

ARPANSA Regulatory Assessment of the Replacement Reactor Construction Application

9 July 2001 - Reactive Review Comments, Questions and Issues

PSAR Chapter 1 Introduction and General Description of the Facility

Question reference	Section number and name	Topic	ARPANSA Comment, Issue and/or Question and ANSTO's Response
			General Response: Chapter 1 is a general introduction and overview. Many of the questions raised by ARPANSA are dealt with substantively in later chapters to which cross reference is made here.
1.1.	All PSAR Chapters	References	Not all chapters of the PSAR have a list of references provided at the end of the chapter. Please provide a list of all references used in each chapter.
			Response: A list of references for each Chapter will be provided where it is appropriate. Where the Sections of a Chapter are self-contained (as in Chapter 5 for example) the reference will be mentioned at the end of the Section only (Note that this does not relate to Codes and Standards which are generally mentioned in a separate section within the chapter).
1.2.	1.1 Introduction	Reference to safety principles, criteria and the PSAR identifying criteria for Operating Limits and Conditions (OLCs).	In addition to setting criteria for OLCs, the PSAR sets the bases for the OLCs and this should be reflected in the PSAR and the safety analyses undertaken. This should be reflected in the document.
			Response: This is detailed in Chapter 17 of the PSAR
1.3.	1.1.2 Format and content of PSAR	There is a reference to "the requirements of ARPANSA RAPS are met".	The ARPANSA RAPS are not requirements, they are a set of guidance principles for the ARPANSA assessors. ARPANSA notes there is no reference to the ARPANSA design guideline. This should be reflected in the document.
			Response: Comment noted. ARPANSA document RG5 is mentioned in Chapter 2, Section 2.3.
1.4.	1.1.3 Purpose and size of the facility	Rated thermal power is 20 MW(t)	There appears some confusion over the power rating and it needs to be confirmed whether it is all from the fuel elements, or does it include the 1.2 MW from the reflector (see Table 1.2/1 and 1.4/1). The core power is important since it sets the basis for fission product release in the consequence analysis. Please review.

Checked / agreed:

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			Response: This is discussed in Chapter 5 of the PSAR.
1.5.	1.1.4.1 Effect of RRR on the public	From the PSAR the doses from normal operation are less than annual dose limits. The accidents covered in Chapter 16 of the PSAR focus on loss of integrity of fuel cladding and the cladding of irradiation rigs.	There is only a reference to cladding damage, and no mention of fuel melting as assumed in the RRR Reference Accident. The detailed review of Chapter 16 and the PSA (Appendix A) will be important, in particular in relation to the postulated initiating events (PIES), including the PIEs included, the PIEs screened out, the fuel damage success criteria in terms of thermal hydraulic parameters such as ONB, DNBR and Flow Instability Margins.
			Response: Comment noted.
1.6.	1.1.4.1 Effect of RRR on the public	It is claimed that the analyses in Chapter 16 and the PSA are conservative.	The level of conservatism will be judged in the detailed review and the extent to which beyond design basis accidents are considered, such as Anticipated Transients without Scram
			Response: Comment noted.
1.7.	1.1.4.1 Effect of RRR on the public	There is a reference to the PSA demonstrating that the radiation consequences and risk are low and met ARPANSA "requirements".	The reference to the PSA would suggest it is a Level 3 PSA. This is not the case as the treatment of Level 2 and Level 3 issues is superficial. Please explain the extent to which the PSA is used to demonstrate compliance with Table 2 of the RAPs?
			Response: This is discussed in the PSA.
1.8.	1.2.1 Introductory description of the facility.	The main features of the reactor are described, and the Engineered Safety Provisions (ESPs) are identified.	The items included in the ESP list look reasonable. However following review of the PSAR this list should be revisited in relation to the importance of the Ultimate Heat Sink (should it be the Cooling Tower pond?), and the importance of the Emergency Make up Water System. The classification as an ESP is important since it sets the design requirements in terms of quality, seismicity etc.
			Response: Comment noted.

