Hitachi-GE Nuclear Energy, Ltd.
UK ABWR GENERIC DESIGN ASSESSMENT
Resolution Plan for RO-ABWR-0065
(Demonstration of adequate design and implementation of inherently safe techniques and structures to minimise radiation dose rates via through wall penetrations during all operating modes and for the lifetime of the facility, whilst being cognisant of design requirements relating to other discipline areas)

RO TITLE:	Demonstration of adequate design and implementation of inherently safe techniques and structures to minimise radiation dose rates via through wall penetrations during all operating modes and for the lifetime of the facility, whilst being cognisant of design requirements relating to other discipline areas
REVISION :	0
Overall RO Closure Date (Planned):	October 2016
REFERENCE DOCUMENTATION RELATED TO REGULATORY OBSERVATION	
Regulatory Queries	RQ-ABWR-0506
Linked ROs	RO-ABWR-0006, RO-ABWR-0009, RO-ABWR-0010, RO-ABWR-0011, RO-ABWR-0014, RO-ABWR-0015, RO-ABWR-0016, RO-ABWR-0017, RO-ABWR-0018, RO-ABWR-0020, RO-ABWR-0034, RO-ABWR-0035, RO-ABWR-0036, RO-ABWR-0037, RO-ABWR-0040, RO-ABWR-0041, RO-ABWR-0045, RO-ABWR-0054, RO-ABWR-0064
Other Documentation	RI-ABWR-0001, RI-ABWR-0002

Scope of work :

Background

During Step 3 of GDA, ONR's review has identified shortfalls in the Hitachi-GE proposed solution for the replacement of "Lead Wool" as circumferential shielding material around pipework penetrations through shielding walls. Also, ONR is aware of UK relevant good practice (RGP) used routinely to ensure that structural penetrations are generally at right angles to walls and floors and are designed in such a way that radiation is blocked from leaving one room and entering another. This issue is cross cutting, and multidisciplinary and linked with other issues raised in the UK ABWR GDA process.

In this Regulatory Observation (RO) Penetration [Ref-1], ONR expectation can be summarised as follows:

"It is important to ensure the penetrations are adequately designed to either remove the potential for elevated dose rates in adjacent areas or to minimise this to a level that is considered ALARP. In addition, the shielding materials for radiation shine path are adequately selected to minimise worker dose and relevant risks including environmental

impact for disposal are ALARP."

Scope of Work

Hitachi-GE will carry out the following actions based on the ONR expectation:

(1) Hitachi-GE to identify the geometry of the penetrations and level of relevant hazards.

(2) Hitachi-GE to provide ONR with a strategy for design such that shine paths through the penetrations are suitably attenuated to ensure dose rates are reduced so far as is reasonably practicable.

(3) Hitachi-GE to provide evidence that the strategy ensures the engineering designs are inherently safe and utilise the hierarchy of controls focusing on passive safety.

In this RO, the operating conditions of normal operation, conditions beyond normal operation up to the design basis faults in relation to Design Basis Analysis (DBA) and decommissioning are to be covered.

Detailed discussion of the work programme is given in the "Description of work" below. This Resolution Plan describes Hitachi-GE's current plan to address the RO.

Description of work:

Under the RO-ABWR-0065, the following 7 actions have been requested by ONR:

RO-ABWR-0065.A1: Hitachi-GE to provide a Resolution Plan detailing the process to be followed and how it intends to comply with the remaining actions.

RO-ABWR-0065.A2: Hitachi-GE to Identify the number, location and configuration of penetrations through shielding structures within the UK ABWR generic design.

RO-ABWR-0065.A3: Hitachi-GE to Identify the nature (i.e. radiation, type(s) and level of hazard posed by each penetration from the relevant radiation sources.

RO-ABWR-0065.A4: Hitachi-GE to Identify any potential competing requirements in relation to the penetrations identified.

RO-ABWR-0065.A5: Hitachi-GE to Identify a range of solutions which could be applied to the identified penetrations based on the results of the previous actions.

RO-ABWR-0065.A6: Hitachi-GE to report to ONR on the output of the previous actions.

RO-ABWR-0065.A7: Hitachi-GE revises all relevant documentation including the PCSR accordingly to reflect the output of this RO.

