ANSTO Answers to ARPANSA Questions of 22 August 2001 on Spent Fuel and Radioactive Wastes

Answers were received by ARPANSA on 25 September 2001. The ANSTO response (R) follows each *question* (Q) or group of questions.

COGEMA reprocessing option

Q1. *What will be the volume of radioactive waste returned from reprocessing of Silicide spent nuclear fuel in France from the proposed new reactor?*
Q2. *If U-Mo fuel is reprocessed in France, what is the volume of waste that will be returned?*
R1. & R2. ANSTO estimates the volume of vitrified and compacted wastes to be returned from COGEMA reprocessing of RRR spent fuel will amount to 0.4-0.5 m^3 per year of operations, regardless of whether U-silicide or U-molybdenum fuel is used.

Q3. *What is the overall volume including the inner containers and transport flasks?*
R3. The volumes in 1&2 above include the volumes of inner canisters. Each canister of vitrified or compacted waste has an overall volume of around 180 litres. Therefore the 40 year arisings of spent fuel wastes from RRR lifetime operations will amount to some 16-20 m^3, encapsulated in 100-125 canisters. The canisters will be returned to Australia in multi-purpose (transport/storage) casks which will also act as the required primary storage facility. Based on the current designs, each cask will hold up to 28 canisters so that 5-7 such casks will store the lifetime arisings of spent fuel wastes. While the volume of these storage facilities is not a relevant factor for radiological safety assessment, each cask occupies a floor area of under 5 m^2 . The casks are around 7 m high.

Q4. *Will the waste be returned as vitrified long-lived intermediate level waste?*
R4. The waste will be returned in roughly equal numbers of vitrified waste canisters and compacted waste canisters. Almost all of the radioactive content of the spent fuel will be contained in the vitrified waste canisters. The compacted wastes are the "technological wastes", and consist of the offcut metallic pieces and solid components and other contaminated solids generated in the reprocessing operation. Both types of waste will comply with the long-lived intermediate level waste category and with the internationally accepted specifications for these types of waste.

Q5. *What facilities will Cogema use to reprocess these fuel types?*
R5. Such reprocessing is perhaps 20 years in the future. It is for COGEMA to decide what facilities they will use at that time.

Q6. *What is the current situation regarding the authorisations for the facilities at La Hague where Silicide or U-Mo spent nuclear fuel from Australia will be reprocessed?*
R6. COGEMA holds a generic licence allowing reprocessing of such types of fuel in the existing UP2 facilities at La Hague. The generic licence is the only one that is deemed necessary by legal requirements.

In accordance with the administrative procedures established by the French Nuclear Safety Authority, permanent safety review of specific operations is enframed in sequential steps. A first step operational authorisation is obtained to receive, unload and store the fuel pending reprocessing. A second step operational authorisation to proceed with reprocessing itself is obtained subsequently. Each operational authorisation is obtained immediately before undertaking the relevant step. This has been the established procedure instituted by the French Nuclear Safety Authority for many years.

In accordance with these presently applicable administrative procedures, the same procedure will be followed for any type of fuel for the replacement research reactor.

Q7. *What is the situation regarding legal action in France concerning the La Hague plant and reprocessing authorisations*?
R7. We are advised by COGEMA that there are no legal actions in France that would currently prevent further shipments of spent fuel to France under the ANSTO/COGEMA Contract.

Q8. *Are there any implications for reprocessing of spent nuclear fuel from the new reactor if the authorisations are not given or if there are continued legal challenges that delay those authorisations?*
R8. No. In addition to an intergovernmental agreement to facilitate the contract, the French Government has given assurances that it will ensure COGEMA is able to fulfil its obligations under its Contract with ANSTO.

Q9. *Does Cogema have authorisations to reprocess Silicide and U-Mo fuel in those facilities*?
R9. See answer to Question 6.

Q10. *What is the estimated radioactive inventory of the wastes resulting from the reprocessing of spent nuclear fuel from the replacement reactor?*
R10. See answers to Questions 19 and 46.

Q11. *What is the earliest expected date of return of that waste?*
R11. Since it will take the wastes arising from 10 years' of operations to fill a single transport cask, and allowing the required cooling time for the various stages of the operation, return of the first cask load of waste cannot take place until several years after the second delivery of five years' worth of spent fuel to France. This suggests the first return shipment would occur by around 2025. [Note however, that all the wastes from the reprocessing of spent fuel from the existing HIFAR reactor are expected to be returned in two casks in a single shipment by 2015.]

