

PART 5

Safety Assessment





PART 5

SAFETY ASSESSMENT	3
INTRODUCTION	3
NORMAL OPERATION DOSE ASSESSMENT	4
Measured and Predicted Dose	4
Normal Operations ALARP Review	6
Safety ASSESSMENT	7
Overview of Assessment Method	7
Deterministic Safety Assessment	16
Probabilistic Risk Assessment	26
ALARP Assessment	29
REFERENCES	35
FIGURES	
Figure 5.1 Overview of Safety Assessment Methodology	10
Figure 5.2 Outline of Hazard Assessment Methodology	11
Figure 5.3 Hazards Summary	11
Figure 5.4 Shiplift Facility (Platform and 12 Berth) Individual Public Risk Distribution by Hazard	32
Figure 5.5 Shiplift Platform Vanguard Class Public Risk Distribution by Hazard	33
Figure 5.6 Vanguard Class 12 Berth Public Risk Distribution by Hazard	33
Figure 5.7 Shiplift Platform Swiftsure/Trafalgar Class Public Risk Distribution by Hazard	34
Figure 5.8 Swiftsure/Trafalgar Class 12 Berth Public Risk Distribution by Hazard	34
TABLES	
Table 5.1 Dose Limits and Recorded/Predicted Values	6
Table 5.2 Hazard Assessment Summary	13
Table 5.3 Load Path Assessment Summary	17
Table 5.4 PRA Assumed Occupancy Figures for Shiplift Facility	27
Table 5.5 Risk Estimates for Shiplift Facility	27
Table 5.6 Internal/External Risk Estimates for Shiplift Facility	28

Safety Assessment





THIS PAGE INTENTIONALLY LEFT BLANK

SAFETY ASSESSMENT

INTRODUCTION

- 5001 This part of the Shiplift FSC presents the results of the hazard identification, analysis and safety assessment studies carried out to support the Shiplift FSC. The scope and complexity of the hazard study has been commensurate with the potential nuclear and radiological hazards and risks associated with the Facility.
- 5002 The Shiplift Facility interfaces directly with nuclear submarines. In addition to providing physical stability when docked on the Shiplift platform and secure mooring when berthed alongside at 12 Berth, it provides overside M&E services to the submarine for both general vessel and NSRP specific requirements. The safety assessment therefore considers the Shiplift with submarines berthed or docked as an entity. When a submarine is not present the Facility does not present any nuclear or radiological hazard.
- 5003 This issue of the FSC is founded on the Facility hazards assessment (Ref. ¹) and Facility safety functional requirements (FSR, Ref. ²). These reports, together with the Facility Design Safety Reports (DSRs) and site generic DSRs, have enabled a robust, quantitative safety case to be developed as follows.
- 5004 The Facility hazards assessment built on the earlier safety work for the Facility by integrating the findings of the most recent HAZOP studies (undertaken for the 12 Berth and Shiplift in support of the NSSJ) into an updated Hazard Log.
- 5005 The Hazard Log entries were categorised and assessed for their significance in respect of their capacity to adversely affect nuclear safety, taking into account the withstands and safeguards that are claimed in the safety case, as established by the Facility safety functional requirements report, Ref. 2.
- 5006 The hazard assessment and safety functional requirements for the Facility have been reflected in a series of DSRs. These reports substantiate the capability and adequacy of the Facility's systems and procedural arrangements, established within the context of HMNB Clyde's safety management system, to provide the withstands and safeguards claimed in the safety case. These engineered and procedural arrangements control risk such that the residual risks associated with the range of normal operations, fault conditions and hazards examined in the hazard assessment, and the underlying studies on which it is based, are small and negligible compared with the significant contributors identified in the hazards assessment summary set out below.
- 5007 The safety assessment is presented in two main elements that are set out consecutively in this FSC Part, these are:
- a. A summary of the control of potential radiation exposure in normal operations and the resultant radiation dose levels.
 - b. A summary of the safety assessments, embodied in the supporting documentation, that encompass normal operations, hazards (environmental and man made) and fault conditions. This summary is presented under two main headings, deterministic safety and probabilistic risk assessment.



