‘The Return to Service programme which was launched in November 2013 marked the start of the optimisation of our nuclear infrastructure. My role in this programme was Logistics operational leader, responsible for reviewing the internal and external transport and identifying and mitigating all possible risks. Together with the Logistics team, we achieved a great result.’ – Caroline Pricker, Irradiation & Development, Logistics manager
NRG Profile

NRG is an internationally operating nuclear service provider. The company produces isotopes, conducts nuclear technological research, is a consultant on the safety and reliability of nuclear installations and provides services related to radiation protection. Research is performed for governments aimed at developing knowledge about nuclear technology.

NRG is a market leader in producing medical isotopes in the world. In the Netherlands, NRG is the leading authority with regard to integral radiation protection. NRG operates the High Reflux Reactor owned by the European Union.

The more than 400 employees are innovative and have high quality know-how, and works for and with partners in healthcare, the energy market, industry, government and science.

NRG was founded on 17 September 1998 as a general partnership by Stichting Energieonderzoek Centrum Nederland (ECN) and KEMA Nucleair B.V. On 1 December 2006, ECN acquired the KEMA Nucleair B.V. shares. NRG’s registered place of business is Petten, with another site in Arnhem.

Mission
NRG fulfils the social need for high quality nuclear research and innovation, safe and reliable nuclear isotope production and services to organisations working with nuclear technology.

Core values
• Safe and reliable
• Financially robust
• Market and customer-oriented
• Professional and expert-level
• Open and transparent

2013 Key Figures
Operating revenue (x € 1,000) 65,919
Company result (x € 1,000) -/- 7,870
Net result (x € 1,000) -/- 8,161
FTE, hired workers excluded 406
Employees, hired workers excluded 439
Sickness absence (%) 3.79
Collective radiation dose (People-mSv) 91

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2013 was a particularly difficult year for NRG. This had a great impact on all the stakeholders of NRG. The year started with a reactor which had not been in operation since November 2012 due to a fault in the cooling system. After the restart in June 2013, we carried out three radiation cycles with the High Flux Reactor during the summer. However, we were again unable to start the reactor in October, partly due to a fault identified in a control rod which operates the reactor. After several other organisational and procedural incidents, on 15 November 2013 I decided to safely and responsibly shut down all the nuclear installations. I believe that a company that operates installations which involve risks can only work if the safety of employees and the environment is absolutely safeguarded.

We then took three months to run our Return to Service programme. This involved inspecting all the installations, identifying and analysing potential risks and then implementing improvements in technology, organisation and procedures. Since 15 February 2014, all the nuclear installations – after a ‘declaration of no objection’ from the Department of Nuclear Safety, Security and Safeguards – have been back in operation, safely and responsibly.

However, other NRG activities relating to consultancy and advice, radiation protection and in-service inspections continued successfully in 2013. Last year was therefore not all gloom and doom at NRG. Management and employees from these business units achieved their goals.

The events involving the nuclear installations once again confirmed for me the results of an asset integrity assessment that we commissioned in the spring of 2013 into the status of the nuclear installations. This assessment showed that several installations were approaching the end of their economic life. Considerable investments are required to continue to safeguard their reliability and safety. For this reason, an investment programme was set up which will enable the reactor to continue operating until the arrival of the new PALLAS reactor. In order to safeguard this investment programme in economic terms, a business case was also developed which presents the necessary revenue model. This business case was also developed which presents the necessary revenue from the business case, intensive negotiations with our clients were started.

In a short space of time, on two occasions I decided not to start the reactor and other nuclear installations. This obviously resulted in a significant reduction in turnover and a considerable loss over 2013. A loss over 2014 is also to be expected. Furthermore, an investment programme is necessary. For that reason, I believed that we also needed to review the business strategy and organisational structure. That programme also started in mid-November 2013 and was implemented in close consultation with the management board and the Supervisory Committee of ECN – as a parent company of NRG.

We have chosen a strategy with three spearheads. Firstly, we will reorganise the radiation chain. Secondly, for the government and industry we will perform research aimed at knowledge development and innovation. Thirdly, we will invest in the international growth of consultancy and services related to radiation protection. These activities must contribute to our business results and thus the continuity of our company. Furthermore, we are investing in the knowledge and competences of our personnel.

Our strategy requires considerable investments in our nuclear installations. In recent years, it has become clear at international level that the production of medical isotopes must be based on different principles. The Organisation for Economic Co-operation and Development (OECD) has played an essential role in that process. The member countries and organisations agree that a number of changes must be implemented. Reserve capacity must be created to make delivery more reliable and there must be a level playing field for all parties. All the costs involved in the production of medical isotopes must be incorporated in the prices – which is known as full cost recovery. The Ministry of Economic Affairs has lobbied internationally to get these principles accepted in other countries where reactors produce isotopes.

As the market leader, NRG has been the first to take the initiative of implementing full cost recovery. We have now reached agreement with our six biggest clients concerning sales prices which are based on this principle. This also gives the financial basis for the investments required to enable us to continue operating the installations safely and reliably. The Ministry of Economic Affairs has now agreed to provide temporary finance for this investment programme in the form of a bridge loan. This guarantees the delivery of medical isotopes in the Netherlands, in Europe and elsewhere in the world. In due course, the banks will have to take over this financing.

Based on the strategy, the organisational structure has also been changed. We have chosen a product-oriented organisational structure which is best suited to serving our clients. The structure comprises four units: Irradiation Solutions, Consultancy & Services, Research & Innovation and Nuclear Operations. This new structure has been implemented in October 2014 and is a condition for achieving the strategic goals.
With these four units, the responsibilities for operating the nuclear installations and the commercial services in the radiation chain are separated. This benefits the reliability and safety of the operations. In addition, a separate unit has been created to conduct (subsidised) research and forces have been combined in the field of consultancy and services for asset management, safety, permits, radiation protection, inspections, waste processing and decommissioning. This will help boost our international growth.

In order to continue developing our organisation and our personnel, we have adopted the principles of the High Reliability Organisation. These are key to the daily work of our employees.

Although 2013 may have been the most difficult year so far in the existence of NRG, a huge amount of work was done. 150 employees were directly involved in the Return to Service programme to first safely and responsibly shut down all the nuclear installations, implement improvements in technology, organisation and procedures and to restart all the installations at the beginning of 2014. Others were involved in reformulating the strategy, developing the new structure and improving the management system. These efforts were also made possible by strengthening the management team with knowledge and experiences from other industries and by appointing an operational director.

I cannot emphasise enough my huge appreciation for all the input, commitment and loyalty of all our employees. Furthermore, they have made sacrifices arising from an intensive cost savings programme which meant it was not possible to pay overtime or holidays. We were also unable to grant salary increases for promotions, no new studies and training could be attended, there was no Christmas box and they also bore the burden of other cost savings or delayed investments. I would also like to mention the contribution of members of our Works Council in their assessment and advice on many dossiers. Many colleagues from ECN also supported and helped us and worked hard on our future.

Without our personnel, we would not be where we are today: on the brink of a new period in which safety for the environment and personnel is central, in which we operate as a reliable supplier in a company that will become financially robust in order to guarantee continuity. A company with whom clients are happy to do business and where people enjoy their work.

However, various external relations also supported us last year in difficult times, for example the Ministers of Economic Affairs and Public Health, Welfare and Sport and various members of their staff, administrators and public servants in the province of North Holland and the municipality of Schagen, and supervisory directors. Fellow companies in different countries adjusted and extended their reactor schedules and postponed maintenance programmes in order to continue to meet the global demand for isotopes. And not least, our clients whose patience was so often called on and who were also prepared to accept significant price increases for the sustainable delivery of isotopes and for technological research. I would like to thank them all for the faith they had in us in this difficult year.

Petten, November 2014

Niels Unger
managing director
‘In all our operations, we have to prove that NRG is a responsible partner for operating nuclear installations. With the Return to Service programme, NRG took three months to implement improvements in technology, organisation and procedures.’