Following the review of the above actions, Hitachi-GE have assembled a resolution plan that enables Hitachi-GE experts to demonstrate to ONR that the penetrations design methodology generally adopted in the UK nuclear industry

has been understood and implemented. This will be carried out through a systematic approach with the aim to facilitate knowledge transfer from UK experts to Hitachi-GE experts, and will allow Hitachi-GE to implement such principles effectively to the UK ABWR design.

The UK ABWR design will be subjected to the systematic review as described in this Resolution Plan, which is expected to continue the duration of the GDA as well as post-GDA. In the GDA phase, Hitachi-GE will group the penetrations and identify the representative penetrations which can cover all penetrations. Then Hitachi-GE will demonstrate that the representative penetrations designs are ALARP taking into account UK good practice. In the post-GDA (the site licence) phase, the future operator will design each penetration through the shielding in more detail based on the outputs of the GDA phase provided by Hitachi-GE. On satisfactory demonstration that a sufficiently robust review process is in place and the 7 actions points have been suitably addressed, it is considered that RO-ABWR-0065 may be closed out whilst the remaining design for each individual penetration continue to undergo the similar review process. This is planned to be demonstrated to ONR by the end of October 2016.

Hitachi-GE propose to carry out the following tasks to address the RO:

- ***A1: Hitachi-GE to provide a Resolution Plan detailing the process to be followed and how it intends to comply with the remaining actions***

Hitachi-GE's scope:

This action is to provide a resolution plan. The programme is included in Table 1.

Deliverables:

(1) Resolution Plan (this document)

From Action 2 to 7, Hitachi-GE would like to follow the 4 working steps below.

< Working Step-1 >

Hitachi-GE will develop a penetration design philosophy in line with UK good practice with regards to radiation and other hazards. All design requirements for penetrations will be considered; in addition to shielding these will also include other aspects such as fire protection, hermetic and impermeable seals. This philosophy will also outline any potential competing requirements to be considered in relation to the penetration design.

< Working Step-2 >

Hitachi-GE will develop, with appropriate input from the UK experts, a penetration design guideline (e.g. selection flow for penetrations design) in line with UK good practice based on the penetration design philosophy. This guideline will outline the penetrations design options and their selection in line with UK good practice. All relevant design

requirements for the penetrations will be taken into account in this guideline. This guideline will enable Hitachi-GE to understand the penetration design of UK good practice and to aid justification that the penetration design of UK ABWR is ALARP.

The following considerations will be taken into account in the penetration design guideline, in addition to others where necessary:

- Hierarchy of Control: The ERIC-PD approach in line with IRR99 Ref 8(2) and SAP RP.7 is to be considered.
- All Relevant Technical Areas: All relevant technical areas in relation to penetration design are to be covered.
- All Operating Conditions: Normal operation, conditions beyond normal operation up to the design basis faults in relation to DBA and decommissioning are to be covered.
- All Tasks / Roles: All tasks / roles which link to contribution from the penetration design such as maintenance, sampling, etc. are to be covered.
- Number, location and configuration of penetrations through shielding structures
- Nature (i.e. radiation, type(s) and level of hazard) posed by the penetration from the relevant radiation sources
- Relevant Input: Relevant input information will be in the form of the penetration design philosophy and the appropriate resolutions from all other relevant RO(s)/RI(s). These various input documents will help in the formulation of the design guideline document.

In terms of shielding material made of or incorporating lead, Hitachi-GE will commission a survey of the UK industry for alternative shielding materials to lead for use in the penetrations. This is expected to not only include nuclear power plants but also facilities containing radioactive sources such as medical facilities and laboratories in the UK. The alternative shielding materials need to be selected taking into account the following key elements for the penetration design in addition to others where necessary:

- Physical properties including radionuclide composition and material densities of the alternative shielding materials
- Resistance to radiation, taking into account radiation types such as neutron and gamma-ray, and fire etc. of the alternative shielding materials

<u>Deliverables of Step-1 and 2:</u>

(1) Penetration Design Guideline Document

< Working Step-3 >

Hitachi-GE will perform a penetration design study of UK ABWR against UK good practice using the penetration design guideline. The followings will be especially considered:

- feasibility of alternative penetration options such as a “Joggle Box” and
- investigation of any countermeasures.

