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COMMISSION STAFF WORKING PAPER

Accompanying document to the Report "Operation of the High Flux Reactor in the year 2011"

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1. INTRODUCTION

This staff working document is a companion document to the Report from the Commission to the Council and the European Parliament "Operation of the High Flux Reactor in the year 2011".

The High Flux Reactor (HFR), located in Petten (The Netherlands), is one of the most powerful multi-purpose materials testing reactors in the world. The reactor is of the tank-in-pool type, light water cooled, moderated and operated at 45 MW. In operation since 1961, and following a new vessel replacement in 1984 and large repair in 2010 on the Bottom Plug Liners (BPL), the reactor provides a variety of irradiation location possibilities (reactor core, reflector region and in the poolside). Horizontal beam tubes are available for research with neutrons as well as gamma irradiation facilities. Furthermore, excellently equipped hot cell laboratories on the site provide Post Irradiation Examinations possibilities.

The European Atomic Energy Community (Euratom) is the owner of the plant (for a lease of 99 years from the Dutch state). The HFR is managed by the European Commission's Joint Research Centre (JRC) and operated by the Nuclear Research and Consultancy Group (NRG). The close co-operation between the JRC and the NRG on all aspects of nuclear research and technology has led to a unique HFR structure, in which both organisations are involved. The JRC is the plant and budget manager and develops a platform around HFR as a tool for European collaborative programmes, while NRG operates and maintains the plant and manages the commercial activities around the reactor. Furthermore each organisation provides complementary possibilities around the reactor activities, such as the hot cell facilities of NRG or the experiment commissioning laboratory of the JRC.

As of February 2005, NRG has become the holder of the operation licence granted under the Dutch Nuclear Energy Law.

During the last three decades the HFR has been operated from supplementary research programmes regularly discussed and approved by the European Council. On 25 May 2009, the European Council adopted a three-year (2009-2011) supplementary research programme to be implemented by the JRC for Euratom concerning the operation of the Community's High Flux Reactor.

The present document reports the results of the implementation of the scientific and technical activities for the year 2011. The report also provides information regarding the financial contributions received for the execution of the programme and the yearly contribution to the decommissioning fund that the supplementary research programme provides to Euratom.

1. HFR: REACTOR MANAGEMENT

The HFR reactor has an operating licence granted by the Dutch national regulator, the Kernfysische Dienst. In April 2011, the HFR has been the subject of an independent INtegrated Safety Assessment for Research Reactors (INSARR) review mission performed by the International Atomic Energy Agency (IAEA).

1.1. HFR Safety, Operation and Related Services

Operating Schedule

In 2011 the regular cycle pattern consisted of a scheduled number of 293 operation days and two maintenance periods of 19 and 16 days respectively. The In-Service Inspection of the north and south reducer and the annual leak test of the reactor containment were performed during the summer maintenance period in August 2011, which implied a final effective annual operation time of the HFR of 290 days (see Figure 1). This performance corresponds to an actual availability of 99.22 % with reference to the original scheduled operation plan.

Nominal power was 45 MW with a total energy production in 2011 of approximately 13,008 MWd, corresponding to a fuel consumption of about 16.24 kg U-235. The detailed operating characteristics are given in Table 1.

During the reporting period the power distribution measurements for the FLUX 2011 programme was carried out. In the framework of the regular HFR operators' training, the annual 30 MW reactor training course for the operators was performed after the scheduled end of each cycle at 45 MW operation.

HFR cycle 11.08 was preceded by short runs of reactivity measurements at low power. The aim of the measurements was to test the reactivity characteristics of two new fresh fuel elements. The result of the measurements showed that the characteristics were consistent with regular fuel elements and that the elements could be used as test elements in the HFR starting with cycle 11.08.

All details on power interruptions and power disturbances, which occurred in 2011, are given in Table 2. This table shows that twelve automatic reactor scrams, two manual reactor shut-downs and three automatic power decreases occurred (see also figure 2). Two of these scrams were due to human intervention while the remaining ones were due to normal intervention by the safety protection systems of the reactor instrumentation devices.

