IAEA-NSNI
ORIGINAL: ENGLISH

IAEA
International Atomic Energy Agency

REPORT OF THE

SAFETY REVIEW MISSION

TO THE

High Flux Reactor HFR

Petten, The Netherlands

11-15 January 2010

DEPARTMENT OF NUCLEAR SAFETY AND SECURITY

DIVISION OF NUCLEAR INSTALLATION SAFETY

INTERNATIONAL ATOMIC ENERGY AGENCY

ORIGINAL: ENGLISH

Mission date:	11–15 January 2010
Location:	Den Haag and Petten, The Netherlands
Facility:	High Flux Reactor (HFR)
Organized by:	IAEA at the request of the Nuclear Safety, Radiation Protection, Security and Safeguards Department of the Inspectorate of the Ministry of Housing, Spatial Planning and the Environment (VROM- Inspectorate/KFD), Den Haag, The Netherlands

Conducted by:

Mr. Hassan Abou Yehia	(IAEA/NSNI - Team Leader)
Mr. David Winfield	(Canada)
Mr. Denis Rive	(France)
Mr. Wolfgang Hienstorfer	(Germany)
Mr. Alan D'Arcy	(South Africa)

CONTENTS

1. INTRODUCTION

1.1 BACKGROUND

Safety Review Missions for Research Reactors are an IAEA review service offered, upon request, to all Member States. This mission was requested (see Annex 1) by the Nuclear Safety, Radiation Protection, Security and Safeguards Department of the Inspectorate of the Ministry of Housing, Spatial Planning and the Environment, which is the Dutch regulatory authority for the supervision of nuclear installations (VROM-Inspectorate/KFD) in the Netherlands. The IAEA conducted the mission from 11 to 15 January 2010. The mission reviewed the final plan for the repair of the reducers in the primary cooling system at the High Flux Reactor (HFR) in Petten, Netherlands. The IAEA had previously conducted a related mission from 16 to 18 February 2009 to this reactor[1] concerning the interim operation of the HFR reactor without repair.

The review was based on the final repair plan and safety case documents provided by NRG with regard to the proposed repair of the aluminium reducers in the primary coolant system. The review was also conducted in line with existing IAEA procedures for the Integrated Safety Assessment of Research Reactors (INSARR) missions, which are based on the IAEA safety standards.

The mission was conducted following the Agenda attached in Annex 2. The IAEA review team was composed of five members; an IAEA staff member: Mr. Hassan Abou Yehia, (Team Leader) with four international experts: Mr. David Winfield, Mr. Denis Rive, Mr. Wolfgang Hienstorfer and Mr. Alan D'Arcy, (see Annex 3). Ms. Elfriede Bosch (IAEA) provided secretarial assistance.

1.2 SUMMARY REACTOR DESCRIPTION AND STATUS OF THE FINAL REPAIR PLAN

The High Flux Reactor (HFR), Petten is a 45 MW tank-in-pool research reactor, commissioned in 1961. The HFR is the property of the European Commission and is operated and maintained by NRG, who is the license holder of the reactor. Figure 1 gives a simplified cross sectional view of the reactor building, the reactor vessel, the reactor vessel plug (RVG) and the sub-pile room layout.

The reactor is used for the production of medical isotopes and research on nuclear fuels and materials. In 2005 several inward deformations were observed in the wall of the primary cooling piping. During the In-service Inspection programme in August 2008 a pinhole was revealed by a small gas bubble jet at one of the inward deformations of the primary cooling system reducers, which are embedded in the concrete biological shield. This inspection led to the conclusion that the reactor no longer complied with its license conditions. However, due to the strong need for medical isotopes and taking into account the results of the safety analysis made by NRG and the corresponding safety assessment made by KFD, a ministerial order was issued authorizing the licensee to operate the reactor from February 2009 to March 2010 under specific conditions, including enhanced water leakage monitoring.

[1] http://www.vrom.nl/get.asp?file=docs/publicaties/w1248.pdf&dn=w1248...

In January 2009 KFD requested an IAEA mission to review its safety evaluations concerning the safety case submitted by NRG. The IAEA mission team concluded in February 2009 that the assessment made by KFD regarding the interim operation of the HFR reactor in the degraded condition of its primary cooling system was justified from a safety point of view. The final repair plan will be carried out in stages with the following key dates:

Engineering ready:	December 2009
Start of repairs:	February 2010
Patch weld repair option completed:	July 2010
Complete reducer replacement option completed:	August 2010

The review related to the repair of the reducers was based upon the information presented in the document: "Final Repair of HFR Reducers; Project Repair Plan; Ref. No. NRG-25183/09.95270" and supporting documents listed in Annex 4.

Two different repair options have been studied to restore the integrity of the reducers:

(i) local replacement of corroded areas by welded-in patches, and
(ii) replacement of the existing reducers by new reducers.

The choice between these options will be made after removal of the concrete surrounding the reducers and detailed inspections to characterize the condition of the reducers. Figure 2 shows simplified cross-sectional views through the reactor vessel and the sub-pile room. The left hand side shows the situation before the reducer repair and the right hand side shows the situation after removal of concrete around both reducers.

The reducers will be repaired from the outside after removing the surrounding concrete. The following sequential repair activities are planned:

(a) removal of all fuel from the reactor vessel;
(b) securing of the reactor vessel, supporting the bottom plug; disassembling internals and externals and placing Densimet® shielding on the bottom of the pool liner;
(c) removal of all removable components from the reactor vessel, draining of the primary cooling water lines and reactor pool and concrete removal around the location of the reducers;
(d) inspection of the reducers; evaluation and decision on a patch repair or replacement;
(e) removal of a part of the north reducer jacket pipe;
(f) in the case of patch repair: replacement of corroded areas by welded-in patches;
in the case of replacement: measurement of the geometry, removal of the old reducers, manufacturing new reducers, inspections/tests, installation and welding into place;
(g) performance of NDT inspections;
(h) application of a watertight or corrosion-resistant layer to the outside of the reducers (elimination of the root cause);
(i) repair of the north and south reducer jacket pipes, as determined by inspection;
(j) casting of new watertight concrete at the location of the reducers;
(k) performance of baseline measurements with filled system as a reference point for future measurements;
(l) re-commissioning of the primary coolant system and restart of the reactor.

1.3 CURRENT LICENSING STATUS

Since 12 February 2009 the reactor operated under a temporary licence, issued under a ministerial order, authorizing the licensee to operate until 1 March 2010. This licence has allowed for the preparation of the reducer final repair plan and continued radio-pharmaceutical production since February 2009. The main safety related temporary licence conditions were:

(i) The feasibility of a permanent repair within a reasonable time frame to be demonstrated to KFD;
(ii) The proposed additional surveillance and monitoring systems for interim operation to be approved by KFD, installed and fully functional before the reactor is restarted;
(iii) The changes of the technical specifications shall be approved by KFD;
(iv) The approval of the deviation shall expire on 1 March 2010 and shall not be extended;
(v) In case of any detected primary coolant leakage from the reducers prior to 1 March 2010, the reactor shall be shut down immediately.

Planning for the final permanent repair was well underway at the time of the present mission. A mock-up to demonstrate concrete removal, reducer repair and the concrete refilling process was already constructed and tested at the civil engineering contractor's site. Figure 3 shows this reducer mock-up, prior to pouring concrete. Figure 4 shows the mock-up reducer after a test of a patch weld repair. Three other mock-ups of the reducers have been constructed at the HFR. The reactor was shutdown on 19 February 2010 to begin the repairs.