This design study will apply to the representative penetrations which can cover all penetrations. The representative

penetrations will be selected taking into account the penetration geometry and specification (e.g. size and location), the process conditions and sources contained in the components such as piping and cables through the penetrations (e.g. radioactive or non-radioactive), the environment around the penetrations (e.g. radiation zone) and so on. More detailed design for each penetration will be performed by the future operator based on these representative penetrations provided by Hitachi-GE.

The justification of adequacy of the UK ABWR representative penetrations will be provided in the penetration design study document(s) using the design guideline as a tool. The design change will be performed as necessary if the significant gap is identified.

< Working Step-4 >

Hitachi-GE will demonstrate that the representative penetrations will meet compliance with the ALARP principle. In terms of dose contribution from the penetrations, the dose evaluation from the representative penetrations will be performed taking into account the penetration geometry and radioactive sources location etc. The evaluation result will be fed back to the penetration design optioneering appropriately if dose contribution from the penetrations is not ALARP.

Deliverables of Step-3 and 4:

(1) Penetration Design Study Document(s)

The relevant PCSR(s), Topic Report(s) and Supporting Document(s) will be updated as necessary to be consistent with the deliverables of this RO.

Hitachi-GE's scopes of work from Action 2 to 7 are included in working step-1 to 4 above.

■ ***A2: Hitachi-GE to Identify the number, location and configuration of penetrations through shielding structures within the UK ABWR generic design***

Hitachi-GE's scope:

This action is to provide the number, location and configuration of the representative penetrations. This links to working step-2 to 4 addressed in A1 above.

Deliverables:

(1) Penetration Design Guideline Document
(2) Penetration Design Study Document(s)

The penetration design guideline will be formulated to enable Hitachi-GE to understand the penetration options and their selection in line with UK good practice and to aid justification of the UK ABWR representative penetrations. Hitachi-GE will perform penetration design study against the representative penetrations using this guideline. A design change will be performed as necessary if the significant gap is identified. Then the number, location and configuration of the representative penetrations through shielding within UK ABWR will be identified in the penetration design study document(s).

■ ***A3: Hitachi-GE to Identify the nature (i.e. radiation, type(s) and level of hazard posed by each penetration from the relevant radiation sources***

Hitachi-GE's scope:

This action is to identify the nature of the representative penetrations and level of hazard posed by the representative penetrations from the relevant radiation sources. This links to working step-2 to 4 addressed in A1 above.

Deliverables:

(1) Penetration Design Guideline Document
(2) Penetration Design Study Document(s)

The appropriate options for the representative penetrations will be identified after the penetration design study using the penetration design guideline. Then dose evaluation from the representative penetrations will be performed based on the identified penetration options and location of the relevant radioactive sources etc. The dose evaluation result will be fed back appropriately to the penetration design if dose contribution from the penetrations is not ALARP. This dose evaluation result will be summarised in the penetration design study document(s) and supporting this response will be the Topic Report on Radiation Shielding [Ref-2] and relevant supporting documents.

■ ***A4: Hitachi-GE to Identify any potential competing requirements in relation to the penetrations identified.***

Hitachi-GE's scope:

This action is to identify the potential competing requirements in relation to the penetration design. This links to working step-1 addressed in A1 above.

Deliverables:

(1) Penetration Design Guideline Document

The penetration design guideline will include the potential competing requirements in relation to the penetration

design.

■ ***A5: Hitachi-GE to Identify a range of solutions which could be applied to the identified penetrations based on the results of the previous actions***

Hitachi-GE's scope:

This action is to provide a range of solutions to protect from the relevant hazards from the representative penetrations and to meet the relevant design requirements of such penetrations. This links to working step-2 and 4 addressed in A1 above.

Deliverables:

(1) Penetration Design Guideline Document
(2) Penetration Design Study Document(s)

Hitachi-GE will select and demonstrate appropriate penetration options for the representative penetrations after the penetration design study, taking into account the penetration design in line with UK good practice using the penetration Design guideline. These representative penetration options for UK ABWR will be justified in the penetration design study document(s). In other words, the range of solutions for the representative penetrations for the UK ABWR will be addressed in the penetration design study document(s).

■ ***A6: Hitachi-GE to report to ONR on the output of the previous actions***

Hitachi-GE's scope:

This action is to report to ONR on the outputs of the previous actions. This links to working step-1 to step-4 addressed in A1 above.

