EXTERNAL EVENTS REVIEW INITIATIVE

Earthquake and Tsunami with Induced Events

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DOCUMENT REVISION HISTORY

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1	2013-08-28	J Bezuidenhout	Update with unit 2 containment building seismic assessment information.
2	2014-06-30	J Bezuidenhout	Update with unit 1 containment building seismic assessment information.
3	2015-12-11	I Kungoane	• Proposal in § 1.2 and § 6 augmented according to NNR request. • § 3, 3rd bullet: The last sentence revised.

LIST OF ABBREVIATIONS

Abbreviation	Description
ASG	Auxiliary Feedwater System
CDFM	Conservative Deterministic Failure Margin
CM	Combination Mitigation
CRF	Main Circulating Water System
EAS	Containment Spray System
ECC	Emergency Control Centre
EDG	Emergency Diesel Generator
JPP	Fire Fighting Water Production System
JPS	Mobile Fire Fighting System
KNPS	Koeberg Nuclear Power Station
KRT	Plant Radiation Monitoring System
LBC	125 V dc Equipment Control Supply
LBD	125 V dc Equipment Control Supply
LBE	125 V dc Equipment Control Supply
LBF	125 V dc Equipment Control Supply
LCB	48 V dc Relaying and Control Supplies
LHA	6.6 kV Essential Switchboard (Train A)
LHB	6.6 kV Essential Switchboard (Train B)
LHC	6.6 kV Essential Switchboard (Common)
LHS	Emergency Diesel Generator (Common)
LLA	380 V ac Essential Supply
LLB	380 V ac Essential Supply
LLC	380 V ac Essential Supply
LLD	380 V ac Essential Supply
LLE	380 V ac Essential Supply
LLI	380 V ac Essential Supply
LLJ	380 V ac Essential Supply
LNA	220 V ac Protection and Control Supply
MSL	Mean Sea Level
PEE	Portable Emergency Equipment
PO	Pump
PTR	Reactor Cavity and Spent Fuel Pool Cooling System
RCP	Reactor Coolant System
RCV	Chemical and Volume Control System

Abbreviation	Description
REA	Reactor Boron and Water Make-up System
RF	Cooler
RIC	In-Core Instrumentation System
RIS	Safety Injection System
RRA	Residual Heat Removal System
RRI	Nuclear Island Component Cooling System
SBO	Station Black-Out
SEC	Essential Service Water System
SED	Nuclear Island Demineralised Water Distribution System
SEP	Potable Water System
SER	Conventional Island Demineralised Water Distribution System
SFP	Spent Fuel Pool
SG	Steam Generator
SSC	Structures, Systems, and Components

1 INTRODUCTION

The occurrence of a significant earthquake in close proximity to the coast is sometimes accompanied by a tsunami event. EERT-12-021 (*External Hazard Screening Assessment*) found that the combination of an earthquake generating a tsunami could also induce additional on-site hazards such as chemical spills, explosions, and fires [1].

This report assesses the robustness of Koeberg Nuclear Power Station (KNPS) to cope with an earthquake and subsequent tsunami and the simultaneous occurrence of a chemical spill, explosion, and fire event as stated in EERT-12-023-RPT (*On-site Induced Hazards*). Conservative analysis is used in the safety re-assessment. The implementation of several proposals made in EERT-11-013 (*External Events Safety Re-assessment Interim Report*) is simulated to illustrate the ability of the plant to shut down safely following a combination event. Proposed modifications are discussed in § 3 (*Proposed Modifications*). The combination study comprises the events described below.

1.1 EARTHQUAKE

EERT-11-015 (*Seismic Hazard Report*) assessed the robustness of the KNPS design to maintain its safety functions when challenged by a seismic hazard beyond the design basis [2]. The study enveloped geological hazards such as submarine landslides, liquefaction, and subsidence/upliftment. Potential cliff edges were identified where small deviations in plant behaviour could give rise to severe plant damages.

The nuclear safety related structures at KNPS are constructed on a common foundation referred to as the aseismic raft. The main function of the seismic raft is to decrease horizontal ground motion experienced by the nuclear safety related equipment. The KNPS seismic design basis is based on an earthquake, with an epicentre of 8 km at the postulated Milnerton-Hangklip fault zone that measures 7 on the Richter scale. The Dames and Moore method predicted that a safe shutdown earthquake is defined as 0.3 g zero-period horizontal acceleration and 0.2 g zero-period vertical acceleration.

The seismic hazard report includes several functional requirements diagrams for different magnitude seismic events. This method exposed potential vulnerabilities of structures, systems, and components (SSCs) during normal operating conditions due to a seismic event. The seismic event is used as the basis of this combination assessment using the functional requirements diagrams as explained in EERT-11-014 (*Minimal Needs to Prevent and Mitigate Fuel Melt*). The diagram indicating seismic failures is augmented with additional failures as described below.

1.2 TSUNAMI

EERT-11-016 (*Tsunami Hazard Report*) assessed the robustness of the facility's design to maintain its safety functions in the event of flooding as a result of a tsunami [3].

The tsunami assessment comprises three sections. The potential sources of a tsunami at KNPS were investigated first together with the risk posed by each of the initiating events. Secondly, the robustness of KNPS to mitigate a design-basis as well as a beyond-design-basis tsunami was evaluated for different levels of flooding. Potential vulnerabilities were highlighted and associated cliff edge effects identified. Finally, proposals were presented to increase the plant's robustness against tsunamis.

This study assumes the simultaneous occurrence of an earthquake and tsunami event as this is believed to be the most enveloping scenario. The so-called lag time between the earthquake and tsunami event is ignored to ensure the proposals made in this study are robust against extreme events.

There is currently no tsunami early warning system installed at Koeberg to provide an indication on possible tsunami formation following an earthquake event.

> ***CM 1**: It is proposed that Koeberg develop a tsunami early warning system to provide accurate early indication on possible tsunami formation following an earthquake event. Furthermore, it is proposed to develop a locally calibrated tsunami hazard assessment model/methodology.*

The tsunami assessment used a similar method, i.e. a functional requirements diagram, as used in the earthquake assessment to identify potential failure of SSCs. The failures documented in the original tsunami study are used to augment the functional requirements diagram of the earthquake assessment in order to generate a combined earthquake and tsunami functional requirements diagram.

1.3 CHEMICAL SPILL

EERT-11-025 (*Chemical Spill Hazard Report*) assessed the risk of chemical spills to KNPS. The assessment concluded that the risk of chemical spills is limited to personnel safety [4]. Chemical spills do not have a direct consequence to nuclear safety.

This combination study compounds the chemical spills with an earthquake and induced tsunami event, as the earthquake and subsequent tsunami may result in damage to on-site chemical storage tanks (envelopes mobile chemical tankers). Although chemical spills do not cause additional damage to SSCs, failure of chemical tanks is presented as specified in EERT-12-023-RPT to indicate potential danger to plant operators due to the presence of toxic gases. The functional requirements diagram does not contain any chemical storage sources and as a result, these potential failures, due to the occurrence of an earthquake and subsequent tsunami, will be briefly discussed in the text.

1.4 EXPLOSION

EERT-11-019 Rev 1 (*Explosion Hazard Report*) assessed the risk of explosions to KNPS from both on- and off-site sources. The study concluded that the locations of potential explosive sources outside of the access control point 2 are far enough to not induce a risk to nuclear safety [5].

All the potential on-site explosive sources documented in the explosion hazard report were analysed in EERT-12-023-RPT as on-site induced hazards [10]. The findings of this report are used to derive additional failures of SSCs which could possibly be induced by an earthquake and/or tsunami event. The earthquake and tsunami functional requirements diagram is augmented with the potential failures as a result of an explosion initiated by either an earthquake, tsunami, or fire event (no mechanism was found whereby a chemical spill could initiate an explosion).

1.5 FIRE

EERT-11-018 (*Fire Hazard Report*) analysed the risk of fires to KNPS. The safety re-assessment showed that KNPS is sufficiently capable of detecting and mitigating an on-site fire [6].

This study considers the combination of an earthquake and subsequent tsunami inducing a fire on SSCs. EERT-12-023-RPT identified on-site induced fires as a result of an initiating event such as an earthquake, a tsunami, or an explosion (no mechanism was found whereby the chemicals used at KNPS could result in a fire). Failures of SSCs as a result of an initiating fire event are shown in the functional requirements diagram.

2 METHODOLOGY

Earthquakes, being geological events, cannot be prevented. The methodology followed in this combination study is that of identifying vulnerabilities during normal plant operating conditions due to a combination of external events and presenting applicable proposals to mitigate those events. This method ensures that core and spent fuel pool (SFP) cooling is continuously maintained and containment integrity is not compromised.

The safety re-assessment completed in EERT-11-015 (*Seismic Hazard Report*) is the cornerstone of the combination study, as this is the initiating event. Therefore, this study is used as the basis for the combination study. The functional requirements diagram generated in EERT-11-015 (*Seismic Hazard Report*) is augmented with the functional requirements diagram populated in EERT-11-016 (*Tsunami Hazard Report*) as the majority of failures are caused by these two events. The methodology of combining two safety re-assessments is discussed in § 2.1 (*Functional Requirements Diagram Methodology*).

Various combinations of magnitudes can be assessed. The study performed in EERT-11-015 (*Seismic Hazard Report*) found that a definite cliff edge (in terms of equipment failure) occurred between a 0.3 g and a 0.4 g earthquake. Table 1 illustrates the expected failures (includes SSC failure due to a supporting system) following seismic events of various magnitudes. The cells highlighted in grey illustrate the point where increased equipment loss is experienced due to the seismic magnitude increasing from design-basis to beyond-design-basis.

Table 1:
Potential failures identified during seismic events

Seismic Magnitude	Number of failures expected
0.2 g	6 potential failures identified
0.3 g	2 additional potential failures identified
0.4 g	61 additional potential failures identified
0.5 g	4 additional potential failures identified
0.6 g	23 additional potential failures identified

Seismic walkdowns for equipment inside the unit 2 containment building were completed during outage 219. In addition, seismic walkdowns for unit 1 were subsequently completed during outage 120. The findings from the unit 2 walkdowns were incorporated into this report using the functional requirement diagram. Any discrepancies, in terms of additional equipment failure, found during the unit 1 seismic walkdowns will be briefly discussed.

The terrace level of KNPS is constructed 8 m above the mean sea level (MSL). Minimal damage to safety equipment is expected for a tsunami wave up to 8 m above MSL. The majority of water-caused damage occurs when the site is inundated up to a water level of 3.8 m above the terrace level (11.8 m MSL). By increasing the water level up to 6 m above the terrace level (14 m MSL) the only additional significant failure is the station batteries. By further increasing the water level up to 7 m (15 m MSL) above the terrace level, results in the failure of the SBO diesel generators. Water levels beyond the 7 m

terrace level (> 15 m tsunami) will cause failure of the electrical switchboards. The assumption is made that any SSC underneath the water surface will be unavailable. This assumption envelopes damage caused by water-borne debris and will therefore not be discussed further. The impact energy from a tsunami wave on buildings and SSCs was not considered in the tsunami hazard report, and is therefore not considered in this combination assessment.

***CM 2**: It is proposed that EERT-11-016 (*Tsunami Hazard Report*) be revised to include the potential damage to plant buildings and SSCs as a result of the impact energy from the tsunami waves.*

The detailed combination of assessments, which includes functional requirements diagrams, is only performed for a tsunami wave height below the 0 m terrace level and a tsunami wave height less than 3.8 m above the terrace level (indicated in grey in Table 2) as this is where the significant cliff edges (regarding equipment loss) occur. Additional assessments were performed for a tsunami with wave height exceeding 3.8 m above the terrace level although this is limited to a brief discussion.

Table 2:
Tsunami combination evaluation

Tsunami Height (above/below terrace level)	SSC failure	Cumulative SSC failure
> 7 m	Electrical switchboards	JPS connection Most pumps on 0 m terrace SER and SED tanks Station and unit transformers All five EDGs 30 V, 48 V, 125 V, 230 V batteries supply to monitoring equipment. Station black-out diesel generators
6 m to < 7 m	Station black-out diesel generators	JPS connection Most pumps on 0 m terrace SER and SED tanks Station and unit transformers All five EDGs 30 V, 48 V, 125 V, 230 V batteries supply to monitoring equipment
3.8 m to < 6 m	30 V, 48 V, 125 V, 230 V dc batteries supply to monitoring equipment	JPS connection Most pumps on 0 m terrace SER and SED tanks Station and unit transformers All five EDGs
0 m to < 3.8 m	All pumps on the 0 m terrace level (excludes reactor building) SER and SED tanks Station and unit transformers All five EDGs	JPS connection
– 4 m to 0 m	JPS connection	-
– 8 m to – 4 m	-	-

Based on the analysis above, the following combinations of seismic and tsunami magnitudes for unit 1 and 2 were assessed in detail using a functional requirements diagram comparison:

- Design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level;
- Design basis earthquake (0.3 g) inducing a tsunami wave up to 3.8 m above the terrace level;
- Beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level;
- Beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level;
- Beyond-design-basis earthquake (0.5 g) inducing a tsunami wave up to the 0 m terrace level;
- Beyond-design-basis earthquake (0.5 g) inducing a tsunami wave up to 3.8 m above the terrace level;
- Beyond-design-basis earthquake (0.6 g) inducing a tsunami wave up to the 0 m terrace level;
- Beyond-design-basis earthquake (0.6 g) inducing a tsunami wave up to 3.8 m above the terrace level.