– Jelmer Offerein, HFR reactor manager
The relationship between the Foundation ECN and NRG goes back a long way. In fact, ECN originated in the Reactor Centrum Nederland (RCN) which was founded on 6 July 1955. Following the oil crisis of 1973, in 1975 the RCN became the Energy Research Centre of the Netherlands (ECN), responsible for developing knowledge relating to sustainable energy.

A partnership with KEMA led to the formation of the Nuclear Research and consultancy Group (NRG) in 1996. Later, TNO Dosimetry Services joined this partnership. In 2006, we acquired the shares in KEMA Nucleair BV and NRG became a full subsidiary of Foundation ECN.

As a result of the changing activities of NRG, such as the production of medical and industrial isotopes and international consultancy, NRG embarked on a development process whereby it has become less of a research institute and increasingly a business and a production company with capital-intensive installations.

Under its new director, in 2013 NRG started a transition in which this process of change accelerated while retaining the social research component. The urgency of speeding up this transition also became clear in 2013; on two occasions in a short space of time, the reactor could not be used due to technical faults. Strengthening our reliability as a supplier, building a financially robust company and continuing to develop the safety culture are thereby the principles which the executive board of ECN fully support.

In 2013, NRG and ECN were both subject of the judgement in cassation by the Supreme Court in the conflict with OMEN, a society of former employees, about the indexation of pensions. The Supreme Court overturned the judgement of the court in which the Foundation ECN was ordered to index the pensions, although this exceeded the financial capacity of ECN and NRG. Meanwhile OMEN has announced that it will submit its claim to the Court again, despite this judgement.

Last year, the management board of ECN worked closely with the managing director of NRG and his management team. The decision to shut down all the nuclear installations on 15 November 2013 and take three months to run a ‘Return to Service’ programme had our full support. NRG’s review of the strategy and the restructuring of the organisation were also conducted in good consultation with us.

During this process, we also concluded that, as a service provider in nuclear technology and as a capital-intensive production company, NRG no longer reflected the character of the Foundation ECN, where international research in the field of sustainable energy is the core activity. A new structure between ECN and NRG is required and will have to be addressed in close consultation with the Ministry. NRG’s investment programme, which is necessary for the safe and reliable operation of the nuclear installations until the arrival of PALLAS, exceeds the capacity of ECN. Although private financiers have indicated an interest in financing NRG, they have imposed conditions which cannot be met in the very short term. We have therefore approached the Minister of Economic Affairs for a bridge loan. October 17 this bridge loan was granted under specific conditions. With this decision by the minister NRG can carry out its business plan for the coming years.

Finally, I would like to express my appreciation, also on behalf of the management board of ECN, for all the efforts and hard work of the employees of NRG. They have shown tremendous commitment, working many hours of overtime and demonstrating great loyalty. In short, they have done an amazing job. The board, the management and the employees of NRG are doing what is necessary to safeguard the future of their company. This has borne fruit, but our work is certainly not finished. Many challenges await us in 2014.

I am confident that NRG will once again be restored to health and be able to offer its services to society, safely and reliably.

Petten, November 2014

Paul Korting
CEO Executive Board, ECN
ROSA is a software tool developed by NRG to perform the in-core fuel management of Pressurised Water Reactors. The outcome of this optimisation process is better usage of the nuclear fuel which produces considerable economic and environmental benefits. My current focus is the extension of the application of ROSA to the Boiling Water Reactor.” – Luca Gilli, Safety & Power, research consultant
STRATEGY

NRG last formulated its strategy in 2011. This resulted in the Strategic plan 2012-2015 From Institute to Enterprise. In response to changing conditions in the market for radiation services and the lengthy shutdown of the High Flux Reactor. NRG decided to review in the second half of 2013 and realign its strategy to the current situation.

The management embarked on the strategy realignment in the summer and continued the process in the autumn. The second phase of that process was supported by consultants BoerCroon and also involved various external stakeholders. This process was completed in early 2014.

Based on the core activities, i.e. production of isotopes, applied nuclear research and consultancy and service provision, the review looked at how nuclear technology is used in the medical market, the energy industry and other industrial sectors, and at developments therein in the coming years. In each of its core activities, NRG was shown to have a clear social impact. This could be with regard to developing knowledge and innovation for the Dutch government and for international business, the production of isotopes for the health sector or industry as well as in the field of radiation protection, safe handling of radioactive material and the safe and reliable operation of nuclear installations in the Netherlands and abroad.

Growth based on strength

In its strategy, NRG chooses growth based on strength. In the coming years, the emphasis in the radiation chain is on safe and reliable production methods and service provision. Financial robustness is further guaranteed by following the OECD/NEA guideline for ‘full cost recovery’. That means that all costs related to the safe and reliable operation of the reactor and other installations and processes are included in the prices of products and services. This includes, therefore, security and the replacement of high-enriched uranium by low-enriched uranium for the production of molybdenum 99, the most important medical isotope.

In addition, the subsidised and commercial research conducted at NRG continues to occupy an important place as a contract with Dutch society. This is not only for the development of knowledge about nuclear technology, but also serves as a basis for product innovation for its own portfolio and for commercial partners.

Growth is also possible in consultancy and service provision. This may be through international expansion and through closer cooperation with chain partners – in both the scientific and business sectors.

NRG has developed a new organisational structure based on its new strategy and on experiences with the current structure over the past few years. The starting point here is how to use the strategy to enable NRG to optimally serve the markets in which it operates.

Culture

The changing market conditions not only require a new strategy and structure, but also demands different behaviour among staff. NRG is becoming an increasingly commercial enterprise in which decisiveness and stronger commercial competences are necessary assets.

Furthermore, the company operates various nuclear installations which must function reliably and safely. Experiences in recent years have highlighted the potential and necessity for more improvements in safety management and in the safety culture. In the autumn of 2013, a programme was therefore launched to implement a new safety management system and strengthen the safety culture. The aim is for NRG to become a High Reliability Organisation (HRO) which will perform better, more reliably and more safely than other market parties over a long period.

Relationship with ECN

Fine-tuning the strategy also involved examining the relationship between ECN and NRG. NRG is currently a general partnership, with Stichting ECN and Stichting ECN Nucleair as partners. It was concluded that there is a lack of synergy between the organisations’ core activities. As organisation, ECN focuses on applied research into sustainable energy, while NRG has increasingly developed into a commercial nuclear technology service provider. NRG’s company activities also present financial risks that would probably be more manageable in an adapted organisational structure.

For these reasons it was decided to investigate whether NRG could operate in a more independent form. An exploration is being conducted regarding whether risks relating to historic radioactive waste and decommissioning of nuclear systems should be accommodated in a separate fund.

PALLAS

In April 2013, the PALLAS quartermaster from the Ministry of Economic Affairs published his final report about the quality of the plans and fundability of PALLAS. In July, the European Commission approved the government loan for the first phase of PALLAS. The European Commission does not feel that this decision is in conflict with European regulations for state aid and decided that the loan would contribute to the communal interest of assuring the availability of medical isotopes for European patients.

In December 2013, the Province of North Holland and the Ministry of Economic Affairs set up the Stichting
‘NRG aims to become a High Reliability Organisation (HRO). This requires investments in technical installations as well as in organisation and management.’ – Hans Hegeman, Return to Service, programme manager
Voorbereiding PALLAS reactor. This foundation can now start preparing the first phase of establishing a new reactor: European invitation to tender, producing a reactor design and obtaining the necessary permits. This is expected to take four years. The province and the Ministry have each made 40 million Euros available for this phase. The next phase, involving the construction and commissioning of the PALLAS reactor, will then have to be entirely privately funded and with risk-bearing capital.

This milestone marks the end of the preparations for which NRG was responsible as the future user of PALLAS. NRG obviously totally supports the objectives of the foundation and also recognises the leading role of the foundation in constructing PALLAS. Where necessary, NRG will provide the foundation with all the support it requires to enable it to achieve its goals. In view of the length of time before PALLAS is completed, NRG is taking several scenarios for PALLAS into account in its own strategy.
SAFE

Safety has top priority for NRG and is one of NRG’s core values. This applies to both the safety of the environment as well as of its own employees and others working on site. At NRG, one of our standards is to work safe. If this cannot be guaranteed, work will not be carried out – even if that has far-reaching economic consequences. Non-proliferation of nuclear fuels and nuclear technology and the processing of radioactive waste are also safety-related areas.