NORMAL OPERATION DOSE ASSESSMENT

- 5008 The purpose of the normal operations dose assessment is to provide a critical comparison of measured and predicted radiation doses to demonstrate that the Facility is compliant with relevant dose limits and that normal operation doses are ALARP. This comparison is of external exposure, there are no sources of internal exposure in normal operation. This comparison is presented in Table 5.1. (A brief assessment of the dose records relating to the Shiplift Facility is presented in Part 6 of this FSC).
- 5009 Normal operations with potential radiological consequences include the following activities which take place at the Shiplift Facility:
- a. Normal NSRP operation whilst berthed and docked.
 - b. Maintenance activities on board submarines.
 - c. Transfer of primary effluent from 12 Berth.
 - d. Handling solid radioactive waste from submarines.
 - e. Handling contaminated or activated items to/from submarines.
 - f. Transfer of contaminated liquid effluent in carboys.
 - g. Diving operations.
 - h. Facility maintenance sources e.g. NDE.
- 5010 Doses which are incurred as a result of maintenance work onboard submarines berthed at the Shiplift Facility are attributed to individual jobs and the submarines, but not the Facility. This means that the current dose record system at HMNB Clyde does not permit collection of dose records for persons that can be directly attributed to operations at a specific facility, such as the Shiplift Facility. Dose records for persons are identified only by Job Identification Numbers (JINs), which encodes the type of work, and the relevant submarine. Doses which accrue as a result of types of work or by submarines cannot be attributed, accurately, to the Shiplift Facility because:
- a. Individuals may and do work on more than one Facility;
 - b. There is no single JIN for work at Shiplift Facility; and submarines may and do occupy different facilities. S&T class submarines can berth at any of the nuclear berths at HMNB Clyde; Vanguard class submarines can berth at the Finger Jetty. Astute class submarines will in the future berth at the new Valiant Jetty.

Measured and Predicted Dose

- 5011 The current dose record system at HMNB Clyde, as previously stated, does not readily permit collection of the radiation dose accrued by individuals in a way which can be directly attributable to the Shiplift Facility as a Facility.
- 5012 The control of dose to crew and workers from normal NSRP activities alongside and from maintenance activities on board is therefore addressed in the HMNB Clyde SSC (Ref. ³), as part of the assessment of aggregate dose consequence for submarine and site personnel.

**RESTRICTED**

- 5013 The normal operations dose associated with handling and moving PETs is dealt with as part of the safety case report for the REDF as the operation is carried out by REDF staff.
- 5014 Radioactive wastes, including solids and liquids in carboys, are taken from the submarines via the Facility to the APF for disposal. As the movement of this material across the Site crosses several Facility boundaries, it is dealt with in accordance with NSAG procedures. The same applies to contaminated items, which go to the APF for decontamination. Operations are well controlled such that only a trivial dose results from handling solid waste and contaminated components. This assessment is based on the historical record of the very low normal operations doses to workers in the APF who handle waste from all the submarines and facilities.
- 5015 There is potential for divers to get a radiation dose when in proximity to the exterior of the lightly shielded lower parts of the RC. The doses to both submarine crew and Facility-based divers are measured in accordance with the appropriate HMNB Clyde health physics and diving procedures. Doses to divers are judged to be very low, however, due to the shielding effect of the water and diving restrictions which are applied when the submarine is in plant state 'A' or 'B' shutdown. In support of this judgement doses associated with routine diving operations in the Shiplift are estimated in Radiological Risk Assessment (RRA) No. 007 (Ref. ⁴) to be of the order of 3 μSv based on a maximum contact dose rate of 17.5 $\mu\text{Sv/hr}$, and a maximum stay time of 10 minutes. All diving operations are subject to the requirements of a written system of safe working which includes the appropriate instructions and advice in respect of the relevant ALARP considerations in accordance with the IRR99 (Ref. ⁵).
- 5016 Ionising radiation is emitted from the exterior of the submarine hull whenever a submarine's NRP is critical and operating at power, and for periods of time thereafter corresponding with the initial stages of cool down and rapidly reducing decay heat levels. For protection and ALARP reasons barriers are erected by ES(HP) at the 2.5 micro sieverts per hour ($\mu\text{Sv/hr}$) contour to ensure that workers nearby, on the Facility, are not exposed to a significant amount of radiation in accordance with the requirements of the RPSOs (Ref. ⁶). The specific spatial boundary of the 2.5 $\mu\text{Sv/hr}$ dose rate varies between submarines, although for all submarines it is basically a half annulus around the RC. Dose rates forward and aft of the restricted area fall away rapidly due to the shielding at the internal bulkheads. The reactor is, of course, shut down for most of the time when the submarine is berthed/docked and the external radiation flux in this state is negligible.
- 5017 Estimates of the maximum doses that arise from those activities which involve the greatest exposures to radiation during routine operations in the Shiplift are presented in Part 6 as part of the operational review. These estimates support the consideration that dose rates in the Shiplift are small and doses to operators are controlled to low levels that do not challenge the relevant criteria.
- 5018 Given the distance of the site boundary from the Shiplift Facility and that there are no significant emissions from the Facility, or external dose rates measurable above background levels, the normal operations dose to members of the public is considered negligible.
- 5019 Normal operating dose limits are prescribed in JSP 518 Issue 2 (Ref. ⁷). Note that these values are now being superseded by those specified in the Naval Nuclear Safety Principles (NNSPs) (Ref. ⁸). The development and adoption of the NNSPs at HMNB Clyde is described in Part 2 of this FSC.



- 5020 The JSP 518 normal operating dose limits are set out in Table 5.1 below. Any variations within the NNSPs are also identified in the Table.