2. SCOPE OF THE MISSION AND BASIS OF THE ASSESSMENT

In August 2009 KFD requested the IAEA to conduct a peer review mission of the safety assessments concerning the final repair plan for the reducers, see Annex 1. Based on the scope of the request defined by KFD, the IAEA mission team reviewed the following items:

- The last In-service Inspection results and review of the general repair plan;
- The proposed repair methods, including the jacket pipe repair;
- The repair plan of the reducers and review of welding qualifications;
- The provisions adopted to perform the repair work, including the dismantling process, radiological and labour safety;
- Test information from the mock-ups representing the zones to be repaired;
- Commissioning programme and work planning; and
- Implementation status of the recommendations of the previous IAEA mission of February 2009.

The list of the related documents, received prior to and during the mission and reviewed by the mission team, is provided in Annex 4.

2.1 REVIEW MADE BY THE IAEA TEAM

The results of the IAEA team review are presented as Issue Pages and were discussed with NRG and KFD. The Issue Pages are presented in Annex 6.

2.2 REVIEW CRITERIA

The review was conducted in line with practices found in other research reactors worldwide and existing IAEA procedures for the Integrated Safety Assessment of Research Reactors (INSARR) missions, which are based on the IAEA Safety Standards. The results are provided as recommendations, suggestions, comments and good practices, presented to the counterparts by the team as a whole, in accordance with the following definitions:

Recommendations

This is a team advice to improve safety, based on IAEA Safety Standards and good recognized practices. The recommendations focus on WHAT it is recommended to do. However, under 'Comments' see below, approaches on the HOW may be mentioned. The recommendations are numbered in the Issue Pages as R.

Suggestions

These are team proposals in conjunction with a recommendation, or they may stand on their own. They may indirectly contribute to improvements of the safety but they are primarily intended to enhance performance. The suggestions are numbered in the Issue Pages as S.

Good Practices

These are proven performances, activities or uses of equipment, which the team considers to be markedly superior to that observed elsewhere. The good practices are numbered in the Issue Pages as GP.

Comments

These are proposals for the implementation of the recommendations or suggestions, but do not constitute a team advice. The comments are numbered in the Issue Pages as C.

3. CONDUCT OF THE MISSION

The entry meeting was held on Monday 9:00 am, 11 January 2010 for the introduction of the mission and discussion of the agenda at the Hotel Mercure, Den Haag. The list of participants of the entry meeting is provided in Annex 5. Introductory remarks were given by Mr. Piet Müskens, Director of the KFD and by the IAEA team leader. NRG staff then made a presentation on the HFR Reducer Repair Plan and provided a summary of the implementation status of the recommendations from the IAEA 2009 mission. KFD presented an oversight of safety assessment activities performed and planned.

The IAEA mission team discussed general aspects of the repair plan and related technical issues with KFD and NRG, in the presence of representatives of Lloyd's Register[2]. Lloyd's Register is assigned by KFD to evaluate the repair plan and to supervise NRG's repair activities.

[2] An independent government-accredited body that inspects nuclear pressure equipment.

From Den Haag the IAEA team travelled to Petten on Monday afternoon. The remainder of the mission was dedicated to the assessment of technical documents provided by NRG, in relation to assessments made by KFD. NRG made detailed presentations on all topics of the repair, which were followed by extensive and open discussions. A representative from KFD was also in attendance at Petten. A visit to mock-ups of the reducers at HFR was made and test examples of the cold spray technique were seen.

On Thursday, 14 January 2010 the IAEA team returned to Den Haag at 1.30 pm.

The exit meeting (see Annex 5) was held on Friday 11:00 am, 15 January 2010 at Den Haag. Representatives of various Dutch Ministries attended the exit meeting and provided comments and questions. An executive summary[3] with the main recommendations and conclusions was provided by the IAEA team and agreed to by KFD and NRG at this meeting.

4. MAIN CONCLUSIONS

The team was pleased to note the satisfactory implementation status by NRG of the majority of the nine recommendations from the 2009 mission. Six recommendations have been satisfactorily addressed and implemented. Recommendation (R9) for ground water monitoring, is under implementation and scheduled for completion when ground temperature conditions become suitable after winter. Recommendation (R4), for inspection of other components embedded in concrete, is part of the Repair Project Inspection and Test Plan. Recommendation (R7), for efforts to improve the leak tightness of the pool, remains valid.

The IAEA mission team would like to highlight the satisfactory follow-up and supervision strategy of KFD related to the preparation and implementation of the repair plan. The team also considers that the provisions and activities proposed by NRG should take into account the mission recommendations. The team noted with satisfaction the use and quality of the mock-ups, particularly the full scale concrete-based assembly at the civil engineering contractors site, as a good practice, to train repair staff and to establish optimum repair techniques.

The team appreciated the strong motivation of NRG for the implementation of the repair plan and the good preparation by KFD and NRG for the mission. A follow-up of the implementation of the recommendations formulated by the present mission should be made.

In the opinion of the IAEA mission team, the lessons learned from the coolant piping degradation event and the conclusions from the investigations made, should be documented by NRG and utilized, nationally and internationally, for existing reactors and new research reactor projects.

[3] http://www.vrominspectie.nl/actueel/nieuws/iaea-tevreden-over-aanpak-reparatie-hfr-petten.aspx

5. RECOMMENDATIONS

Recommendations are listed below and have been extracted sequentially from the issue pages of Annex 6.

Support structure in sub-pile room

R1: An adequate support structure should be installed in the sub-pile room to provide protection against potential collapse of the reactor vessel and pool structure and to compensate for the removal of concrete surrounding the reducers of the primary cooling system.

Use of polyurethane seal and polyethylene tape

R2: The choice of polyurethane as a sealing material for the jacket pipe should be reassessed, with regard to potential corrosion of the primary cooling pipe. The use of concrete for this purpose was suggested as an option by the team. The choice of polyethylene tape around the primary cooling pipe should also be reassessed for the same reason. Initiating a new root cause should be prevented (corrosion between Al/concrete).

Repair of the Reducers

R3: Action should be taken to:

- ensure that there is no leakage of the repaired parts of the primary coolant system before the new concrete encasings are poured,
- inspect the pool liners with the objective to repair possible defects causing the existing water leakage and to restore the leak tightness of the pools. The pool leakage rate should be quantified.

Radiation Protection and Waste Management Programme

R4: Existing radiation protection procedures should be reviewed with the objective to ensure that they adequately cover the radiological conditions during the repair activities. A radioactive waste management programme should define the volume, activity and final disposition of the radioactive waste, including concrete dust, generated during the implementation of the repair activities.

R5: A dose mapping profile should be established and maintained. A radiation protection officer should be present during the repair process. Repair work in a radiation environment should be performed by personnel classified as radiological workers class A.

R6: In the interest of ALARA, NRG should consider the possibility of keeping a limited amount of water in the reactor pool as an additional means to reduce the dose rates to workers during repair work.

Re-commissioning

R7: A commissioning programme should be established to check the satisfactory performance of the repaired parts of the primary cooling system and the reactor facility before return to operation. Special emphasis should be given to the treatment of deficiencies, deviations and non-conformances.

Summary Report

R8: NRG should submit to the regulatory authority the results of the inspection of the reducers, after removal of the surrounding concrete, and the proposed option for the reducer repair (partial repair or complete replacement).