Non-proliferation
At the end of March 2014, the Nuclear Security Summit was held in The Hague. During the previous summits in Washington (2010) and Seoul (2012), the Netherlands, France, Belgium and the United States agreed that for safety reasons they would no longer use high-enriched uranium in civilian applications – such as in the production of medical isotopes.

Since 2010, technical preparations for the conversion to low-enriched uranium in the production of isotopes have been continuing. In the summer of 2012, NRG was the first in Europe to carry out the qualification radiation of low-enriched uranium followed by the post radiation investigation in the NRG laboratory. In the year under review, NRG worked on additional calculations to supplement the qualification results for assessment by the authorities. In this project, NRG is working closely with chain partners in the pharmaceutical industry.

Four times a year, inspectors from the UN’s International Atomic Energy Agency (IAEA) and the European Union’s Euratom visit NRG to check the administration and the presence of nuclear fuels. These inspections take place in the framework of the Non-Proliferation Treaty (1968) which was also signed by the Netherlands and which aims to prevent the spread of nuclear weapons. Every year NRG has three regular inspections of the nuclear facilities and one total audit of the nuclear fuels. The Nuclear Safety, Security and Safeguards Department (KFD) is also invited to attend these inspections. In 2013 nothing untoward was found and the administration was approved.

On 1 January 2012, the Strategic Services Act (Wsd) and the Strategic Services Implementing Decree came into force. The starting point for this legislation was the ban on helping the development or production of a weapon of mass destruction or military goods for an end user in a country subject to an arms embargo. There is no ban on offering technical assistance or supplying dual use goods for civil use, but an export licence is required. On account of its international contacts regarding nuclear knowledge and materials, NRG is also confronted with Wsd licensing obligations. In 2013, NRG radically reviewed and adjusted its export control management system.

In November 2013, a new version of the Export Control Manual came into force.

In 2013, nineteen applications for an export licence were submitted to the Central Import and Export Office (CDIU). In response, fifteen licences were issued and four more are being processed by the Ministry of Foreign Affairs.

Quality management
In 2013, the NRG quality system was further developed, with responsibility for the primary processes being placed with the business units. The quality system was adjusted accordingly. However, in November of the year under review, it became clear that the development was not progressing satisfactorily. Extensive improvements were subsequently implemented on a project basis alongside the Return to Service programme. This approach resulted in many procedural improvements which thus boosted the quality. This was followed by a positive audit in February 2014, which confirmed the good progress and made it clear that NRG would retain its ISO certificate. Continuous improvement of the management system has now been embedded in the daily practice of NRG and identified as a spearhead for 2014.

Security
On 1 January 2013, ECN transferred the management and ownership of the security systems to NRG. NRG also addressed the security monitoring of the ICT systems administered by ECN, dividing up the responsibilities and assigning them to the appropriate places. ECN now performs a number of ICT tasks, while NRG monitors ICT security.

In the year under review, the government implemented the new Design Basis Threat (DBT) for cyber security. Based on this DBT, an extensive risk analysis was performed for the ICT situation within NRG and ECN. In response to the results of this analysis, NRG tightened its security procedures. It also appointed an ICT security expert and took several urgently required measures. For the employees, clear measures were the introduction of secure printing and the use of encryption for mobile information carriers. In 2014, NRG is continuing to work on ensuring that its ICT is DBT-proof. This can be demonstrated by its ISO-27001 certification and the audits performed by the Nuclear Safety, Security and Safeguards Department as supervisory body.

At the request of the Ministry of Economic Affairs, NRG contributed to new legislation relating to nuclear security and safeguards.

The physical security of the NRG complexes has already been compliant with the government’s DBT since 2012.
Pursuant to the Radiation Protection Decree, any company working with ionising radiation must have a Nuclear Energy Act dossier (KEW dossier). We have therefore developed ReGuard, an online digital version of such a dossier which helps companies update their dossier.” – Klaas Hoogeboom, Radiation & Environment, product manager
Radiation hygiene
As is usual in the nuclear sector, the emphasis at NRG is also on preventing unnecessary exposure to ionising radiation. Here the ALARA principle applies: as low as reasonably achievable. Eighty percent of the collectively received dose at NRG is a result of operating the HFR. When the reactor is in frequent operation, the individual and the collective doses are higher. Due to the unavailability of the reactor in the first, second and last quarter of 2013, the collective dose was therefore lower than in previous years: 91 people∙mSv versus 173 people∙mSv in 2012 and 218 people∙mSv in 2011.

By taking appropriate measures, the extra maintenance and inspection work performed as a result of the outages did not affect the collective dose. In 2013, the highest individual exposure was 3.62 mSv for an employee in the NRG inspection team, but this was mainly the result of working in (foreign) nuclear power installations.

Power outages
On 27 March, a power outage was reported to the emergency room. According to procedure, measures were immediately taken to ensure that fire and security reports could continue to be received. Safety and security were not at risk at any time. The cause of the power outage was found to be an imbalance in the mains voltage. Recovery measures were taken.

On Saturday 13 July, a power cut occurred in the public power grid in one of the two 10,000 volt power cables which provide electricity to the Petten Research Location. The HFR was subsequently shut down and the emergency power supply switched on. Various systems which were not connected to the emergency power were disabled. Later that afternoon, the power supply was restored.

In the year under review, there were 106 reports of potentially unsafe situations. Each report was tested against the NRG risk matrix; the score of this test determines how thoroughly a report is investigated. In some cases, the report led to a Safety Alert which draws everyone’s attention to a lesson learned. In 2013, nine Safety Alerts were issued.

In mid 2013, NRG informed the authorities about an improvement which was introduced at the access control of areas which may not be entered while the reactor is in operation. This improvement was in response to an incident whereby two employees accidentally entered a room with heightened radiation levels. Because they had the correct radiation measurement equipment with them, they were alerted and immediately left the room. However, as a result of this incident, the employees concerned received around 0.5 milliSievert of radiation in one go. This is equivalent to the average annual dose at NRG.
The Return to Service programme has facilitated a fundamental reorganisation of the primary business operations. Among others, this has resulted in the merger of the quality management and safety management systems into one integral management system.

– René Meekel, Irradiation & Development isotopes business manager
Radioactive Waste Management Programme (RWMP)
The RWMP programme initiates projects aimed at the safe and efficient removal of all the radioactive waste from the Petten Research Location. The programme monitors the progress and ensures the efficient and effective use of the knowledge and experience present at NRG. The Plan of Approach was approved by the Ministry of Economic Affairs earlier in 2013.

The RWMP includes the removal of historic radioactive waste from the reactor and the laboratories as well as the residue materials released when dismantling facilities. Furthermore, new transport routes are being set up for current operational radioactive waste flows.

The historic waste from the nuclear research activities is stored in barrels in a specially designated storage facility. This waste must be sorted and repacked according to radiation levels before being sent to the Central Organisation for Radioactive Waste (COVRA) in Vlissingen. In October, a start was made with lifting and opening the first barrels and sorting the contents. Several new pieces of equipment were developed for this purpose.

Because a Belgian supplier is involved in conditioning the waste, approval is required from the Belgian government. In addition, specially designed transport containers for international transport must be certified. These international dependences are factors which may affect the planning. The Return to Service programme also had an impact on progress in the RWMP.

In 2013, NRG also transported historic radioactive waste to COVRA, including nuclear fuel elements from the Low Flux Reactor (LFR). Because this was the most radioactive part of the reactor, this waste transport was an important milestone in the dismantling of this old training reactor. At the end of 2013, the permit application for dismantling was submitted to the Ministry of Economic Affairs. The site will become available for other purposes following dismantling, which started in the second half of 2014.