Table 5.1 Dose Limits and Recorded/Predicted Values (JSP 518/NNSPs)

Criteria	BSO	BSL	Actual
Radiation Worker - Effective dose to an individual	2 mSv/yr <i>1 mSv/yr*</i>	20 mSv/yr	See HMNB Clyde SSC (Ref. 3)
Radiation Worker- Average effective dose to the radiation workers at a particular site or on a single plant	1 mSv/yr <i>0.5 mSv/yr*</i>	10 mSv/yr	See HMNB Clyde SSC (Ref. 3)
Non-Radiation Workers - Effective dose to an individual	0.5 mSv/yr <i>0.1 mSv/yr*</i>	5 mSv/yr <i>2 mSv/yr*</i>	Insignificant
General Public	0.02 mSv/yr	1 mSv/yr	Insignificant

* *NNSP Dose Targets*

Normal Operations ALARP Review

- 5021 All activities involving exposure to ionising radiation at the Shiplift Facility in particular, and HMNB Clyde in general, are conducted in accordance with the HMNB Clyde dose reduction policy statement as contained within RPSOs (Ref. 6) authorised by the NBC(C). Priority is given to keeping individual doses ALARP and alternative methods of work are investigated with the objective of minimising the collective dose.
- 5022 The Shiplift Facility is not a thoroughfare and serves only to provide access to vessels at 12 Berth and in the Shiplift. The Shiplift Facility does not have any permanent radiation or radiological controlled areas since it is judged that there are no significant radiation doses attributable to normal operations at the Facility. Confirmation of this judgement is provided in RRA No.18 (Ref.⁹) which estimated that the doses associated with routine operations in the Shiplift do not exceed 44 μ Sv, given that the maximum exposure time in the higher dose rate areas is approximately 30 minutes. The potential radiation exposures of staff at the Facility have been minimised through progressive changes in dose management and working practices during the operational life of the Facility, and no more reasonably practicable measures are considered beneficial.
- 5023 Notwithstanding the above, operational and personnel radiological hazards have been considered, as detailed in the Shiplift RRA No.18 (Ref. 9), and appropriate safeguards put in place consistent with the ALARP principle.
- 5024 Access to any submarine alongside in Plant State 'A' is controlled by exclusion zones which are authorised by the PAG and set up by the staff of the ES(HP), in accordance with NOP 402(A) (Ref.¹⁰).
- 5025 Within the submarine, entry to the RC is only made under the supervision of a properly trained Health Physics person, or a SQEP Tunnel Monitor. Adherence to the



procedures given in HMNB Clyde RPSOs (Ref. 6) ensure that the dose to workers is ALARP.

- 5026 Controlled areas under docked vessels are established in accordance with PAG procedures.

SAFETY ASSESSMENT

- 5027 The Facility safety assessment can be considered as having two main branches, the deterministic assessment, and the probabilistic assessment. The outcomes of these branches of assessment are summarised later in this Part of the FSC, following the presentation of the basic building blocks of the safety assessment as a whole, through which the relevant deterministic and probabilistic methodologies have been implemented, as explained in detail in the supporting FSR and DSR documentation.

Overview of Assessment Method

- 5028 In Part 4 of this FSC the overall structure of the documentation that supports the FSC is explained. This section of Part 5 shows how the FSRs and DSRs are interconnected such that it can be seen that a systematic and comprehensive approach has been pursued in the development of the safety case embodied in the documentation. In Figure 5.1 the approach taken is presented by showing the principal interfaces between the FSR documents and DSRs, their supporting Technical Reports (TRs), and the SSN/SSBN safety studies which have informed the development of the Facility probabilistic risk assessment. Also represented are the HMNB Clyde safety management arrangements in accordance with which the requirements for, and upkeep of, Clyde NSSJ safety documentation is managed.
- 5029 The Facility hazard assessment FSR identifies those challenges to the Facility and docked/berthed submarine(s) that could potentially result in the increased radiation exposure of any individual member of the crew, site workers, or public above levels that arise during normal operations. The Facility safety functional requirements FSR identifies the performance, withstand and safeguard requirements that are claimed in demonstrating that the Facility is adequately safe, given that it may be subject to the challenges identified in the hazard assessment. The DSRs demonstrate that the safety requirements identified in the safety functional requirements SFR are appropriately substantiated, and that appropriate safety management arrangements have been made in respect of the use and upkeep of the relevant structures, systems and equipment.
- 5030 The DSRs draw on two main sources of reference in demonstrating the adequacy of the design and operational arrangements to enable the achievement of safety. In respect of design safety the relevant detailed demonstrations are presented in a series of reports on the reliability of the systems, and on the integrity of the systems with regard to their performance and withstand capabilities. With regard to operational safety management the Facility is operated in accordance with the Standard Operating Procedures and Maintenance Operations Procedures.
- 5031 Design Assessment In order to generate the reliability information necessary to support a robust quantitative assessment of risk a number of TRs have been produced which present the detailed methodologies used and results obtained from the reliability assessment studies performed for the Shiplift FSC. These studies consist of, Failure Mode and Effects Analyses (FMEAs) - carried out preparatory to the development of equipment fault schedules, which were quantified using fault tree and event tree analyses in order to establish event frequencies. The event frequencies generated were used to populate the risk array, as set out in the Facility PRA (Ref ¹¹),



and outlined below, with frequency data for events such as loss of overside services, dropped loads from the 12 Berth and Shiplift EOT cranes, and the loss of stable support of a boat whilst on the Shiplift platform.