Deliverables:

(1) Penetration Design Guideline Document
(2) Penetration Design Study Document(s)

■ ***A7: Hitachi-GE revises all relevant documentation including the PCSR accordingly to reflect the output of this RO.***

Hitachi-GE's scope:

This action is to revise all relevant documentation including the PCSR to reflect the output of this RO.

Deliverables:

(1) Revised documents as necessary

Hitachi-GE will assess the consequences and impacts of changes to penetration design and selection of suitable shielding materials against the existing PCSR chapters and Topic Reports, e.g. the Topic Reports on Radiation Shielding [Ref-2], Zoning [Ref-3] and Worker Dose [Ref-4][Ref-5]. This review will be captured as part of the ALARP assessment carried out in Step 4.

Summary of impact on GDA submissions:

The GDA submissions that will be affected by the actions to resolve this RO are summarised below. These documents will be originated and/or revised in accordance with the corresponding Resolution Plan Actions.

Impacted GDA Submission Documents:

Related RO Actions	GDA Submission Document Title (Generic PCSR)	Document ID (Document No.)	Submission Date to the Regulators
ROA1 to 7	Chapter 6 : External Hazards	GA91-9101-0101-06000 (AE-GD-0168)	20th October 2015
	Chapter 7 : Internal Hazards	GA91-9101-0101-07000 (SE-GD-0127)	
	Chapter 8 : Structural Integrity	GA91-9101-0101-08000 (RE-GD-2043)	
	Chapter 9 : General Description of the Unit (Facility)	GA91-9101-0101-09000 (SE-GD-0136)	
	Chapter 10 : Civil Works and Structures	GA10-9101-0101-10000 (LE-GD-0035)	
	Sub-chapter 12.1 : Reactor Coolant Systems and Associated Systems	GA91-9101-0101-12001 (SE-GD-0134)	
	Sub-chapter 12.2 : Reactivity Control Systems	GA91-9101-0101-12002 (SE-GD-0135)	
	Sub-Chapter 13.1 : Summary of Description of Engineered Safety Systems	GA91-9101-0101-13001 (ASE-GD-0009)	
	Sub-Chapter 13.2 : Containment System	GA91-9101-0101-13002 (ASE-GD-0010)	
	Sub-chapter 13.3 : Emergency Core Cooling System	GA91-9101-0101-13003 (SE-GD-0137)	
	Chapter 14: Control and Instrumentation	GA91-9101-0101-14000 (3E-GD-A0063)	
	Sub-chapter 15.2 : Safety Claims – CAE and approach to protection against CCF	GA91-9101-0101-15002 (EE-GDA-C282)	
	Sub-chapter 15.3 : Architecture – power supply and power distribution	GA91-9101-0101-15003 (EE-GDA-C283)	
	Sub-chapter 15.4 : Electrical Equipment and systems	GA91-9101-0101-15004 (EE-GDA-C284)	
	Sub-chapter 15.6 : Panel and Raceway Layout	GA10-9101-0101-15006 (ES-GD-B010)	
	Sub-chapter 16.1 : Water Systems	GA91-9101-0101-16001 (SE-GD-0129)	
	Sub-chapter 16.2 : Process Auxiliary Systems	GA91-9101-0101-16002 (SE-GD-0130)	
	Sub-chapter 16.3 : Heating Ventilating and Air Conditioning System	GA91-9101-0101-16003 (HPE-GD-H018)	
	Sub-chapter 16.4 : Other Auxiliary Systems	GA91-9101-0101-16004 (SE-GD-0131)	
	Sub-chapter 17.2 : Turbine Generator	GA91-9101-0101-17002 (TEQ-14-282)	
	Sub-chapter 17.3 : Turbine Main Steam, Turbine Auxiliary Steam and Turbine Bypass System	GA91-9101-0101-17003 (SBD-GD-0023)	
	Sub-chapter 17.4 : Extraction Steam System	GA91-9101-0101-17004 (SBD-GD-0024)	
	Sub-chapter 17.5 : Turbine Gland Steam System	GA91-9101-0101-17005 (SBD-GD-0025)	
	Sub-chapter 17.6 : Feedwater Heater Drain and Vent System	GA91-9101-0101-17006 (SBD-GD-0026)	
	Sub-chapter 17.7 : Condenser	GA91-9101-0101-17007 (SBD-GD-0027)	
	Sub-chapter 17.8 : Circulating Water System	GA91-9101-0101-17008 (SBD-GD-0028)	
	Sub-chapter 17.9 : Condensate and Feedwater System	GA91-9101-0101-17009 (SBD-GD-0029)	
	Sub-chapter 17.10 : Condensate Purification System	GA91-9101-0101-17010 (VPD-GD-0002)	
	Sub-chapter 18.1 : Source Terms	GA91-9101-0101-18001 (WE-GD-0018)	
	Sub-chapter 18.2 : Liquid Radioactive Waste Management System	GA91-9101-0101-18002 (WE-GD-0019)	