### Received radiation dose at NRG

<table>
<thead>
<tr>
<th>Average radiation dose in milliSievert (mSv)</th>
<th>0.26</th>
<th>2009: 0.70</th>
<th>2010: 0.62</th>
<th>2011: 0.74</th>
<th>2012: 0.54</th>
</tr>
</thead>
</table>

|-----------------------------------------|------|-------------|-------------|-------------|-------------|

Dose limits: the dose limit for a radiological worker is 20 mSv per year and for members of the population 1 mSv per year. The exposure resulting from natural background radiation in the Netherlands is around 2 mSv per year.
RELIABILITY

At the end of 2013, neither the High Flux Reactor (HFR) nor the Molybdenum Production Facility (MPF) were in operation: age-related and other problems continued to plague them. In order to prevent unplanned shutdowns in the future, NRG felt it was essential to make modifications in the technology, the safety system and in the organisation. In order to achieve this, the management board safely decommissioned the entire nuclear infrastructure at NRG and incorporated it in the Return to Service programme. NRG’s customers and business relations were informed of this temporary situation.

Earlier in 2013, an analysis was performed of how the nuclear infrastructure could optimally continue to operate reliably and safely for man and the environment during the operational service life until 2024. In the following three months, hundreds of improvements in technology, organisation and procedures were subsequently implemented through the Return to Service programme. Three months later, in mid February 2014 most of the installations were operating safely and sustainably again. The last – the Molybdenum Production Facility – followed on 17 April 2014.

The situation at the end of 2013 clearly shows that NRG needs to adopt a new philosophy, a new way of working and thinking. NRG wants to become a High Reliability Organisation (HRO). This demands substantial investments, both in technical installations and in organisation and management. In short, NRG must be more sensitive to ‘weak signals’ and learn to anticipate unexpected events better. Routines must be avoided and the organisation may no longer be satisfied with simple statements and can learn more effectively from errors and near-errors.

This route to a High Reliability Organisation will involve continuous training and education of employees who will have a range of working methods to enable them to effectively deal with different situations. Every employee will be made aware of his/her responsibility in the organisation chain. Being critical of colleagues, listing well and addressing each other with mutual respect are the conditions; knowledge is more important than hierarchy. Once employees are permanently updated about the entire operational process and there is a continuously learning organisation in place, NRG will achieve its goal in becoming an HRO.

Outages nuclear infrastructure
The High Flux Reactor (HFR) was shut down on 11 November 2012 for standard maintenance. After identifying an anomaly in the cooling water system, the restart was postponed. A tiny amount of tritium was leaking into the groundwater. The leaking pipe was replaced and fitted with leak sensors. During 2013, work was carried out to remove the tritium contamination from the groundwater. At sites with raised concentrations, some 6,000 litres of water were pumped up every day and removed via the industrial wastewater circuit. The groundwater measurements showed that this worked very effectively. In the second half of the year under review, it was agreed with the Ministry of Economic Affairs that the chosen approach would be continued. At the end of 2013, around 40 percent of the tritium contamination had been removed.

Early in 2013, it also became clear that the packing of the bottom plug in the basin under the HFR’s reactor vessel was not leak-free. Primary and basin cooling water came into contact with each other through a hole measuring several square millimetres in a place which was very difficult to access. NRG therefore decided not to submit a request to the regulator to restart the reactor and chose to make modifications to the system. After the Nuclear Safety, Security and Safeguards Department (KFD) had issued a certificate of no objection, the primary cooling water system was modified and the reactor was re-started on 11 June 2013.

During the annual summer shutdown, the reactor was connected to the new secondary cooling water pipeline which discharges into the sea. This was necessary because the existing pipeline would disappear below the sand following the coastal reinforcement. On 3 September 2013, the reactor was re-started with the new cooling water pipeline.

Shortly afterwards, a problem was found during planned maintenance with one of the six control rods which operate the HFR. NRG immediately decided not to start up the reactor and initiated an investigation. The cause of the damage was found to be the blind rivet between the cadmium and nuclear fuel element of a number of control rods. The HFR was back in operation within the Return to Service programme on 14 February 2014.

In October, the Molybdenum Production Facility (MPF) in the Hot Cell Laboratories (HCL) was also shut down following problems with the monitoring technology. When extrapolating the analysis data for a sample from one of the wastewater tanks, it could not be demonstrated that the results for the entire tank would remain below the limit value for uranium. As a precaution, NRG decided to shut down the facility and informed the regulator. Within the Return to Service programme, various organisational, procedural and technical improvements were implemented. These resulted in better control of the inflow of uranium and an improved sampling method.
‘For Decontamination and Waste Treatment, ‘Return to Service’ has enabled risk analysis to take a huge step forwards. Collectively producing detailed analyses has produced new insights about safe and reliable operations in the installation.’ – Arthur Wijker, Operational Services & DWT manager
IRRADIATION & DEVELOPMENT

The Irradiation & Development (I&D) business unit supplies nuclear knowledge, data and semi-manufactured products to the medical and nuclear industry – including isotopes for applications in the health sector and industry. The business unit I&D manages the High Flux Reactor and other nuclear facilities. Developments relating to the reactor in 2013 have been described in the previous chapters Safe and Reliable.

Markets and market segments
Irradiation & Development focuses on three product groups: medical isotopes, industrial isotopes and nuclear technological research. It also aims to develop new product-market combinations for the unique combination of NRG’s nuclear facilities.

The temporary shutdown of NRG’s nuclear infrastructure seriously affected the business unit. NRG feels that it is its responsibility to do its utmost to ensure the safe and reliable operation of its nuclear facilities and has regularly informed its customers and branch organisations about the status of the nuclear infrastructure.

Implementation investments
Based on the Asset Integrity Assessment launched in 2012, an implementation plan was drawn up for investments in the nuclear infrastructure for the period 2014-2024. This concerns, among other things, major investments arising from the programme following the 10 yearly evaluation of the HFR, the robustness investigation following the tsunami in Fukushima and the investments in the Hot Cell Laboratories (HCL). In order to implement all the technical, procedural and organisational improvements, a three year transition programme was set out. By focusing on the principles of asset management in the coming years, NRG can become a High Reliability Organisation (HRO) and adopt a reliable position in the market at all levels.

Products and services
NRG has been involved in developing the high temperature reactor (HTR) for two decades. The HTR is a compact, very safe nuclear reactor and thus a potentially important concept for nuclear combined heat and power – supplying both heat and electricity – in existing (industrial) conglomerations.

In February of the year under review, 34 European partners met in Petten in the framework of Archer. This European project explores the possible application of high temperature reactors in existing industrial processes. NRG contributes in the field of fuel and material research, for example into the behaviour of graphite under extremely high temperatures in the reactor. In the year under review, research was conducted to support the safety evaluation and the licensing process. This project has received great interest from the United States, Japan, China, South Korea and South Africa.

The project is worth 10.5 million Euros, 5.4 million of which has been financed by the European Union. Besides NRG, AREVA and Westinghouse are also involved in this project.

On the east coast of China, INET is building the world’s first reactor of twice 250 MWth (100 MWe): the HTR-PM twin reactor. These reactors have a core filled with a large number of fuel balls. NRG is carrying out the fuel qualification, which it has been doing for several years. The six centimetre fuel balls are subjected to radiation in the HFR under representative conditions, whereby the release of the nuclear fission gases krypton and xenon is measured during the radiation. The result reflects the integrity and the quality of the reactor fuel. This radiation project is expected to be completed at the end of 2014 and will be followed by a post-radiation investigation lasting one and a half years in which NRG will be responsible for the non-destructive part and the German organisation JRC-ITU in Karlsruhe will be responsible for the destructive part. After this has been completed, the Chinese fuel will be assessed to ascertain whether it fulfils the required quality standards. For INET, the qualification is conditional for obtaining a licence to operate. The qualification project fits in well with the building project in China, which is now in full swing. Once the HTR-PM has demonstrated that it can operate successfully, it is expected that China will start building several of these reactors on a commercial basis.