Figure 1: HFR availability

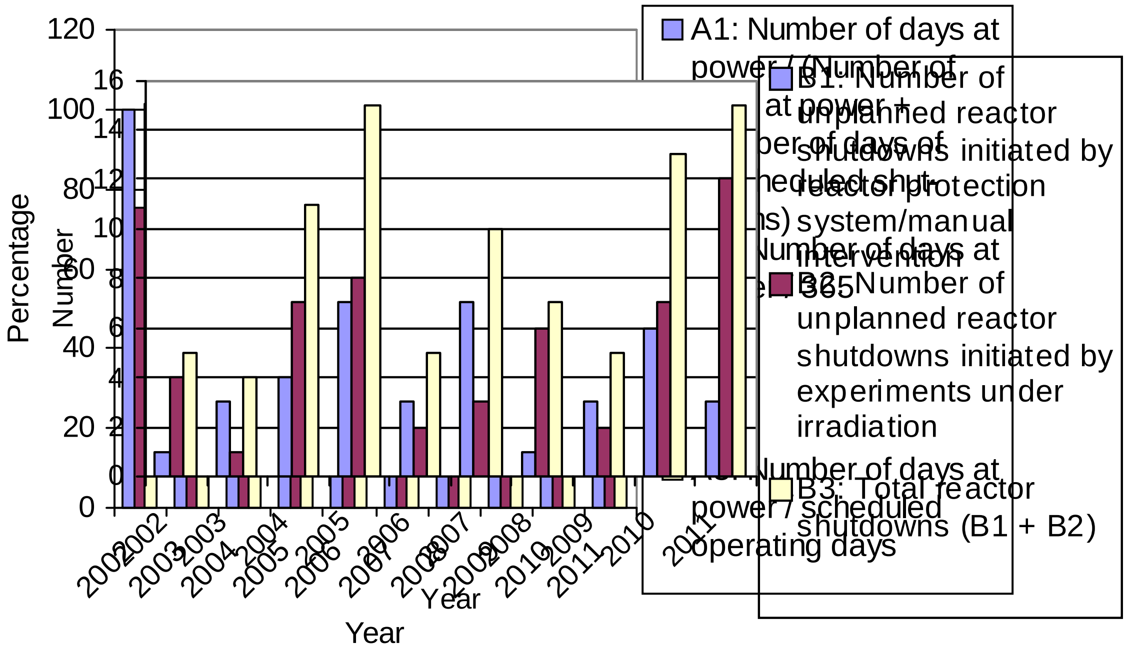

Figure 2: HFR unscheduled shutdowns

Maintenance Activities

In 2011 the maintenance activities consisted of the preventive, corrective and breakdown maintenance of all Systems, Structures and Components of the HFR, as described in the annual and long-term maintenance plans. These activities are executed with the objective to enable the safe and reliable operation of the HFR and to prevent inadvertent scrams caused by insufficient maintenance.

The periodic leak testing, as one of the licence requirements (0.5 bars overpressure for 48 hours duration) and the In-Service Inspection of the north and south reducers, were also successfully performed. As part of the HFR Modification Plan, several modifications were performed (LOCA 4, 5 and 6). All modifications were implemented after the revision of the plant description and operating instructions and following successful commissioning and testing and licensing approval where necessary.

1.2. Fuel cycle

Front end

During 2011, 50 Low Enriched Uranium (LEU) fuel elements and 15 control rods were inspected at the manufacturer's site and delivered to Petten. Since May 2006, the HFR is running completely on LEU fuel.

Back end

In the first quarter of 2011, the last 18 High Enriched Uranium (HEU) spent fuel elements were shipped in a CASTOR MTR2 container to the storage facility (HABOG) of the Dutch Central Organisation for Radioactive Waste (COVRA). Before this shipment, all HEU spent fuel elements used in the HFR have been either sent back to the USA (between 2005 and 2006) or are stored in the HABOG.

Support has also been provided to the "Interfacultair Reactor Instituut" (IRI) of TU Delft in the second quarter of 2011 by providing a MTR-2 container and equipment for a transport of spent fuel from the Delft research reactor to the HABOG by making available .

In the third quarter of 2011, the "Gesellschaft für Nuklear-Service" (GNS) successfully carried out the compulsory 3 years inspection of the MTR2 container GP-24, the 6 year inspection of the MTR2 container GP-23, as well as of other transport and ancillary equipment.