Q12. *What is the maximum amount of Silicide fuel covered by the contract with France?*
R12. There is no absolute limit to the quantity; rather the limit is on the proportion of the fuel delivered to COGEMA which is in the form of silicide fuel. That is, the greater the amount of non-silicide fuel provided with which to dilute the silicide fuel, the greater will be the amount of silicide fuel accepted under the ANSTO/COGEMA contract. This arrangement will permit at least two years arisings of silicide spent fuel to be reprocessed by COGEMA.

Q13. *How might this relate to the operation of facilities at La Hague and Cogema fulfilling its contractual obligations with ANSTO?*
R13. This proportion of silicide fuel already takes into account the capacity of the operations at La Hague to fulfil its contractual obligations to ANSTO.

Q14. *What modifications would have to be made to Cogema's La Hague facilities to allow for reprocessing of Silicide fuel covered in the contract? For example, if the maximum amount of Silicide fuel that Cogema can reprocess without modification is two years fuel please give details of changes necessary to allow additional reprocessing.*
R14. No modifications are necessary.

Q15. *What are the regulatory implications in France of making such modifications?*
R15. See Q 14.

Q16. *Could a copy of the amendment, and letter of agreement, which details the modification to the contract with Cogema to allow for Silicide fuel reprocessing be made available?*
R16. With the concurrence of COGEMA, ANSTO has provided a copy of these contract documents (except for financial details) to the Australian Senate in the course of the Industry, Science and Resources portfolio Estimates Hearing on 4 June 2001.

Q17. *What is the status of negotiations between ANSTO and Cogema on costs regarding Silicide fuel reprocessing (eg. when will they be completed)? We need to know that the costs of reprocessing have/are being considered and that ANSTO will be able to meet these - for the preferred option (assuming that there will be options).*
R17. ANSTO has no reason to expect the unit costs for reprocessing the small quantity of silicide fuel to differ substantially from the costs for reprocessing non-silicide fuel.

Q18. *Could a copy of the provision for Cogema to take damaged elements be made available?*
R18. If any damaged fuel were to be sent to COGEMA it would come under the contract provision whereby COGEMA will accept spent fuel out of specifications under conditions which are to be agreed on a case specific basis. ANSTO would bear the extra costs if there were any.

Q19. *Could information on the agreement with France concerning the 'flagging' waste from spent nuclear fuel from Australia?*
R19. Each customer's share of the waste is allocated to the customer's account at each relevant process step. The allocation reflects the activity content of each customer's actually reprocessed spent fuel as well as that of the pieces of structure associated with the spent fuel and that of the process solid waste produced by the reprocessing operation. This ensures each customer is allocated that share of the waste attributable to their own spent fuel. The waste accountancy, waste conditioning process and allocation to customers are independently and continuously audited by a quality assurance organisation, presently Bureau Veritas.

INVAP processing option

Q20. *What are the contract conditions and time-lines relating to INVAP accepting spent nuclear fuel from ANSTO and on waste returns?*
R20. The specific contract conditions are commercially confidential. If this option were to be used, (it must be remembered that it is only a fallback option), shipments to INVAP would commence around 2012. The wastes resulting from processing would be returned to Australia subsequently.

Q21. *What reprocessing or conditioning processes are proposed for Silicide or U-Mo spent nuclear fuel by INVAP from Lucas Heights?*
R21. The processing/conditioning process proposed by INVAP is a proprietary technology developed in Argentina for processing fuel elements from the Argentinean research reactors. Hence the details are confidential. However, in outline, it involves a dry step to remove the aluminium cladding, followed by oxidation of the fuel meat and incorporation of the entire fuel meat into a vitrified wasteform. No fissile materials are separated, hence it is not a reprocessing technology.

Q22. *What are the locations and names of the facilities in Argentina where Australian spent nuclear fuel will be reprocessed or conditioned?*
R22. The process will be implemented at "Centro Atómico Ezeiza" where adequate hot cells are available.

Q23. *What is the status of these facilities (eg. are they complete or partially completed)? If not, what are the plans and proposed time-lines for completing these facilities?*
R23. The small quantity of fuel to be processed, if any, can be handled in existing hot-cells.

Q24. *When will they be fully commissioned?*
R24. See answer to Question 23.

Q25. *What regulatory process and authorisations are needed in Argentina for plants to become operational?*
R25. According to Argentinean law, the Nuclear Regulatory Body (ARN – Autoridad Regulatoria Nuclear) is responsible for such regulation.

Q26. *Has INVAP set a deadline on when it will have its conditioning facilities ready to accept Australian spent nuclear fuel?*
R26. See answer to Q 22.