In September, research was started into a new type of fuel for Generation IV nuclear reactors which can recycle radioactive waste. Besides uranium and plutonium, the fuel – a ‘mixed oxide’ or MOX – also contains americium which is formed by bombarding uranium with neutrons in a nuclear reactor. Americium is one of the components from nuclear waste with a long lifespan. NRG works together with the Joint Research Centre of the European Commission. The budget is around one million Euros and generates around seventeen man months of work at NRG in Petten.

In February 2013, NRG embarked on international research into steel samples which have been exposed to a high dose of neutron radiation in a nuclear reactor over the course of 27 years. The results of the research provide insight into the future behaviour of steel in the practical conditions of a nuclear reactor. Because this insight is a condition for a licence for long term operations, operators of nuclear power stations all over the world are interested in the results. This research is also important for the development of improved, self-repairing steel types for the new Generation IV nuclear reactors. Because these new reactors operate at very high temperatures (up to 500 oC), there is the possibility that the intended steel type will repair radiation damage itself.
A reactor vessel will then have a significantly longer service life.

Another research project which will provide the world with more knowledge about the ageing of reactor vessels is the LYRA experiment which was initiated by NRG together with the Joint Research Centre. In the coming years, NRG will irradiate various steel samples in the HFR with randomly applied contaminations in differing concentrations. By bombarding the steel with these contaminations with neutrons, better insight is obtained into the behaviour of the reactor vessel steel in the future.

In 2013, a neutron experiment was also prepared for the future nuclear fusion reactor ITER being built in Cadarache (France). The future heat shield around the plasma in the fusion reactor will be very heavily bombarded with neutron radiation. Before this takes place, it must be established how the wall material of ITER will behave. The experiment design has already been reported to ITER. In 2014, China and Russia will produce mock-ups of the material for the heat shield which will be subjected to radiation in the HFR from 2015.

For EDF Energy, NRG is conducting a series of radiation experiments in order to find out more about the behaviour of graphite during radiation. Graphite is an important material used in fourteen gas-cooled reactors in England. These reactors are approaching the end of their technical service life, which EDF wishes to extend. In order to ensure that this is achieved safely and in a responsible manner, EDF needs to demonstrate that all the components are fit to deal with this longer lifespan. After tests had already showed that the graphite retains its strength after oxidation, the gliding properties of graphite are now being studied. In these experiments, small graphite samples are subjected to radiation under pressure, after which the dimension changes are determined. Within one year, the entire experiment was designed, built, subjected to radiation and the first measurements taken. In 2013, the first phase was implemented, consisting of one cycle of radiation. The second phase started in 2014. This radiation is expected to take six cycles. With the new data, EDF can more accurately predict the tensions in the graphite blocks and demonstrate that the lifespan can be safely extended.

Organisation
NRG works with international partners to ensure the optimal continuity of the production of medical isotopes. Since June 2013, the business unit has been negotiating with the Top5 customers about the necessary price rises recommended by the OECD based on full cost recovery. This is necessary in order to maintain safe and reliable operation of the nuclear infrastructure until at least 2024. In this programme, the commercial organisation of NRG is also further developed in terms of portfolio management, account management, sales and operations planning, business development & licensing, market research and competition analyses.
Products and Services

Before, during and after production – cycle

**RADIATION PROTECTION SERVICES**
- Licences & RI&E’s
- Training
- Dosimetry
- Monitoring & Supervision
- Radiation Protection Management Software
- Laboratory Services

**SAFETY & RISK**
- Environmental Impact Assessment
- Safety Evaluations
- Safety Analyses
- Probabilistic Safety Analysis
- Safety and Reliability Analysis
- Technical Safety Report

In production

**ISOTOPEN**
- Medical Isotopen
- Industrial Utilities

**MATERIAL QUALIFICATION**
- Material Characterization & Qualification
- Fuel Qualification & Testing

Maintenance – Optimization during production

**ASSET OPTIMIZATION**
- Core & Reload Optimalisation
- Long Term Operation
- In Service Inspections (ISI)
- EDM Services
- Asset Integrity Assessments

Dismantling – End of use

**DECOMMISSIONING & WASTE MANAGEMENT**
- Integrated project approach reducing ‘footprint’
- Characterization & Sorting
- Decontamination & Disposal
RADIATION & ENVIRONMENT

The Radiation & Environment business unit helps customers handle ionising radiation safely and responsibly. The transformation towards a market-focused service provider already embarked on earlier was successfully continued in 2013.

Markets and market segments
Radiation & Environment delivers services and products to businesses and organisations involved with radioactivity and the frameworks of the Nuclear Energy Act. Within these legal frameworks, the employees help customers offer safety to man and the environment, so that continuity of their business operations is guaranteed. NRG thus contributes to the high quality and sustainability of the products and services of its customers.

NRG has observed an increasing need for support in the international market sectors Nuclear, Healthcare and Process Industry. This is due to the ever more stringent demands imposed by the legislator on market sectors with business processes which intentionally or unintentionally experience the effects of ionising radiation. The resulting licensing obligation aims to minimise the risks. That increasingly requires a wide range of measurements, analyses and the related registration by the licence holder. In order to relieve the burden on these businesses as much as possible, NRG offers practical and specialist nuclear services. These vary from laboratory, analysis and measuring services to consultancy and support for the dismantling and decontamination of radioactively contaminated installations.

2013 was a good year for the business unit. Fluctuations in the market had a limited impact on the portfolio compared with statutory changes, which had a greater effect. In 2013, businesses were preparing for the changes in the Radiation Protection Decree which came into force in January 2014. This tightened legislation requires certain tasks to be only executed by or under supervision of a registered radiation expert (minimum level 3). NRG helps businesses meet these requirements by providing radiation risk analyses and training, and implementing these specific responsibilities. NRG also provides support for dosimetry, reports, licence applications and modifications.

In the field of oil and gas extraction in the Netherlands, NRG has now made good progress and the business unit is increasingly looking across the national border. Healthcare appears to be another growth market with potential. Nuclear medicine and all the other disciplines which use nuclear technology or materials are also interesting markets for services, products, knowledge and expertise. Finally, demand for nuclear expertise is also growing in the process industry.

Products and services
It is in this light that a Dutch project to dismantle a phosphoric acid installation should be seen. NRG was integrally responsible and managed the entire project according to the specifications in the permit, from the dismantling and radiation protection to the removal and decontamination of the radioactively contaminated parts in Petten. By separating contaminated residue from non-contaminated residue, the storage costs of radioactive waste remained low.

NRG also supplies these decommissioning and decontamination services to the nuclear sector. In November, for example, uranium enricher URENCO commissioned the decontamination of a dismantled installation. Some twenty containers with parts which were released were brought to Petten from Almelo. There they were inspected for possible contamination and then cleaned. The materials were subsequently removed as scrap and the radioactive residual products were stored at COVRA in Vlissingen. For AREVA, the global market leader in the field of nuclear energy, NRG decontaminated a transport container.

In October, NRG hosted the IAEA workshop Naturally Occurring Radioactive Materials (NORM). Around forty representatives from over thirty countries saw how the Netherlands deals with NORM. In this field, the business unit maintains a long-term relationship with mainly Dutch companies drilling for gas and oil in the North Sea and helps them with NORM issues. NRG also has added value for international companies, particularly in countries with less knowledge and experience in dealing with NORM.

Besides doing investigations, NRG also gives courses and training to employees and provides advice on adapting and applying procedures. One example of the increasing internationalisation of these services is an inspection conducted in Egypt. A Dutch customer requested a NORM investigation of two sites. In April – before all the political unrest in Egypt – two employees were sent to analyse the possible NORM contamination at these sites.

In 2013, NRG was also active in Angola. This Central African country is experiencing economic growth of nearly ten percent, stimulated by the big (offshore) oil industry. NRG was assigned an advisory role by the Angolan government with regard to legislation and regulations relating to NORM. NRG aims to be awarded more projects of this kind elsewhere in the world.

On behalf of the Ministry of Social Affairs and Employment, NRG monitors the individual radiation dose registration of over a hundred thousand people. In 2013, a representative
‘For our customer Rosier we decommissioned their Phosphorus facility in Sas van Gent. NRG was the main project leader in the execution of this non-nuclear decommissioning project. The gained knowledge and experience from this project is useful for future decommission projects in the oil and gas industry.’ – Robert de Groot, project manager, Radiation & Environment
random sample revealed that these customers were extremely satisfied with this service.