R9: A summary report presenting the overall and updated safety case for the repair plan should be submitted to KFD. This report should present the selected repair option with its justification, and should reflect the updated status of all technical and organizational activities, with associated hold points related to the implementation of the repair plan. The summary report should be self consistent and include: a technical description with figures of the HFR installation; the initial problems with the reducers; the results of inspections and tests; the final repair option with its justification; the repair work performed and the final, as-built, configuration of the repaired components of the primary coolant system.

APPENDIX 1: FIGURES

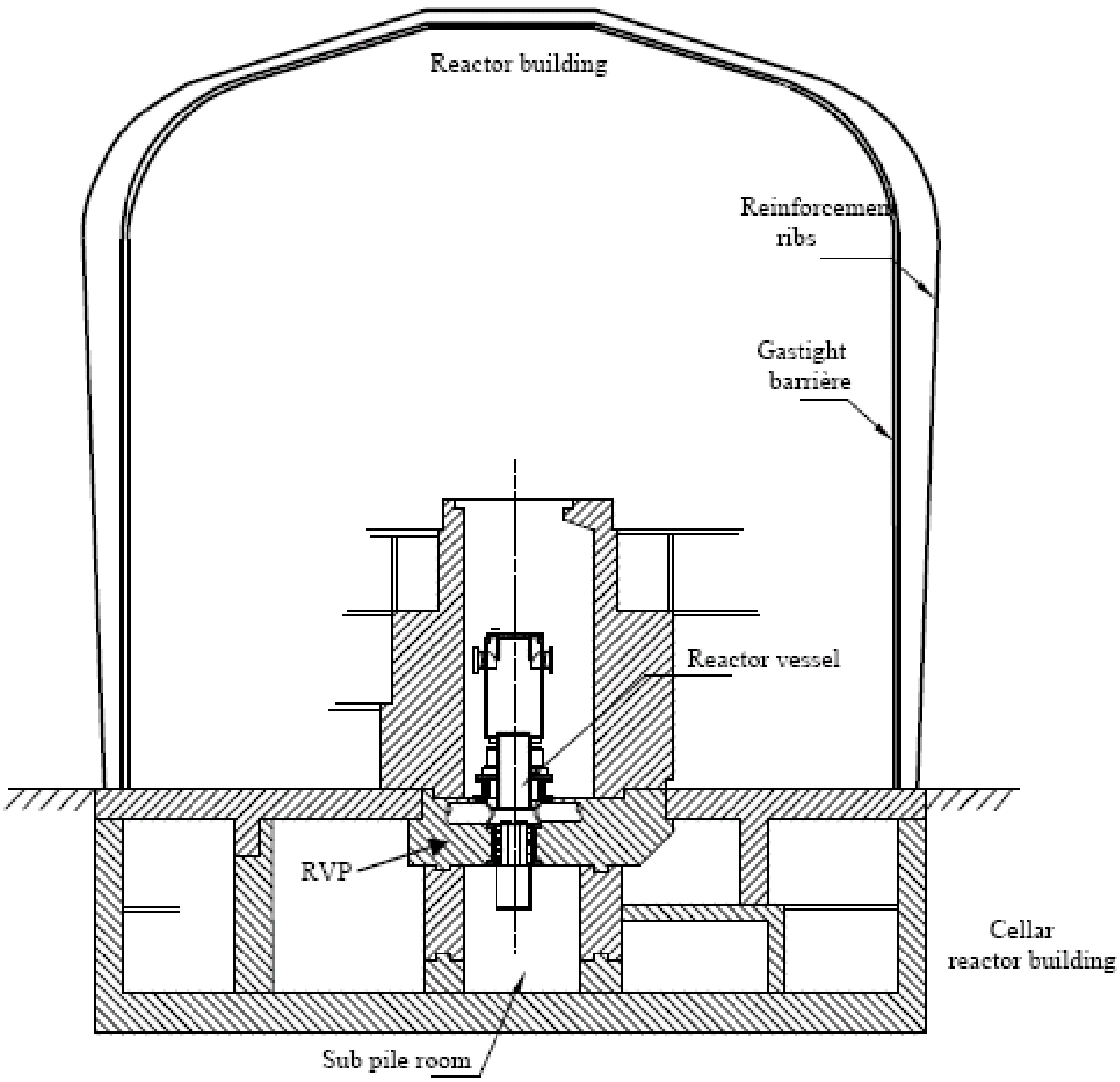

FIG. 1: Simplified Cross-section of the Reactor Building showing location of the Reactor Vessel, the Reactor Vessel Plug (RVP) and the Sub-pile Room