	Sub-chapter 18.3 : Off-Gas Radioactive Waste Management System	GA91-9101-0101-18003 (GE-GD-0022)	
	Sub-chapter 18.4 : Solid Radioactive Waste Management System	GA91-9101-0101-18004 (WE-GD-0020)	
	Sub-chapter 20.2 : Definition of Radioactive Sources	GA91-9101-0101-20002 (HE-GD-5052)	
	Sub-chapter 20.3 : Strategy to Ensure that the Exposure is ALARP	GA91-9101-0101-20003 (HE-GD-5053)	
	Sub-chapter 20.4 : Protection and Provisions against Direct Radiation	GA91-9101-0101-20004 (HE-GD-5054)	
	Sub-chapter 20.6 : Radiation and Contamination Monitoring of Occupational Exposure	GA91-9101-0101-20006 (3E-GD-K025)	
	Sub-chapter 20.7 : Dose Assessment for Public from Direct Radiation	GA91-9101-0101-20007 (HE-GD-5055)	
	Sub-chapter 20.8 : Post Accident Accessibility	GA91-9101-0101-20008 (HE-GD-0045)	
	Chapter 21 : Human-Machine Interface	GA91-9101-0101-21000 (3E-GD-A0060)	
	Chapter 23 : Reactor Chemistry	GA91-9101-0101-23000 (WPE-GD-0058)	
	Chapter 24 : Design Basis Analysis	GA91-9101-0101-24000 (UE-GD-0208)	
	Chapter 25 : Probabilistic Safety Assessment	GA91-9101-0101-25000 (AE-GD-0171)	
	Chapter 27 : Human Factors	GA91-9101-0101-27000 (HFE-GD-0057)	
	Chapter 28 : ALARP Evaluation	GA91-9101-0101-28000 (SE-GD-0140)	
	Chapter 29 : Commissioning	GA91-9101-0101-29000 (QGI-GD-0011)	
	Chapter 30 : Operation	GA91-9101-0101-30000 (QGI-GD-0012)	
	Chapter 31 : Decommissioning	GA91-9101-0101-31000 (DCE-GD-0007)	
	Relevant Supporting Documents	-	-

As the work progress other areas affected may be identified and will be updated as required.

Programme Milestones/ Schedule:

Refer to the attached Gantt-chart (Table 1) for the programmed activities and the schedule for the resolution of the RO.

Reference:

[Ref-1] Office for Nuclear Regulation, RO-ABWR-0065, " Demonstration of adequate design and implementation of inherently safe techniques and structures to minimise radiation dose rates/short paths via through wall penetrations ", 20 October 2015