A common functional requirements diagram to represent both units 1 and 2 is completed for the combinations mentioned above. Failure of equipment identified is applicable to both units unless stated otherwise.

The on-site induced failures from chemical spills, explosions, and fires as documented in EERT-12-023-RPT are then presented to derive a comprehensive list of potential SSCs failure for this combination of events. The seismic and tsunami functional requirements diagram is augmented with these additional on-site induced failures (limited to fires and explosion as no mechanism could be found whereby a chemical spill could cause failure of SSCs).

As this document is identifying additional failures due to the combination of events, only additional proposals or amendments, where necessary, are made to the previous proposals in order to ensure continuous core and SFP cooling and maintaining containment integrity.

2.1 FUNCTIONAL REQUIREMENTS DIAGRAM METHODOLOGY

The functional requirements diagram is a summary of all the essential systems and sub-systems that could be used to prevent and mitigate the effects of core melt, in line with the existing relevant incident and accident procedures and severe accident management guidelines. The functionality of the functional requirements diagram is comprehensively discussed and explained in EERT-11-014 (*Minimal Needs to Prevent and Mitigate Fuel Melt*) [7]. The functional requirements diagram uses unique colour coding to indicate the availability of different systems. Green illustrates that the system is functional following an event, red refers to a system being unavailable, and pink indicates a system is unavailable due to an on-site induced failure. Where a system is unavailable due to an initial event (either earthquake, tsunami, or both) together with an on-site induced hazard (explosion, fire, or both), the initial event always takes preference and is indicated in red. Orange colour coding is used to illustrate that a system is not available due to the loss of a supporting system. Grey colour coding illustrates the system was not assessed

(specific for seismic resilience) and subsequently no credit is taken for that system. Finally, yellow colour coding indicates the availability of a system; however the expected operational lifetime is less than 24 hours.

In EERT-11-015 (*Seismic Hazard Report*) and EERT-11-016 (*Tsunami Hazard Report*) the plant's ability to survive a single event was assessed using a functional requirements diagram.

A combined functional requirements diagram is completed for an earthquake inducing a tsunami. As previously mentioned, the seismic hazard report is used as the basis for the earthquake and induced tsunami assessment. The functional requirements diagram for the seismic event is augmented with additional failures caused by a tsunami event.

Different cell patterns were used to differentiate between the failure-causing event and the event that has no influence on the failure of a system. The cell patterns can be interpreted as follows:

- horizontal line pattern – tsunami event is the cause for failure of a system or components;
- vertical line pattern – seismic event is the cause for failure of a system or component;
- no line pattern – both tsunami and earthquake events contribute to the failure of a system or component.

The combinations involving a tsunami wave height exceeding 3.8 m above the terrace level are assessed on a case-by-case basis as it was found that failure of additional systems above this point is limited. Functional requirements diagrams are not completed for these assessments and are only briefly discussed.

3 PROPOSED MODIFICATIONS

Several vulnerabilities were documented in EERT-11-013 Rev.1 (*External Events Safety Re-assessment Interim Report*), which lead to numerous proposals being made for the mitigation of external events. To ensure the safe removal of decay heat while maintaining the integrity of the SFP, these proposals were prioritised for maximum benefit. The proposed modifications which are seismically qualified to 0.5 g are described below.

- Shutdown seals

  Installation of shutdown seals on the primary pump shafts ensures the primary system inventory is not lost due to loss of seal cooling. With the shutdown seal installed, there will be negligible inventory loss from the RCP system, and therefore additional make-up is not required, as reflected in the functional requirements diagrams.

- Installation of an additional auxiliary feedwater system (on each unit)

  It is proposed to install an additional hardened auxiliary feedwater system independent of ac power, to supply core cooling should all other pumps fail. This will provide sufficient core cooling to ensure that fuel integrity is not compromised.

- SEP tank and hardened line upgrade

  The SEP potable water tank was found to be a reliable, alternative source of cooling water for KNPS plant reactor and SFP in the event of loss of cooling water supply through existing plant systems due to an extreme event. It is envisaged that the current SEP tanks will need to be replaced with hardened tanks and piping that can withstand a seismic loading of at least 0.5 g.

  In order to ensure the SEP water is reliably delivered to the plant, it is proposed to install a hardened SEP pipe system to supply SEP water to the plant. A header with several connection points will be fitted to the end of the pipe to allow diesel-driven pumps to connect.

- Portable emergency equipment (PEE)

  The procurement of several PEE diesel-driven pumps is proposed. These pumps, supplied by the hardened SEP line, will be used to supply the following:

  * ASG tank make-up or direct to ASG 003 PO suction at 60 m^3/h;
  * EAS spray piping at 370 m^3/h;
  * SFP make-up line at 20 m^3/h;
  * PTR tank make-up line at 60 m^3/h; and
  * RCV charge flow piping at 60 m^3/h.

- Hardened instrumentation

  In order to ensure continuous monitoring of essential SSC, it is proposed to install hardened instrumentation for the following:

  * core exit temperature indication;
  * steam generator pressure indication;

- steam generator level indication;
- containment pressure indication; and
- SFP level indication.

- Mobile diesel generators

  During a complete loss of off-site power, KNPS will require a reliable power source to ensure safe shutdown is maintained. The procurement of mobile diesel-driven generators is proposed to ensure critical equipment remains supplied. These mobile units will be connected into pre-installed connection points supplying the LHA and LHB switchboards.

The proposed modifications mentioned above are indicated on the functional requirements diagram, using a blue colour coding to illustrate the plant's ability to maintain SFP cooling and containment integrity.

4 SEISMIC / TSUNAMI HAZARD ASSESSMENT

4.1 INTRODUCTION

KNPS, being situated close to the coast, could be vulnerable to tsunamis caused by amongst others, an earthquake (envelopes submarine slumping). This section discusses the combination of an earthquake inducing a tsunami event. Furthermore, the potential on-site induced failures as a result of either the earthquake and/or tsunami are discussed. The functional requirements diagrams for the seismic and tsunami assessments are combined and any additional potential failures from on-site induced hazards are shown.

The combined functional requirements diagram is completed for the eight combinations stated in § 2 (*Methodology*). The combination assessments are constructively discussed, that is, as the magnitude of the seismic and tsunami hazard is increased, only additional potential failures are highlighted.

The functional requirements diagram is also updated with the proposals made in § 3 (*Proposed Modifications*). The success path to ensure critical plant functions is discussed.

4.2 DESIGN BASIS (0.3 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO THE 0 M TERRACE LEVEL

KNPS is robust against a tsunami wave of up to 8 m above MSL. As a result, minimal damage to SSCs can be expected in the event of a tsunami wave up to 8 m following a 0.3 g earthquake. The functional requirements diagram, which provides a graphical summary of all the essential systems affected during a combined event, is illustrated in Table 5 in Appendix 1.

4.2.1 Potential Failure Identification

Damage to plant equipment is mostly caused by the occurrence of the seismic event. Critical components that could fail include:

- SEP tank and associated piping (failure at 0.2 g earthquake due to slope collapse);
- JPS piping connection (cracked suction and rusted discharge);
- Electrical cabinet drawers left unsecured; and
- REA water and SER tanks.

The potential failure of equipment following a tsunami wave with a height of less than 8 m is limited to the JPS pump connection point which is located next to the SEC pump house.

The power transformers and 6.6 kV non-essential switchboards were not assessed during the seismic margin assessment and as a result no credit is taken for the functionality of the equipment. The assumption is made that this combined event will result in a loss of off-site power. The functionality of the SER pumps, which are supplied by 380 V ac non-essential switchboards, will be lost as these switchboards are energised by the 6.6 kV non-essential switchboards.

EERT-12-023-RPT identifies additional on-site hazards (such as fire, explosion, and chemical release) that could also be initiated by off-site external hazards (and combinations), which could cause additional damage that must be considered [10].

The only credible additional compounding damage that is initiated by a design basis earthquake (0.3 g) is the possible failure of an ammonia tank in the demineralisation plant and a fire and/or explosion at the hydrogen storage facility. It is possible that a fire/explosion in the hydrogen storage facility could also damage the SEP tank (could also be caused by the earthquake) and the turbine hall.

***CM 3**: It is proposed that the seismically hardened SEP tank and associated pipework be robust against any overpressure generated by an explosion due to its proximity to the hydrogen storage facility, which could be vulnerable in the event of a seismic activity. An alternative solution would be the relocation of the hydrogen storage facility to a remote area not surrounded by critical equipment.*

Damage to the SEP tank could lead to a flooding event at the south-side EDGs; however this is unlikely [9]. Due to the inherent uncertainty, a conservative approach is taken by making the assumption that the EDGs are not available following such a flooding event.

***CM 4**: It is proposed that a seismically qualified barrier be erected in front of the south-side EDGs to protect these EDGs from possible water ingress in the event of an SEP tank rupture.*

No credit is taken for any equipment inside the turbine hall and therefore any potential damage does not lead to any additional consequences.

The rupture of the ammonia tank at the demineralisation plant, could impact implementation of mitigation strategies, and necessary provision to either eliminate or deal with the consequences in the event of a seismic and tsunami combination event must be made.

***CM 5**: It is proposed that any preventative (such as tank strengthening) and/or mitigation strategies (such as protective clothing) to deal with a potential chemical release be robust against the sequential occurrence of an earthquake and a tsunami.*

The CRF piping, which is not seismically designed, situated in the basement of the turbine hall below the normal seawater level, could potentially flood parts of this building in the event of seismic activity as a result of a pipe rupture. However, this does not result in additional failures as no credit is taken for any equipment inside the turbine hall.

As previously mentioned, the functional requirements diagram illustrating the critical equipment functionality following an earthquake, tsunami and on-site induced hazards is shown in Table 5 in Appendix 1.

4.2.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration at KNPS. The functional requirements diagram generated in § 4.2 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) indicates the potential failure of

equipment in the event of a postulated 0.3 g earthquake inducing a tsunami wave with maximum height of 8 m. Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami) is also indicated.

The magnitude of the combined event is within the design basis of KNPS and therefore as expected, the majority of the conventional systems are still functional. In this case, the proposed modification serves a redundant purpose. By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirement could be maintained following the event described:

- Essential indications such as core exit temperature, SG level, SG pressure, containment pressure, and SFP level.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram Table 6 in Appendix 1.

4.3 DESIGN BASIS (0.3 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO 3.8 M ABOVE THE TERRACE LEVEL

Table 3 indicates the effect on the essential systems and critical functions if the site is inundated up to 3.8 m above the terrace level following a 0.3 g earthquake.

4.3.1 Potential Failure Identification

The functionality of many SSCs will be lost primarily due to a tsunami causing a flooding hazard as most pumps and the EDGs are located either at or below the 0 m level. The potential damage caused by a 0.3 g earthquake hazard was discussed in the previous section and therefore only additional failures due to a tsunami hazard are discussed:

- Loss of primary system make-up due to the failure of the RCV, emergency seal supply, RIS and EAS pumps;

> ***CM 6****: It is proposed that a connection point, robust against earthquakes and tsunamis, be installed on the RCV charging line to allow connection of a permanent/portable pump to directly inject borated water into the RCP system (refer to EERT-11-026 (*Loss of Off-Site Power Report*) [11]). This will provide an emergency make-up path for the injection of borated water into the primary system to ensure sub criticality if other conventional means of injection are not available.*

- Additional pumps situated outside the reactor building below a height of 3.8 m above the terrace level. Pumps that were assessed to potentially fail include the JPP, REA water and boron, SEC, JPS, RRI, PTR and ASG pumps;
- In addition to the SEP tank, the SED tanks located on 0 m terrace level were estimated to be unavailable when inundated up to a height of 3.8 m above terrace level;
- The station and unit transformers would become inoperable as these units are located on the 0 m terrace level. However, this does not result in any additional

failures as the original assumption of an immediate loss of off-site power following an earthquake event envelopes the failure of this equipment;

- The EDGs, located on the 0 m terrace level, are used to supply the station with power in the event of a loss of off-site power. Intake louvres are installed at the front of the EDG buildings to ensure filtered air is supplied to the EDGs for the combustion process. These louvres offer no resistance to water ingress. Therefore, once water moves over the 0 m terrace level, the EDGs will not be available as the fuel transfer pumps are likely to be flooded.

EERT-12-023-RPT showed that it is possible to experience additional damage as a result of water rapidly moving over the 0 m terrace level [10]. The kinetic energy embedded in the tsunami wave could cause damage to the hydrogen storage facility which could propagate into a fire and/or explosion. The explosion could cause damage to the SEP tank (refer to proposal **CM 3**) and the turbine hall (could also be vulnerable to a generator explosion due to the seismic event) which are located close by. However, damage to the SEP tank is enveloped by the seismic event and the flooding hazard posed by the SEP tank is enveloped by the tsunami wave. No credit is taken for equipment inside the turbine hall which is required for safe shutdown of the plant.

