area should be established as required.
4. References A and B contain sound guidance on carrying out surveys of the [REDACTED] to ensure a restriction of exposure in these areas. Both of these procedures, and any other procedure associated with operating [REDACTED] reactor powers, would benefit from including statements to direct radiation surveys to also be carried out [REDACTED]
5. All activities that have radiological safety implications should be identified and deconflicted at the appropriate planning meetings onboard. This emphasises the need to have a SSHP representative at such meetings.
6. Consideration be given to reviewing the procedure for granting access into open tanks onboard, [REDACTED] to include a statement that prohibits any tank entry [REDACTED] If operationally imperative, access should only be granted after a prior risk assessment has been conducted, meeting the requirements of IRR99, Reg 7.
7. A comprehensive estimated dose review must be carried out for each individual that was exposed to ionising radiation within the [REDACTED] tank, as mandated in IRR99, Reg 22. All personnel that were inadvertently exposed must be informed of their estimated doses.
8. To ensure cooperation between employers, the findings of this investigation and subsequent actions by HMNB Clyde, should be communicated to NCHQ (fao RADPOL(SM)) and Dstl as the RPA.
9. Communications by the MCO TL to the DHPO need to be improved. It is recommended that the MCO TL provides a brief (verbal or written) to the DHPO each morning, including weekends, to detail any occurrences over the previous 24 hours.

[REDACTED]

Annex A: Narrative of Reactor Plant Operating History and [REDACTED] Tank Entries

15 Aug 12:

[REDACTED] trial commenced.

1033: [REDACTED] until 2359).

0950-1035: Contractor Log entry (x3) for [REDACTED] tank work.
1115-1130: Contractor Log entry (x4) for [REDACTED] tank work.
1315-1351: Contractor Log entry (x1) for [REDACTED] tank work.
1315-1605: Contractor Log entry (x3) for [REDACTED] tank work.

16 Aug 12:

0001: [REDACTED]

0015: [REDACTED]

0400-0900: [REDACTED]

0415: Radiation survey (Secondary Shield) (Ref: CA065/12). Only one dose-rate recorded at [REDACTED] tank access [REDACTED]

0900-1400: [REDACTED]

0912-1030: Contractor Log entry (x1) for [REDACTED] tank work.
0912-1050: Contractor Log entry (x2) for [REDACTED] tank work.
0912-1105: Contractor Log entry (x1) for [REDACTED] tank work.
0950-1050: Contractor Log entry (x1) for [REDACTED] tank work.
1342-1606: Contractor Log entry (x3) for [REDACTED] tank work.

1400-2359: [REDACTED]

1505-1600: Contractor Log entry (x1) for [REDACTED] tank work.
1525-1600: Contractor Log entry (x2) for [REDACTED] tank work.
1710-1855: Contractor Log entry (x2) for [REDACTED] tank work.
1710-1810: Contractor Log entry (x1) for [REDACTED] tank work.
2015-2206: Contractor Log entry (x1) for [REDACTED] tank work.
2040-2206: Contractor Log entry (x3) for [REDACTED] tank work.
2300-2330: Contractor Log entry (x4) for [REDACTED] tank work.

2345: Radiation survey of [REDACTED] tank (Ref: CA071/12). Maximum dose rate [REDACTED] at the bottom of the access ladder into the tank. PL incorrectly recorded on this survey; SSHP recorded [REDACTED]

17 Aug 12:

0001-0715: [REDACTED]

0145-0715: Contractor Log entry (x4) for [REDACTED] tank work.

0500-0710: Contractor Log entry (x2) for [REDACTED] tank work.

0709-0806: Contractor Log entry (x1) for [REDACTED] tank work.

0730-0800: [REDACTED]

0823: [REDACTED]

0900: Radiation survey of [REDACTED] tank (Ref: CA072/12). Maximum dose rate [REDACTED] at upper level of the tank. [REDACTED] incorrectly recorded on this survey; SSHP recorded [REDACTED]

0900-1130: Contractor Log entry (x4) for [REDACTED] tank work.

0910-1045: Contractor Log entry (x1) for [REDACTED] tank work.

0955-1120: Contractor Log entry (x1) for [REDACTED] tank work.

1106: [REDACTED]

1245-1540: Contractor Log entry (x1) for [REDACTED] tank work.

1300-1540: Contractor Log entry (x2) for [REDACTED] tank work.

1325-1340: Contractor Log entry (x1) for [REDACTED] tank work.

1400-2300: [REDACTED]

1545-1730: Contractor Log entry (x1) for [REDACTED] tank work.

1545-1615: Contractor Log entry (x1) for [REDACTED] tank work.

[REDACTED]

[REDACTED]

1545-NK: Contractor Log entry (x2) for [REDACTED] tank work.
1550-1730: Contractor Log entry (x1) for [REDACTED] tank work.
1640-1730: Contractor Log entry (x2) for [REDACTED] tank work.
2110-2200: Contractor Log entry (x4) for [REDACTED] tank work.
2120: Radiation survey of [REDACTED] tank (Ref: CA074/12). Maximum dose rate [REDACTED] at [REDACTED] worksite. Correct PL recorded on this survey.
2140-2200: Contractor Log entry (x2) for [REDACTED] tank work.
2315-2359: [REDACTED]
2345: Radiation survey of [REDACTED] tank (Ref: CA075/12). Maximum dose rate [REDACTED] at [REDACTED] worksite. [REDACTED] incorrectly recorded on this survey; SSHP recorded [REDACTED]

18 Aug 12:

0001-0030: [REDACTED]
0029-0345: Contractor Log entry (x3) for [REDACTED] tank work.
0045: [REDACTED]
Post 0045: Numerous [REDACTED] tank entries were made, however there was no associated radiation exposure risk, as the [REDACTED] until all work was complete. These tank entries are therefore omitted from this investigation.

[REDACTED]

Annex B: Individual Estimated Doses

The estimated doses are calculated using the maximum worksite dose rate of [REDACTED] and tank entry times that correlate to the information on the contractor's log.

Person	Date	Time in tank (mins)	Estimated dose (mSv)	Total Estimated Dose (mSv)
A	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
B	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
C	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
D	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
E	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
F	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
G	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
H	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
I	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
J	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
K	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
L	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
M	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
N	16-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
	17-Aug-12	[REDACTED]	[REDACTED]	
O	17-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
P	17-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
Q	17-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]
R	17-Aug-12	[REDACTED]	[REDACTED]	[REDACTED]

[REDACTED]

S	17-Aug-12					
T	17-Aug-12					
TOTAL						1.160 Man mSv

[REDACTED]