- 5032 Deterministic Assessment The adequacy of the integrity of the Facility's systems, structures and equipment is demonstrated in a series of TRs, which present detailed assessments of their performance/capability under normal operating conditions and foreseeable hazard and fault loadings. The analyses from which these loadings have been derived are also presented in the supporting TR documentation. The DSRs present the findings of the TRs in putting forward substantiated arguments for the safety of the Facility's systems, structures and equipment.
- 5033 Probabilistic Assessment The Facility PRA (Ref 11) develops a risk array comprised of all of the elements of quantitative information necessary to derive the risk associated with Facility operations. The total Facility risk is produced by summing the risk contributions from all of the hazards identified in the hazard assessment that have significant residual risks, when the withstands and safeguards substantiated in the DSRs are taken into account. The Facility PRA draws on information presented in the DSRs and SSBN/SSN specific safety studies to populate the risk array with initiating event frequencies and hazard specific risk consequence information to enable the assessment of risk. The basis of the PRA and its findings are summarised later in this Part.
- 5034 Operational Assessment The FSRs and DSRs collectively identify a range of operating conditions and limits, which represent the safe operating envelope for which the safety case is valid, and derive conditions and limits the exceedance of which could result in an unsafe state. The conditions and limits of safe operation FSR, represented in Figure 5.1, draws all of the conditions and limits together and shows that the relevant equipment and procedures are in place to ensure that they are meaningful and are properly supported by HMNB Clyde's safety management arrangements.
- 5035 In the event that a fault or hazard impingement occurs that might threaten safety, and has not been foreseen within the Standard or Emergency operating procedures, then management arrangements are in place at HMNB Clyde to ensure that appropriate action is taken to prevent escalation or propagation of the condition. Also, that appropriate information is gathered and expertise assembled to enable the appropriate safety optimal decisions to be made in returning the Facility to its normal operating condition. These arrangements are set out in the Fault Recovery Guidance FSR*, see Figure 5.1, which brings together the key safety issues associated with maintaining nuclear safety in a recovery situation, with the understanding of the Facility's safety characteristics and capabilities expressed in the DSRs.
- *The Fault Recovery FSR is currently being revised to provide detailed fault-specific recovery guidance
- 5036 The documentation which supports this FSC safety assessment, consisting of the FSR and DSR documents and the TRs that provide the quantitative substantiation of the deterministic and probabilistic elements, is shown within the documentation structure chart presented at Annexe B.
- 5037 The Regulatory assessment of the safety justification currently presented in the FSC and supporting substantiation has highlighted a number of issues. These are identified and discussed in Part 7 of the FSC.

5038 The following text sets out, in consecutive sections, the basis of the safety assessment in respect of the identification and categorisation of hazards, and for SWS and TWS safety. These sections lead to the presentation of a summary of the findings of the constituent assessments which substantiate this overall assessment of the Facility's safety characteristics. This overall assessment is divided under three consecutive headings, being Deterministic Safety Assessment, Probabilistic Risk Assessment and ALARP Assessment.