In addition, it is credible that the tsunami wave could cause damage to the ammonia tanks located on the 0 m level next to the demineralisation plant and result in a chemical release. However, the failure of the ammonia tanks is enveloped by the initiating event (earthquake) and they are therefore not considered for the tsunami event (refer to proposal **CM 5**).

Apart from those failures documented in the individual seismic and tsunami combination, no additional on-site failures were found. The functional requirements diagram indicating the estimated failure of safe shutdown equipment is shown in Table 3.

Table 3:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM						
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV				RCV-CL			
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI			
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP							
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*			
		SG	C-I22	SG Integrity	SG*	SGs*								
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*			
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL						
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP		
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI			
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO				RCV-CL			
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP						ESS-SI			
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO				
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP		SMP-RIS				RIS-LSI			
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*				
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*				
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP		
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM						
			C-L51	GCTc Steam Dump	SG/VVP/GCTc			GCTc-STM	CEX-TNK	CEX-PO				
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
			C-L54	ARE Main Feed	CEX/APA/SG	CEX-TNK	CEX-PO	ABP-HX*	APA-PO	AHP-HX*	ARE-SG/FL			
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK				
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV						
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG					
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG					
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK						
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*		
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT								
		Direct Core Injection	*See C4. Primary System Make-up											
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT			
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx					
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS					
			C-L64	Containment Venting										
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs								
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding										

Table 3:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNI]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNI]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNI]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNI]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNI]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNI]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHxxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNI]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNI]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNI]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT				
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD		VLT			
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT	SEP-VLT								
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 3:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	**E1. Essential 6.6kV Switchboard Supply**	LHA Switchboard Supply **[LHA]**	E-1	400 KV LHA Supply	400KV/LHA	**400KV**	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*		
			E-2	132 KV LHA Supply	132KV/LHA	**132KV**	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	**LHP-DSL**	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply **[LHB]**	E-5	400 KV LHB Supply	400KV/LHB	**400KV**	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*		
			E-6	132 KV LHB Supply	132KV/LHB	**132KV**	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	**LHQ-DSL**	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHA					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply **[LLY]**	E-10	LLY Switchboard Supply	LLS\LLX\LLY	**LLS-DSL**	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply **[LCA]**	E-21	LCA Switchboard - LHA	LCA\LLi\LHA	**[LHA]**		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	**[LLY]**									
			E-23	LCA Switchboard - Battery	LCA\BAT	**LCA-BAT**									
		LCB 48V Switchboard Supply **[LCB]**	E-24	LCB Switchboard - LHB	LCB\LLi\LHB	**[LHB]**		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	**[LLY]**									
			E-26	LCB Switchboard - Battery	LCB\BAT	**LCB-BAT**									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply **[LBA]**	E-31	LBA Switchboard - LHA	LBA\LLi\LHA	**[LHA]**		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	**[LLY]**									
			E-33	LBA Switchboard - Battery	LBA\BAT	**LBA-BAT**									
		LBB 125V Switchboard Supply **[LBB]**	E-34	LBB Switchboard - LHA	LBB\LLi\LHB	**[LHB]**		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	**[LLY]**									
			E-36	LBB Switchboard - Battery	LBB\BAT	**LBB-BAT**									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards **[LNA]**	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA		LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA	**[LHA]**	LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	**[LLY]**									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	**LBC-BAT**									
		LNB 220V Essential Switchboards **[LNB]**	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB		LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB	**[LHB]**	LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	**[LLY]**									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	**LBD-BAT**									
		LNC 220V Essential Switchboards **[LNC]**	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA		LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA	**[LHA]**	LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	**[LLY]**									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	**LBE-BAT**									
		LND 220V Essential Switchboards **[LND]**	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB		LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB	**[LHB]**	LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	**[LLY]**									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	**LBF-BAT**									
Ultimate Heatsink	**U1. Essential Cooling**	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

4.3.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration for implementation at KNPS. The functional requirements diagram generated in § 4.3 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) indicates the potential failure of equipment in the event of a postulated 0.3 g earthquake inducing a tsunami wave with maximum height of 11.8 m (3.8 m above the terrace level). Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami), is also indicated.

By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirements could be maintained following the event described:

- RCP seal injection

  By installing the shutdown seals, the water inventory inside the primary system can be maintained to ensure the functionality of primary system seal injection is not required.

- Core cooling

  The installation of a hardened SEP tank and associated piping to provide cooling water to the core following a seismic event together with the installation of a fourth ASG pump would ensure the core cooling functionality is not lost.

- Containment integrity

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the EAS spray system. This pump will inject water into the EAS sprays. High-temperature steam will condense into water and subsequently reduce the pressure inside the containment.

- Essential indication

  Hardened instrumentation to indicate core exit temperature, SG level, SG pressure, containment pressure, and SFP level will be installed.

- SFP bulk boiling

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the SFP. In the event that no cooling is available, the SFP water will be allowed to boil and make-up will be provided from the SEP tank.

- Essential 6.6 kV switchboard supply

  It is proposed to procure mobile diesel generators to supply power to the plant following a combined event. The mobile EDGs will be connected to the LHA and LHB switchboards to supply power to available equipment.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram in Table 4.

Table 4:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM						
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV				RCV-CL			
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI			
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP							
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*			
		SG	C-I22	SG Integrity	SG*	SGs*								
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*			
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL						
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP		
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI			
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal								
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO							
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP						ESS-SI			
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS							
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP		SMP-RIS			RIS-PO				
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*	RIS-LSI			
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*				
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP		
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM						
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~				
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~			
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK				
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV						
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG					
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG					
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK						
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO							
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*		
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT								
		Direct Core Injection	*See C4. Primary System Make-up											
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT			
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx					
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS					
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS	PEE-PO						
			C-L64	Containment Venting										
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs								
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding										

Table 4:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHIxxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool		SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
	S1. SFP Integrity	PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 4:

Functional requirements diagram for a design basis (0.3 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON								
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON								
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

4.4 BEYOND-DESIGN-BASIS (0.4 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO THE 0 M TERRACE LEVEL

A beyond-design-basis assessment is performed by increasing the seismic loading experienced by SSCs to a 0.4 g earthquake causing a tsunami wave up to 8 m above MSL (below the 0 m terrace level).

4.4.1 Potential Failure Identification

As expected, failure of equipment is predominantly caused by the seismic event as most of the equipment can only be inundated once water moves over the 0 m level.

Tsunami-induced failures are limited to the JPS water connection point located next to the SEC pump house and were discussed earlier.

The cumulative potential failure of critical equipment as a result of a 0.4 g earthquake includes [11]:

- Possible failure of fuel assemblies and control rods;
- Possible failure of the unit 2 pipework connecting the accumulator and RCP system. During the unit 1 seismic walkdown it was found that these components have a conservative deterministic failure margin (CDFM) capacity in excess of 0.5 g PGA;
- Potential failure of the unit 2 pipework connecting the RCV and Safety Injection system due to a collapsed support. Unit 1 pipework was found to be robust;
- Possible failure of the unit 2 pipework between the RCV and High Head Safety Injection system due to a loose support. Unit 1 pipework was found to be robust;
- Multiple electrical cabinets were assessed in the seismic walkdowns and were found to be vulnerable during a beyond-design-basis earthquake. Minor problems include unsecured racked-out 6.6 kV breakers, interaction with surrounding equipment (primarily hanging lamps), and taut connecting cables. Electrical systems affected include LHC, LLA, LLB, LLC, LLD, LLE, LLI, and LLJ switchboards;
- The REA boron and PTR tanks were assessed to be vulnerable to failure beyond 0.3 g;
- The REA water pump and RIS and EAS isolation piping are vulnerable; these vulnerabilities must be resolved before credit can be taken for their integrity beyond 0.3 g;
- Unit 1 VVP-GCT (pipework from main steam supply system to steam dump system) found to be vulnerable to a 0.4 g earthquake due to poor support;
- EAS mini-flow line was found to be not robustly supported. The seismic walkdown revealed that the line is not robust against a 0.4 g earthquake;
- The exhaust stacks for the five EDGs have limited allowable displacement. This is primarily due to the movement of both the turbine hall and the aseismic raft. Additionally, the glass level column of the fuel tanks, oil tanks and the water circuit header tanks for the five EDGs were assessed and found to be vulnerable during a beyond-design-basis seismic event;

- The PTR third train heat exchanger was assessed to be vulnerable to a beyond-design-basis earthquake. This is primarily due to the RRI feed-pipe to PTR 004 RF which is long and not adequately supported. This could result in considerable strain being induced on the heat exchanger;
- Containment penetrations on unit 2 were found to be vulnerable for an earthquake beyond 0.4 g due to several cable tray lids not being tied down and/or resting on cables. Unit 1 containment penetrations were found to be robust; and
- The Emergency Control Centre (ECC) was found to be vulnerable to a beyond-design-basis earthquake. However, this is limited to the superterranean structure. According to the seismic walkdown experts, the lower level of the ECC, where the technical support team will be stationed, will still be operable.

EERT-12-023-RPT found that it is possible to incur additional damage as a result of a 0.4 g seismic activity. No additional on-site damage is expected as a result of a tsunami wave up to the 0 m terrace level [10].

The hydrogen storage facility and turbine alternator are regarded as potential fire/explosion sources in the event of an earthquake due to the presence of hydrogen gas. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 3**) and turbine hall, does not result in additional failures as the SEP tank is expected to be unavailable due to the seismic event. The potential flooding risk posed by the SEP tank to the south-side EDGs could result in their unavailability, however, this is unlikely as it is estimated that this system has already failed due to the seismic event (refer to proposal **CM 4**). No credit is taken for equipment inside the turbine hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from either the hydrogen storage facility or turbine alternator explosion or the initiating seismic event. However, an immediate loss of off-site power is assumed and the unavailability of this equipment does not cause additional consequences.

It is possible for the seismic activity to cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The CRF piping situated in the basement of the turbine hall could potentially flood parts of this building in the event of seismic activity. However, this does not result in additional failures as no credit is taken for any equipment inside the turbine hall.

The functional requirements diagram indicating the potential failure of equipment in the event of an earthquake, tsunami, and on-site induced failures is shown in Table 7 in Appendix 1.

4.4.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration for implementation at KNPS. The functional requirements diagram generated in § 4.4 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) indicates the potential failure of equipment in the event of a postulated

0.4 g earthquake inducing a tsunami wave with maximum height not higher than 8 m (below the 0 m terrace level). Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami) is also indicated.

By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirements could be maintained following the event described:

- RCP seal injection

  By installing the shutdown seals, the water inventory inside the primary system can be maintained to ensure the functionality of primary system seal injection is not required.

- Core cooling

  The installation of a hardened SEP tank and associated piping to provide cooling water to the core following a seismic event together with the installation of a fourth ASG pump would ensure the core cooling functionality is not lost.

- Containment integrity

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the EAS spray system. This pump will inject water into the EAS sprays. High-temperature steam will condense into water and subsequently reduce the pressure inside the containment.

- Essential indication

  Hardened instrumentation to indicate core exit temperature, SG level, SG pressure, containment pressure, and SFP level, will be installed.

- SFP bulk boiling

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the SFP. Should no cooling be available, the SFP water will be allowed to boil and make-up will be provided from the SEP tank.

- Essential 6.6 kV switchboard supply

  It is proposed to procure mobile diesel generators to supply power to the plant following a combined event. The mobile EDGs will be connected to the LHA and LHB switchboards to supply power to available equipment.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram in Table 8 in Appendix 1.

4.5 BEYOND-DESIGN-BASIS (0.4 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO 3.8 M ABOVE THE TERRACE LEVEL

An assessment was completed on the plant's robustness following a 0.4 g earthquake causing a tsunami wave up to 3.8 m above the terrace level. The functional requirements diagram is illustrated in Table 9 in Appendix 1. The water from the tsunami will project over the 0 m terrace level and inundate the plant up to the 3.8 m level above the terrace

level. The assessment does not include a tsunami wave in excess of 11.8 m (3.8 m above the terrace level).

4.5.1 Potential Failure Identification

Damage to plant equipment is caused by both the seismic and subsequent tsunami event. § 4.4 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) assessed the damage caused to equipment experiencing a combined event of a 0.4 g earthquake causing a tsunami up to 8 m. The failure of plant equipment as a result of a seismic event was discussed and therefore, the seismic damage caused by this combination will not be discussed as this is similar to that of § 4.4 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*).

§ 4.3 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) discussed the damage caused to equipment from a tsunami wave with a height of up to 3.8 m above the terrace level. Tsunami damage simulated in this combination would be similar and is also not discussed.

EERT-12-023-RPT found that it is possible to incur additional damage as a result of a 0.4 g seismic activity and tsunami wave up to the 3.8 m above the terrace level [10].