Q27. *Will these facilities be able to reprocess or condition Silicide fuel and U-Mo fuel types?*
R27. Yes, they are able to process and condition both silicide and U-Mo fuel types.

Q28. *Who owns these facilities?*
R28. The facilities belong to CNEA – Argentina.

Q29. *Are any further agreements needed to allow reprocessing to go ahead at a third party facility (eg. between CNEA and INVAP or CNEA/INVAP/ANSTO)?*

R29. This is covered by the existing contract between ANSTO and INVAP, documentation for which was prepared in collaboration with CNEA and the Argentinean nuclear regulator and which confirms, inter alia, the processing of the spent fuel is allowed under existing legislation.

Q30. *What volume of waste will be returned if reprocessing/conditioning of Silicide and/or U-Mo takes place in Argentina?*
R30. If this fallback option were utilised the estimated volumes of waste to be returned, whether silicide or U-Mo fuel is processed, are 0.6-0.7 m^3 of vitrified waste (containing all the fuel meat and its radioactive contents) per year of operation. This vitrified waste would be packaged identically to the COGEMA vitrified waste as indicated at Q 3. In addition to the vitrified waste there would be some lower activity technological wastes arising similar to those arising from COGEMA reprocessing (see Q 4). These technological wastes could be returned to Australia either as drums of cemented wastes or such other form as may be agreed. In the case of cement, an indicative estimate of arisings is 3.0 m^3 per year; other possible waste forms would be of lesser volume.

Q31. *What is the overall volume including the inner containers and transport flasks?*
R31. The overall volume depends on the quantity of fuel processed, if any, and is given by the values in Q 30 above.

Q32. *Will all the waste be returned as vitrified long-lived intermediate level waste?*
R32. See Q 30 above. The categories of the two waste forms will not be higher than long-lived intermediate level waste.

Q33. *What is the estimated amount of radioactivity that will be in that waste?*
R33. See answer to Question 46.

Q34. *What is the status of the INVAP-ANSTO negotiations of costs of reprocessing/ conditioning of Silicide or U-Mo spent nuclear fuel?*
R34. INVAP and ANSTO would only enter into such negotiations in the event that option were to be selected for implementation. Nonetheless, INVAP have provided indicative costings on an in-confidence basis which confirm that overall costs for this option would be of the same order as for the COGEMA reprocessing option.

Q35. *Has INVAP provided information to ANSTO on possible contingency plans of where Australian spent nuclear fuel will go if it is not dealt with in Argentina?*
R35. It would be premature to commit to any specific alternative more than 10 years ahead of its highly unlikely need.

Q36. *Can details of those plans be made available?*
R36. See Q 35 above.

Q37. *What are the implications of INVAP dealing with Silicide fuel or third party reprocessing/conditioning in terms of additional contracts and/or agreements between Australia and a third party?*
R37. See Q 35 above.

Q38. *What countries and companies are being considered for this work?*
R38. See Q 35 above.

Q39. *Has any assessment been made of the regulatory implications if a third party accepts Australian spent nuclear fuel for reprocessing? For example, if spent nuclear fuel is sent to Russia, what are the implications of this?*
R39. Australia's bilateral agreement with Argentina grants Australia prior consent rights over the transfer of Australian obligated nuclear material to third countries. In considering whether to approve such arrangements Australia would need to be satisfied the third country has in place adequate nuclear safeguards and nuclear safety infrastructure. For example, Australia would require that the third country have a bilateral nuclear agreement with Australia and could require them to be party to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

Q40. *Has INVAP set a deadline for completing negotiations with a third party on reprocessing or conditioning spent nuclear fuel from Australia if its domestic reprocessing/conditioning options fail?*
R40. See Q 35 above.

Spent nuclear fuel in Australia

Q41. *What contingency plans does ANSTO have if spent nuclear fuel is not sent overseas?*
R41. ANSTO is satisfied that there are comprehensive overseas arrangements in place and available for the management of the spent fuel.

Q42. *What long-term storage options has ANSTO considered within Australia if its spent nuclear fuel is not sent overseas?*
R42. See Q 41.

Q43. *Could information be provided on conditioning options within Australia for spent nuclear fuel?*
R43. The Government has specifically ruled out domestic conditioning of spent fuel at Lucas Heights or anywhere else in Australia.

Q44. *Has ANSTO considered sending unreprocessed/unconditioned spent nuclear fuel to the proposed national store for LLILW?*
R44. The plans for the national ILW store do not envisage this scenario. See Q 41.

Q45. *Has ANSTO a contingency plan for on-site storage if it accumulates more than ten years worth of spent nuclear fuel from the new reactor?*
R45. The commitment not to store more than 10 years arisings of spent fuel was part of the Environmental Impact Statement for the replacement research reactor.