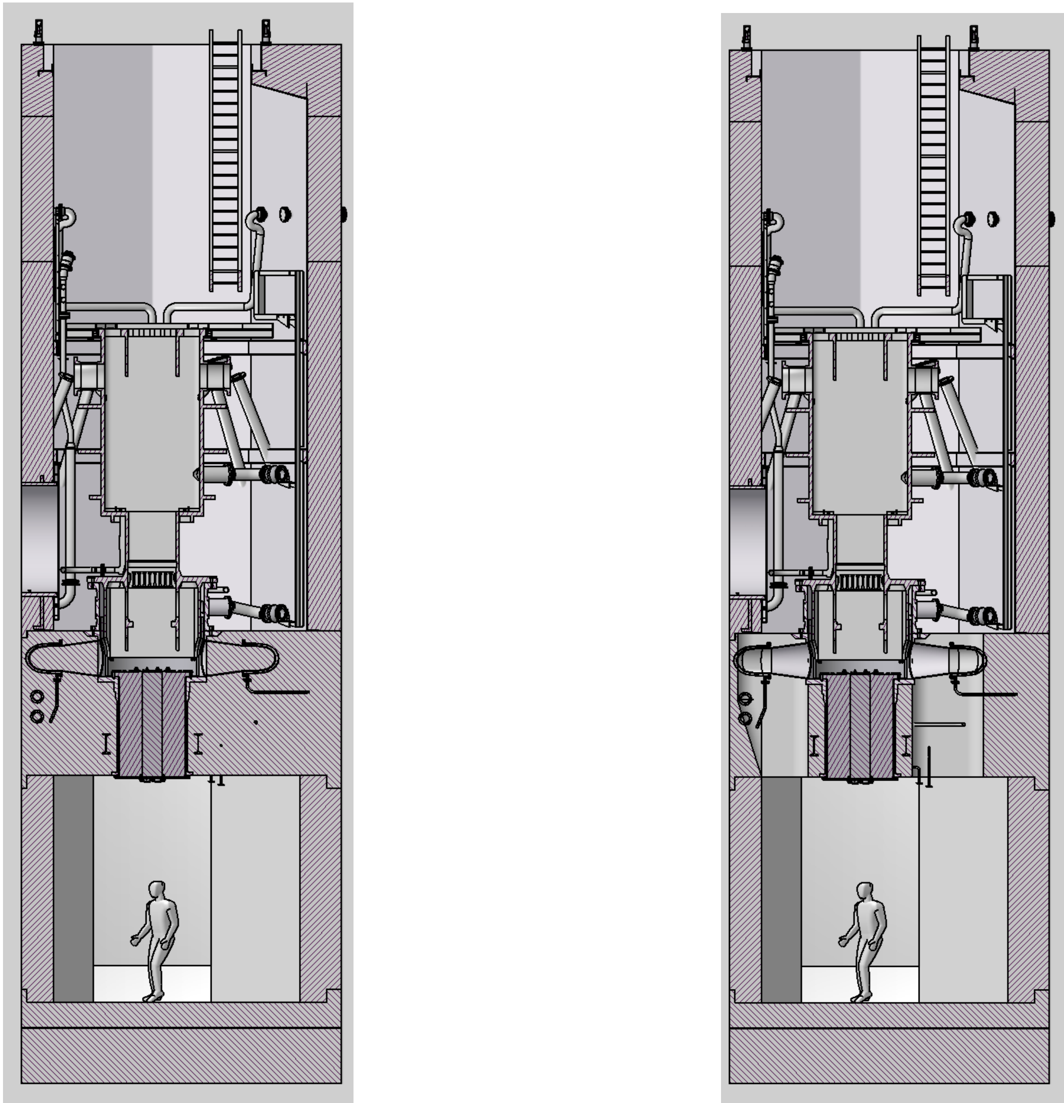

FIG 2: Cross-section through the Reactor Vessel and the Sub-pile room.
Left: Shows situation before reducer repair
Right: Shows situation after removal of concrete around both reducers

FIG. 3: Mock-up of reducer prior to pouring concrete.

FIG. 4: Mock-up of reducer after a test patch weld repair of the reducer.

ANNEX 1: LETTER REQUESTING THE MISSION

Inspectorate of Housing, Spatial Planning and the Environment
Ministry of Housing, Spatial Planning and the Environment

> Returnaddress P.O. Box 16191 2500 BD The Hague

International Atomic Energy Agency
NSNI / Research Reactor Section
Mr. H. Abou Yehia
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VROM-Inspectorate
Department for Nuclear Safety Security Safeguards

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Our reference
VI/KFD/2009051810_507_JaR

Copy to
NRG
Mr. dr. R.J. Stol
P.O. Box 25
1755 ZG Petten
The Netherlands

Enclosure(s)
RT09-126.507

Date August 20, 2009
Subject IAEA peer review mission on final repair plan HFR in 2009

Dear Mr. Abou Yehia,

With this letter the nuclear safety authority (KFD) formally requests IAEA to organise a peer review mission on the final repair plan of the HFR (High Flux Reactor) in Petten, The Netherlands. The HFR is operated by the responsible licensee NRG (Nuclear Research and consultancy Group).

Due to observed inward deformations in specific pipes of the primary cooling system and gas leaking the HFR was taken out of operation August 2008. After implementation of compensatory measures the reactor restarted February 12, 2009 and a ministerial order was granted to operate until March 2010. After this period repair is required before continuing operation.

February 16-18, 2009 a IAEA safety review team visited the HFR and concluded that operation of the HFR without repair but with compensatory measures until March 2010 was justified. One of the recommendations the team made was to review the final repair plan before implementation. To satisfy this recommendation I request IAEA to organise and execute a peer review mission for the end of November / beginning December 2009, when the final repair plan will be completed but not yet implemented.

Enclosed you will find a document describing the scope of the intended mission.

Please let me know your financial offer and what steps, including time, documents and further information are needed in the preparation of the mission.

Sincerely yours,

b/a L. Vogels

dr. P.W.J.M. Müskens
Director of KFD

ANNEX 2: AGENDA

Time	Title
Sunday, 10 January 2010	
18:00	Arrival at Amsterdam/Schiphol Airport, Train from Schiphol to Den Haag CS (Central Station), Travel to the Hotel Mercure in Den Haag.
19:00	Dinner on behalf of KFD.
20:00	Briefing meeting for the Team (Hotel Mercure).
Monday, 11 January 2010	
09:00-09:30	Welcome and coffee/tea at Meeting Room Hotel Mercure.
09:30-10:30	General overview presentation about the repair by NRG (including general questions); attended by IAEA, KFD, NRG and Lloyd's Register.
10:30-11:00	Video of mock-up "Removal of concrete, repair and reinstallation of concrete" by NRG (including general questions); attended by IAEA, KFD and NRG.
11:00-11:30	Feedback on recommendations IAEA Safety Review mission 16-18 February 2009 (Interim Solution) by NRG; attended by IAEA, KFD and NRG.
11:30-11:45	Break.
11:45-12:30	Presentation by KFD and discussion about its review approach, main findings and conditions to be fulfilled before and during the repair and before start-up. Different roles of KFD and Lloyd's Register. IAEA and KFD; NRG stays as observer.
12:30-13:30	Lunch break at Mercure Hotel.
13:30-16:30	Continuation of discussion about KFD review and activities of Lloyd's Register (review of several repair methods and qualification). IAEA, KFD and Lloyd's Register; NRG stays as observer.
16:30-18:00	Travel by KFD-taxi to Hotel Marijke/Bergen. Team meeting, Dinner included, Drafting mission report.

Tuesday, 12 January 2010	
08:00	Transfer from the Hotel Marijke to HFR in Petten by NRG-taxi.
09:00-09:30	Welcome and opening. Introduction of participants. Presentation by NRG. R. Stol and E.J. de Widt.
09:30-10:00	Confirmation of scope and agenda, IAEA team.
10:00-10:15	Coffee break.
10:15-12:30	Presentations and discussions with IAEA team on subprojects of the repair plan: – Repair and qualification, J. Verbruggen – Shielding, J.Best – Labour Safety and radiation protection/Health Physics, J. Minkema – Dismantling and construction process., J. Waard
12:30-13:30	Lunch break.
13:30-14:45	Review and discussion on: Project organization / planning / decision process (go/no go junctions), general repair plan / construction plan R. Goetjaer and IAEA Safety Review members
13:30-18:00	Continuation of the review and discussion of the team with the counterparts. Visit to the three reducer mock-ups and inspection of examples of cold spray technique test samples (Wednesday)
14:45-15:00	Coffee break
15:00-16:45	Presentations on subprojects of the repair plan (cont.): – Civil analyses reactor floor E. Bach – Concrete removal and renewal (civil engineering E. Bach
16:45-17:30	Visit mock-ups at HFR.
17:30-18:00	First day close-out – Summary of first day – Determination of outstanding questions
18:00	Transfer from HFR in Petten to the Hotel Marijke by NRG-taxi. Dinner included. Drafting of the mission report.

Wednesday, 13 January 2010	
08:00	Transfer from the Hotel Marijke to HFR in Petten by NRG-taxi.
09:00-10:30	Review and discussion on: – Qualification process reducer repair (methods, test results etc.) and inspection and test plan (ITP) – Jacket pipe repair J. Verbruggen/R. Van der Stad and IAEA Team members.
10:30-10:45	Coffee break.
10:15-12:30	Presentations and discussions with IAEA team on subprojects of the repair plan: – Repair and qualification, J. Verbruggen – Shielding, J.Best – Labour Safety and radiation protection/Health Physics, J. Minkema – Dismantling and construction process., J. Waard
12:30-13:30	Lunch break.
13:30-14:45	Review and discussion on: – Dismantling/construction process J. Waard/M. Vervecken and IAEA Safety Review members
13:30-15:00	Review and discussion on: – Civil analyses reactor floor E. Bach/R. Goetjaer and IAEA Safety Review members – Concrete removal and renewal
15:00-15:30	Coffee break
15:30-16:45	Discussion on open items and answering of outstanding questions.
16:45-18:00	First day close-out – Summary of third day – Determination of outstanding questions
18:00	Transfer from HFR in Petten to the Hotel Marijke by NRG-taxi. Dinner included. Drafting of the mission report.