The hydrogen storage facility is vulnerable to seismic activity and a tsunami wave due to the presence of hydrogen gas in the system. Furthermore, the turbine alternator could be vulnerable to seismic activity for similar reasons. Oxygen ingress into the system could result in a fire and/or explosion. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 4**) and turbine hall (could also be damaged in the seismic event), however this does not result in additional failures as the SEP tank is estimated to be unavailable due to the seismic event. The flooding risk posed by the SEP tank is not considered as the assumption is made that this quantity of water is enveloped by the water from the tsunami wave. No credit is taken for equipment inside the turbine hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from either the hydrogen storage facility or turbine alternator explosion or the initiating seismic event. However, an immediate loss of off-site power is assumed following a seismic event and the unavailability of this equipment has no additional consequences.

It is possible for seismic activity to cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The potential seismically-induced CRF pipe rupture resulting in a flooding event in the turbine hall basement is not considered as the assumption is made that the quantity of water is enveloped by the extent of tsunami water.

The failure of the equipment as a result the seismic, tsunami, and on-site induced hazards is graphically shown in the functional requirements diagrams in Table 9 in Appendix 1.

4.5.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration for implementation at KNPS. The functional requirements diagram generated in § 4.5 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) indicates the potential failure of equipment in the event of a postulated 0.4 g earthquake inducing a tsunami wave above the terrace level up to a level of 3.8 m. Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami) is also indicated.

By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirements could be maintained following the event described:

- RCP seal injection

  By installing the shutdown seals, the water inventory inside the primary system can be maintained to ensure the functionality of primary system seal injection is not required.

- Core cooling

  The installation of a hardened SEP tank and associated piping to provide cooling water to the core following a seismic event together with the installation of a fourth ASG pump would ensure the core cooling functionality is not lost.

- Containment integrity

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the EAS spray system. This pump will inject water into the EAS sprays. High-temperature steam will condense into water and subsequently reduce the pressure inside containment.

- Essential indication

  Hardened instrumentation to indicate core exit temperature, SG level, SG pressure, containment pressure, and SFP level will be installed.

- SFP bulk boiling

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the SFP. Should no cooling be available, the SFP water will be allowed to boil and make-up will be provided from the SEP tank.

- Essential 6.6 kV switchboard supply

  It is proposed to procure mobile diesel generators to supply power to the plant following a combined event. The mobile EDGs will be connected to the LHA and LHB switchboards to supply power to available equipment.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram in Table 10 in Appendix 1.

4.6 BEYOND-DESIGN-BASIS (0.5 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO THE 0 M TERRACE LEVEL

This assessment analyses the plant's robustness following a 0.5 g earthquake causing a tsunami wave up to the 0 m terrace level.

4.6.1 Potential Failure Identification

As previously mentioned, most KNPS equipment is not vulnerable to a tsunami with a maximum wave height of 8 m (0 m terrace level). The water will not breach the terrace level and will not pose a flooding risk to the plant. With the occurrence of an 8 m tsunami, damage is limited to the JPS pump connection point, which is located next to the SEC pump house.

Damage to the plant is predominantly caused by the 0.5 g seismic activity. § 4.4 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) describe the cumulative estimated damage as a result of a 0.4 g earthquake. Increasing the magnitude of seismic activity to 0.5 g, the following could result:

- Failure of the JPP tank at 0.49 g;
- Failure of unit 2 RRA suction line due to an unrestrained cable junction box;
- Failure of unit 2 low head safety injection pipework into reactor coolant system due to possible interaction between the outlet valves RIS 001, 002, and 003 VP and the electrical control box;
- Potential failure of unit 2 containment radiation KRT 003 AR due to exposed wiring; and
- Failure of the EDG, SEC, and turbine hall buildings.

EERT-12-023-RPT found that it is possible to incur additional damage as a result of a 0.5 g seismic activity and tsunami wave up to the 0 m terrace level [10].

The hydrogen storage facility and turbine alternator are potential fire/explosion sources in the event of an earthquake due to the presence of hydrogen gas. A rupture in the system could lead to oxygen ingress which could result in a fire/explosion. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 3**) and turbine hall (could also be damaged by seismic activity), does not result in additional failures as the SEP tank is expected to be unavailable due to the seismic event. The flooding risk posed by the SEP tank to the south-side EDGs does not result in their being unavailable as the EDG buildings were assessed and found to be vulnerable to a 0.5 g seismic activity. No credit is taken for equipment inside the turbine hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from either the overpressure created by the explosion of the hydrogen storage facility or turbine alternator or the initiating seismic event. However, an immediate loss of off-site power is assumed and the unavailability of this equipment has no additional consequences.

The SBO diesel generators were assessed and found to be vulnerable to fire following a 0.5 g earthquake. However, these systems were not analysed during the seismic margin

assessment and hence no credit is taken for their availability. The fire at the SBO diesel generators will not spread to affect any other critical systems; therefore, the potential fire at the SBO diesel generators does not result in additional consequences.

It is possible for the seismic activity to cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The CRF piping, situated in the basement of the turbine hall, could potentially flood parts of this building in the event of seismic activity. However, this does not result in additional failures as no credit is taken for any equipment inside the turbine hall. The RIS / EAS, RRI / SEC, and RCV piping is vulnerable to shearing as a result of seismic activity, which could lead to the internal flooding of equipment. An RIS / EAS pipe rupture could cause the inventory of the PTR tank (if still intact following an earthquake event) to flood the basement of the fuel building. In extreme cases, this water can flood above the 0 m level causing the PTR pumps to be unavailable. This however, does not result in any further consequences as the pumps are only required if the PTR tank and water inventory is still available. Internal flooding as a result of an RRI / SEC pipe rupture would result in the unavailability of the RRA, PTR, and EAS heat exchangers and the EAS and RRI pumps as these systems are cooled by the RRI system. Flooding inside the RRI / SEC rooms would not yield additional failure of critical equipment. Flooding due to an RCV pipe rupture could cause water ingress into the RCV pump itself and the emergency seal supply pump (ESS), however, the RCV pumps were assessed and found to be vulnerable to the earthquake event and the ESS pump was not assessed and hence, no credit is taken for its availability [9].

The functional requirements diagram showing the estimated failures as a result of a combined seismic and tsunami with on-site induced failures is illustrated in Table 11 in Appendix 1.

4.6.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration for implementation at KNPS. The functional requirements diagram generated in § 4.6 (*Beyond-Design-Basis (0.5 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) indicates the potential failure of equipment in the event of a postulated 0.5 g earthquake inducing a tsunami wave not higher than the 0 m terrace level. Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami) is also indicated.

By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirements could be maintained following the event described:

- RCP seal injection

  By installing the shutdown seals, the water inventory inside the primary system can be maintained to ensure the functionality of primary system seal injection is not required.

- Core cooling

  The installation of a hardened SEP tank and associated piping to provide cooling water to the core following a seismic event together with the installation of a fourth ASG pump would ensure the core cooling functionality is not lost.

- Containment integrity

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the EAS spray system. This pump will inject water into the EAS sprays. High-temperature steam will condense into water and subsequently reduce the pressure inside the containment.

- Essential indication

  Hardened instrumentation to indicate core exit temperature, SG level, SG pressure, containment pressure, and SFP level will be installed.

- SFP bulk boiling

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the SFP. In the event that no cooling is available, the SFP water will be allowed to boil and make-up will be provided from the SEP tank.

- Essential 6.6 kV switchboard supply

  It is proposed to procure mobile diesel generators to supply power to the plant following a combined event. The mobile EDGs will be connected to the LHA and LHB switchboards to supply power to available equipment.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram in Table 12 in Appendix 1.

4.7 BEYOND-DESIGN-BASIS (0.5 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO 3.8 M ABOVE THE TERRACE LEVEL

This assessment analyses the plant's robustness following a 0.5 g earthquake causing a tsunami wave that moves over the terrace level up to 3.8 m.

4.7.1 Potential Failure Identification

Damage to the plant is caused by both the seismic and subsequent tsunami events. § 4.6 (*Beyond-Design-Basis (0.5 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) assessed the damage caused to equipment experiencing a combined event of a 0.5 g earthquake and a tsunami wave up to 8 m (0 m terrace level). Seismic damage to plant equipment is similar to that discussed in § 4.6 (*Beyond-Design-Basis (0.5 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) and is therefore not discussed again.

§ 4.3 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) discussed damage to equipment caused by a tsunami wave with a height of up to 3.8 m above the terrace level. Tsunami damage simulated in this combination is similar and is therefore not discussed. The combined functional requirements diagram for

a 0.5 g earthquake inducing a tsunami wave up to 3.8 m above the terrace level is shown in Table 13 in Appendix 1.

EERT-12-023-RPT found that it is possible to experience additional damage as a result of a 0.5 g seismic event and tsunami wave of up to 3.8 m above the terrace level [10].

The hydrogen storage facility could potentially be vulnerable to fire/explosion in the event of a 0.5 g earthquake and/or tsunami wave. Both initiating events could rupture pipework, which could result in oxygen ingress leading to a fire and/or an explosion due to a hydrogen/oxygen mixture. The turbine alternator is also vulnerable to a seismic event, which could lead to a fire/explosion event. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 3**) and the turbine hall, which could also be damaged by alternator explosion, does not result in additional failures as the SEP tank is estimated to be damaged in the seismic event. The flooding risk posed by the SEP tank to the south-side EDG does not result in any further consequences as the assumption is made that the SEP tank water quantity is enveloped by that of the tsunami wave. No credit is taken for equipment inside the turbine hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from the turbine alternator or hydrogen storage facility explosion, tsunami wave, or seismic activity. However, an immediate loss of off-site power is assumed and the unavailability of this equipment does not cause additional consequences.

The SBO diesel generators were assessed and found to be vulnerable to fire following a 0.5 g earthquake. However, these systems were not analysed during the seismic margin assessment and hence no credit is taken for their availability. The potential fire at the SBO diesel generators would not propagate to any critical equipment and therefore, it does not result in additional consequences.

It is possible for the seismic activity or subsequent tsunami wave to cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The CRF piping situated in the basement of the turbine hall below the normal seawater level could potentially flood parts of this building in the event of seismic activity. However, the potential internal flooding hazard posed by the CRF system is not considered, as the assumption is made that the water from the tsunami wave will envelope the water from the CRF rupture. Furthermore, no credit is taken for any equipment inside the turbine hall. The RIS / EAS, RRI / SEC, and RCV piping is vulnerable to shearing as a result of the seismic activity; however, this is not considered as it is assumed that the water released from these systems would be enveloped by the tsunami wave.

No additional on-site induced failures were found and failure of systems is therefore limited to the damage caused by the seismic activity and subsequent tsunami. The functional requirements diagram indicating the estimated damage to plant equipment as a result of the earthquake, tsunami and on-site induced hazards is shown in Table 13 in Appendix 1.

4.7.2 Proposal Implementation

§ 3 (*Proposed Modifications*) lists proposed modifications under consideration for implementation at KNPS. The functional requirements diagram generated in § 4.7 (*Beyond-Design-Basis (0.5 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) indicates the potential failure of equipment in the event of a postulated 0.5 g earthquake inducing a tsunami wave up to a height of 3.8 m above the terrace level. Furthermore, the potential failure of on-site equipment due to on-site hazards induced by the combined event (earthquake and tsunami) is also indicated.

By implementing the proposals as set out in § 3 (*Proposed Modifications*), the following functional requirements could be maintained following the event described.

- RCP seal injection

  By installing the shutdown seals, the water inventory inside the primary system can be maintained to ensure that the functionality of primary system seal injection is not required.

- Core cooling

  The installation of a hardened SEP tank and associated piping to provide cooling water to the core following a seismic event together with the installation of a fourth ASG pump would ensure that the core cooling functionality is not lost.

- Containment integrity

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the EAS spray system. This pump will inject water into the EAS sprays. High-temperature steam will condense into water and subsequently reduce the pressure inside the containment.

- Essential indication

  Hardened instrumentation to indicate core exit temperature, SG level, SG pressure, containment pressure, and SFP level will be installed.

- SFP bulk boiling

  The installation of the hardened SEP tank and associated piping will provide water to a portable pump connected to the SFP. In the event that no cooling is available, the SFP water will be allowed to boil and make-up will be provided from the SEP tank.

- Essential 6.6 kV switchboard supply

  It is proposed to procure mobile diesel generators to supply power to the plant following a combined event. The mobile EDGs will be connected to the LHA and LHB switchboards to supply power to available equipment.

The implementation of the proposed modifications is graphically shown in the functional requirements diagram in Table 14 in Appendix 1.

4.8 BEYOND-DESIGN-BASIS (0.6 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO THE 0 M TERRACE LEVEL

This assessment analyses the plant's robustness following a 0.6 g earthquake causing a tsunami wave up to the 0 m terrace level.

4.8.1 Potential Failure Identification

As previously mentioned, most KNPS equipment is not vulnerable to a tsunami with a maximum wave height of 8 m (up to the 0 m terrace level). The water will not move over the terrace level and pose no flooding risk to the plant. With the occurrence of an 8 m tsunami, damage is limited to the JPS pump connection point, which is located next to the SEC pump house.