Table 1: 2011 operational characteristics

			OPERATING TIME					SHUT-DOWN TIME			
Cycle Begin-End	**HFR Cycle**	**Generated Energy**	**Planned**	**Low Power**	**Nom. Power**	**Other Use**	**Total**	**Planned**	**Unscheduled**	**Number of Interruptions**	
2011		**MWd**	**hrs**	**h.min**	**h.min**	**h.min**	**h.min**	**h.min**	**h.min**	**Power Dec.**	**Scram**
01.01 – 12.01	11.01	510.04	272		272.00		272.05	16.00			
13.01 – 13.02	11.02	1291.83	688	02.05	688.41		690.46	77.08	00.06		1
14.02 – 16.03	11.03	1247.90	664	03.16	666.09		669.25	74.25	00.10	1	1
17.03 – 17.04	11.04	1204.75		04.51	640.48		645.39	74.21	47.00		4
18.04 – 06.05	Maintenance period							456.00			
07.05 – 05.06	11.05	1279.33	688	02.23	681.45		684.08	35.33	00.19		3
06.06 – 05.07	11.06	1201.73	640	02.34	639.17		641.51	78.00	00.09		2
06.07 – 07.08	11.07	1281.66	688	05.45	682.16		688.01	102.05	01.54		2
08.08 – 23.08	Maintenance period and ISI inspection reducers							384.00			
24.08 – 23.09	11.08	1239.51	664	04.20	660.19		664.39	77.39	01.42	1	
24.09 – 24.10	11.09	1253.50	664	02.23	666.45		669.08	74.52			
25.10 – 27.11	11.10	1248.37	688	03.18	661.05		664.23	122.32	30.05	1	1
28.11 – 28.12	11.11	1232.69	664	01.43	657.45		659.28	84.32			
29.12 – 31.12	12.01	16.94	8	01.55	08.45		10.40	61.20			
TOTAL :		13008.27	7016	35.52	6925.35		6961.27	1717.08	81.25	3	14
Percentage of total time in 2011 (8760 h):				0.41	79.06		**79.47**	**19.60**	**0.93**		

Table 2: 2011 full power interruptions of HFR

DATE	CYCLE	TIME OF ACTION	RESTART OR POWER IN-CREASE	NOMINAL/ ORIGINAL POWER	ELAPSED TIME TO		DISTURBANCE CODE				REACTOR SYSTEM OR EXPERIMENT CODE	COMMENTS
2011		hour	hour	hour	RESTART OR POWER INCREASE h.min	NOMINAL/ ORIGINAL POWER h.min	1	MW	2	3		
11 Feb	11.02	16.16	16.22	16.35	00.06	00.13	AS	0	A	E	Main Power interruption	Main power interruption caused an automatic reactor shutdown.
24 Feb	11.03	16.16	16.22	16.35	00.06	00.13	AP	37.5	R	H	Power demand	A wrong switch was activated so that the reactor power demand was not switched on, with as result an automatic power decrease.
27 Feb	11.03	00.33	00.43	01.06	00.10	00.23	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
29 Mar	11.04	09.42	08.21	09.30	46.31	47.48	MS	0	R	M	Power demand	The control rod could not be moved due to a defect in power demand, the reactor was stopped manually.
01 Apr	11.04	00.42	00.51	01.24	00.09	00.33	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too high with an automatic reactor shut-down as result.
01 Apr	11.04	01.33	01.38	01.55	00.06	00.16	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
14 Apr	11.04	16.04	16.10	16.24	00.06	00.20	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
09 May	11.05	22.33	22.38	23.00	00.05	00.22	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
20 May	11.05	11.00	11.08	11.24	00.08	00.16	MS	0	P	I	Experiment 354-01	Manual shut-down for testing the reactor interlock settings of cooling water systems of experiment 354-01.
31 May	11.05	22.33	22.39	22.50	00.06	00.11	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
14 Jun	11.06	09.21	09.26	09.43	00.05	00.22	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.

14 Jun	11.06	11.44	11.48	12.05	00.04	00.21	AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
01 Aug	11.07	14.18	14.22	14.39	00.04	00.21	AS	0	P	I	Experiment 292-01	Cooling water pressure of experiment 292-01 too high with an automatic reactor shut-down as result.
07 Aug	11.07	06.10					AS	0	P	I	Experiment 354-01	Cooling water pressure of experiment 354-01 too low with an automatic reactor shut-down as result.
02 Sep	11.08	11.40	11.44	11.48	00.04	00.08	MP	35	P	S	Experiment 354-02	Reactor power temporary decreased to 35 MW to check if the production of bubbles in the cooling water outlet of Prod. Facility 354-02 depends on the reactor power.
29 Oct	11.10	22.29					AP	0	R	A	Reactor Ventilation	Reactor ventilation stopped due to the failure of a relay in the instrumentation. This caused an automatic power decrease to 0 MW
31 Oct	11.10		03.45	04.15	30.01	00.30					Restart	After repair and Xenon decay the reactor was restarted on 31 Oct at 03.45 hr.
04 Nov	11.10	08.34	08.38	09.03	00.04	00.25	AS	0	A	E	Main power interruption	Main power interruption caused an automatic reactor shutdown