Thursday, 14 January 2010	
08:00	Transfer from the Hotel Marijke to HFR in Petten by NRG-taxi.
09:00-12:30	Drafting of the mission report (HFR Petten).
12:30-13:30	Lunch at HFR Petten.
13:30-15:30	Travel by KFD-taxi to Hotel Mercure (Den Haag).
15:30-19:30	Finalization of the mission report.
20:00	Dinner on behalf of KFD in the Hague.
Friday, 15 January 2010	
08:00-10:00	Finalization of the mission results.
10:15-11.15	Presentation of the main conclusions and recommendations to NRG, VROM-KFD, Lloyd's Register and discussion of final comments.
11:30-12.30	Exit Meeting (IAEA Mission Team and Counterparts).
12.30-13.30	Lunch on behalf of KFD.

ANNEX 3: IAEA REVIEW TEAM

Name	Job Title/ Section/Organization	Office Address	Telephone Number:	Email
Mr. Hassan Abou Yehia	Team Leader/ Research Reactor Safety Section (RRSS), IAEA	Wagramer Strasse 5 PO Box 100 1400 Vienna Austria	+43 1 2600 22400	h.abouyehia@iaea.org
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Mr. Alan D'Arcy	Nuclear Energy Corporation of South Africa (NECSA), South Africa	Church Street West Extension, PO Box 582, 0001 Pretoria, South Africa	+27 12 3055017	Alan.D'Arcy@necsa.co.za
Ms. E. Bosch	Secretary	Wagramer Strasse 5 PO Box 100 A-1400 Vienna	+43 1 2600 26076	e.bosch@iaea.org

ANNEX 4: DOCUMENTS RECEIVED FROM THE NRG AND VROM/KFD PRIOR TO AND DURING THE MISSION

Document and Revision	Date	Title
08.91837 Rev. C	02-12-08	Radiation dose rate at the location of the reducers
09.93454 Rev. A	02-02-09	Permanent Repair of the Reducers. Feasibility Study "Concrete Route"
09.93492 Rev. C	26-02-09	Minimal required wall thickness of the reducers
09.94379 Rev. C	24-11-09	Permanent Repair of the BPL-reducers, Technical Specification repair by welding
09.94663 Rev. B	17-04-09	Removal of reactor pool contents to safe locations. Clearing out reactor pool and pool 1 for repair work BPL
09.95549 Rev. B	27-05-09	Actions to be taken to remove fuel to safe locations - Removal of fuel from pool 1
09.93935 Rev. C	29-09-09	Definitive repair of BPL reducers. Technical specification for radiation shielding
09.95270 Rev. E	01-10-09	Project Repair Plan
09.95420 Rev. D	24-09-09	ALARA plan. Repair of HFR bottom plug liner reducers BPL
09.96862 Rev. B	07-09-09	Definitive repair of the HFR reducers - Qualification Plan
09.96988 Rev. B, English 09.96988 Rev. D, Dutch	09-09-09 23-12-09	Definitive repair of the HFR reducers, Inspection and Test Plan Definitieve reparatie van de reducers HFR, Inspectie en Testplan
IDPBW/LDE/CVE/2009/1708	07-09-09	Visiplan Modelling for the Repair of the BPL Reducers at HFR Petten
09.94834 Rev. C	09-04-09	SHE risk management, Repair of HFR Bottom Plug Liner Reducers
Revision 9, Dec 2009	09-12-09	Construction planning (English)
25183/09.99385	18-12-09	Bottom Plug Liner Peer Review report (Powerpoint Presentation)
25076/09.99100 Rev. 2	17-12-09	Peer Review Repair project reducers BPL – Scope, Participants and draft Agenda – 16 to 18 December 2009
TEPA090156/iv-01 Rev. 0	11-12-09	Repair coolant piping reactor, Check reactor floor
RT09-083.507	28-05-09	Comments on 'Final repair of HFR reducers' report
Project 507; 1.B2	22-06-09	Repair plan for HFR reducers
RT09-126.507	18-08-09	Scope of mission IAEA
Project 507; 1.B2	03-12-09	Repair plan for HFR reducers
RT09-185.507.B Revision 3	03-12-09	Evaluation of the plan for final repair of cooling water outlet lines of the HFR
104-09-19.478	10-12-09	VROM/KFD Inspection Report 10 December 2009

ANNEX 5: ATTENDANCE AT MEETINGS

Monday, 11 January 2010, 9.0 a.m. – Opening Meeting in Den Haag

IAEA Team (see Annex 3)

Name	Function	Organization
P. Müskens	Director	KFD
L. Lindhorst	Senior Inspector (Materials)	KFD
L. van der Wiel	Senior Expert Nuclear Safety	KFD
R. Jansen	Manager	KFD
C. des Bouvrie	Senior Inspector (Auditing)	KFD
IJ. van der Plas	Senior Inspector Nuclear Safety	KFD
R. van Tol	Senior Inspector (In Service Inspection)	KFD
G. Delfini	Policy Co-ordinator	VROM (Ministry)
R. van der Stad	Licensing Manager	NRG
R. Goetjaer	Project Manager	NRG
E. Zeelenberg	Lead NDE specialist	Lloyd's Register
R. Bambach	Senior Specialist Metallurgist	Lloyd's Register

Tuesday, 12 January 2010, 9.30 a.m. – Opening Meeting in Petten

IAEA Team (see Annex 3)

Name	Function	Organization
R. Goetjaer	Project Manager	NRG
R. van der Stad	Licensing Manager	NRG
J. Offerein	Engineering Manager	NRG
M. Vervecken	Reactor Operations Manager	NRG
C. Timmermans	Radiation Shielding	NRG
J. Best	Radiation Shielding	NRG
J. Minkema	Safety Health and Environment	NRG
J.Verbruggen	Reducer Repair	NRG
R. Stol	Managing Director	NRG
E. Back	Civil Engineering Repair	NRG
R. van Tol	Senior Inspector (ISI)	KFD

Friday 15 January 2010, 11.00 a.m. – Exit Meeting in Den Haag

IAEA Team (see Annex 3)

- Ministry of Housing, Spatial Planning and the Environment
  - Piet Müskens, VROM-Inspectorate/KFD - Director
  - Rob Jansen, VROM-Inspectorate-Manager Supervision Nuclear Safety
  - Rob van Tol, VROM-Inspectorate - Senior Inspector (In Service Inspection)
  - IJsband van dr Plas, VROM-Inspectorate - Senior Inspector Nuclear Safety
  - Louis van der Wiel, VROM-Inspectorate - Senior Expert Nuclear Safety
  - Kees des Bouvrie, VROM-Inspectortate - Senior Inspector (Auditing)
  - Gerard Westerhof, VROM-Inspectorate - Public Information Officer
  - Olaf Welling, VROM Inspectorate - Director of Execution Division
  - Ginevra Delfini, Environmental Safety and Risk Management Directorate - Policy coordinator
  - Theo Klomberg, Environmental Safety and Risk Management Directorate - Policy coordinator.