~~RESTRICTED~~

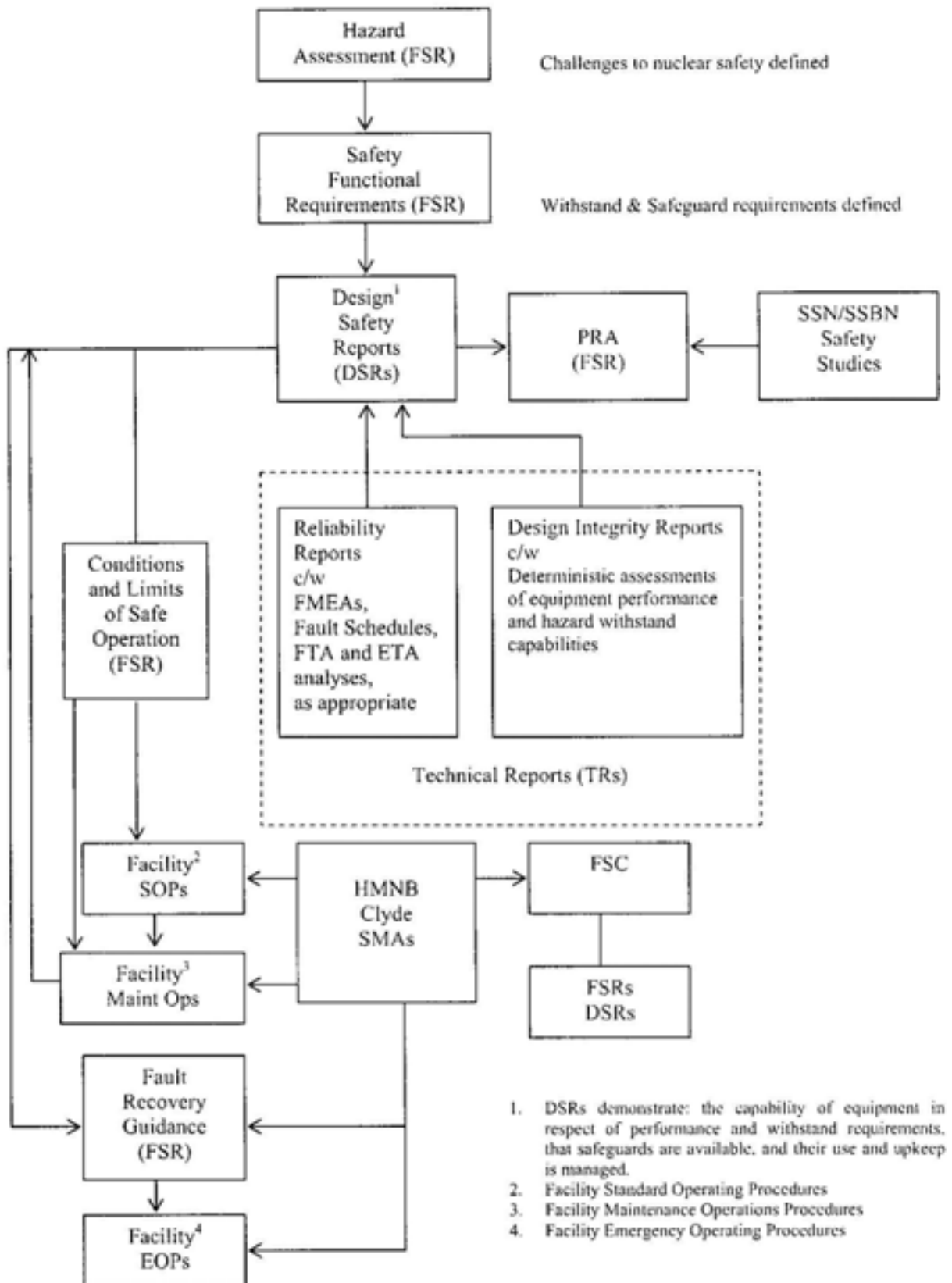


Figure 5.1 Overview of Safety Assessment Methodology

~~RESTRICTED~~

Hazard Assessment

5039 The Hazard Assessment methodology has been developed such that the available supporting information is used to provide the best case. An outline of the methodology is shown diagrammatically in Figure 5.2.

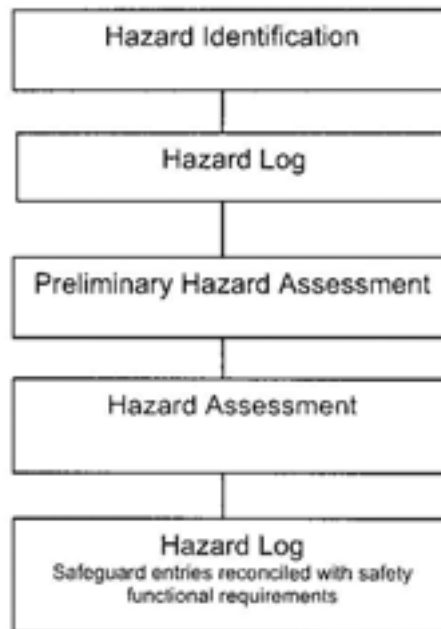


Figure 5.2 Outline of Hazard Assessment Methodology

Hazard Identification

5040 The dominant source of risk at the Shiplift Facility is the NSRP contained within the berthed/docked submarine(s). The hazard identification methodology has therefore focused on fault and accident conditions that could lead to significant fission product release. Hazards can be categorised as being internal or external to the Facility or the submarine. External Facility hazards include environmental hazards such as earthquake and Facility internal hazards include hazards such as dropped load. These hazards are all sources of submarine external hazards. If submarine internal hazards are also considered then the hazards that drive risk can be considered as shown in Figure 5.3.