Q46. *What is the amount of radioactivity in a year's worth of spent nuclear from the current reactor and the proposed reactor (Silicide and U-Mo use) in GBq?*
R46. On the basis of six years cooling (the typical time at which spent fuel might be shipped overseas) and average anticipated burnups, the total activity associated with

one year's arisings of spent fuel from HIFAR and from the replacement research reactor is estimated to be typically:
HIFAR 1800 TBq
RRR 3300 TBq (This calculation is based on current silicide fuel design and would be of similar magnitude for U-Mo fuel, depending upon its final design.)
This activity will continually decay so will be lower still at the time of reprocessing and will be further decayed by the time of future return of waste to Australia.

Qualification of U-Mo fuel

Q47. *When will the U-Mo fuel, of the right density, be worldwide qualified for the new reactor?*
R47. The fuel manufacturers involved in the development of U-Mo fuel continue to project that it will be fully qualified in the period 2003-2005.

Q48. *Could a full description of the fuel (ie. dimensions, weight, etc.) be provided?*
R48. The U-Mo fuel assemblies will be square section box-type fuel of 8cm square cross-section and 1 m long and will consist of 21 parallel fuel plates. Depending upon experience in the qualification tests, it is expected they will contain around 3.5 kg of 19.7% enriched uranium per assembly and will have an overall weight of around 6.2 kg. Figures 5.3/1 and 5.3/2 in the PSAR part of ANSTO's licence application for the replacement reactor are drawings of the fuel assembly.

Q49. *What is the current status of the qualification process and program and which companies/countries are involved?*
R49. See copies of two reports from RRFM 2001 provided:
Snelgrove J. L, Hofman G. L, Hayes S.L and Meyer M. K, Progress in Qualifying Low-Enriched U-Mo Dispersion Fuels, 5th International Topical Meeting on Research Reactor Fuel Management, April 2001, Aachen, Germany.
Sacristan P, Languille A et al, Experimental Irradiation of Full-Sized Plates of High Density UMo Fuels, 5th International Topical Meeting on Research Reactor Fuel Management, April 2001, Aachen, Germany.
[ARPANSA note: these are only available on paper]

Q50. *Why is a change of fuel types necessary (ie. why change from Si to U-Mo fuel)?*
R50. U-Mo fuels will provide better back end solutions for the spent fuel as they are more readily accepted at existing reprocessing plants. They will also enable higher density fuels to be used, resulting in the production of fewer spent fuel elements for a given performance, and will enable longer operating cycles with resulting overall benefits to performance.

Q51. *Who are the potential suppliers companies?*
R51. Fuel manufacturing companies presently developing U-Mo fuels and intending to supply U-Mo fuels to the research reactor market are CERCA (France), BWXT (USA) and CNEA (Argentina). Other supplier companies may well enter the market once demand is established.

Q52. *When will the supplier be finalised?*

R52. For U-Mo fuel it is anticipated this will be finalised in the 2003-05 period – see answer to Q 47.

Q53. *Could an outline of key issues to be raised in the licence application to use U-Mo fuel be provided? What modifications will be necessary to change from using Silicide fuel to U-Mo fuel in the reactor?*

R53. No modifications will be necessary to change from silicide to U-Mo fuel. The U-Mo fuel will be designed to be a direct substitute for the silicide fuel with the same geometry, same cladding and at least the same operational safety margins. The licence application to use U-Mo will address the same fuel related issues dealt with in the current application to use silicide fuel.

Q54. *What are the implications of changeover on isotope quality/therapeutic goods issue (if any)?*

R54. None.

Q55. *Who will ANSTO buy the Silicide fuel from?*

R55. The initial two cores are already provided for under the reactor contract with INVAP with ANSTO having the right to influence the source. ANSTO will seek competitive bids for all subsequent supplies.

Q56. *Can the supplier provide fuel suitable for use in the proposed new reactor that will meet safety and performance criteria?*

R56. Silicide fuel has routinely been supplied for research reactors, fully satisfying safety and performance criteria, for many years. Since the mid-1980's more than 10,000 uranium silicide fuel elements (fuel plates) have been used each year in research reactors around the world with no problems – e.g. there has not been a single element failure in either of the high performance OSIRIS or NRU reactors using uranium silicide fuel.

Q57. *Are there any implications for spent fuel or waste management implications in the agreement with the supplier?*

R57. There is, as yet, no agreement with a supplier for fuel, hence the question does not apply. (See Q 55 and Q 52) .