Damage to the plant is predominantly caused by the 0.6 g seismic activity. § 4.2 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*), § 4.4 (*Beyond-Design-Basis (0.4 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*), and § 4.6 (*Beyond-Design-Basis (0.5 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) describe the cumulative estimated damage as a result of 0.3 g, 0.4 g, and 0.5 g earthquakes respectively. Increasing the magnitude of seismic activity to 0.6 g could yield the following additional failures:

- the JPP-, and REA boron pumps;
- the residual heat removal system safety valves;
- the RCP system integrity (vessel, pumps, and pressuriser);
- steam generators including all relevant valves, flanges and fittings;
- the containment sump functionality. This includes filters and piping inside the containment for sump water collection for supply to low-head safety injection and containment spray systems;
- ASG tank, due to compression buckling of the tank wall at 0.55 g;
- the KRT monitors located on the + 20 m level inside the containment building;
- in-core temperature indication (RIC);
- containment airlocks integrity could be vulnerable; and
- the following switchboards:
    - 6.6 kV train A essential switchboard (LHA);
    - 220 V train A essential switchboard (LNA);
    - 48 V train B relaying supply switchboard (LCB);
    - 220 V train A switchboard (LBC and LBD);
    - 220 V train B switchboard (LBE and LBF).

EERT-12-023-RPT found that it is possible to incur additional damage as a result of a 0.6 g seismic event and tsunami wave up to the 0 m terrace level [10].

The hydrogen storage facility and the turbine alternator are regarded as potential fire/explosion sources in the event of an earthquake due to the presence of hydrogen gas. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 3**) and turbine hall, does not result in additional failures as the SEP tank is expected to be vulnerable to the seismic event. The unlikely flooding risk posed by the SEP tank to the south-side EDGs does not result in their potential unavailability as it is estimated that these systems have failed already due to the seismic event. No credit is taken for equipment inside the turbine hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from either the overpressure generated by the hydrogen storage facility or turbine alternator explosion or the initiating seismic event. However, an immediate loss of off-site power is assumed and the unavailability of this equipment does not have additional consequences.

The SBO and EDG diesel generators were assessed and found to be vulnerable to fire following a 0.6 g earthquake. However, the SBO diesel generators were not analysed during the seismic margin assessment and hence no credit is taken for their availability. The EDGs were found not to be robust against a 0.6 g earthquake and would have failed already due to the seismic event. The potential fire inside the SBOs and EDGs is not likely to propagate to areas outside the building and does not pose a risk to surrounding equipment. Therefore, the potential fire at the SBO and EDG diesel generators does not result in additional consequences.

It is likely that the seismic activity would cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The CRF piping situated in the basement of the turbine hall is likely to rupture during a 0.6 g earthquake, which could potentially flood parts of this building. However, this does not result in additional failures as no credit is taken for any equipment inside the turbine hall. The RIS / EAS, RRI / SEC, and RCV piping is vulnerable to shearing as a result of seismic activity which could lead to the internal flooding of equipment. Flooding due to an RCV pipe rupture could cause water ingress into the RCV pump itself and the ESS pump, however the RCV pumps were assessed and found to be vulnerable to the earthquake event; the ESS pump was not assessed and hence no credit is taken for its availability. Therefore, this does not result in further consequences. The RIS / EAS pipe rupture could cause the inventory of the PTR tank to flood the basement of the fuel building. In extreme cases, this water can flood above the 0 m level causing the PTR pumps to be unavailable. This however, does not result in any further consequences as the PTR tank is only qualified up to a 0.3 g earthquake and it is likely that the water inventory would be lost. In this case, the PTR pumps would not be required. Internal flooding as a result of an RRI / SEC pipe rupture could result in the unavailability of the RRA, PTR, and EAS heat exchangers and the EAS and RRI pumps as these systems are cooled by RRI. Flooding inside the RRI / SEC rooms would not yield additional failure of critical equipment. The ASG tanks are likely to fail in the event of a 0.6 g earthquake. The consequence of the unit 2 ASG tank failure is limited to the loss of the tank's water inventory. This is because the tank is situated inside its own building and poses no risk to surrounding equipment. The consequence of the unit 1 ASG tank failure is the flooding of adjacent rooms

containing the ASG motor and steam-driven pumps. This would result in the unavailability of these pumps [9].

The functional requirements diagram showing the combined seismic and tsunami with on-site induced failures is illustrated in Table 15 in Appendix 1.

4.8.2 Proposal Implementation

The functional requirements diagram for the implementation of the proposed modification is not performed as the proposals are only qualified up to a 0.5 g earthquake. Although the modifications are likely to be robust beyond 0.5 g, it is currently not possible to quantify this.

4.9 BEYOND-DESIGN-BASIS (0.6 G) EARTHQUAKE INDUCING A TSUNAMI WAVE UP TO 3.8 M ABOVE THE TERRACE LEVEL

This assessment analyses the plant's robustness following a 0.6 g earthquake causing a tsunami wave that moves over the terrace level up to 3.8 m.

4.9.1 Potential Failure Identification

Damage to the plant is caused by both the seismic and subsequent tsunami events. § 4.8 (*Beyond-Design-Basis (0.6 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) assessed the damage caused to equipment experiencing a combined event of a 0.6 g earthquake causing a tsunami up to 8 m. Seismic damage to the plant in this assessment is similar as highlighted in § 4.8 (*Beyond-Design-Basis (0.6 g) Earthquake inducing a Tsunami Wave up to the 0 m Terrace Level*) and therefore is not discussed again.

§ 4.3 (*Design Basis (0.3 g) Earthquake inducing a Tsunami Wave up to 3.8 m above the Terrace Level*) discussed damage caused to equipment from a tsunami wave with a height of up to 3.8 m above the terrace level. Tsunami damage simulated in this combination would be similar and is therefore not discussed. The combined functional requirements diagram for a 0.6 g earthquake inducing a tsunami wave up to 3.8 m above the terrace level is shown in Table 16 in Appendix 1.

EERT-12-023-RPT found that it is possible to experience additional damage as a result of a 0.6 g seismic activity and tsunami wave up to 11.8 m (3.8 m above the terrace level) [10].

The hydrogen storage facility could potentially be vulnerable to fire/explosion in the event of a 0.6 g earthquake and tsunami wave. Both initiating events could rupture pipework, which could result in oxygen ingress leading to a fire and/or explosive hydrogen/oxygen mixture. The turbine alternator is also vulnerable to a seismic event, which could lead to a fire/explosion event. The fire/explosion of the hydrogen storage facility, which could cause damage to the SEP tank (refer to proposal **CM 3**) and turbine hall, does not result in additional consequences as the SEP tank is estimated to be unavailable due to the seismic event. The flooding risk posed by the SEP tank to the south-side EDGs does not result in any further consequences as it is believed that the SEP tank water quantity is enveloped by that of the tsunami wave. No credit is taken for equipment inside the turbine

hall and the fire/explosion of the turbine alternator will predominantly cause damage to equipment inside this building. Furthermore, it is possible that the power transformers could be damaged from either the turbine alternator or hydrogen storage facility explosion, initiating seismic event or subsequent tsunami. However, an immediate loss of off-site power is assumed and the unavailability of this equipment does not have additional consequences.

The SBO and EDG diesel generators were assessed and found to be vulnerable to fire following a 0.6 g earthquake. However, the SBO diesel generators were not analysed during the seismic margin assessment and hence no credit is taken for their availability. The EDGs are not robust against a 0.6 g earthquake, and it is estimated that they would have failed already due to the seismic event. The potential fire inside the EDGs and SBOs is not likely to propagate to areas outside the building and does not pose a risk to surrounding equipment. Therefore, the potential fire at the SBO and EDG diesel generators does not result in additional consequences.

It is possible for the seismic activity or subsequent tsunami wave to cause damage to the ammonia tanks situated close to the demineralisation plant. Although this will not result in any additional failures, it could hamper corrective actions by plant personnel in the event of an accident by virtue of the site being uninhabitable as a result of the chemical release (refer to proposal **CM 5**).

The CRF piping situated in the basement of the turbine hall below the normal seawater level could potentially flood parts of this building in the event of seismic activity. However, this water is not considered, as the assumption is made that the water from the tsunami wave will envelop the water from the CRF rupture. Furthermore, no credit is taken for any equipment inside the turbine hall. The RIS / EAS, RRI / SEC, and RCV piping and the ASG tank are vulnerable as a result of the seismic activity; however this is not considered as the water released from these systems would be enveloped by the tsunami event.

No additional on-site induced failures were found and failure of systems is therefore limited to the damage caused by the seismic activity and subsequent tsunami. The functional requirements diagram for a 0.6 g seismic event inducing a tsunami wave up to a 3.8 m level above the terrace level is shown in Table 16 in Appendix 1.

4.9.2 Proposal Implementation

The functional requirements diagram for the implementation of the proposed modification was not performed as the proposals are only qualified up to a 0.5 g earthquake. Although the modifications are likely to be robust beyond the 0.5 g point, it is currently not possible to quantify this.

4.10 FLOODING HAZARDS IN EXCESS OF THE 3.8 M TERRACE LEVEL

In the event of an earthquake inducing a tsunami wave greater than 11.8 m (3.8 m above the 0 m terrace level), it is estimated that additional systems would be unavailable. The functional requirements diagrams are not illustrated and additional failures are only discussed.

Increasing the water height that inundates the site area up to a level of 14 m (6 m above the 0 m terrace level) results in the flooding of the battery rooms on the 3.8 m level (11.8 m above MSL). This will cause failure of the station batteries and yield any battery-powered equipment such as the essential instrumentation for monitoring purposes unavailable, highlighting the need for a robust, hardened indication system as proposed.

By increasing the tsunami wave height up to 15 m (7 m above the terrace level) the only additional failure is the station black-out (SBO) diesel generators. The SBO diesel generators were installed as a back-up system to supply two functions; charging of the station batteries, and supplying power to an emergency seal injection pump. Failure of the SBO diesel generators yields no additional system failures as the station batteries (3.8 m level) and emergency seal injection pump (0 m terrace level) are located below the level of the SBO diesel generators (14 m above MSL). These systems would already be unavailable as they are submerged in water and therefore no additional failures were found.

Flooding levels exceeding 15 m above MSL (7 m above the terrace level) will result in the failure of the station's electrical switchboards. In this event, total reliance on the external mobile pumps would be required [8].

5 CONCLUSION

The occurrence of an earthquake with subsequent tsunami at KNPS is unlikely. However, if such an event had to occur; it is plausible that the earthquake and/or tsunami could induce events such as chemical spills, explosions, and fire. This study completed an assessment on the combination of these events.

This assessment is comprehensive for seismic activity up to 0.6 g for both unit 1 and 2.

The most equipment failures would occur due to the occurrence of an earthquake and/or tsunami. The risks and mitigations were documented in EERT-11-015 (*Seismic Hazard Report*) and EERT-11-016 (*Tsunami Hazard Report*).

This assessment assumes the installation of the following modifications as detailed in § 3:

- shutdown seals;
- installation of an additional auxiliary feedwater system (on each unit);
- hardened SEP tank and associated piping;
- portable emergency equipment (PEE);
- hardened instrumentation; and
- mobile diesel generators and connection points.

The functional requirements diagram highlighted the plant's ability to ensure core and SFP cooling and to maintain containment integrity. With the installation of the modifications proposed in this report, Koeberg should maintain critical functional requirements required to survive a beyond-design-basis earthquake with a subsequent tsunami event. In addition, Koeberg will also be able to survive the occurrence of on-site failures due to seismic/tsunami induced on-site hazards (explosion, fire, and chemical spill).

The only significant additional damage and failures found are:

- An explosion at the hydrogen storage facility could result in a loss of integrity of the SEP tank and associated piping. If this is combined with station black-out conditions, which could be caused by an earthquake and induced tsunami, such an explosion would affect the proposed mitigative strategy of using the SEP tank as an ultimate water source.
- In the event that the explosion of the hydrogen storage facility causes damage to the SEP tank, the water inventory of this tank could pose a flooding risk to the south-side EDGs. The diesel transfer pumps are located at the lowest point in the diesel building and are vulnerable to water ingress.
- The possible vulnerability of the ammonia tanks could hamper the implementation of mitigative strategies to prevent or mitigate core melt.
- Internal flooding from the ASG tanks and RRI / SEC piping could result in additional failure of equipment.

Other induced failures such as fires or explosions in the turbine hall, unit and generator transformer fires, and flooding by CRF do not lead to additional failure as the loss of off-site power and the loss of ultimate heat sink have already been identified. Based on the results derived in this assessment, additional proposals are made in the following section.