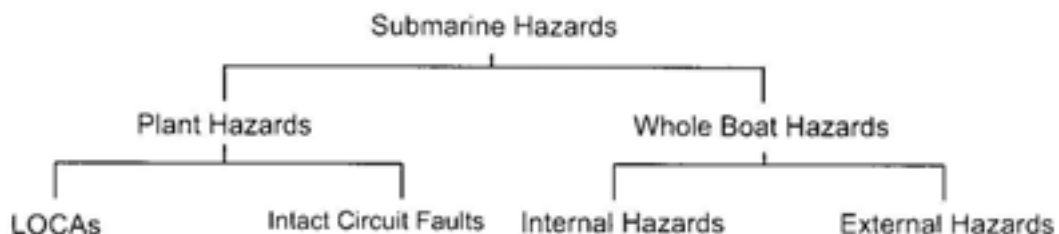


Figure 5.3 Hazards Summary



- 5041 Plant Hazards are conditions lying solely within the NSRP and so are beyond the scope of the justification in this safety case and hence are not addressed in the hazard assessment. They are included in the Facility Risk Model because of their contribution to the risks associated with the Facility.
- 5042 Whole boat hazards relate to the whole submarine: Internal Hazards arise within the submarine, and have some potential to adversely affect the integrity of the NSRP, and External Hazards arise outside the submarine, comprising hazards whose cause lies within (the scope of) the Facility and others caused by circumstances beyond the Facility.
- 5043 Internal Hazards or faults originating within the submarine casing are excluded from explicit consideration within the scope of this Facility safety case and for this Shiplift FSC they are treated in the same way as Plant Hazards. Plant hazards and submarine internal hazards are taken into account quantitatively in the PRA (Ref 11), collectively they are referred to as internal events.
- 5044 The Shiplift Hazard Log, presented in Ref. 1, summarises and categorises the findings of the HAZOP studies which have been performed to identify all of the relevant hazards and their sources and contains approximately 400 entries.
- 5045 The outcome of the Hazard Assessment is summarised in Table 5.2. This table presents a review of the detailed considerations made in Ref. 1. Significant hazards were carried forward into the Shiplift Facility PRA (Ref 11), whilst the insignificant or lesser hazards were judged, on the basis of the Ref. 1 assessment to be insignificant contributors to residual risk when the extant safeguards and withstands are taken into account.
- 5046 The significant hazards/faults identified are assessed using complementary deterministic and probabilistic methods. As discussed above safeguards have been identified for each hazard or fault condition and their adequacy demonstrated in the deterministic assessments reported in the supporting DSRs. The deterministic assessments employ pessimistic data thereby ensuring high confidence that safety related Facility structures, plant and systems integrity will be maintained. These assessments allow the equipment protection trips to be set and define the operational conditions and limits (Ref. 12) to prevent the hazard occurring. The risks from those hazards, where it has been assessed that the residual risk is significant despite the capabilities demonstrated for the Facility, are derived in the probabilistic safety assessment.
- 5047 It should be noted that two potentially significant hazards associated with the SWS and TWS were excluded from the Vanguard RPSJ PSA. The inadvertent detonation of embarked weapons on the submarine is recognised as a potential hazard to nuclear safety. However, the deployment of weapons is essential to the operational capability of nuclear powered submarines and its justification necessarily resides with the appropriate StratSys and TWS IPTs. Notwithstanding this the following presents a brief discussion of the tolerability of risk with SWS and TWS embarked on submarines utilising the Shiplift Facility.



Table 5.2 Hazard Assessment Summary

HAZARD	Potentially Significant in the PHA (Y / N)	Significant in the HA (Y / N)
Earthquake	Y	Y
Extreme Sea State (Tidal Range)	Y	N
Extreme Ambient Temperatures	Y	N
Precipitation	Y	N
High Wind	Y	N
Lightning	Y	N
Humidity/Moisture	Y	N
Meteorite Impact	N	N
Aircraft Crash	Y	Y
External Fire	Y	N
Underwater Shock	N	N
Flooding	Y	Y
Ship Collision ¹	Y	N
Grounding	N	N
Loss of Services (Cooling Water)	Y	Y
Loss of Services (60 Hz Supplies)	Y	Y
EMC/EMI	Y	N
Vibration	N	N
Static Electric Charge	Y	N
Hazardous Substances	Y	N
Release of Gas	Y	N
Excessive Boat Attitude	Y	Y
Impact	Y	N
Blast/Explosion ²	Y	N
Dropped Loads	Y	Y
Crane Collapse	Y	Y
Loss of Ventilation (Control and Protection) System	N	N
Radiological Release	N	N
Landslide	N	N

- 1 This is considered insignificant subject to confirmation of data. A sensitivity study is presented within the PRA (Ref 11) to demonstrate that the residual risk is small
- 2 This is considered as insignificant in the hazards assessment in consideration of the limited explosive quantities and handling activities at the Facility and wider safeguards concerning other sources of explosion at Faslane. A sensitivity study is presented within the PRA to demonstrate that the residual risk is small.