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1.9.	1.2.3. Buildings and Structures	It is stated that all nuclear systems are in the reactor building.	The provision of essential services clearly come from outside the reactor building. This includes the provision of electricity and cooling water from the Cooling Towers. An issue may be the location of the standby diesels (and fuel tanks) within the building and how it is considered from a fire hazard perspective.
			Response: Comment noted. The diesels are located in the auxiliary building as described in Chapter 4, Section 4.7.
1.10.	1.2.3. Buildings and Structures	All ESPs are designed to withstand the Safe Shutdown Earthquake (SSE or SL-2), and the other safety related systems are designed to the Operating Basis Earthquake (OBE).	The breakdown of Structures, Systems and Components (SSC) designed to the SSE and OBE will be key matter. Any such breakdown will have to give consideration to failure of SSC, designed to the OBE, on the functioning of the SSC or ESPs important to safety.
			Response: Comment noted.
1.11.	1.2.4 Reactor Core	The basic details are given in Table 1.2. It is claimed that all reactivity feedback coefficients are negative.	It is important to check that all reactivity, thermal and material values quoted in Table 1.2 are checked and validated independently. There have been differences between values used in the design and in the safety analysis noted already.
			Response: Comment noted.
1.12.	1.2.5 Reflector Vessel.	Fabricated from Zircaloy 4 plate using a mixture of welds and flanges. It has a number of major penetrations for neutron beam tubes, Cold Source, Hot Source and irradiation tubes.	The Reflector Tank design is unique to this reactor and has a number of functions in addition to housing most of the irradiation facilities. Its role as a secondary shutdown (dump) system makes it a key safety item. The main issues relate to its complex design, difficulty of fabrication, difficulty of inspection or replacement and its close proximity to the core and high neutron flux.

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			Response: Comment noted. The Reflector Vessel is designed, and will be constructed, to last the life of the reactor facility. Please refer to the information provided in the IAEA Peer Review Report, Appendix 1, Issues 7, 1, 6 and 10.
1.13.	1.2.6. Reactor and Service Pool	Manufactured from high density concrete it houses the reactor, service pool and decay tanks.	The integrity of the reactor pool, its metal liner and its penetrations are key features in maintaining the fuel in a safe condition. The main design load is associated with an earthquake and the pool structure and penetrations must be demonstrated to remain intact for earthquakes beyond the SSE.
			Response: The comment is noted. This is detailed in Chapter 4, Section 4.5 of the PSAR.
1.14.	1.2.7.1 Primary Cooling System	The flow through the core is upward and heat removal is by means of plate type heat exchangers. The flow rate is very high in view of the compact nature of the core.	Thermal hydraulics and flow induced vibration will be key issues that need to be demonstrated both theoretically and experimentally. The upward flow tends to lift the fuel and Control rods out of the core so the detail design is important.
			Response: This is discussed in Chapter 5 of the PSAR. It is noted that the flow drag is not sufficient to lift the control rods.
1.15.	1.2.7.2 Reactor and Service Pool cooling system	This cooling system removes spent fuel decay heat, and irradiation rig heat. It is noteworthy that the flow direction is downward through the irradiation tubes within the Reflector Tank.	The transition from forced flow to natural convection will be a key design issue for the irradiation rigs since the natural convection flows upwards. The analysis (Ch.16) should demonstrate that thermal hydraulic limitations, such as ONB are met during the transition, and under all the reactor PIEs.
			Response: It is noted that ONB is not a limiting phenomenon. Refer to the accident analysis in Chapter 16, Section 16.7.

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1.16.	1.2.7.3 Reflector cooling and purification system	Unlike the Primary Cooling System (PCS) this system has an intermediate heat exchanger, which is at lower pressure than both the primary and secondary.	There will be a build up of explosive gases in the Reflector Tank if the purification system (recombination unit) breaks down. Check that this has been considered as a PIE in Ch.16.
			Response: There will not be a build-up of explosive gasses in the Reflector Vessel as there is an expansion tank located above the Vessel level. This is detailed in Chapter 6, Section 6.6 and Chapter 16, Section 16.14.
1.17.	1.2.7.4 Secondary Cooling System (SCS).	The SCS removes heat from the PCS, the service pool and reflector cooling. It also cools the Cold Neutron Source.	The SCS is not an ESP, so it will be designed to the OBE. This will cover the SCS pipes, the Cooling Tower Pond walls and the Cooling Tower. Since natural circulation within the pool is an ESP, decay heat removal by means of the SCS is not considered as a safety system. The treatment of decay heat removal via the SCS needs to be examined further in view of the heat load inputs into the containment from the pool in the natural circulation mode with the containment sealed.
			Response: Comment noted. This is discussed in Chapter 6, Section 6.8 (SCS) and Chapter 7, Section 7.5 and Chapter 6, Section 6.2.5 (natural circulation).
1.18.	1.2.8.3 Decay Heat Removal by Natural Circulation	Four flaps in the PCS pipework open on a loss of flow and Natural Circulation is achieved once the PCS pumps have coasted down. There is no flow reversal needed since the flow is upward	This is an ESP system and it depends on the opening of the flap valves. These valves are a unique design and will need extensive testing for a range of conditions. They will also be required following earthquake, so seismic testing will be required well beyond the SSE.
			Response: The flap valves will be qualified during construction, inspection and testing to ensure that they achieve the required performance.