6 PROPOSALS

The combination assessment completed in this report yielded the following proposals to increase the robustness of the plant against external events such as earthquakes and tsunamis:

- It is proposed that Koeberg develop a tsunami early warning system to provide accurate early indication on possible tsunami formation following an earthquake event;
- It is proposed to develop a locally calibrated tsunami hazard assessment model/methodology;
- It is proposed that EERT-11-016 (*Tsunami Hazard Report*) be revised to include the potential damage to plant buildings and SSCs as a result of the impact energy from the tsunami waves;
- It is proposed that the seismically hardened SEP tank and associated pipework be robust against any overpressure generated by an explosion due to its proximity to the hydrogen storage facility, which could be vulnerable in the event of a seismic activity. An alternative solution would be the relocation of the hydrogen storage facility to a remote area not surrounded by critical equipment;
- It is proposed that a seismically qualified barrier be erected in front of the south-side EDGs to protect these EDGs from possible water ingress in the event of an SEP tank rupture; and
- It is proposed that any preventative measures (such as tank strengthening) and/or mitigation strategies (such as protective clothing) to deal with a potential chemical release be robust against the sequential occurrence of an earthquake and tsunami. An alternative solution would be to investigate the use of alternative non-toxic chemicals to replace the existing ammonia on site.
- It is proposed that a connection point, robust against earthquakes and tsunamis, be installed on the RCV charging line to allow connection of a permanent/portable pump to directly inject borated water into the RCP system (refer to EERT-11-026 (*Loss of Off-Site Power Report*) [11]). This will provide an emergency make-up path for the injection of borated water into the primary system to ensure sub criticality if other conventional means of injection is not available.

7 REFERENCES

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APPENDIX 1:

FUNCTIONAL REQUIREMENTS DIAGRAMS

Table 5:
Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM						
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI			
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP							
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*			
		SG	C-I22	SG Integrity	SG*	SGs*								
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*			
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL						
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP		
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI			
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO							
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO	ESS-SI			
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP									
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI			
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS							
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*				
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*				
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP		
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM						
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~				
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~			
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK				
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV						
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG					
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG					
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK						
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*		
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT								
		Direct Core Injection	*See C4. Primary System Make-up											
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT			
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx					
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS					
			C-L64	Containment Venting										
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs								
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding										

Table 5:
Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHIxxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT				
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD		VLT			
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 5:
Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 6:
Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement									
	Functional Requirement	**Sub-Function**	**Methods to fulfil Functional Req. (SSCs)**			**Sub-SSC**						
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM				
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV					
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI	
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP					
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*	
		SG	C-I22	SG Integrity	SG*	SGs*						
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*	
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL				
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV					
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI	
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal						
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO					
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV					
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP						ESS-SI	
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI	
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI	
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS					
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*		
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*		
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM				
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~		
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL			
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~	
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK		
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV				
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG			
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG			
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK				
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO					
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT						
		Direct Core Injection	*See C4. Primary System Make-up									
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT	
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx			
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS			
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS	PEE-PO				
			C-L64	Containment Venting								
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs						
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL			
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding								

Table 6:

Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 6:

Functional requirements diagram for a design basis earthquake (0.3 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*	
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB					
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA							
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA				
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON							
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*	
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB					
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB							
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB				
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON							
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB					
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB				
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]								
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT								
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB				
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]								
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT								
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB				
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]								
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT								
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB				
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]								
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT								
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB				
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB					
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]								
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT								
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB				
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB					
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]								
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT								
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB				
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB					
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]								
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT								
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB				
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB					
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]								
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT								
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]			
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX				
		Alternative Heatsink	U-3	Alternative Heatsink										
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]						
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]						
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]						
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]						

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 7:
Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM							
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO					
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI				
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP								
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*				
		SG	C-I22	SG Integrity	SG*	SGs*									
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*				
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL							
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP			
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI				
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO								
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO					
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP						ESS-SI				
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI				
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI				
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS								
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*					
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*					
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP			
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM							
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~					
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~				
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK					
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV							
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG						
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG						
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK							
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*			
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT									
		Direct Core Injection	*See C4. Primary System Make-up												
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT				
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx						
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS						
			C-L64	Containment Venting											
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs									
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding											

Table 7:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHIxxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 7:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 8:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement				
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC	
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD / CRDM
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP / RCP
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps* / RCP Vessel* / RCP Pressuriser* / PORVs* / Safety Valves*
		SG	C-I22	SG Integrity	SG*	SGs*	
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL* / RRA-PO* / RRA-Hx* / RRA-DL* / RRA-SV*
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL / RRA-DL
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-SI / RCP
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-SI / RCP
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal	
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-HSI / RCP
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP	PTR-TNK	PTR-RIS / RIS-PO / RIS-LSI / RCP
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS / RIS-PO / RIS-LSI / RCP
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO / EAS-RIS / RIS-PO* / RIS-LSI / RCP
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO* / EAS-4PO / RIS-PO* / RIS-LSI / RCP
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS / RIS-PO* / RIS-LSI / RCP
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT / GCTa-STM
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~	SGs	VVP-GCT / GCTc-STM / ~~CEX-TNK~~ / ~~CEX-PO~~
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	ASG-M/PO / ASG-M/FL / ASG-SG/FL / SGs
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~ / ~~ABP-HX*~~ / ~~APA-PO~~ / ~~AHP-HX*~~ / ~~ARE-SG/FL~~ / SGs
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK	SER-PO / SER-ASG / ASG-TNK
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)	SER-TNK	SER-BV / SER-ASG / ASG-TNK
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK	JPP-PO / JPD-ASG / ASG-TNK
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S / JPS-PO / JPD-ASG / ASG-TNK
			C-L59	SEP Make-up to JPP	SEP/JPP	SEP-TNK	SEP-JPP/S / JPP-TNK
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL / RRA-PO / RRA-Hx / RRA-DL / RRA-SV / RCP*
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT	
		Direct Core Injection	*See C4. Primary System Make-up				
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS / EAS-PO / EAS-SPR / CONT
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS / EAS-PO / EAS-Hx / EAS-SPR / CONT
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO / JPP-JPC / JPC-EAS / EAS-SPR / CONT
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS / PEE-PO / EAS-SPR / CONT
			C-L64	Containment Venting			
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs	
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	ASG-M/PO / ASG-M/FL / ASG-SG/FL / SGs
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding			

Table 8:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 8:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON								
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON								
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 9:
Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM						
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO	ESS-SI			
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP									
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP							
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*			
		SG	C-I22	SG Integrity	SG*	SGs*								
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*			
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL						
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP		
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI			
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO							
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO	ESS-SI			
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP									
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO				
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS				RIS-LSI			
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*				
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*				
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP		
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM						
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~				
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~			
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK				
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV						
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG					
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG					
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK						
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*		
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT								
		Direct Core Injection	*See C4. Primary System Make-up											
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT			
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx					
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS					
			C-L64	Containment Venting										
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs								
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding										

Table 9:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 9:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHB	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 10:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM							
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCV-CL		RCP	
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		ESS-SI			
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP										
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP								
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*				
		SG	C-I22	SG Integrity	SG*	SGs*									
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*				
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL							
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCV-SI		RCP	
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO		ESS-SI			
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal									
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCV-CL		RCP	
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO								
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		ESS-SI			
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP										
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO		RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO					
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS					RIS-LSI			
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*					
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*					
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*		RIS-LSI		RCP	
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM							
		~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~				~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~					
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	ASG-T/SS	ASG-T/FL			ASG-SG/FL		SGs	
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~				
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK					
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV							
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG						
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG						
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK							
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO								
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*			
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT									
		Direct Core Injection	*See C4. Primary System Make-up												
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT				
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx						
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS						
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS	PEE-PO							
			C-L64	Containment Venting											
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs									
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	ASG-T/SS	ASG-T/FL			ASG-SG/FL		SGs	
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding											

Table 10:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHxxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 10:

Functional requirements diagram for a beyond-design-basis earthquake (0.4 g) inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON								
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON								
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 11:

Functional requirements diagram for a beyond-design-basis earthquake (0.5 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM							
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO					
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI				
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP								
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*				
		SG	C-I22	SG Integrity	SG*	SGs*									
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*				
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL							
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP			
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI				
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO								
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO	ESS-SI				
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP										
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI				
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI				
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP		SMP-RIS								
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*					
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*					
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP			
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM							
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~					
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~				
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK					
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV							
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG						
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG						
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK							
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*			
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT									
		Direct Core Injection	*See C4. Primary System Make-up												
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT				
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx						
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS						
			C-L64	Containment Venting											
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs									
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding											

Table 11:

Functional requirements diagram for a beyond-design-basis earthquake (0.5 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 11:

Functional requirements diagram for a beyond-design-basis earthquake (0.5 g) inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	**400KV**	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*		
			E-2	132 KV LHA Supply	132KV/LHA	**132KV**	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	**LHP-DSL**	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	**400KV**	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*		
			E-6	132 KV LHB Supply	132KV/LHB	**132KV**	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	**LHQ-DSL**	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	**LLS-DSL**	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	**[LHA]**		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	**[LLY]**									
			E-23	LCA Switchboard - Battery	LCA\BAT	**LCA-BAT**									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	**[LHB]**		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	**[LLY]**									
			E-26	LCB Switchboard - Battery	LCB\BAT	**LCB-BAT**									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	**[LHA]**		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	**[LLY]**									
			E-33	LBA Switchboard - Battery	LBA\BAT	**LBA-BAT**									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	**[LHB]**		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	**[LLY]**									
			E-36	LBB Switchboard - Battery	LBB\BAT	**LBB-BAT**									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	**[LHA]**	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	**[LLY]**									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	**LBC-BAT**									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	**[LHB]**	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	**[LLY]**									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	**LBD-BAT**									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	**[LHA]**	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	**[LLY]**									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	**LBE-BAT**									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	**[LHB]**	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	**[LLY]**									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	**LBF-BAT**									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 12:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM							
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO					
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI				
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP								
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*				
		SG	C-I22	SG Integrity	SG*	SGs*									
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*				
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL							
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP			
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI				
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal									
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP			
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO								
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV								
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO					
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP						ESS-SI				
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI				
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI				
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS								
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*					
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*					
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP			
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM							
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~					
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~				
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK					
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV							
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG						
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG						
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK							
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO								
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*			
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT									
		Direct Core Injection	*See C4. Primary System Make-up												
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT				
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx						
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS						
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS	PEE-PO							
			C-L64	Containment Venting											
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs									
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL						
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding											

Table 12:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 12:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to the 0 m terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON								
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON								
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 13:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement													
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC										
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM								
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCV-CL		RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV									
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		ESS-SI				
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP											
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP									
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*					
		SG	C-I22	SG Integrity	SG*	SGs*										
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*					
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL								
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI		RCP			
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV									
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI					
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO		RCV-CL		RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO									
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV									
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO		ESS-SI				
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP											
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI					
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO						
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS					RIS-LSI				
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*						
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*						
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP				
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM								
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~						
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	~~ASG-T/SS~~	~~ASG-T/FL~~		ASG-SG/FL		SGs			
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		~~ASG-M/PO~~		~~ASG-M/FL~~							
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~					
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK						
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV								
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG							
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG							
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK								
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*				
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT										
		Direct Core Injection	*See C4. Primary System Make-up													
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT					
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx							
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS							
			C-L64	Containment Venting												
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs										
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~	~~ASG-T/SS~~	~~ASG-T/FL~~		ASG-SG/FL		SGs			
			~~C-L53~~	Motor Driven ASG Pumps	ASG/ASGm/SG		~~ASG-M/PO~~		~~ASG-M/FL~~							
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding												

Table 13:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		AREXXXMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 13:
Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 14:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement				
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC	
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD / CRDM
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP / RCP
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps* / RCP Vessel* / RCP Pressuriser* / PORVs* / Safety Valves*
		SG	C-I22	SG Integrity	SG*	SGs*	
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL* / RRA-PO* / RRA-Hx* / RRA-DL* / RRA-SV*
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL / RRA-DL
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-SI / RCP
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-SI / RCP
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
		Shutdown Seal	C-I25	Emergency Shutdown Seal	RCP	SD-Seal	
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-HSI / RCP
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP	PTR-TNK	PTR-RIS / RIS-PO / RCV-HSI / RCP
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS / RIS-PO / RIS-LSI / RCP
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO / EAS-RIS / RIS-PO* / RIS-LSI / RCP
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO* / EAS-4PO / RIS-PO* / RIS-LSI / RCP
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS / RIS-PO* / RIS-LSI / RCP
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT / GCTa-STM
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~	SGs	VVP-GCT / GCTc-STM / ~~CEX-TNK~~ / ~~CEX-PO~~
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~ / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	ASG-M/PO / ASG-M/FL / ASG-SG/FL / SGs
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~ / ~~ABP-HX*~~ / ~~APA-PO~~ / ~~AHP-HX*~~ / ~~ARE-SG/FL~~ / SGs
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK	SER-PO / SER-ASG / ASG-TNK
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)	SER-TNK	SER-BV / ASG-TNK
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK	JPP-PO / JPD-ASG / ASG-TNK
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	JPS-PO / JPD-ASG / ASG-TNK
			C-L59	SEP Make-up to JPP	SEP/JPP	SEP-TNK	SEP-JPP/S / JPP-TNK
			C-L67	4th SG Injection	SEP/ASGx/SG	SEP-TNK	ASG-4PO
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL / RRA-PO / RRA-Hx / RRA-DL / RRA-SV / RCP*
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT	
		Direct Core Injection	*See C4. Primary System Make-up				
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS / EAS-PO / EAS-SPR / CONT
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS / EAS-PO / EAS-Hx / EAS-SPR / CONT
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO / JPP-JPC / JPC-EAS / EAS-SPR / CONT
			C-L68	EAS Emergency Backup	SEP/EASx/CNT	SEP-TNK	SEP-EAS / PEE-PO / EAS-SPR / CONT
			C-L64	Containment Venting			
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs	
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~ / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	ASG-M/PO / ASG-M/FL / ASG-SG/FL / SGs
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding			