- Nuclear Research and Consultancy Group (NRG); Licensee for the High Flux Reactor (HFR) in Petten
  - Rob Stol, General Director
  - Rob van der Stad, Manager Licensing
  - Eric Jan de Widt, Product Group Manager, Irradiation Services
  - Ron Goetjaer, Project Manager

- Dutch Ministry Representatives:
  - Ministry of Foreign Affairs, Hendrik E.C. Koets
  - Ministry of Economic Affairs, Gert van Uitert

- Lloyd's Register:
  - Erick Zeelenberg

- Dutch Press Representative
  - N. Elsink, Journalist, Hand Having

ANNEX 6: ISSUE PAGES

ISSUE 01: Temporary Support Structure in the Sub-Pile Room during Repair

ISSUE 02: Use of Polyurethane for Jacket Pipe Seal and use of Polyethylene Tape / Polyken Tape for Reducer Corrosion Protection

ISSUE 03: Repair of the Reducers

ISSUE 04: Radiation Protection and Waste Management Programme

ISSUE 05: Re-commissioning

ISSUE 06: Work Protection Practices during Repair: Crane Operations and Concrete Removal

ISSUE 07: Summary Report

ISSUE 01: TEMPORARY SUPPORT STRUCTURE IN THE SUB-PILE ROOM DURING REPAIR

BASIS AND REFERENCES

[1] Repair coolant piping reactor, check reactor floor, TEPA090156/iv-01, Rev. 0, 11 December 2009.

[2] Presentation, Bottom Plug Liner Peer Review Report, 18 December 2009, Ref. 25183/09.99385.

[3] Permanent Repair of the BPL Reducers, Feasibility Study "Concrete Route", NRG-25079/09.93454, Rev. A, 2 February 2009.

[4] Definitive repair of the HFR Reducers, Repair Project Plan, NRG -25183/09.95270, Rev. E, 1 October 2009.

ISSUE CLARIFICATION

Structural stress calculations indicated there is no requirement for a temporary support structure in the sub-pile room, to provide protection against potential collapse (downwards into the sub-pile room) of the reactor vessel and pool structure during concrete removal around the reducers. The potential consequences of inadequate support for the vessel and pool structure were though considered by the team to be so high that the requirement for a compensatory support was recommended, despite the assurance of the stress calculations.

OBSERVATIONS

- To carry out the reducer repairs access holes are required from within the underside of the sub-pile room concrete ceiling slab. The thickness of concrete removal will be close to the height of the slab (2.2 m), [3, pool construction drawing].
- Two test concrete boreholes (35 cm length) were made close to the bottom plug liner and strength data (Young's Modulus) were checked. Reference [1] did not document sufficient information on these boreholes (e.g. size, location).
- Finite elements calculations [1] predicted that insignificant movement of the vessel or pool structure is expected and that there should be no need for a temporary support structure in the sub-pile room, based on concrete strength conservatively assumed to be 0.33 x test borehole strength. Reference [1], Section 1, additionally suggests the reactor floor is designed for radiation protection and not primarily for stiffness and strength.
- A temporary support structure in the sub-pile room was originally intended to be used and was designed [4], Section 4.
- A temporary support structure could impede working conditions due to size of the sub-pile room. The peer group review [2] did not recommend using a temporary vessel support structure in the sub-pile room, primarily because of this reason.
- Installation of monitoring equipment is planned, to detect any vessel movement, particularly for verticality, which is important for control rod alignment.

From a safety point of view, and according to the defence in depth principal, the team considers that compensatory support measures for the concrete removal should be considered. Holes of significant size are to be made in the concrete slab, and while the two test boreholes appear to give good confidence in the concrete strength, with stress calculations allowing a conservative factor of three, there could still be uncertainties about concrete properties and the validity of the calculational model.

POSSIBLE SAFETY CONSEQUENCES

1. Potential injury of repair personnel working in the sub-pile room during demolishing and removal of concrete ceiling slab and also during welding operations.
2. Potential damage to the vessel and pool liner during the repair.

COUNTERPARTS VIEW AND MEASURES ON THE FINDINGS

The civil engineer counterpart agreed that, while the stress calculations gave confidence that the vessel and pool support movement should be negligible, there was no complete guarantee. After reviewing the existing multi-post support design it seemed feasible that the installation of an alternate single post support, designed to minimize the space restrictions for repair personnel, was possible. It was agreed to perform an additional stress calculation to verify that a suitable optimum location for a single support could be found.

RECOMMENDATION

R1: An adequate support structure should be installed in the sub-pile room to provide protection against potential collapse of the reactor vessel and pool structure and to compensate for the removal of concrete surrounding the reducers of the primary cooling system.

SUGGESTION

S1: The team suggested that Report TEPA090156/iv-01, Rev. 0, 11 December 2009 should be updated to include detailed information on the two core samples taken.

COMMENTS

C1: It should be noted, as mentioned above, that recommending the use of a temporary support conflicts with one conclusion of [2] where the use of a temporary support was not recommended.

C2: Discussions indicated that if there was any significant vessel movement it would be a very difficult task to realign the vessel back to the original position.

ISSUE 02: USE OF POLYURETHANE FOR JACKET PIPE SEAL AND USE OF POLYETHYLENE TAPE / POLYKEN TAPE FOR REDUCER CORROSION PROTECTION

BASIS AND REFERENCES

[1] Definitieve reparatie van de reducers HFR, Inspectie en Testplan, 23 December 2009 draft version NRG-25083/09.96988, Rev. D, Items Z3.17 and Z3.18.

[2] Adiprene® L100 Chemtura Technical Information Bulletin 10/17/2007, (see Evaluation of the plan for final repair of cooling water outlet lines of the HFRRT09-185.507B, 3/12/2009, Rev. 3, p.18).

[3] Presentation, Repair and Qualification of BPL Reducers, 12 January 2010, (J. Verbruggen).

[4] Presentation, Bottom Plug Liner Peer Review Report, 18 December 2009, Ref. 25183/09.99385.

ISSUE CLARIFICATION

The team has reservations concerning:

- The use of Polyurethane (PU) (specifically Adiprene® L100, see [2]) to seal the jacket pipe end against the influx of concrete during the concrete refilling operation, and
- The application of a layer of Polyethylene/Polyken® tape to protect the 0.3 mm cold spray layer of zinc on the repaired reducers against potential abrasion damage during the concrete refilling operation.

OBSERVATIONS

Ref. [2] indicates the rubber sleeve of polyurethane is radiation resistant. Ref. [2] Information Bulletin though indicates only that Adiprene® offers the greatest resistance to gamma rays of many radiation tested elastomers and plastics and Ref. [3] illustrates radiation damage to the irradiation-tested jacket pipe seal mock-up.

Without being able to rigorously justify the reservations regarding use of polyurethane, the team noted that the generic chemical formulation of polyurethane ($C_{25}H_{42}N_2O_6$) has the ingredients under irradiation to produce corrosion-inducing compounds (e.g. nitric acid) in a localized area. The actual composition of the polyurethane is proprietary and the composition of any curing material used is also not known. Given that large-molecule organic compounds are, as demonstrated from the polyurethane mock-up test, susceptible to radiolytic decomposition and that other unfavourable conditions (e.g. moisture, heat) may exist in the region of the reducers, it is possible that corrosive compounds be produced and be in direct contact with the material of the repaired reducers and jacket pipe. Similarly the polyethylene tape, (Polyken®, a polyethylene film with a butyl rubber-based adhesive, [3]) may yield corrosive compounds upon radiolytic decomposition.

POSSIBLE SAFETY CONSEQUENCES

Radiolytically produced corrosion compounds might cause localized pitting corrosion on the jacket pipe and adjacent reducer piping. The unanticipated production of corrosion-inducing compounds could lead to the premature corrosion of the reducers / jacket pipe, with the same safety-related consequences.