Innovation
Together with several big organisations, NRG developed software for the complete dossier creation relating to the obligations of the Nuclear Energy Act permit: ReGuard. Pursuant to article 120 of the Radiation Protection Decree, organisations which have a permit or which have submitted a report must record relevant information pertaining to radiation protection in a Nuclear Energy Act dossier. ReGuard administers and monitors the statutory requirements and registrations arising from this Nuclear Energy Act permit, such as the permit documents and the permit criteria contained therein, risk analyses and the inventory of sources and appliances. In addition, ReGuard offers the possibility of registering maintenance, personnel training and tasks. This produces an intuitive dashboard for the users, who can immediately see which parts of the permit require action.

The development of ReGuard is an initiative that NRG started together with several hospitals at the start of 2012. This user group was extended during the project and included Rijnstate Hospital in Arnhem, Jeroen Bosch Hospital in Den Bosch, Medical Centre Alkmaar and Amsterdam Medical Centre. At the end of 2013, the market launch of ReGuard was prepared. In the last quarter, a simple version was also made available for dental practices. This can be ordered online.

In 2014, the first complete version of ReGuard was introduced. This version is not only interesting for hospitals, but also for other organisations in the process industry and the nuclear sector. At the moment it is being considered whether other divisions of ReGuard should be made available for the market for specific sectors, for example veterinary practices.

Organisation
In order to provide customers with a satisfactory service now and in the future, Radiation & Environment continues to develop as a business unit. Its high quality awareness constantly challenges the business unit to implement changes and improvements in products, processes and the structure.

SAFETY & POWER

The Safety & Power business unit provides consultancy and inspection services for nuclear reactors. This expertise also finds its way to other sectors working with high risk or high performance installations, such as the oil and gas industry and civil and hydraulic engineering. The ultimate goal is to enable customers to operate their installations safely, reliably and efficiently throughout their entire service life.

Markets and market segments
The business unit has an international focus, whilst also attaching great importance to the domestic market. For NRG, a satisfied Dutch market is the basis for international success. The reverse is also true: NRG serves all the bigger nuclear parties in the Netherlands with international expertise and international customers with domestic expertise.

The business unit conducts complex reactor inspections all over Europe. It also plays an increasingly important role in Long Term Operation programmes. NRG has identified growth markets in Scandinavia, where it wishes to establish its own base in Sweden and it has also qualified for Finnish customers. Eastern Europe is an emerging market which NRG is closely monitoring. In the United States and the United Kingdom, NRG was awarded a contract through partners to support complex safety analyses of the US-NRC and ONR regulators respectively. In the Netherlands, NRG has had success for some time at Rijkswaterstaat with its probabilistic maintenance method ProBo. Through this approach, the infrastructure manager achieves the desired safety and reliability at lower costs. In 2014, growth is targeted in other sectors at home and abroad.

Products and services
The Safety & Licensing product line covers all the relevant activities for nuclear installations, ranging from periodical safety evaluations and drawing up safety cases to conducting complex thermohydraulic calculations and risk analyses.

The Asset Integrity & Cost Optimisation product line not only targets safety but also asset management and optimisation. In international terms, NRG is leading in the field of long term operation (LTO), safety analyses, core optimisation and reactor inspections.

With the experience acquired during the LTO permit for Borssele, NRG has become an important player on the European asset integrity market. In 2013, NRG was awarded the contract to assist the Swedish nuclear power stations in Ringhals in setting up the programme relating to the planned operating time extension. This experience was then applied in the Asset Management Improvement Plan for its own High Flux Reactor. Thus NRG also raised its profile on
‘Conducting an ultrasonic examination of the core barrel of Borssele nuclear reactor in April 2013 marked the completion of an extensive qualification. This qualification was carried out in NRG’s test laboratory in Arnhem, which is well equipped for this and other complex projects requiring ‘remote handling of operations.’

– Hans-Peter Vierstraete, Safety & Power, In-Service Inspections manager
the market for long term operation of research reactors and facilities.

With regard to the modification of research reactors, in 2013 NRG signed a cooperative agreement with the Reactorinstituut Delft (RID) which will be formalised in 2014. NRG and RID will work together to modernise the training reactor at Delft University of Technology and the HFR.

On 7 January 2013, NRG’s In Service Inspections team renewed its ISO/IEC 17025 certificate for mechanised ultrasonic, visual and eddy current testing, this time by the Dutch Accreditation Council. With this certificate, NRG proves that it fulfils the high standards imposed on conducting these inspections in the nuclear sector.

In April 2013, the nuclear power station in Borssele was shut down for its annual nuclear fuel change. EPZ asked NRG to inspect the reactor vessel during this period. The inside of the reactor vessel was inspected using ultrasonic measuring technology. Based on the inspection results, the Nuclear Safety, Security and Safeguards Department confirmed that the so-called Doel-3 phenomenon was not present in the reactor vessel of Borssele’s nuclear power station. This assignment led to another contract for three of the four Ringhals power stations in Sweden.

**Innovation**

NRG’s ROSA reactor core optimisation software is famous all over the world. In 2013, a start was made on developing a new application of the ROSA software. This tool has acquired a reputation with its fuel savings for pressurised water reactors. Demand for the ROSA software for boiling water reactors is particularly high. The proof of principle phase should be completed in 2014, after which ROSA will also be ready for use in these reactors in 2015.

In various post-Fukushima activities, NRG has contributed its innovations in the nuclear sector. The employees from the business unit perform calculations with state-of-the-art computational fluid dynamics models for hydrogen distribution and boron dilution in accident situations. Borssele nuclear power station thus leads the field in the optimisation of hydrogen management in accident conditions based on NRG’s calculations.

Following Fukushima, several nuclear power stations in Europe were closed earlier than planned. This has created new decommissioning issues for which NRG has found innovative responses. By means of spark erosion and robotics, damaged nuclear fuel elements can from now on be dismantled on site in the cooling water basin without damaging the coating of the nuclear fuel particles. Deformed or damaged nuclear fuel elements can thus be removed from the shut-down power stations safely and cost effectively.

A new approach to external flood analyses has been developed and applied. By re-evaluating the reliability of flood barriers and where possible replacing the conservative assumptions in the current design by realistic approaches, an improved safety assessment is achieved. In 2013, steps were also taken to develop a model for the modelling of digital measurement and control technology in a probabilistic safety analysis. NRG is actively contributing to this within an OECD/NEA work group.

**Organisation**

NRG strives to achieve local presence on growth markets by entering into partnerships and opening offices, in Sweden, for example. For this purpose, the business unit has appointed an employee who will focus on international operations.
NRG played a decisive role in the ‘Long Term Operation (LTO)’ project in Borssele, which resulted in an amendment to the licence extending the life of the nuclear power plant by twenty years. The acquired knowledge and experience was then used by NRG for the LTO project at the Ringhals nuclear plant in Sweden.’ – Frederic Blom, Safety & Power, Asset Integrity Services team manager
RESEARCH PROGRAMME

The national government’s objectives involve safeguarding and continuously improving nuclear safety and radiation protection, finding solutions for radioactive waste and contributing to a low CO₂ energy supply. This programme facilitates participation in research programmes funded by the European Union. Furthermore, the research programme is used for knowledge development and public information.

Nuclear safety
Efforts in this field are aimed at improving nuclear safety in existing and future power stations. Previously developed methods to predict the distribution, mitigation and combustion of hydrogen have been further refined in order to be able to assess the effectiveness of mitigating measures and to be able to predict the pressure build-up and load during a hydrogen explosion in the reactor enclosure. Work also continued on developing new methods to evaluate the cooling of a nuclear fuel storage basin in accident situations. Safeguarding integrity is an aspect of nuclear safety which is particularly relevant when extending a reactor’s operating time. Based on the research programme, in 2013 studies were conducted into the effects of mixing cold emergency cooling water and hot water in the primary system on the mechanical properties of the reactor vessel.