Embarked Strategic Weapons

- 5048 The Safety Case for the Trident II (D5) Strategic Weapons System is presented in CSSE T2053 (Ref. ¹³). The safety case for full operational deployment of the SWS is effectively expressed by the Certificate of Safety - Ordnance Munitions Explosives (CSOME), formerly the Certificate of Safety - Shipbourne Munitions (CSSM). The issue of this CSOME by the OME Safety Review Panel (OSRP) and a Certificate of Safety Explosives for each vessel by the Naval Authority Explosives (NA Exp), and by implication compliance with the associated weapons codes and standards, ensures that providing the SWS is maintained within its operational envelope the likelihood of a quiescent SWS explosion on an SSBN berthed alongside at 12 Berth or docked on the Shiplift Platform is sufficiently low as to be considered a lesser hazard and is currently excluded from formal assessment in the PRA (Ref 11). In support of the above, it has been demonstrated in DSWS Tech Memo 35/99 (Ref. ¹⁴) that the accelerations experienced by SWS systems' during a typical Shiplift docking/undocking evolution are an order of magnitude less than those encountered during typical patrol at sea.
- 5049 The safety assessment reported in CSSE T2053 (Ref. 13) concluded, on a qualitative basis, that the majority of hazards and potential consequences lay in the extremely unlikely to negligible category and were therefore judged to present tolerable risks to safety. However a small number of hazards including that associated with potential Shiplift platform collapse were considered to lie outwith the above range and were assessed quantitatively. This assessment concluded that the overall risk of inadvertent ignition/detonation of missile/SWS ordnance was dominated by the possibility of platform collapse resulting in a significant impact between the submarine and the adjacent civil structures/water which initiated a major SWS accident with Re-entry Body Assembly (RBAs) fitted.
- 5050 CSSE, the custodians of CSSE T2053 (Ref. 13), have employed the latest upper bound estimate of the platform reliability reported in the FSC Issue 2 (Ref. ¹⁵) to assess the calculated risk of inadvertent ignition/detonation of missile/SWS ordnance following Shiplift platform collapse against appropriate SWS acceptance criteria. It was concluded that, from an SWS safety standpoint, it is tolerable to dock SSBNs with SWS embarked for up to [REDACTED] days per year, which covers the current SSBN utilisation of the facility. An extension to the current CSSE approval to [REDACTED] days per year is conditional on the provision of an improved platform reliability figure.
- 5051 The programme of work undertaken for this FSC has both improved platform reliability and provided a quantitative understanding of the potential challenge to the SWS. StratSysIPT identified that the only potential concern was possible shock loading in the event of EBA. The bounding maximum accelerations have been assessed CSSCA/TR 3901, Ref ¹⁶, and it has been previously confirmed with StratSysIPT that these accelerations fall within the capability of the SWS by a substantial margin. Also, an improvement in platform reliability of a factor of greater than 30 has been achieved CSSCA/TR 3250, Ref ¹⁷.
- 5052 The integration of the Strategic Weapons Safety Case and the Facility Safety Case is an outstanding issue identified in Part 7.

Embarked Tactical Weapons

- 5053 Embarked tactical weapons constitute a potential internal explosion hazard in their own right and a potential secondary explosion hazard which may be initiated by some



other internal/external hazard such as fire or external shock demands. Both of these potential scenarios are discussed as follows.

Quiescent WSC Munitions Explosion

- 5054 As weapons are not handled at the Facility (other than occasional handling of non-warshot variants at 12 Berth under strict controls in adherence with JSP 862 (Ref. ¹⁸)) the relevant potential weapons hazard relates to weapons securely stowed in a quiescent state within a submarine's Weapons Storage Compartment (WSC). As the current licence for handling explosives at the Faslane berths is limited to very small Net Explosive Quantity (NEQ), sufficient to handle only small quantities of explosives and some practice (Torpedoes or Missiles) variants, handling of explosives in Faslane is not considered a significant hazard.
- 5055 The only potentially significant hazard associated with a stowed quiescent tactical weapons is that, which could in principle arise, due to undetected fuel mixing in a Spearfish leading to a fuel fire and resultant explosion; there are no equivalent safety concerns associated with other relevant fuel systems. BAe Systems have undertaken a review of the safety of the fuel system ISP5 SF0033 (Ref. ¹⁹) - Feasibility study for Spearfish casualty response for embarked weapons. The report recommends that Spearfish remain embarked during docking on the Shiplift and concludes the potential for an explosion due to undetected fuel mixing for a VANGUARD Class is negligible, and this can be read across to other Current Class submarines.
- 5056 This amendment was supported by the Tactical Weapon Systems (TWS) Forward Action Plan (FAP) (Ref. ²⁰). This starts with the assumption that it is tolerable for all Spearfish and Tactical Land Attack Missile (TLAM) tactical weapons variants to be embarked in nuclear submarines alongside approved berths, including the 12 Berth component of the Shiplift Facility. This assumption is supported by the Certificate of Safety Ordnance, Munitions and Explosives (CSOME) and Certificate of Safety Explosives (CSE) for the relevant torpedoes which permit them to be retained on vessels, providing the mandatory requirements of JSP 862 (Ref. 18) are adhered to.
- 5057 Having assumed tolerability for a wet berth, the FAP examined the differences in the magazine boundary conditions, and in the conduct of the relevant casualty procedures, between being at 12 Berth and on the platform. Based on the following principal assumptions, it makes the case that it is equally tolerable to dock with these tactical weapons embarked and a programme of work has been undertaken to achieve a full substantiation (Ref. 11). This has confirmed the following:
- Firefighting water availability to support the WSC Spray system is adequate.
 - Hazards to the TWS while on the Shiplift have been demonstrated to be comparable with the alongside situation and casualty procedures developed to mitigate identified eventualities.
 - The potential secondary effect of accumulation of firefighting water with respect to submarine/platform load distribution is acceptable.
 - Shock withstands of TWS bounds shock demand following platform collapse.
 - Submarine and TWS response following platform collapse remain within their design envelopes.
 - Sufficient confidence exists in the integrity of the FOT cranes.