1. LEADING TO		**2. RELATED TO**		**3. CAUSE**	
- automatic shut-down	AS	- reactor	R	- scheduled	S
- manual shut-down	MS	- experiment	E	- requirements	R
- automatic power decrease	AP	- auxiliary system	A	- instrumentation	I
- manual power decrease	MP	- production facility	P	- mechanical	M
				- electrical	E
				- human	H

2. INSAAR 2011

At the request of the Dutch authorities, a full scope IAEA-INSARR mission was performed at the HFR in March 2011. The general objectives of the mission were to conduct a comprehensive safety review of the HFR research reactor according to the applicable documents and IAEA standards.

The findings/recommendations formulated in the previous IAEA-INSARR mission (13-18 February 2005) and in the 2010 IAEA inspection dedicated to the repair of the BPL were also scrutinized, in order to determine the degree of implementation of the related corrective actions. The safety areas to be examined in detail were determined in a Pre-INSARR mission in January 2011.

The INSARR Team (3 IAEA experts + 5 external experts) and inspectors of the Dutch regulatory body conducted the review by means of documentation analyses, facilities walk-through, and observation of the operations and interviews with the personnel.

The INSARR review concluded that all the recommendations/suggestions deriving from the safety review regarding the BPL repair and about 50% of those deriving from the INSARR 2005 mission have been addressed. The implementation of all the corrective actions will be completed in 2012.

3. EU STRESS TESTS

Following the nuclear disaster in Fukushima, Japan, in March 2011, all of the nuclear power plants in Europe were subject to stress tests. Although the HFR is not a power plant, but a research and isotope production reactor, it was subject of such a stress test on both the reactor and on the other nuclear facilities on the nuclear site.

The stress test investigated the impact of flooding events, earthquakes and extreme weather as well as events resulting from human activities (such as explosions, fires, malevolence and aircraft crashes). NRG has employed the same scenarios as used for nuclear power plants, which were ‘tailored’ to the specific nature of the facilities in Petten.

The results of this test showed that the nuclear installations in Petten met all of the safety-relevant licensing requirements and can also withstand a wide range of extreme external conditions, including flooding and earthquakes or a combination of both.

The stress test also showed that it is feasible to increase even more the safety margins by taking a number of measures. For example, measures that can be taken: to install seismic instrumentation with notification in control room, to make it possible to rapidly install an external generator for power supply to vital reactor systems; to improve the anchoring of water storage tanks in the event of an earthquake or flood; to improve the autonomy of the emergency response organisation; to develop new procedures when there is a threat of a serious situation.

Finally, a number of other identified measures which can be envisaged to increase robustness of the nuclear facilities on the HFR site will be investigated to see whether any additional measures could contribute to increasing the current safety margins.

4. HFR AS A TOOL FOR RESEARCH

4.1. Network on Neutron Techniques Standardization for Structural Integrity (NeT)

The European Network on Neutron Techniques Standardization for Structural Integrity (NeT) supports progress towards improved performance and safety of European nuclear energy production systems. The JRC organises and manages the Network and it contributes to the scientific work through the neutron scattering for residual stress measurement and assessment of thermal material ageing effects, using its beam tube facilities at the HFR.

The 19th and 20th Steering Committee Meetings of NeT took place in June and December in 2011, respectively. About 35 organisations are actively participating in the work of NeT, including eight organisations from the new EU Member States and three organisations from candidate countries. From outside the EU, organisations from Japan, Australia and Russia are actively contributing to NeT. Furthermore, in 2011 for the first time measurements for NeT have been undertaken at the Spallation Neutron Source in Oak Ridge, TN, USA.

While the final output documents of the first Task Group of NeT are being drafted, a new activity has been defined on residual stress investigations in a welded nickel-base alloy plate. Other possible future activities have been under discussion during the year. Furthermore the NeT Task Group 1 has been setting a benchmark for numerical and experimental work available to nuclear engineers throughout the world for testing, in particular, the performance of their numerical methods.