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1.19.	1.2.8.5 Siphon Effect Breakers	Small holes are drilled in the PCS pipework within the pool at about 5 m above the core. In a primary circuit LOCA the siphoning of water out of the pool stops when the level drops below the holes and air gets in to the pipework.	While essentially a passive system it could be defeated if the PCS holes are blocked by debris or plastic sheets that drop into the pool. Mechanisms that could defeat the siphoning should be investigated.
			Response: This is discussed in Chapter 16 of the PSAR.
1.20.	1.2.8.6 Emergency Make Up Water System (EMWS)	This is a passive system that drains into the reactor chimney if the level of water in the pool falls below two float valves. It is not an ESP and its purpose is to make up for evaporation of water in the core/chimney.	It is not classed as an ESP and has no redundancy of make up pipes. It is passive, and other than failure during an earthquake it is virtually fail-safe. Its role is examined in the PSA for Loss of Coolant accidents.
			Response: Comment noted.
1.21.	1.2.14.12. Services for Neutron Research Equipment	Various gas supplies within the Neutron Guide Halls are identified	ARPANSA will check the use of pressurised gases within the containment building, and what happens on a containment isolation signal.
			Response: Comment noted. Discussed in Chapters 7, 10 and 16 of the PSAR.
1.22.	1.2.14.2 Radioactive Waste and Spent Fuel Management	Ten years of spent fuel can be stored in the pool and the design provisions for solid, liquid and gaseous waste arisings are identified.	The review needs to look closely at waste management arrangements to ensure it is given sufficient priority at the design stage. One issue that needs resolution is the contingency spent fuel storage arrangements for inspection of the pool, or repair which should be anticipated.
			Response: Comment noted. The transfer gate between the two pools provides the ability to have one pool empty while the other is full; see Chapter 4, Section 4.5.

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1.23.	1.2.14.3 Fire Protection	The fire protection will be to Australian and international standards. The reactor building will be manned continuously and this may have some implications for the extent of automatic suppression	A fire hazard assessment of the design should be undertaken to identify the adequacy of the arrangements for fire detection, fire suppression, manual fire fighting, smoke clearance and operator escape routes. Specific guidance from the IAEA on fire should also be referenced.
			Response: Comment noted. Discussed in Chapter 10, Section 10.2 of the PSAR.
1.24.	1.2.14.4 Heating, Ventilation and Air Conditioning (HVAC)	Conventional HVAC provided for normal operation	The ventilation system has a strong interface with safety in both normal operation and in accidents. The design provisions to shutdown the ventilation system and seal the building (CIS) were identified in the Siting Reference Accident for the RRR.
			Response: Comment noted. This is discussed in Chapter 7.
1.25.	1.2.14.5 Cranes and hoists	A range of cranes will be needed, some of which will involve lifting hazardous loads such as spent fuel.	Need to check the detail specifications for cranes that lift hazardous loads to ensure guidance from nuclear standards is considered, with respect to redundant breaking and detail design.
			Response: The crane in the reactor hall is nuclear grade. This is discussed in Chapter 4, Section 4.5.2.
1.26.	1.2.14.6 Physical Security	The requirements of the Australian Safeguards and Non-Proliferation Organisation to be met	The security arrangements proposed should be comparable to those currently in place within the HIFAR complex.
			Response: The security arrangements will comply with all appropriate requirements. They will be approved by ASNO and made available to ARPANSA for review.
1.27.	1.2.14.7 Water supply system	Water supply to come from the existing site water supply system.	The PSAR claims that there is no need for external cooling water in view of the heat sink and natural circulation provided by the reactor pool. This is in contrast to HIFAR, which requires the provision of water services in accidents.