Radiation protection
In 2013, specific courses targeting the fire service and medical assistants were developed. Because of the relative size (and diversity) of the latter group, it was decided to develop an e-learning module for this profession. Another activity was the further development of the ‘Coreshield’ programme which makes it possible to calculate doses and the effects of different forms of protection in different configurations quickly and easily.

Waste
A literature study was used to explore alternative routes for recycling and the re-use of contaminated or activated concrete. In the Netherlands, this concrete is stored at COVRA. In several other European countries, however, this concrete would be used as a filler for radioactive waste.

Low CO₂ energy provision
As part of studies into the feasibility of innovative reactor concepts, safety calculations are performed, generally in an international context. For the High Temperature Reactor (HTR), a model which can reveal the existence of possible ‘hot spots’ in an HTR ball bed was created. In addition, the effect of rapid power changes on the mechanical properties of the heat exchangers of an HTR was charted. In the Czech Republic, a structure is being developed as a model for another type of innovative reactor: the supercritical water reactor. In 2013, NRG determined, among other things, the temperature distribution in the final design of the fuel bundle and established the resulting thermal distortions and currents.

A complete overview of all on-going or completed international projects and research programmes in 2013 is included in the ‘Annual Report 2013 from the NRG EL&IS Research Programme’.
**FINANCES**

NRG is a capital-intensive company which operates in a global market. In order to operate in this market, it is important that a robust financial policy is developed. This policy should focus on achieving sufficient returns to safeguard the continuity of the company and facilitate the safe and reliable operation of the installations, also in the long term.

In the last quarter of the year under review, NRG decided to temporarily decommission its nuclear installations in a safe and responsible way and to maximise the reliability through the Return to Service programme. The resulting measures have had negative consequences for the short-term position in terms of returns and liquidity. The results of the Return to Service programme, however, will contribute in the mid term to achieving a financially robust policy.

**2013 Results**

In the year under review, the HFR was only in operation for three cycles. This was one of the main reasons why 2013 was so disappointing financially for NRG. Operating income was 65.9 million Euros, compared to 74.7 million in 2012. That represents a fall of 8.8 million, or over 11.7 percent. The operating revenue fell from 0.3 million Euros over 2012 to a loss of 7.9 million Euros in 2013. The net result after interest and tax amounted to minus 8.2 million Euros.

The relatively high turnover or in other words minimal decline can be explained by two factors. Firstly, the work involved in modifying the reactor’s secondary cooling water pipeline, in which NRG only played an intermediary role, was accounted for in the revenue and the costs, the effect being around 4 million Euros. Secondly, all the costs related to NRG’s purchasing of radiation materials – at around 3 million Euros – could be charged to the biggest customer. This has been accounted for in the same way.

The much worse company result was mainly caused by the shutdown of the High Flux Reactor. The majority of the costs of operating the HFR are fixed, a fact which is immediately reflected in the net result: set against loss of turnover totalling over 18 million Euros, there were only savings in variable costs – mainly fuel costs – of nearly 5 million Euros. Furthermore, total costs of 3 million Euros were incurred in the framework of the Asset Integrity programme and the cleaning of the groundwater around the reactor due to the tritium contamination.

In response to the falling revenue, a cost savings programme was introduced on 15 October. Over a period of four months, over 1.3 million Euros were saved. This was achieved, among other things, by not giving bonuses and Christmas parcels, savings in business trips, training and assessments, cost savings in ICT, a recruitment moratorium, limiting external insourcing and postponing the relocation of the Arnhem branch. Expenditure must now fulfil one of the following three criteria: it must directly contribute to the turnover or results, be necessary to comply with legislation or regulations or be essential for the continuity of work. However, savings may not compromise safety, the environment or quality, including customer satisfaction.

Against these negative developments in radiation-related activities, there were good results for the Safety & Power and Radiation & Environment business units. Their operating result totals 3.7 million Euros and is thus comparable with 2012.

As a result of the disappointing results and the necessary loss financing, solvability became worse. The deterioration in solvability, defined as capital base in percentage of the total assets, was limited from 9.6% at the end of 2012 to 9.0% at the end of 2013 due to the receipt of a subordinated loan from ECN.

**2014 Prospects**

While technical issues involving the HFR were the main cause for the disappointing results in 2013, the solutions set in motion for these in 2014 will also have a huge impact on the results. The aim is still to become a High Reliability Organisation with the potential to expand the other activities. NRG strives to achieve further growth in the results in the Radiation & Environment and Safety & Power business units and expects to return to profitability in 2015.

In the meantime, in 2014 NRG and ECN obtained credit from the Ministry of Economic Affairs. This was not only required to finance the 2013 and 2014 negative results, but also to finance planned investments. In order to safeguard the future High Reliability Organisation, a so-called Recovery Plan has been formulated that, as well as safeguarding planned investments should also result in improvements in organisational structure, safety culture, marketing and the executive organisation. All this implies an extra strain on finances in the short and medium term, both for this extensive investment programme and for the recruitment of external advisors.

In the coming years, NRG will develop and implement a new price strategy based on the OECD/NEA’s guideline of full cost recovery, particularly for medical and industrial isotopes. NRG will also seek medium-term contracts with its biggest customers.

**Corporate governance**

Although NRG is a general partnership and not a company listed on the stock market, where possible the Dutch Corporate Governance Code will be applied with regard to corporate governance. NRG places responsibilities on individual managers who are accountable for this. In principle, the
‘Not every organisation knows exactly what needs to be done to ensure safe and responsible operations involving radiation. In order to help these organisations, NRG has developed an informative website: www.werkenmetstraling.nl. This also targets dentists, for example.’ – Bob Blijlevens, Radiation & Environment, business development manager
procedures at NRG make it impossible for key officials to use resources unobserved or improperly, or abuse their function or mandate within the organisation in any other way.

The management team comprises the Managing Director, the Business Unit Directors and Managers of the Staff Groups, supplemented by the managers of large projects. The Managing Director is responsible for compliance with legislation and regulations, risk management and the financing of the company.

The supervision of the daily business from the perspective of shareholders is incorporated within the managing partner Foundation ECN. The ECN Supervisory Board is somewhat more remote. It comprises unconnected experts and monitors the key themes. The members have fixed appointment terms and the Board has a broad composition. The Board assesses the annual budget and accounts andputs forward proposals for fixed and variable rewards. Of course the external accountant also audits the financial situation at NRG and approves the annual accounts.

Finally there are the external government regulators who maintain control of permits. For NRG, the Nuclear Safety, Security and Safeguards Department is the most important one because of the Nuclear Energy Act permit.

Operating income

€ 65,919 (x € 1,000)
in 2013

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The classification of the income statement changed from 2012.

Company result

€ 7,870 (x € 1,000)
in 2013

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<td>1,417</td>
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The classification of the income statement changed from 2012.
NRG is an organisation in motion. Early in 2013, the influence of a new direction for the company became visible. NRG started to focus more on procedures which are standard in the process industry and more attention was devoted to mutual trust and cooperation. At the end of the year, the initiative was taken to design a new structure on the basis of the new strategy and to give more attention to developing the culture – particularly in the field of safety.

Management
In the course of 2013, nearly all the positions in the management team were newly appointed. The QSE manager and the Irradiation & Development Business Unit Director were replaced. In the autumn of 2013, Mr V.A. Wichers, the Safety & Power Business Unit Director, indicated his wish to take early retirement and was succeeded by one of the other team members. The positions of Communications and Finance & Control managers were filled on an interim basis. Thus experience and expertise from other organisations was brought in which is essential if a fundamental change of course is to be achieved. The composition of the management team as at 31 December 2013 is shown on page 35. In the autumn, the reactor manager of the HFR was replaced. Taking the current reorganisation into account, this position was also filled on an interim basis and from among the members of the management team.