4.2. Neutron diffraction investigations at the HFR

In the reporting period a feasibility study has been undertaken for diffraction measurements in the nickel-base alloy that is considered for the next Task Group within NeT. Nickel has a considerably higher neutron attenuation coefficient than iron, and in addition it also produces a stronger background signal in neutron scattering. These effects result in higher limitations in the material thickness that can be covered by neutron diffraction experiments and in the need for longer counting times at comparable peak intensity due to the higher background. It was therefore necessary to obtain a quantitative estimation of the magnitude of the problems in order to define the geometry of the specimens to be investigated.

The measurements were undertaken at the Large Component Neutron Diffraction Facility at beam tube HB4 at the HFR. They resulted in an estimate for the attenuation coefficient of 0.175 mm^{-1}, relevant to the particular nickel-based alloy and relevant to the (111)-crystallographic reflection plane. As expected, this is considerably higher than the corresponding values observed for iron-based alloys in the past. Based on the findings it was concluded that specimens with a thickness of 12 mm could be investigated. Consequently it was decided at the NeT Steering Committee Meeting in December 2011 that specimens of this thickness would be manufactured for the new Task Group.

5. FUEL IRRADIATIONS IN THE HFR

In the frame of the Euratom 7th Framework Programme (FP7), the 4-year project FAIRFUELS (Fabrication, Irradiation and Reprocessing of FUELS and targets for transmutation) aims at a more efficient use of fissile material in nuclear reactors by implementing transmutation. Transmutation provides a way to reduce the volume and hazard of high level radioactive waste by recycling the most long-lived components. In this way, the nuclear fuel cycle can be closed in a sustainable manner. The FAIRFUELS consortium consists of ten European research institutes, universities and industry. The project started in 2009 and is coordinated by NRG. In 2011, both NRG and JRC continued working together in the planning of the HFR irradiations that are scheduled in FAIRFUELS.

5.1. MARIOS Fuel Irradiation: Minor Actinide Recycling

The MARIOS irradiation programme, as part of FAIRFUELS, is a series of irradiations dealing with heterogeneous recycling of Minor Actinides (MAs) in sodium-cooled fast reactors (i.e. the MA-bearing blanket concept). Minor Actinides, such as americium and curium, are long-lived elements in the high level waste, which are currently not recycled. The aim of the MARIOS irradiation test is to investigate more closely the behaviour of minor actinide targets in a uranium oxide matrix carrier. In these targets, large amounts of helium are produced, which causes significant damage to the material under irradiation. This experiment is the first case where americium (^{241}Am) is included in a (natural) uranium oxide matrix $Am_{0.15}U_{0.85}O_{1.94}$ to conduct an experiment in order to study the behaviour in terms of helium production and swelling.

After having obtained the approval for the irradiation, the MARIOS irradiation started as planned on 19 March 2011. The test specifications of MARIOS, in terms of controlled working temperature of the fuel pellets, are very strict and the first cycle showed a small deviation from that expected. Nevertheless, due to the large operational margins foreseen in the design of the experiment, it was possible to successfully correct the deviation already from the second cycle. MARIOS will run till 1st April 2012 (approximately 300 days).

5.2. SPHERE Fuel Irradiation: Safer Fuels

Within the FP7 FAIRFUELS project, the irradiation test SPHERE has been planned for 2012. SPHERE has been designed to compare conventional pellet-type fuels with so-called Sphere-Pac fuels. The latter have the advantage of an easier, dust-free fabrication process. Especially when dealing with highly radioactive minor actinides, dust-free fabrication processes are essential to reduce the risk of contamination.

To assess the irradiation performance of Sphere-Pac fuels compared to conventional pellet fuel, a dedicated SPHERE irradiation experiment will be performed. For this purpose, americium-containing fuel, both pellet-type and Sphere-Pac-type, will be fabricated at JRC. These fuels will be irradiated at HFR in a dedicated test-facility. It is the first irradiation test of this kind, as Minor Actinides bearing Sphere-Pac fuel has never been irradiated before. The SPHERE irradiation should start in 2012 and will last for approximately 300 full power days.

During 2011, the preliminary design of SPHERE has been finalised. The fuel has been fabricated at JRC and some preliminary nuclear analyses have been concluded.