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			Response: Comment noted.
1.28.	1.2.14.9 Compressed air system	Air supply will be from the existing site compressed air system.	The use of compressed air within the reactor building will be evaluated in the detailed review. In particular any pneumatic driven instrumentation and isolation of any air flow into the containment isolation. A case that may need to be investigated is what happens to the numerous pneumatic rig irradiation cans when the air is isolated. If ejected they could possibly cause a reactivity insertion, if left in the reactor they could over heat.
			Response: The use of compressed air is discussed in Chapter 10, Section 10.3. The loss of the compressed air supply will not result in the loss of any safety-related instrumentation. The pneumatic rigs are powered by nitrogen gas, not air. Loss of nitrogen supply would not result in ejection of irradiation cans. The cans in the irradiation rigs will not overheat. Refer to Chapter 11, Section 11.4.2 and Chapter 16.
1.29.	1.2.15.3 Neutron beams and shutters	A range of thermal neutron beams is provided.	Since the beam tubes penetrate the containment, their needs to be an examination of containment integrity if the beam tubes within the containment are being maintained.
			Response: Not necessary since maintenance of the beam tubes could only be undertaken during a major shutdown when no fuel is in the core.
1.30.	1.2.16.2 General Purpose Irradiation Facilities	Irradiation targets with lower heat load and activities are irradiated inside sealed cans that are transported to and from the reflector vessel by means of 55 pneumatic transport systems operated by nitrogen gas.	These cans can be inserted and removed quickly from the core. The amount of reactivity they control and the speed of removal could be key matters to resolve. Could there be a mechanism for gross insertion of reactivity (up to 55 tubes affected) by plant or human failure of the nitrogen gas control system. Another matter that needs to be considered is the use of nitrogen gas, and the possible formation of nitric acid in the irradiated tubes.

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			Response: Discussed in Chapter 11 of the PSAR. The possible formation of nitric acid in the irradiation tubes is being investigated by INVAP. Further detail will be provided to ARPANSA when the study is complete.
1.31.	1.2.16.3 Bulk Production Irradiation Facilities	The bulk production is done with moveable rigs that are manually loaded into the reflector tank.	ARPANSA will review the maximum amount of reactivity that can be controlled by an individual rig, and the total amount permissible for the Bulk Irradiation Rigs, the General Purpose Rigs, and the Silicon Rigs. These would all need to be specified in the Operating Limits and Conditions, and based on the safety analysis reports.
			Response: This is discussed in Chapters 5, 11 and 17 of the PSAR.
1.32.	1.2.16.4 Large Volume Irradiation Facilities	Used primarily to irradiate silicon ingots.	A matter that needs to be raised is the potential for the large volume rigs to shadow neutron flux instrumentation. So location of this instrumentation is important, particularly for reactor control and nuclear safety.
			Response: The location of the neutron flux instrumentation has been determined specifically to avoid the influence of the irradiation facilities. This is discussed in Chapter 11, Section 11.4.4.3, para (i) and Chapter 8, Section 8.7.
1.33.	1.2.16.5 Short Term General Irradiation Facility	A single facility used for neutron activation analysis. It uses nitrogen to inject cans for short periods (seconds to minutes).	The possibility of “overcooking “ a can on failure of the gas or control system should be examined.
			Response: This is discussed in Chapter 11 of the PSAR.
1.34.	1.2.16.6 Transportation of Irradiated Targets	Targets are posted from the pneumatic conveyor Hot Cell to the Radioisotope Production facility (B23) by means of a shielded pneumatic conveyor system.	It is not clear if the conveyor system is above ground or buried, and what arrangements are in place for stuck cans.

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			Response: The conveyor system is below ground and in a covered trench. This is discussed in Chapter 11, Section 11.4.6.
1.35.	1.2.16.7 Shielded Hot Cells	The Hot Cells allow the safe handling of irradiated targets and their transfer for processing at other buildings within the LHSTC.	A check should be made to ensure it is not physically possible to transfer a spent fuel element into the Hot Cells.
			Response: There will be a geometrical configuration in the service pool elevator that will prevent the transfer of a spent fuel assembly. This is discussed in Chapter 11 of the PSAR.
1.36.	1.4.1 Proven Technology—First Shutdown System (FSS)	The Control Plate method adopted is similar to that used in ETRR-2 (Egypt), HTR Petten (Holland) and OSIRIS (France).	Information on the range of accidents considered in these reactors involving the FSS would be useful, in particular to see if Control Plate bank removal is considered.
			Response: Further information will be provided (some discussion is in Chapter 5 of the PSAR). Note that there is no control plate bank extraction in ETTR-2. The interlocks in the RRR are similar to those used in ETTR-2. Refer to Chapter 5, Section 5.5.2.8 and Chapter 16, Section 16.8.3.4.
1.37.	1.4.2 Proven Technology—Second Shutdown System	Table 1.4/2 shows reactors and critical facilities that have shutdown systems based on dumping of heavy water. They include three Canadian Nuclear Power Plants.	Information on the amount of reactivity controlled by these dumps, and the time after initiation at which the shutdown is effective would be useful.
			Response: The characteristics of the dump system in terms of reactivity worth and actuation time are given in Chapter 5, Sections 5.5.4 and 5.7.