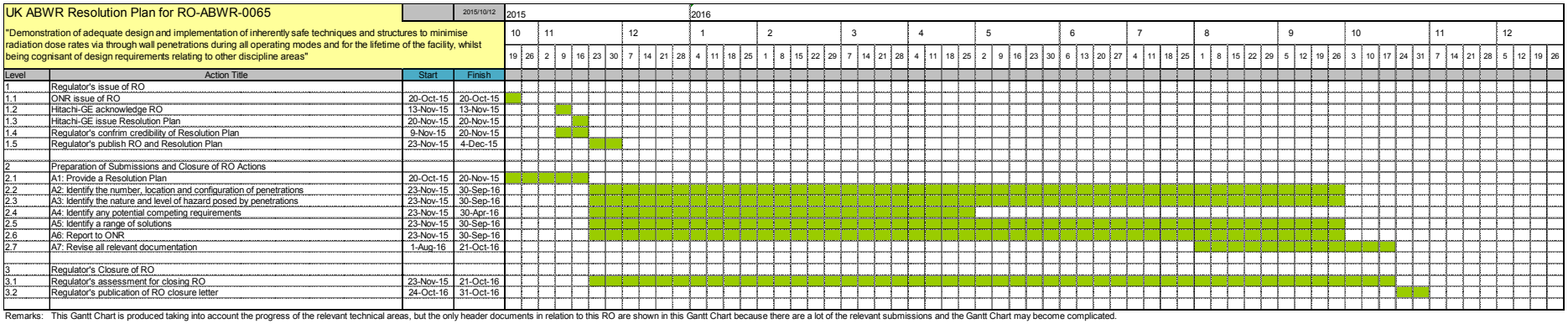
[Ref-2] Hitachi-GE Nuclear Energy, Ltd., "Topic Report: Radiation Shielding for All Relevant Buildings during System Start-up, Power Operation, Normal Hot Stand-by, System Shutdown and Outages excluding ILW, LLW and SFIS", GA91-9201-0001-00109 (HEGD-5084) Rev.1, July 2015

[Ref-3] Hitachi-GE Nuclear Energy, Ltd., "Topic Report: Radiation and Contamination Zoning for All Relevant Buildings during System Start-up, Power Operation, Normal Hot Stand-by, System Shutdown and Outages excluding ILW, LLW and SFIS", GA91-9201-0001-00116 (HE-GD-5085) Rev.1, July 2015

[Ref-4] Hitachi-GE Nuclear Energy, Ltd., "Topic Report: Worker Dose Evaluation for All Relevant Buildings during System Start-up, Power Operation, Normal Hot Stand-by, System Shutdown and Outages excluding ILW, LLW and SFIS", GA91-9201-0001-00120 (HE-GD-5107) Rev.1, July 2015

[Ref-5] Hitachi-GE Nuclear Energy, Ltd., “Topic Report: Demonstration to Ensure that External and Internal Doses are ALARP for All Relevant Buildings during System Start-up, Power Operation, Normal Hot Stand-by, System Shutdown and Outages excluding ILW, LLW and SFIS”, GA91-9201-0001-00119 (HE-GD-5102) Rev.1, June 2015

Table 1 RO-ABWR-0065 Gantt Chart



UK ABWR Resolution Plan for RO-ABWR-0065		2015/10/12
"Demonstration of adequate design and implementation of inherently safe techniques and structures to minimise radiation dose rates via through wall penetrations during all operating modes and for the lifetime of the facility, whilst being cognisant of design requirements relating to other discipline areas"		
Level	Action Title	Start	Finish
1	Regulator's issue of RO		
1.1	ONR issue of RO	20-Oct-15	20-Oct-15
1.2	Hitachi-GE acknowledge RO	13-Nov-15	13-Nov-15
1.3	Hitachi-GE issue Resolution Plan	20-Nov-15	20-Nov-15
1.4	Regulator's confrim credibility of Resolution Plan	9-Nov-15	20-Nov-15
1.5	Regulator's publish RO and Resolution Plan	23-Nov-15	4-Dec-15
2	Preparation of Submissions and Closure of RO Actions		
2.1	A1: Provide a Resolution Plan	20-Oct-15	20-Nov-15
2.2	A2: Identify the number, location and configuration of penetrations	23-Nov-15	30-Sep-16
2.3	A3: Identify the nature and level of hazard posed by penetrations	23-Nov-15	30-Sep-16
2.4	A4: Identify any potential competing requirements	23-Nov-15	30-Apr-16
2.5	A5: Identify a range of solutions	23-Nov-15	30-Sep-16
2.6	A6: Report to ONR	23-Nov-15	30-Sep-16
2.7	A7: Revise all relevant documentation	1-Aug-16	21-Oct-16
3	Regulator's Closure of RO		
3.1	Regulator's assessment for closing RO	23-Nov-15	21-Oct-16
3.2	Regulator's publication of RO closure letter	24-Oct-16	31-Oct-16

Remarks: This Gantt Chart is produced taking into account the progress of the relevant technical areas, but the only header documents in relation to this RO are shown in this Gantt Chart because there are a lot of the relevant submissions and the Gantt Chart may become complicated.
All relevant references will be addressed in these header documents appropriately.