6. MATERIALS IRRADIATIONS

6.1. BLACKSTONE Irradiations: Investigation of AGR Lifetime Extension

The UK has a fleet of Advanced Gas Cooled Reactors (AGRs). In order to extend the lifetime of the AGRs, graphite data at high dose and weight loss is required, to allow prediction and assessment of the behaviour of AGR graphite cores beyond their currently estimated lifetimes. Graphite degradation is considered to be one of the key issues that will determine the remaining life of the AGRs, thus materials property data at extended weight loss and dose is essential for continued safe operation and lifetime extension. The BLACKSTONE irradiations use samples extracted from AGR core graphite and subjected to accelerated degradation in the HFR. The results are designed to enable the future behaviour of the AGR graphite to be predicted with confidence.

The first BLACKSTONE irradiations were completed in 2010 after achieving the required weight loss and dose levels. In 2010 the dismantling of both BLACKSTONE experiments took place and the larger part of the post irradiation examinations have been performed in 2011. In the meantime two new irradiations have been designed and built to achieve higher dose and weight loss and to irradiate material from different AGRs. The objective of these experiments is to consolidate the database produced in phase I and to provide an extensive properties database for graphite from the Hartlepool and Heysham 1 AGRs. These Phase II experiments were loaded into the HFR core in August 2011 and will be irradiated for a total of 11 and 16 monthly cycles respectively.

6.2. LYRA-10

The LYRA irradiation rig is used in the framework of the AMES (Ageing Materials and Evaluation Studies) European Network activities with the main goal of studying the irradiation behaviour of reactor pressure vessel (RPV) steels, thermal annealing efficiency and sensibility to re-irradiation damage.

The LYRA-10 experiment housed in the Pool Side Facility (PSF) of the HFR consists in the irradiation of different specimens representative of RPV materials, namely model steels, realistic welds and high-nickel welds. The model steels comprise of 12 batches of steels with the basic, typical composition of WWER-1000 and PWR reactor pressure vessel materials used by the JRC with the scope of understanding the role and influence of Ni, Si, Cr and Mn as alloying elements and certain impurities as C and V on the mechanical properties of steels.

The realistic welds are created at eight different heats, specially manufactured on the bases of typical WWER-1000 weld composition with variation of certain elements, such as Ni, Si, Cr and Mn. They are of importance to investigate the role and synergisms of alloying elements in the radiation-induced degradation of RPV welds.

The LYRA-10 irradiation campaign started in May 2007 and up to now underwent 6 HFR cycles. Originally planned to be irradiated for 7 more cycles, it has been decided during the LYRA-10 outage that at least 10 more cycles will be required to allow the analysis of an hypothetically late-blooming effect that may take place in the irradiated materials.

In order to proceed to the resumption of the LYRA-10 experiment, some mechanical testing and other revamping actions have taken place in 2011. Hence, the LYRA-10 feeding lines (which form part of the gas panels to the connection set next to the pool) were adapted following the change in the HFR glove box system. The experiment connection head was completely renewed (i.e. removal of the plastic hose, gas lines, etc.) and commissioned. Most of the still-pending technical issues were resolved in 2011 and LYRA-10 is expected to be irradiated again in the PSF in 2012.

7. IRRADIATION FOR FUSION REACTOR TECHNOLOGY

7.1. CORONIS

In 2011 a new project started in the area for material development and characterisation for ITER. This project is conducted in the framework of Fusion for Energy, the Europe Joint Undertaking for fusion energy, founded in 2007.

The objective is to measure the tensile, fatigue and Charpy impact properties of CuCrZr material and CuCrZr/316L joints before and after irradiation to 0.01, 0.1 and 0.7 dpa at 250 ºC. This material is foreseen in the shielding blanket in ITER due to the high heat dissipation of CuCrZr to the ITER cooling water. This property can be jeopardised if the material would fail during its operational lifetime in ITER.

The irradiation will be performed with the Hungarian Institute AEKI, who will take account of the low level dose irradiation (0.01 dpa). All post-irradiation experiments will be performed at the NRG Hot Cells. The project will run from January 2011 to September 2013.

In 2011, the irradiation design of the two capsules to be irradiated in the HFR was completed, including the preparation of the safety analysis report for licensing purposes. The capsule consists of an assembly of tensile and Charpy specimens and will be filled with sodium to increase the heat transfer during irradiation. The capsules, named CORONIS 01 and CORONIS 2 will be irradiated in positions H2 and G3 in the HFR for 1 and 3 cycles respectively. The start of irradiation is planned for cycle 12-06.