Deterministic Safety Assessment

5058 The current deterministic safety justification for the normal, fault and hazard withstand of the safety related structures, systems, equipment and services as identified in the formal hazard identification processes described above is presented in the appropriate DSRs. Probabilistic assessment of the frequency of fault and hazard levels is used to define the cut-off for the deterministic assessment. The findings of the Shiplift Facility load path assessments are summarised in Table 5.3.

Table 5.3 Load Path Assessment Summary

STRUCTURE & DSR Ref.	LOAD PATH	CC (Y/N)	DSR / TR
Platform	Cradles	Y	Platform DSR N.2522.79
	Rigid / Articulated Bays	Y	
	Hanger Links	Y	TR/3120 ¹
	Ropes	Y	TR/3150 ²
	Hanger Beams	Y	
	Civil Sub-structure	Y	Civils DSR N.2522.78
	EOT Crane	Hook	Y
Rope		Y	
Cross Travel Trolley		Y	TR/3300 Safety Justification
Girder		Y	TR/3301 Seismic Withstand
Long Travel Bogies		Y	TR/3302 Fault & Hazard Assessment
Rails		Y	TR/3303 CT Trolley Assessment
Stanchions		Y	Civils DSR N.2522.78
Civil Super-structure		Y	Civils DSR N.2522.78
12 Berth Crane	Hook	Y	12 Berth Crane DSR N.2522.76
	Rope	Y	
	Trolley	Y	TR/3350 Perf. & Hazard Withstand
	Girder	Y	TR/3352 Seismic Assessment
	Rail	Y	Civils DSR N.2522.78
	Civil Sub-structure	Y	Civils DSR N.2522.78
Civil Structure	Sub-structure – Piles	Y	Civil Structure DSR N.2522.78
	Sub-structure – Quays	Y	
	Sub-structure – Jetty	Y	TR/3600 Normal Ops. Summary
	Sub-structure – 12 Berth	Y	TR/3601 Hazard Withstand
	12 Berth Crane rails	Y	TR/3603 Seismic Summary
	Super-structure:	Y	TR/3607 Dropped Loads & Impacts
	Roof trusses	Y	
	Stanchions	Y	
	EOT Crane rails	Y	

1. TR/3120 summarises the results of the design code compliance assessments for the structural prime members subject to the bounding load cases.

2. TR/3150 provides design demonstration that structural collapse should not occur for events in the 10⁻⁴/year to 10⁻⁷/year frequency range.

~~RESTRICTED~~

Civil Structures - Jetties and Superstructure

- 5059 The Civil Structure DSR (Ref. ²¹) presents the design and substantiation of the Civil Structures which comprise of the following:
- Shiplift Substructure – jetties
 - Shiplift Superstructure – building
 - Vessel Entry and Transfer Ashore Doors
 - Substructure Corrosion Protection (ICCP) System
 - Berthing Equipment
- 5060 The ICCP System and the Berthing Equipment are included here because of their influence upon either the loadings on the structures or the conditions of the structures through life.
- 5061 The key design and safety functional requirements of these civil works are to safely support the Shiplift platform and other nuclear safety related equipment, for example the Electric Overhead Travelling Cranes (EOTC) and to provide protection to the Shiplift and 12 Berth equipment against internal and external environmental hazards including blast.
- 5062 The integrity of the Civil Structures is discussed in Ref. 21, where an acceptable withstand has been shown for dead and imposed loads associated with normal operating and fault loads from the Shiplift Platform and the EOTC and the loads from hazards.
- 5063 The general loading on the civil substructure from external hazards such as wind and wave is enveloped by the seismic loading. The justification of the civil works to meet the safety functional requirements is therefore provided by a deterministic assessment of the structural integrity under the specified earthquake hazard. A detailed as-built seismic analysis of the civil structure has been completed and this demonstrates robust margins at the 0.2g Reference Earthquake (RE) level sufficient to provide the withstand demonstration for the Seismic Margin Earthquake (SME) of 0.28g. It has further been assessed that the structure will also withstand a 0.35g margin event without significant failure. The wind loading on the superstructure is enveloped by the design blast loading from the EHJ at Coulport. The structure has therefore been substantiated to withstand a reference blast event from the EHJ at Coulport.. The risk from other blast sources within HMNB Clyde is currently mitigated by explosives safety regulations and safety management arrangements to restrict the quantity and movement of explosives in the proximity of nuclear vessels, as set out in the Site Safety Case (Ref 3) and Port Operational Management Safety Report (POMSR) (Ref ²²).
- 5064 Detailed as-built assessments of the effects on the civil structure of dropped loads from the EOT Cranes and the Berth 12 Crane and Platform fault loadings have also been undertaken, providing demonstration of satisfactory withstand. For environmental hazards it is demonstrated that the as-designed assessment remains valid and bounding.

~~RESTRICTED~~