

Programme A. NUCLEAR POWER

Rationale: The *Nuclear Technology Review 2002* identified two key features of the market situation regarding nuclear power: currently operating well managed nuclear power plants in many Member States are extremely profitable and reliable; and new advanced nuclear power plants need to be more competitive.

Programme A aims to contribute to the three main areas identified and recommended by the Standing Advisory Group on Nuclear Energy (SAGNE). The first area is the access of the Member States to a worldwide pool of information and expertise on internationally accepted proven engineering and management practices, and on nuclear power plant life cycle management including decommissioning. Guidance on technical and human performance, infrastructure maintenance, quality assurance and quality management will be provided in order to support the current nuclear power programmes of Member States.

The second area relates to advanced and evolutionary nuclear technologies. The Agency will co-ordinate co-operative research, promote information exchange, and analyse technical data and results for all reactor lines (advanced water cooled reactors, high temperature gas cooled reactors, liquid metal cooled reactors and accelerator driven systems), including small and medium sized reactors. Applications will include seawater desalination, process heat and hydrogen generation, in addition to electricity production. The focus will be on reducing capital costs and construction periods while further improving performance, safety and proliferation resistance in order to support the establishment of nuclear power as a sustainable energy source.

The third area relates to the preservation, maintenance and expansion of nuclear power related knowledge. The Agency will continue to manage and update databases supporting the optimization of performance, service life and infrastructure of nuclear power plants and providing economic evaluation of seawater desalination.

The progress of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO), which was initiated in early 2001 in response to two Agency General Conference resolutions in 2000, will be examined at the Agency 2003 international conference on Innovative Technologies for Nuclear Fuel Cycles and Nuclear Power. In 2004–2005, the focus of INPRO will shift to the identification of Member State preferences for specific technologies. Several CRPs will be established in areas of common interest to participating Member States. It is also expected that INPRO members will begin to direct their efforts towards the establishment of one or more international collaborative projects and the Agency may host a secretariat for these collaborative efforts.

Objective:

- To enhance the capability of interested Member States in the improvement of nuclear power plant operating performance, life cycle management including decommissioning, human performance, quality assurance and technical infrastructure;
- To enhance the capacity of Member States for the development of innovative nuclear reactor technology for waste incineration, actinide utilization and transmutation, seawater desalination, process heat and hydrogen production.

Outcomes
<ul style="list-style-type: none"> — Increased use of Agency recommended best engineering and management practices for improved nuclear power plant operating performance, life cycle management including decommissioning, human performance, quality assurance and technical infrastructure. — Increased co-operation between Member States for nuclear reactor technology innovation and establishment of international collaborative innovative nuclear projects under Agency co-ordination.
Performance Indicators
<ul style="list-style-type: none"> — Recorded increase in the use by Member States of Agency recommended best engineering and management practices, guidance, databases and training methodologies contributing to the improvement in performance of nuclear power plants worldwide. — Number of Member States co-operating in advanced and innovative nuclear reactor technology development and applications under Agency co-ordination.

Specific criteria for prioritization:

- Support to existing nuclear power programmes in interested Member States.
- Catalysing of innovation for sustainable development.
- Maintenance of nuclear knowledge and competence.

Subprogramme A.1. Nuclear Power Plant Operating Performance and Life Cycle Management

Rationale: The most significant trend in recent years for the nuclear power plants currently in operation has been the steady increase in availability factors through improvements in operational practices, engineering support and strategic management. During the 1990s the cumulative impact of increased availability factors has been equivalent to the building of 28 GW(e) of new capacity. As indicated in the Country Nuclear Power Profiles 2001, the

growing interest of utilities and regulatory organizations in Member States in improving nuclear power plant (NPP) performance, uprating power and operational licence extensions of well managed nuclear power plants, without compromising safety, represent the most economical options for providing additional generating capacity. This requires an integrated management approach, with emphasis on high standards, resolution of emergent problems, and unwavering pursuit of excellence in all aspects of operation. The subprogramme will contribute to achieving such an environment in interested Member States by enabling the exchange of experience and by developing guidance on proven engineering and management practices. International databases to support these activities in Member States will be further developed and maintained. Increased requests from developing Member States in all geographical regions for services in the application of international proven practices will continue to be met through technical co-operation projects. Advice and recommendations on the framework of the activities have also been received from SAGNE, Technical Working Groups and advisory groups of experts nominated by Member States.

Objective: To improve NPP performance and competitiveness and to optimize plant service life, including decommissioning, through increased Member State capabilities in utilizing proven engineering and management practices developed and transferred by the Agency.