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

The counterparts agreed that the use of the PU seal needs to be more carefully evaluated and justified. The counterpart had already expressed some reservations at the beginning of the review session on the use of the polyethylene tape, and the raising of the issue has highlighted the need for a more careful evaluation.

RECOMMENDATION

R2: The choice of polyurethane as a sealing material for the jacket pipe should be reassessed, with regard to potential corrosion of the primary cooling pipe. The use of concrete for this purpose was suggested as an option by the team. The choice of polyethylene tape around the primary cooling pipe should also be reassessed for the same reason. Initiating a new root cause should be prevented (corrosion Al/concrete).

SUGGESTIONS

S2: The team suggests that, since the sole function of the polyethylene tape is to protect the cold-coated zinc layer on the reducers from abrasion damage during the concrete refilling operation, it may be worth while conducting an abrasion test and, if necessary, simply increase the thickness of the zinc layer to compensate for any abrasive damage, rather than to use the polyethylene tape.

S3: The team suggested the possible elimination of polyurethane by hand packing some concrete (of the same specification that will be used for the repair) around the opening of the jacket pipe several days before the refilling takes place. In this way, no additional materials will be required to prevent the influx of concrete into the jacket pipe. Consideration should be made to ensure any relative concrete / metal thermal expansion and potential stress build up would not be a concern.

COMMENT

C3: It should be noted that the raising of this issue conflicts with one conclusion of [4], where it is stated that the mold of polyurethane is a good and qualified solution

ISSUE 03: REPAIR OF THE REDUCERS

BASIS AND REFERENCES

[1] Definitive repair of the HFR reducers. Inspection and Testing Plan, NRG-2503/09.96988, Rev. B, 9 September 2009.

[2] Definitieve reparatie van de reducers HFR. Inspectie en Testplan, Draft Version, NRG-25083/09.96988, Rev. D, 23 December 2009, (submitted to the IAEA Team during the mission).

[3] Minimal required wall thickness of the reducers. Repair of the Bottom Plug Liner Reducers, NRG-25079/09.93492, Rev. C, 26. February 2009, (submitted to the IAEA Team during the mission).

[4] Permanent repair of the BPL-reducers. Technical Specification repair reducers by welding, NRG-25083/09.94379, Rev. C, 24. November 2009.

[5] Definitive repair of the HFR reducers. Qualification Plan, NRG-25083/09.96862, Rev. B, 7 September 2009.

[6] ASME Boiler and Pressure Vessel Code, Section III: Rules for Construction of Nuclear Power Plant Components, 2007 Edition.

[7] ASME Boiler and Pressure Vessel Code, Section VIII : Pressure Vessels, 2007 Edition.

[8] ASME Boiler and Pressure Vessel Code, Section IX: Welding and Brazing Qualifications, 2007 Edition.

[9] VROM Inspection Report 104-09-19.478, 10 December 2009.

[10] IAEA Safety Series No. 35-G1, Safety Assessment of Research Reactors and Preparation of the Safety Analysis Report, Vienna, 1994, paragraphs 233 to 236 and I-118.

ISSUE CLARIFICATION

The repair should be performed according to proven design and construction standards (including fabrication) to prevent structural failure and to preserve the required pressure boundary.

OBSERVATIONS

Relevant documents are still under development (e.g. [1], [2]).

The rationale for the provision, or lack of provision, for a water leakage test prior to concrete filling was not discussed in the NRG documents. A leak test would not be in full compliance with international codes and standards, but might, to some degree, supplement the planned 'golden weld' procedure. Discussions indicated that some form of leak test, prior to concrete refilling, appears to be feasible. The team also recognizes that, prior to concrete refilling, a full function pressure test after repair is not feasible.

According to [3, Table 1] stress levels under various load cases of bent piping directly connected to the reducers and not cast in concrete are low (showing for all load cases a safety factor >5 from the allowable stresses, [6]). With a patch weld repair, utilizing a minimum patch wall thickness of 7 mm, the safety factor is calculated to be >4 which is considered acceptable. As the repaired reducers are to be re-embedded in concrete the (7 mm) calculated stress levels and safety factors should be very conservative. The stress levels and safety factors based on bent pipes already have some conservatism, when compared to calculations for straight pipes of an equivalent diameter.

Mechanical property tests on base material and weld material from a part of the aluminium primary piping in service for 27 years indicated satisfactory ASME property values for tensile strength and yield strength, [3, Section 1.3], so that changes in elastic stress properties of the old aluminium, from ageing effects of local conditions, are not significant. Reference [3, Section 1.4.5] notes, however, that the effect of welding on material properties has not been taken into account.

With regard to the potential reducer replacement repair option, the difficulty presented by reducer ovality was discussed during the mission, but was not mentioned in the technical documentation.

POSSIBLE SAFETY CONSEQUENCES

Initiation of possible ageing related degradation mechanisms (ARDMs), due to a local change in stiffness from the patch weld thickness discontinuity.

Possible leakage of the primary coolant system piping.

Loss of integrity of the primary coolant system.

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

The counterpart indicated that relevant documents and criteria are still under development and the specifics of some form of leak test are not yet finalized.

RECOMMENDATION

R3: Action should be taken to:

- ensure that there is no leakage of the repaired parts of the primary coolant system before the new concrete encasings are poured,
- inspect the pool liners with the objective to repair possible defects causing the existing water leakage and to restore the leak tightness of the pools. The pool leakage rate should be quantified.

COMMENT:

C4: With regard to Recommendation R3 one possible method of determining the pool leakage rate is to suppress surface water evaporation by plastic sheeting above the pool water level and monitoring it over an adequate period time. Identification of pool liner leak locations might be possible using SF_6 as a tracer gas, injected at some places around the periphery of the pool liner.

SUGGESTIONS

S4: In the NRG documents concerning the two reducer repair options there should be a chapter referencing the applied design and construction codes. The technical rationales for the two options should be clearly provided. The acceptance criteria (technical specifications) for the NDT of the repaired, or replaced, reducers should be clearly defined in the technical specification document [4], Section 2.4.2, and be consistent with, or provide reference to, the current Inspection and Test Plan [2]. While the final choice between patch or replacement repair will not be made until concrete is removed, it would seem prudent to compare the pros and cons of the options and define all the acceptance criteria, e.g. reducer ovality.

S5: Revision of Reference [3], Summary should clarify that the following was the intention: '*... all degraded parts with a thickness of least 7 mm………*' and not …*'of less than 7 mm'*.

S6: Revision of Reference [3], Section 2, paragraphs 2 and 3, should clarify or correct the three statements…….*'reduction of the minimum wall thickness from 9.5 mm to 8 mm, will'*…and……. *'it is safe to replace all parts with a wall thickness less than 8 mm. The renewed parts to be welded in the reducers will have a thickness of 9.5 mm".*

S7: Revision of Reference [3], should clarify further the rationale for the choice for 7 mm, in view of the statements regarding the quoted 8 mm minimum thickness of the unrepaired piping, see S6. In view of the statement that the effect of welding on material properties has not been taken into account, it would be useful to indicate, at least qualitatively, what effect on the stress level safety factor might be expected, given satisfactory 'golden' welds.

ISSUE 04: RADIATION PROTECTION AND WASTE MANAGEMENT PROGRAMME

BASIS AND REFERENCES

[1] ALARA plan BPL, NRG-25183/09.95420/D, 24-09-09.