Crisis organisation
After the nuclear infrastructure was temporarily shut down at the end of 2013, it was decided to set up an interim crisis organisation with a two-man management team consisting of a managing director and an operational director. Thus the strategic dossiers and the daily management were distributed over two people. Mr Harrie Buurlage was appointed temporary operational director, Business Unit Director of Irradiation & Environment since 15 October 2013.

The employees of NRG immediately noticed the consequences of these radical decisions. At the end of 2013, around 120 employees were moved from their normal work to be involved in the safe and responsible decommissioning and- in mid February 2014 – re-commissioning of the nuclear facilities: the Return to Service programme. The employees proved to be open to strengthening the safety culture with new insights from outside the organisation. This meant that many of the risks highlighted could immediately be removed at the start of 2014. After the nuclear installations were re-started, the crisis organisation was dismantled. By mid 2014, all the necessary measures in technology, organisation and processes identified in the Return to Service programme must have been implemented.

Staff turnover
At the end of 2013, NRG had 444 employees on permanent contracts, equivalent to 411 FTEs. In the course of the year, 49 employees joined the organisation and 33 employees left NRG. In the framework of the cost savings programme, after October several temporary contracts were not extended and external employees were only hired when absolutely necessary. At the end of 2013, the number of employees including insourced and temporary personnel totalled 491.

In the year under review, sickness absence was 3.79 percent, excluding those on maternity leave. This was therefore slightly higher than in 2012 when this was 3.02 percent.

Recruiting new employees is not always easy. The scarce talent in the process industry is mainly available in the south of the Randstad and is difficult to move to the tip of the province of North Holland.

Efforts to recruit new talent have been successful, however. In recent years, NRG has experienced a reduction in the age of its employees with women in beta positions being relatively well represented. Recruiting candidates abroad has also had good results.

Works Council
In 2013, the Executive Board invested in its relationship with the Works Council, especially with regard to mutual trust. In the autumn, the incomplete – and thus heavily overworked – Works Council was in particular demand.

In the year under review, seven consultations were held. Furthermore, the Management Board regularly provided the Works Council or a delegation thereof with informal information about current developments. The Management Board submitted seven requests for approval to the Works Council and three requests for advice.

In December, Works Council elections were held, but only seven of the possible eleven positions in the council were filled. The management realises the burden of work on the Works Council members. The Management Board attaches great value to a well functioning works council, particularly in view of the current changing situation and it very much appreciates the commitment and input of the council members.

CLA
In 2013, lengthy negotiations took place with the trade unions about amending the CLA to better reflect the new character of the organisation: more flexibility and a more performance-related reward system. Unfortunately, the results of the negotiations were rejected by the members of one trade union at the end of 2013. Discussions were continued along the same line in 2014.
At the end of the contract with the Health and Safety service provider, a new partner was sought together with ECN and the other Petten-based dune companies. At the beginning of 2014, a contract was entered into with Arboactive.

**Pension conflict**
There was a positive development with regard to the pension conflict, which has now been continuing for several years. Following an adverse judgement from the District Court in Amsterdam for ECN/NRG regarding indexing of pensions, ECN/NRG appealed in cassation to the Supreme Court. On 6 September 2013, the Supreme Court judged in favour of ECN/NRG. The judgement of the District Court in Amsterdam dating from 2011 was thus rescinded.

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</tr>
<tr>
<td>2011:</td>
<td>406.9</td>
<td></td>
</tr>
<tr>
<td>2012:</td>
<td>417.4</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sickness absence figures</th>
<th>3.79%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009:</td>
<td>2.84%</td>
</tr>
<tr>
<td>2010:</td>
<td>2.87%</td>
</tr>
<tr>
<td>2011:</td>
<td>3.76%</td>
</tr>
<tr>
<td>2012:</td>
<td>3.02%</td>
</tr>
</tbody>
</table>
## Balance sheet

### ASSETS

#### Fixed assets

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intangible fixed assets</td>
<td>2,052</td>
<td>1,393</td>
</tr>
<tr>
<td>Tangible fixed assets</td>
<td>14,869</td>
<td>14,656</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17,021</strong></td>
<td><strong>16,049</strong></td>
</tr>
</tbody>
</table>

#### Current assets

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work in progress</td>
<td>6,456</td>
<td>8,745</td>
</tr>
<tr>
<td>Stock of fuel for HFR</td>
<td>14,624</td>
<td>10,711</td>
</tr>
<tr>
<td>Accounts receivable and accrued assets</td>
<td>4,832</td>
<td>6,086</td>
</tr>
<tr>
<td>Receivables from group companies</td>
<td>-</td>
<td>1,728</td>
</tr>
<tr>
<td>Taxes and social security contributions</td>
<td>1,022</td>
<td>932</td>
</tr>
<tr>
<td>Other Receivables and prepayments</td>
<td>282</td>
<td>180</td>
</tr>
<tr>
<td>Liquid assets</td>
<td>5,285</td>
<td>14,487</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32,501</strong></td>
<td><strong>42,869</strong></td>
</tr>
</tbody>
</table>

### LIABILITIES

#### Partnership capital*

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td><strong>49,522</strong></td>
<td><strong>58,918</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subordinated loan*</td>
<td>6,965</td>
<td>-</td>
</tr>
<tr>
<td>Provisions</td>
<td>20,265</td>
<td>18,543</td>
</tr>
<tr>
<td>Current liabilities</td>
<td>24,812</td>
<td>34,734</td>
</tr>
</tbody>
</table>

### Profit and loss account

#### NET OPERATING REVENUE

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding State of the Netherlands</td>
<td>8,113</td>
<td>9,390</td>
</tr>
<tr>
<td>Contracts and other funding</td>
<td>58,953</td>
<td>60,261</td>
</tr>
<tr>
<td>Increase/decrease in work in progress</td>
<td>-/ 2,054</td>
<td>4,325</td>
</tr>
<tr>
<td>Other corporate earnings</td>
<td>907</td>
<td>712</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>65,919</strong></td>
<td><strong>74,688</strong></td>
</tr>
</tbody>
</table>

#### OVERHEADS

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs of consumables and raw materials</td>
<td>-/ 541</td>
<td>6,118</td>
</tr>
<tr>
<td>Salary costs</td>
<td>26,151</td>
<td>25,227</td>
</tr>
<tr>
<td>Social security costs</td>
<td>7,582</td>
<td>6,498</td>
</tr>
<tr>
<td>Depreciation</td>
<td>2,165</td>
<td>1,264</td>
</tr>
<tr>
<td>Other operating costs</td>
<td>38,432</td>
<td>35,323</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>73,789</strong></td>
<td><strong>74,430</strong></td>
</tr>
</tbody>
</table>

#### Operating result

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>-/ 7,870</td>
<td>258</td>
</tr>
</tbody>
</table>

#### Financial result

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>-/ 289</td>
<td>-/ 281</td>
</tr>
</tbody>
</table>

#### Result before taxes

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>-/ 8,159</td>
<td>-/ 23</td>
</tr>
</tbody>
</table>

#### Taxes

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>-/ 2</td>
<td>48</td>
</tr>
</tbody>
</table>

#### Net result

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total</strong></td>
<td>-/ 8,161</td>
<td>25</td>
</tr>
</tbody>
</table>

*Capital base = 4,445

The classification of the income statement changed from 2012.
MANAGEMENT TEAM AS AT 31 DECEMBER 2013

N.C. Unger
managing director
ir. H. Buurlage
business unit director Irradiation & Development, also interim operational director
ir. J.J. van den Broek
business unit director Safety & Power
drs. ing. J.W. van der Haar
business unit director Radiation & Environment
W.C.M. van Beek, ACQC
interim manager Finance & Control
drs. E. Brinkman-Eggermond
manager Human Resources
drs. M. Janssen
manager Quality, Health, Safety & Environment
drs. R.R. Kool
interim manager Communications
P.G.M. van Saaze
program manager RWMP

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V.M. Smit-Groen
chair
R.J.J.N. Janssen
deputy chair
ing. B.R.W. Haverkate
secretary and deputy chair, Petten

A. Makhaising
deputy secretary
der. ir. J.C. Kuijper
H.R. Chevalking
A.J.P.M.C Delpeut RSE