8. ISOTOPE PRODUCTION

After three disrupted operational years for isotope production in the HFR, 2011 was a year with a normal operational pattern as experienced in the years before 2008. Once again, the HFR was able to demonstrate that it plays an essential role as the largest producer of medical isotopes in Europe and one of the largest producers in the world. The total volume and value of the isotopes and associated services supplied from the HFR grew again in 2011.

New interesting product development ideas progressed, both in conventional application areas, as well as some ground breaking areas of medical technology. Existing development projects also progressed well.

The production of Neutron Transmutation Doped (NTD) silicon for the specialist electronics industry was resumed after the final repair of the HFR in September 2010. During 2011, NRG returned to using a standard configuration of the HFR production facilities and reintroduced the irradiation of silicon ingots to produce high quality products used in high voltage and other specialist electronic applications that can only be served with NTD silicon.

In 2011 NRG continued to work closely with other players in the Medical Isotope supply network, as well as with the Medical Community, Governments, the European Commission, AIPES, the OECD/NEA and the IAEA. These actions were to continue to support the coordinated efforts necessary to minimise the future risks to security of supply of critical medical isotopes.

The European Commission fully supports the recommendations of the OECD/NEA High Level Group on the security of supply of medical isotopes and actively participates in the work of the European Observatory on the supply of medical radioisotopes. NRG is working together with other international stakeholders on important issues such as full-cost recovery, outage reserved capacity provision, future infrastructure investment and conversion to LEU targets for Mo-99 production. Further work to ensure the sustainable supply of medical isotopes will be carried out in these international forums to establish an enduring long term solution.

9. FINANCIAL CONTRIBUTIONS FOR THE EXECUTION OF THE PROGRAMME.

In 2011, the following financial contributions were received from Member States for the execution of the programme:

- Belgium: 400,000 €
- France: 300,000 €
- The Netherlands: 8,223,000 €

It should be noted that these contributions cover the expenses according to Annex II of Council Decision 2009/410/Euratom. These amounts have been calculated in order to balance the forecasted costs of the reactor for the period 2011 taking into account an expected level of commercial income. In no case does the Commission cover any operational deficit, including potential costs for maintenance or repair.

From this amount the Commission received 800,000 € as provisions for the Decommissioning fund[1].

As of 31 December 2011, the total amount originating from the decommissioning fund is 13,949,000 €

Other expenditures incurred by the JRC and paid from the supplementary research programme budget:

- Direct Personnel (e.g. for HFR supplementary research program Management): 257,000 €
- Materials : Support HFR (e.g. Legal Advice): 84,000 €, Utilities (e.g., electricity, water, heating): 582,000 €, Spent Fuel Management: 1,652,000 €
- Incidental Expenditures 2,222,000€

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[1] The yearly contribution to the decommissioning fund has passed from 400,000 €/year to 800,000 €/year since 2004 due to a re-evaluation of decommissioning costs. This amount is taken from both the regular budget of the supplementary research programme and by the gained interest on the bank account of the supplementary research programme (the amount of the interest over 2011 was 333K€ and therefore, 467K€ was added from the regular supplementary research programme budget of 2011).

Glossary and Acronyms

BPL	Bottom Plug Liner
COVRA	Dutch Central Organisation for Radioactive Waste
dpa	displacements per atom
EU	European Union
Euratom	European Atomic Energy Community
FAIRFUELS	Fabrication, Irradiation and Reprocessing of FUELS and target for transmutation
FP	Framework Programme
HB	Horizontal Beam Tube
HEU	Highly Enriched Uranium
HFR	High Flux Reactor
IAEA	International Atomic Energy Agency
INSARR	INtegrated Safety Assessment of Research Reactors
ISI	In-Service Inspection
ITER	International Thermonuclear Experimental Reactor
JRC	Joint Research Centre
LEU	Low Enriched Uranium
MARIOS	Minor Actinides in Sodium-cooled Fast Reactors
NeT	EU Network on Neutron Techniques Standardization for Structural Integrity
NRG	Nuclear Research and consultancy Group
OECD/NEA	Organization for Economic Cooperation and Development / Nuclear Energy Agency
PSF	Pool Side Facility (PSF)