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1.38.	1.4.3 Proven Technology— Reactor Protection Systems	The First Reactor Protection System (FRPS) is based on digital and hard wired technology. No information on proven technology is provided. The Secondary Reactor Protection System (SRPS) is based on hard-wired technology with proven performance	More information is needed on the basis of the relative reliability claims for the FRPS and SRPS. The review of the PSA indicates that the reliability of the FRPS is a critical part of the Core Damage Frequency estimates.
			Response: This is discussed in Chapter 8 of the PSAR. Information about the reliability of these systems is also provided in the response to Reactive Review Comment 8.3.
1.39.	1.4.4 Proven Technology of RRR fuel	Low Enriched Uranium Silicide fuel is to be used for the initial core loadings (<19.7%U235). This fuel has been qualified in the 1980s for research reactors (NUREG 1313).	The Argentine Atomic Energy Commission (CNEA) was involved in the 1980s LEU fuel trials, and may well be the fuel manufacturer. Their fuel fabrication arrangements will need to be described more fully.
			Response: Comment noted. Information will be provided in the FSAR of the proposed fuel supplier.
1.40.	1.4.4 Seismic Design	The peak ground acceleration chosen for the RRR (0.3g) is less than that for the similar ETRR-2 reactor in Egypt. This is quoted as support for the adequacy of the RRR seismic design.	The seismic design requirement is site specific so comparisons with the ETRR-2 are spurious.
			Response: The point being made is that expertise and experience in the design of ETRR-2 was used in the design of the RRR. This is discussed in Chapter 4, Sections 4.3 and 4.4 of the PSAR.

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1.41.	1.5.2 Basic Safety Principles in the Construction	General principles for quality assurance and quality control in the construction are identified in a number of statements of intent (a) to (h). They cover design, fabrication, material selection, personnel selection, documentation and a test and commissioning program	The QA of the Construction phase will be an important item for ARPANSA, and mechanisms will have to be developed for an effective ARPANSA interface and involvement.
			Response: Comment noted. This is part of the construction, inspection and test plan.
1.42.	1.5.3 Nuclear Safety Principles for Operation	Reference is made to IAEA documents Safety Series No 35-G2 and a draft IAEA document DS272. There is reference to a set of Operational Limits and Conditions.	ARPANSA will review against its RAPs document, the ARPANSA Expectations for the various management plans and the quoted IAEA documents.
			Response: Comment noted.
1.43.	1.5.4.1 Radiological Criteria for Acceptance in Normal Operation	Dose limits based on the ARPANSA regulations are given, as well as dose constraints currently adopted by ANSTO	The radiological criteria for the constraint of 15 mSv per year for operators has been questioned by ARPANSA in relation to HIFAR operations
			Response: Comment noted. Discussed in Chapter 12 of the PSAR where low doses for operators are estimated.
1.44.	1.5.4.2 Performance Criteria for Acceptance	The key criterion is that there will be no fuel cladding damage in design basis accidents. The design is stated to assure that the frequency of core damage, with significant fuel cladding damage and release of fission products is less than 10^{-4} per year.	It is not clear what is the basis of demonstrating no fuel clad damage. In many countries thermal hydraulic surrogates are used, such as ONB, DNBR or onset of Flow Instability in the flow channels. The review of Ch.16 will need to examine closely the thermal hydraulics.
			Response: This is discussed in Chapters 5 and 16 of the PSAR.

Checked / agreed:

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1.45.	Table 1.4/1 Comparison of Several Multi- Purpose Research Reactors.	Table1.4/1 compares the RRR with five other multi purpose research reactors that have operated around the world.	The most noteworthy features of the RRR relate to its high power density (280kw/litre), maximum to average power flux ratio of 3, and the coolant velocity (8.2m/s). These thermal hydraulic parameters are at the high end of the ranges quoted in the table.
			Response: Comment noted, however, the parameters are within the range of current usage; the power density being consistent with that of Osiris and Orphée. Also note that the maximum/average flux ratio of 3 is a conservative design value for the RRR. The operation value for the reference core is 2.04. See Chapter 5, Table 5.7/18, Criterion 6.