Table 14:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
			S-L7	SEP Make-up	SEP/SFPx	SEP-TNK	SEP/SFPx	PEE-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK	JPP-PO	JPP-JPD	JPD-VLT	VLT				
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 14:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-60	MBL Diesel LHA Supply	MBL-DSL/LHA	MBL-DSL	MBL-DSL-CON								
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
			E-61	MBL Diesel LHB Supply	MBL-DSL/LHB	MBL-DSL	MBL-DSL-CON								
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 15:

Functional requirements diagram for a beyond-design-basis (0.6 g) earthquake inducing a tsunami wave up to the 0 m terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD	CRDM						
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO				
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP						ESS-SI			
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP							
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps*	RCP Vessel*	RCP Pressuriser*	PORVs*	Safety Valves*			
		SG	C-I22	SG Integrity	SG*	SGs*								
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL*	RRA-PO*	RRA-Hx*	RRA-DL*	RRA-SV*			
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL	RRA-DL						
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-SI	RCP		
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP		PTR-ESS			ESS-PO	ESS-SI			
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO	REA-RCV		RCV-PO	RCV-CL	RCP		
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO							
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV							
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP		PTR-ESS			ESS-PO	ESS-SI			
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP									
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP		PTR-RCV			RCV-PO	RCV-HSI			
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP		PTR-RIS			RIS-PO	RIS-LSI			
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	CNT-SMP	SMP-RIS							
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP		SMP-EAS	EAS-PO	EAS-RIS	RIS-PO*				
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP		SMP-EAS	EAS-PO*	EAS-4PO	RIS-PO*				
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS			RIS-PO*	RIS-LSI	RCP		
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT	GCTa-STM						
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~			~~GCTc-STM~~	~~CEX-TNK~~	~~CEX-PO~~				
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~	~~ABP-HX*~~	~~APA-PO~~	~~AHP-HX*~~	~~ARE-SG/FL~~			
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK		SER-PO	SER-ASG	ASG-TNK				
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)			SER-BV						
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK		JPP-PO	JPD-ASG					
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	SEP-JPP/S	JPS-PO	JPD-ASG					
			C-L59	SEP Make-up to JPP	SEP/JPP			JPP-TNK						
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL	RRA-PO	RRA-Hx	RRA-DL	RRA-SV	RCP*		
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT								
		Direct Core Injection	*See C4. Primary System Make-up											
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS	EAS-PO		EAS-SPR	CONT			
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS	EAS-PO	EAS-Hx					
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO	JPP-JPC	JPC-EAS					
			C-L64	Containment Venting										
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs								
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	ASG-T/PO	ASG-T/SS	ASG-T/FL		ASG-SG/FL	SGs		
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG		ASG-M/PO		ASG-M/FL					
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding										

Table 14:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]					
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]					
		Reactor Level Indication	C-I24	RVLIS											
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]					
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]					
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]					
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]					
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN									
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN									
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]					
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]				
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]					
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT									
		Containment Sump Temperature	C-I51												
		Containment Hydrogen Sampling	C-I52												
		Reactor Pit Temperature	C-I53												
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP								
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL			
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN				
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL			
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL					
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD									
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL					
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP						
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO							
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]				
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]					
		Fuel Rack Temperature	S-I3												
		SFP Boron Concentration	S-I4												
		SFP Building Pressure	S-I5												
		SFP Hydrogen Concentration	S-I6												
		SFP Building Humidity	S-I7												
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT				
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD						
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT								
	V.2 Indication	Seismic Vault Temperature	VI-1												
		Seismic Vault Water Level	VI-2												
		Seismic Vault Pressure	VI-3												
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*									
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR								
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks					
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB									
	B3. Electrical Building		B3	Electrical Building		B-ELE									
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL									
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO									
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC									
	B7. Turbine Hall		B7	Turbine Hall		B-TUR									
	B8. LLW Building		B8	Low Level Waste Building		B-LLW									
	B9. ECC		B9	Emergency Control Centre		B-ECC									

Table 14:

Functional requirements diagram for a beyond-design-basis (0.5 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level with proposed modifications implemented

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	E1. Essential 6.6kV Switchboard Supply	LHA Switchboard Supply [LHA]	E-1	400 KV LHA Supply	400KV/LHA	400KV	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	[LCA]	[LBA]		
			E-2	132 KV LHA Supply	132KV/LHA	132KV	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	LHP-DSL	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply [LHB]	E-5	400 KV LHB Supply	400KV/LHB	400KV	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	[LCB]	[LBB]		
			E-6	132 KV LHB Supply	132KV/LHB	132KV	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	LHQ-DSL	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	LHS-DSL	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply [LLY]	E-10	LLY Switchboard Supply	LLS\LLX\LLY	LLS-DSL	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply [LCA]	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	[LHA]		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	[LLY]									
			E-23	LCA Switchboard - Battery	LCA\BAT	LCA-BAT									
		LCB 48V Switchboard Supply [LCB]	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	[LHB]		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	[LLY]									
			E-26	LCB Switchboard - Battery	LCB\BAT	LCB-BAT									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply [LBA]	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	[LHA]		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	[LLY]									
			E-33	LBA Switchboard - Battery	LBA\BAT	LBA-BAT									
		LBB 125V Switchboard Supply [LBB]	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	[LHB]		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	[LLY]									
			E-36	LBB Switchboard - Battery	LBB\BAT	LBB-BAT									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards [LNA]	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	[LHA]	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB		LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	[LLY]		LBC-RD							
			E-44	SIP I Battery Supply	LNA/LBC/BAT	LBC-BAT									
		LNB 220V Essential Switchboards [LNB]	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	[LHB]	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB		LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	[LLY]		LBD-RD							
			E-48	SIP II Battery Supply	LNB/LBD/BAT	LBD-BAT									
		LNC 220V Essential Switchboards [LNC]	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	[LHA]	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB		LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	[LLY]		LBE-RD							
			E-52	SIP III Battery Supply	LNC/LBE/BAT	LBE-BAT									
		LND 220V Essential Switchboards [LND]	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	[LHB]	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB		LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	[LLY]		LBF-RD							
			E-56	SIP IV Battery Supply	LND/LBF/BAT	LBF-BAT									
Ultimate Heatsink	U1. Essential Cooling	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency

Table 16:

Functional requirements diagram for a beyond-design-basis (0.6 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement				
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC	
Reactor Core	C1. Sub-Criticality	Control Rods	C-S1	Control Rod	CRDMs	FL-ASS	CNTL-ROD / CRDM
		Boron Injection	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal charging from PTR tank	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
			C-L34	Charging using Emergency Seal Injection	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
			C-L33	Emergency Seal Injection	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
			C-L11	Accumulators	ACC/RCP	ACC	ACC-RCP / RCP
	C2. Primary System Integrity	RCP System	C-I21	RCP Integrity	RCP*	RCP*	RCP Pumps* / RCP Vessel* / RCP Pressuriser* / PORVs* / Safety Valves*
		SG	C-I22	SG Integrity	SG*	SGs*	
		RRA System Integrity (SD)	C-I23	RRA Integrity	RCP*/RRA*/RCP*	RCP*	RRA-SL* / RRA-PO* / RRA-Hx* / RRA-DL* / RRA-SV*
		RRA System Isolation (SD)	C-I24	RRA Isolation	RCP*	RCP*	RRA-SL / RRA-DL
	C3. RCP Seal injection	Normal Seal Injection	C-L31	Normal Seal Injection	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-SI / RCP
			C-L32	PTR Seal Injection	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-SI / RCP
		Emergency Seal Injection	C-L33	Emergency Seal Injection	ESS/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
	C4. Primary System Make-up	RCV Normal charging	C-L42	REA Boration (direct or normal)	REA/RCV/RCP	REA/B-TNK	REA/B-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L43	Normal charging from REA water system	REA/RCV/RCP	REA/W-TNK	REA/W-PO / REA-RCV / RCV-PO / RCV-CL / RCP
			C-L44	Normal Charging from PTR	PTR/RCV/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-CL / RCP
		ESS Charging Injection (*Low Flow*)	C-L34	Charging using ESS (6m3/hr)	ESS/ESS-CL/RCP	PTR-TNK	PTR-ESS / ESS-PO / RCV-CL / RCP
		ESS Seal injection (*Low Flow*)	C-L33	Emergency Seal Injection (6m3/hr)	ESS/ESS-SI/RCP	PTR-TNK	PTR-ESS / ESS-PO / ESS-SI / RCP
		HHSI - Direct Inj.	C-L45	HHSI Direct Injection	PTR/RCV/BIT/RCP	PTR-TNK	PTR-RCV / RCV-PO / RCV-HSI / RCP
		LHSI - Direct Inj.	C-L46	LHSI Direct Injection	PTR/RIS/RCP	PTR-TNK	PTR-RIS / RIS-PO / RIS-LSI / RCP
		LHSI - Recirculation	C-L47	LHSI Recirculation	SMP/RIS/RCP	PTR-TNK	SMP-RIS / RIS-PO / RIS-LSI / RCP
		EAS Back-up to RIS	C-L48	EAS Back-up to RIS	SMP/EAS/EAS-4PO/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO / EAS-RIS / RIS-PO* / RIS-LSI / RCP
		EAS 004 Back-up to RIS	C-L49	EAS Back-up to RIS	SMP/EAS/EAS-RIS/RIS/RCP	CNT-SMP	SMP-EAS / EAS-PO* / EAS-4PO / RIS-PO* / RIS-LSI / RCP
		PTR Gravity Feed (SD - Head Off)	C-L61	PTR Gravity Feed	PTR/RIS*/RCP	PTR-TNK	PTR-RIS / RIS-PO* / RIS-LSI / RCP
	C5. Core Cooling	SG Steam Dump	C-L50	GCTa Steam Dump	SG/VVP/GCTa	SGs	VVP-GCT / GCTa-STM
			~~C-L51~~	~~GCTc Steam Dump~~	~~SG/VVP/GCTc~~		~~GCTc-STM~~ / ~~CEX-TNK~~ / ~~CEX-PO~~
		SG Feedwater	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~ / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	~~ASG-M/PO~~ / ASG-M/FL / ASG-SG/FL / SGs
			~~C-L54~~	~~ARE Main Feed~~	~~CEX/APA/SG~~	~~CEX-TNK~~	~~CEX-PO~~ / ~~ABP-HX*~~ / ~~APA-PO~~ / ~~AHP-HX*~~ / ~~ARE-SG/FL~~
		SG Long term Feedwater Supply	C-L55	SER Make-up to ASG	SER/ASG	SER-TNK	SER-PO / SER-ASG / ASG-TNK
			C-L56	SER gravity Make-up to ASG	SER/ASG (gravity)	SER-TNK	SER-BV / SER-ASG / ASG-TNK
			C-L57	JPP Make-up to ASG	JPP/JPD/ASG	JPP-TNK	JPP-PO / JPD-ASG / ASG-TNK
			C-L58	JPS Make-up to ASG	SEP/JPS/JPD/ASG	SEP-TNK	JPS-PO / JPD-ASG / ASG-TNK
			C-L59	SEP Make-up to JPP	SEP/JPP	SEP-TNK	SEP-JPP/S / JPP-TNK
		RRA Core Cooling (SD)	C-L60	RRA Cooling	RCP/RRA/RCP	RCP*	RRA-SL / RRA-PO / RRA-Hx / RRA-DL / RRA-SV / RCP*
	C6. Containment Integrity	Containment Isolation	B-1	Containment Building		B-CNT	
		Direct Core Injection	*See C4. Primary System Make-up				
		Containment Pressure Control	C-L61	Containment Spray - EAS Direct Injection	PTR/EAS/CNT	PTR-TNK	PTR-EAS / EAS-PO / EAS-SPR / CONT
			C-L62	Containment Spray - EAS Recirculation	SMP/EAS/CNT	CNT-SMP	SMP-EAS / EAS-PO / EAS-Hx / EAS-SPR / CONT
			C-L63	Containment Spray -JPP Emergency Back-up	JPP/EAS/CNT	JPP-TNK	JPP-PO / JPP-JPC / JPC-EAS / EAS-SPR / CONT
			C-L64	Containment Venting			
		Hydrogen Reduction	C-L65	Hydrogen PARS	ETY (PARS)	PARs	
		SG Creep Rupture Prevention	C-L52	Turbine Driven ASG Pump	ASG/ASGt/SG	ASG-TNK	~~ASG-T/PO~~ / ASG-T/SS / ASG-T/FL / ASG-SG/FL / SGs
			C-L53	Motor Driven ASG Pumps	ASG/ASGm/SG	ASG-TNK	~~ASG-M/PO~~ / ASG-M/FL / ASG-SG/FL / SGs
		Basemat Melt-thro Prevention	C-L66	Reactor Pit Flooding			