Generic and specific radiation protection procedures that govern the application of radiation protection and waste management at the facility have been formulated over time and from experience, for routine operations at the facility.

ISSUE CLARIFICATION

A significant number of the repair project activities are not part of normal operations, and some activities will be unique for operating and maintenance staff. As a result, the adequacy of existing Radiation Protection and Waste Management procedures in particular needs to be reviewed to ensure these unique activities are adequately covered.

In the interest of ALARA [1] the possibility of keeping a limited amount of water in the reactor pool as additional means to reduce the dose rates to workers during repair work should be considered.

OBSERVATIONS

The review team notes that, given the unique nature of the repair plan, radiological safety documentation and waste management plans should be carefully reviewed to ensure that they adequately cover the repair activities.

There is the potential for some small chronic water leakage from the gate seal of pool 1 into the reactor pool, even with the new seals that are proposed, but the provision of a limited height of shielding water should not complicate the control of any leakage into the reactor pool.

POSSIBLE SAFETY CONSEQUENCES

- Inadequate dose control for HFR or contract personnel.
- Inadequate management of active waste generated.
- Reportable event if an activity evolved beyond the scope of existing procedures or authorisations.

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

Discussion with the counterpart revealed that NRG is committed to radiation protection and indeed intends to review the corresponding procedures. The radiation protection issue arose as the intention has not yet been completed and the documentation made available to the review team made no mention thereof.

A limited amount of water in the reactor pool, to be used as additional shielding protection, was already considered as a potential back-up option, in case the dose rate in the working area is higher than predicted. Calculations will be made to check the potential dose reductions.

RECOMMENDATIONS

R4: Existing radiation protection procedures should be reviewed with the objective to ensure that they adequately cover the radiological conditions during the repair activities. A radioactive waste management programme should define the volume, activity and final disposition of the radioactive waste, including concrete dust, generated during the implementation of the repair activities.

R5: A dose mapping profile should be established and maintained. A radiation protection officer should be present during the repair process. Repair work in a radiation environment should be performed by personnel classified as radiological workers class A.

R6: In the interest of ALARA, NRG should consider the possibility of keeping a limited amount of water in the reactor pool as an additional means to reduce the dose rates to workers during repair work.

COMMENT

C5: If there is a need for some water level control equipment in the pool (e.g. sump pump) there should be some convenient means of maintenance access for this equipment through the temporary shielding at the top of the pool.

ISSUE 05: RE-COMMISSIONING

BASIS AND REFERENCES

[1] IAEA Safety Requirements No. NS-R-4, Safety of Research Reactors, Vienna, 2005, paragraphs 7.42 to 7.44.

ISSUE CLARIFICATION

A commissioning programme should be prepared for the testing of the reactor coolant system, reloading of fuel, and re-commissioning of reactor components and systems after the repair to demonstrate compliance with design requirements and with OLCs.

OBSERVATIONS

A re-commissioning programme following the repair of the reducers is under development. Two particular re-commissioning related activities that were raised in discussions were:

– There were conflicting statements regarding the need for a concrete sample to be taken after concrete filling around the reducers.

– Pressure testing requirements of the primary coolant system before concrete refilling were not yet established.

POSSIBLE SAFETY CONSEQUENCES

Improper re-commissioning may result in non-detection of a leakage and/or loss of integrity of the primary coolant system piping.

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

It was agreed that core samples were not required from the repaired concrete areas. Archive concrete samples are in any case intended to be taken during the filling process from the concrete mix.

RECOMMENDATION

R7: A commissioning programme should be established to check the satisfactory performance of the repaired parts of the primary cooling system and the reactor facility, before return to operation. Special emphasis should be given to the treatment of deficiencies, deviations and non-conformances.

SUGGESTION

S8: It is suggested that drilling into the areas refilled with concrete, in order to take archive concrete samples, is unnecessary.

ISSUE 06: WORK PROTECTION PRACTICES DURING REPAIR: CRANE OPERATIONS AND CONCRETE REMOVAL

BASIS AND REFERENCES

[1] PowerPoint Presentation, BPL Radiation Shielding, IAEA Safety Review, 12 January, 2010, J. Best and C. Timmermans.

ISSUE CLARIFICATION

Crane operations are required during the repair to install and remove shielding components in the reactor pool.

Significant quantities of concrete have to be removed from around the reducers.

OBSERVATIONS

Movements of temporary shielding components during the repair using the crane are not routine and some of these operations have not been previously performed.

Removal of the ceiling concrete in the sub-pile room, under the conditions required for the repair, is an uncommon civil engineering activity.

POSSIBLE SAFETY CONSEQUENCES

Potential damage to beam tubes or other major vessel components in the pool from accidents while moving custom designed shielding, in particular from the 40 cm thick concrete shielding slabs above the reactor pool and the Densimet® plates.

During concrete drilling and removal operations there is a potential that the base of the pool liner or the reducers might be accidentally penetrated.

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

The counterpart agreed that special attention is required for the crane and concrete removal operations.

SUGGESTIONS

S9: Routine periodic test and maintenance procedures on the crane should be implemented, prior to the use of the crane for the repair plan.

S10: For the movement of the Densimet® shielding and the concrete slabs inside and above the pool, particular attention should be paid to the rigging and supervision of crane operations, to avoid possible damage to beam tubes.

S11: Particular attention should be paid to the drilling and removal of concrete to avoid accidental penetration of the reducers or the pool liner.

GOOD PRACTICES

GP1: The provision of the mock-ups for the repair and the detailed work performed to simulate, as closely as possible, the composition of the original concrete around the reducers was noted as a good practice.

ISSUE 07: SUMMARY REPORT

BASIS AND REFERENCES

[1] IAEA Safety Standards No. NS-R-4, Safety of Research Reactors, Vienna, 2005, Sections 7.86, 7.87 and 7.88.

ISSUE CLARIFICATION

A summary report presenting the overall and updated safety case for the repair plan should be submitted to KFD. This report should present the selected repair option with its justification, and should reflect the updated status of all technical and organizational activities, with associated hold points related to the implementation of the repair plan.

OBSERVATIONS

No document was available that summarized the overall updated safety case and co-ordinated the current status of the supporting documentation provided in Annex 4.

Steps of the regulatory process were not identified as hold points in the time schedule of the repair plan (e.g. for acceptance of results of the reducer inspection), the re-commissioning and the return to operation of the reactor.

Due to the ongoing nature of the repair plan, the NRG documents contained some redundant information and also a number of proposed repair activities were now obsolete (e.g. use of main crane to suspend the vessel, cold spray repair of deformations).

COUNTERPART'S VIEW AND MEASURES ON THE FINDINGS

The counterpart agreed to provide a summary document.

RECOMMENDATIONS

R8: NRG should submit to the regulatory authority the results of the inspection of the reducers, after removal of the surrounding concrete, and the proposed option for the reducer repair (partial repair or complete replacement).

R9: A summary report presenting the overall and updated safety case for the repair plan should be submitted to KFD. This report should present the selected repair option with its justification, and should reflect the updated status of all technical and organizational activities, with associated hold points related to the implementation of the repair plan. The summary report should be self consistent and include: a technical description with figures of the HFR installation; the initial problems with the reducers; the results of inspections and tests; the final repair option with its justification; the repair work performed and the final, as-built, configuration of the repaired components of the primary coolant system.