Table 16:

Functional requirements diagram for a beyond-design-basis (0.6 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement											
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC								
Reactor Core	C7. Essential Indication	Core Exit Temperature	C-I1	Core Exit Temperature Indication		RICxxxMT				[LNi]				
		RCP Level	C-I2	Pressuriser Level Indication		RCPxxxMN				[LNi]				
		Reactor Level Indication	C-I24	RVLIS										
		RCP pressure	C-I3	RCP Pressure Indication		RCPxxxMP				[LNi]				
		RRA Pressure	C-I5	RRA Pressure Indication		RRAxxxMP				[LNi]				
		SG Level	C-I6	SG WR Level Indication		ARExxxMN				[LNi]				
		SG Pressure	C-I7	SG Pressure Indication		VVPxxxMP				[LNi]				
		ASG Tank Level	C-I8	ASG Tank Level Indication		ASG002LN								
		Diesel Tank Level	C-I9	Diesel Tank Level Indications		LHixxxLN								
		Containment Pressure	C-I20	Containment WR Pressure Indication		ETYxxxMP				[LNi]				
		Containment Radiation	C-21	Containment Radiation Levels		KRT022-23MA				KRT001AR	[LBA]			
		Containment Sump Level	C-I22	Containment Sump Level		RISxxxSL EASxxxSL				[LCA/B]				
		BaseMat Thermocouples	C-I23	Basemat Thermo-couples		KSBxxxMT								
		Containment Sump Temperature	C-I51											
		Containment Hydrogen Sampling	C-I52											
		Reactor Pit Temperature	C-I53											
Spent Fuel Pool	S1. SFP Integrity	SFP Pool	S-S1	SFP Pool Integrity	SFP	SFP-PL	B-SFP							
		PTR 1/2 PO	S-S1	PTR Normal SFP Cooling Integrity	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO*	PTR-HX*	PTR-DL	PTR-SPHN	SFP-PL		
		PTR 6 PO	S-S2	PTR 3rd Train Integrity	SFP\PTR3\SFP		PTR3-SL	PTR3-PO*	PTR3-HX*	PTR3-DL	PTR3-SPHN			
	S2. SFP Cooling	PTR 1/2 PO	S-L1	PTR Normal Cooling	SFP\PTR\SFP	SFP-PL	PTR-SL	PTR-PO	PTR-HX	PTR-DL		SFP-PL		
		PTR 6 PO	S-L2	PTR 3rd Train Cooling	SFP\PTR3\SFP		PTR3-SL	PTR3-PO	PTR3-HX	PTR3-DL				
	S3. Bulk Boiling	SFP Steam Release	S-L3	Open Vent Doors		SFP-VD								
		SFP Emergency Make-up	S-L4	SED Make-up	SED/SFP	SED-TNK	SED-PO		SED-SFP	SFP-PL				
			S-L5	JPP Make-up	JPP/JPD/SFP	JPP-TNK	JPP-PO		JPD-SFP					
			S-L6	JPS Make-up	SEP/JPS/SFP	SEP-TNK	SEP-JPP/S	JPS-PO						
	S4. Indication	SFP Level	S-I1	SFP Level Indication		PTRxxxMN				[LNi]	[SAR-ACC]			
		SFP Temperature	S-I2	SFP Temperature Indication		PTRxxxMT				[LNi]				
		Fuel Rack Temperature	S-I3											
		SFP Boron Concentration	S-I4											
		SFP Building Pressure	S-I5											
		SFP Hydrogen Concentration	S-I6											
		SFP Building Humidity	S-I7											
Seismic Vault	V1. Seismic Vault	Flooding of Seismic Vault	V-L01	JPP Make-up to Seismic Vault	JPP/JPD/VLT	JPP-TNK		JPP-PO	JPP-JPD	JPD-VLT	VLT			
			V-L02	JPS Make-up to Seismic Vault	SEP/JPS/JPD/VLT	SEP-TNK	SEP-JPP/S	JPS-PO	JPS-JPD					
			V-L03	SEP Gravity Feed to Seismic Vault	SEP/JPD/VLT		SEP-VLT							
	V.2 Indication	Seismic Vault Temperature	VI-1											
		Seismic Vault Water Level	VI-2											
		Seismic Vault Pressure	VI-3											
Dry Casks	D1. Cask Integrity	Cask Remain Leak Tight	D-S1	Cask integrity	CASK	CASK*								
	D2. Cask Cooling	Cask Air cooling maintained	D-L1	Cask Cooling	Cask building and Air Flow	B-LLW	CASK-AIR							
Buildings	B1. Containment		B1	Containment Building		B-CNT	Building	Hatch	Penetration	Airlocks				
	B2. NAB		B2	Nuclear Auxiliary Building		B-NAB								
	B3. Electrical Building		B3	Electrical Building		B-ELE								
	B4. Diesel buildings		B4	Unit Diesel Building		B-DSL								
	B5. SBO Diesel Building		B5	SBO Diesel Building		B-SBO								
	B6. SEC pump-house		B6	SEC Pumphouse Building		B-SEC								
	B7. Turbine Hall		B7	Turbine Hall		B-TUR								
	B8. LLW Building		B8	Low Level Waste Building		B-LLW								
	B9. ECC		B9	Emergency Control Centre		B-ECC								

Table 16:

Functional requirements diagram for a beyond-design-basis (0.6 g) earthquake inducing a tsunami wave up to 3.8 m above the terrace level (no modifications)

	Required Function		SSCs that provide Functional Requirement												
	Functional Requirement	Sub-Function	Methods to fulfil Functional Req. (SSCs)			Sub-SSC									
Electrical Support System	**E1. Essential 6.6kV Switchboard Supply**	LHA Switchboard Supply **[LHA]**	E-1	400 KV LHA Supply	400KV/LHA	**400KV**	GEN-TRX	UNT-TRX	LGA-SWB	LGB-SWB	LHA-SWB	*[LCA]*	*[LBA]*		
			E-2	132 KV LHA Supply	132KV/LHA	**132KV**	STN-TRX		LGE/F-SWB						
			E-3	LHP Diesel LHA Supply	LHP/LHA	**LHP-DSL**	LHP-LHA								
			E-4	LHS Diesel LHA Supply	LHS/LHA	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHA					
		LHB Switchboard Supply **[LHB]**	E-5	400 KV LHB Supply	400KV/LHB	**400KV**	GEN-TRX	UNT-TRX	LGD-SWB	LGC-SWB	LHB-SWB	*[LCB]*	*[LBB]*		
			E-6	132 KV LHB Supply	132KV/LHB	**132KV**	STN-TRX		LGE/F-SWB						
			E-7	LHQ Diesel LHB Supply	LHQ/LHB	**LHQ-DSL**	LHQ-LHB								
			E-8	LHS Diesel LHB Supply	LHS/LHB	**LHS-DSL**	LHS-LHC		LHC-SWB	LHC-LHB					
	E2. SBO Diesel Supply	LLY SBO Diesel Supply **[LLY]**	E-10	LLY Switchboard Supply	LLS\LLX\LLY	**LLS-DSL**	LLX-SWB	LLX-LLY	LLY-SWB						
	E3. 48 V Essential Switchboard Supply	LCA 48V Switchboard Supply **[LCA]**	E-21	LCA Switchboard - LHA	LCA\LLI\LHA	**[LHA]**		LLA\E-SWB	LCA-RD	LCA-SWB					
			E-22	LCA Switchboard - LLS	LCA\LLY	**[LLY]**									
			E-23	LCA Switchboard - Battery	LCA\BAT	**LCA-BAT**									
		LCB 48V Switchboard Supply **[LCB]**	E-24	LCB Switchboard - LHB	LCB\LLI\LHB	**[LHB]**		LLB\D-SWB	LCB-RD	LCB-SWB					
			E-25	LCB Switchboard - LLS	LCB\LLY	**[LLY]**									
			E-26	LCB Switchboard - Battery	LCB\BAT	**LCB-BAT**									
	E4. 125 V Essential Switchboard Supply	LBA 125V Switchboard Supply **[LBA]**	E-31	LBA Switchboard - LHA	LBA\LLI\LHA	**[LHA]**		LLC\E-SWB	LBA-RD	LBA-SWB					
			E-32	LBA Switchboard - LLS	LBA\LLY	**[LLY]**									
			E-33	LBA Switchboard - Battery	LBA\BAT	**LBA-BAT**									
		LBB 125V Switchboard Supply **[LBB]**	E-34	LBB Switchboard - LHA	LBB\LLI\LHB	**[LHB]**		LLB\D-SWB	LBB-RD	LBB-SWB					
			E-35	LBB Switchboard - LLS	LBB\LLY	**[LLY]**									
			E-36	LBB Switchboard - Battery	LBB\BAT	**LBB-BAT**									
	E5. Essential Instrumentation Switchboard Supply	LNA 220V Essential Switchboards **[LNA]**	E-41	SIP I Dirty Supply from LHA	LNA/LLC/LHA	**[LHA]**	LLC-SWB	LNA-RD		LNA-SWB					
			E-42	SIP I Clean Supply from LHA	LNA/LBC/LLA/LHA		LLA-SWB	LBC-RD	LBC-SWB						
			E-43	SIP I Supply from LSS	LNA/LBC/LLY	**[LLY]**									
			E-44	SIP I Battery Supply	LNA/LBC/BAT	**LBC-BAT**									
		LNB 220V Essential Switchboards **[LNB]**	E-45	SIP II Dirty Supply from LHB	LNB/LLD/LHB	**[LHB]**	LLD-SWB	LNB-RD		LNB-SWB					
			E-46	SIP II Clean Supply from LHB	LNB/LBD/LLB/LHB		LLB-SWB	LBD-RD	LBD-SWB						
			E-47	SIP II Supply from LSS	LNB/LBD/LLY	**[LLY]**									
			E-48	SIP II Battery Supply	LNB/LBD/BAT	**LBD-BAT**									
		LNC 220V Essential Switchboards **[LNC]**	E-49	SIP III Dirty Supply from LHA	LNC/LLC/LHA	**[LHA]**	LLC-SWB	LNC-RD		LNC-SWB					
			E-50	SIP III Clean Supply from LHA	LNC/LBE/LLA/LHA		LLA-SWB	LBE-RD	LBE-SWB						
			E-51	SIP III Supply from LSS	LNC/LBE/LLY	**[LLY]**									
			E-52	SIP III Battery Supply	LNC/LBE/BAT	**LBE-BAT**									
		LND 220V Essential Switchboards **[LND]**	E-53	SIP IV Dirty Supply from LHB	LND/LLD/LHB	**[LHB]**	LLD-SWB	LND-RD		LND-SWB					
			E-54	SIP IV Clean Supply from LHB	LND/LBF/LLB/LHB		LLB-SWB	LBF-RD	LBF-SWB						
			E-55	SIP IV Supply from LSS	LND/LBF/LLY	**[LLY]**									
			E-56	SIP IV Battery Supply	LND/LBF/BAT	**LBF-BAT**									
Ultimate Heatsink	**U1. Essential Cooling**	SEC Train A Cooling	U-1	SEC Train A Cooling	SEA/SEC-A/SEA	[Sea]	SEC-A-RS	SEC-A-DS	SEC-A-PO	RRI-A-HX	[Sea]				
		SEC Train B Cooling	U-2	SEC Train B Cooling	SEA/SEC-B/SEA		SEC-B-RS	SEC-B-DS	SEC-B-PO	RRI-B-HX					
		Alternative Heatsink	U-3	Alternative Heatsink											
	U2. Component Cooling	RRI Train A Cooling	U-11	RRI Train A Cooling	SEC/RRI-A/HXA	HX-A	RRI-A-PO	[RRI-A-HX]							
		RRI Train B Cooling	U-12	RRI Train B Cooling	SEC/RRI-B/HXA	HX-B	RRI-B-PO	[RRI-B-HX]							
		RRI Commons Cooling	U-13	RRI Commons cooling (Train A)	SEC/RRI-A/HXC	HX-COM	RRI-A-PO	[RRI-A-HX]							
			U-14	RRI Commons cooling (Train B)	SEC/RRI-B/HXC		RRI-B-PO	[RRI-B-HX]							

	Functionality Lost
	Functionality lost due to On-Site Induced Hazard
	Functionality Lost by Failure of Support System
	Functionality Retained but limited to less than 24 hours operation.
	Functionality Retained
	Proposed Plant Changes
	Functionality Not Credited or does not Exist

	Tsunami event results in damage
	Seismic event results in damage

Note * indicates integrity not active function

Note [XXX] indicates as system support dependency