Outcome
— Increased use by interested Member States of proven engineering and management practices transferred by the Agency for improving NPP performance and competitiveness, and for optimizing plant service life, including decommissioning, of existing nuclear power plants with due regard to safety.
Performance Indicator
— Number of Member States applying proven engineering and management practices transferred by the Agency in support of their nuclear power plants.

Programme changes and trends: This subprogramme focuses mainly on integrated life cycle management of nuclear power plants, an area clearly distinct from, although intimately related to, supporting human and technical infrastructure now included in Subprogramme A.2. The activities of 2002–2003 which will be completed and phased out are: the development of guidance on instrumentation and control software with associated licensing requirements; improvement of the effectiveness of in-service inspection, configuration management, optimization of maintenance and outage management programmes, as correlated to performance targets;

and preparation of a document on issues related to delayed NPPs and resulting from early termination of NPP operations.

Activities on the evaluation of radiation damage to reactor pressure vessel and verification of WWER steam generator tube integrity will produce reports as planned and will be completed during the 2004–2005 cycle. The activities for 2004–2005 build upon the progress achieved in the previous biennium and the focus will be on management strategies for achieving continuous process improvement in operating NPPs for superior performance and an integrated approach to nuclear power plant life cycle management, including licence renewals and optimization of resources. Guidance documents will be developed on: effective management of instrumentation and control modernization projects, impact of modern technology on instrumentation and control systems, steam generator replacement, application to reactor pressure vessel integrity assessment of master curve testing; decisions on power uprates and economics of decommissioning. Databases such as the Power Reactor Information System (PRIS), Country Nuclear Power Profiles, Nuclear Economic Performance Information System (NEPIS), and NPP Life Management, will be further developed and maintained to support these activities in Member States. New databases to provide an electronic catalogue of training services within the nuclear industry and an international database on plant life extension costs will be developed.

Resource changes and trends: The proposed resources for Subprogramme A.1 amount to \$1 526 000 in 2004, reflecting an increase in the budget of \$99 000, or 6.9% compared with 2003, with a decrease of \$36 000 in 2005 from 2004. The increase results from strengthening activities in the area of continuous process improvement of NPP operating performance.

Financial resources (2003 prices)

A.1	2003	2004	2005
Reg. budg.	1 427 000	1 526 000	1 490 000

Project A.1.01: Continuous process improvement of NPP operating performance

Main outputs: The main outputs of this project will be: guidance documents on management of continuous process improvement in nuclear power plants, I&C software modernization; on-line calibration technology for longer instrument calibration intervals; and updated guidance on NPP outage management to reflect the new challenges.

Unfunded activities/means of implementation: Guidance on programming techniques for licensing digital I&C systems.

Duration: 2004–2005

Ranking: 1 ex aequo

Project A.1.02: Integrated NPP life cycle management including decommissioning

Main outputs: The main outputs of this project will be: guidance documents on specific aspects of reactor pressure vessel (RPV) integrity assessment, verification of WWER steam generator tube integrity, state-of-the-art methodologies for monitoring of the condition of NPP components, strategies for effective predictive maintenance, and economics of plant life extension.

Unfunded activities/means of implementation: Development of methodologies for quality assurance/quality management during decommissioning and of guidance on requirements for the management of liabilities arising from decommissioning.

Duration: 2004–2005

Ranking: 1 ex aequo

Recurrent Project A.1.03: Databases to support NPP performance and life cycle management and improving human performance, quality and technical infrastructure

Main outputs: This project will result in the following updated databases: Power Reactor Information System (PRIS) available on the Agency web page and on CD-ROM, Country Nuclear Power Profiles, and the Nuclear Economic Performance Information System (NEPIS). Annual publications on *Nuclear Power Reactors in the World* and *Operating Experience with NPPs in Member States* will be produced. An international database on NPP life management, databases on NPP concrete structure and on management of I&C modernization projects, as well as an e-catalogue of nuclear industry training services will also be available.

Ranking: 12 (priority 2)

Subprogramme A.2. Improving Quality Assurance, Technical Infrastructure and Human Performance

Rationale: The future of nuclear power will depend to a large extent on continually improving the economic competitiveness of current and new NPPs in the global market. Establishing and enhancing a sound, stable and adequate nuclear power infrastructure in interested Member States through sharing of internationally accepted proven practices is essential to improve standards in countries which operate, or consider the introduction of NPPs. The review of Agency standards on quality assurance and harmonization with those of the International Organization on Standardization (ISO) to reflect modern approaches and the integration of quality management programmes is recommended by Nuclear Safety Standards Committee (NUSSC). Co-operation with OECD/NEA will continue on the joint

study on projected costs of electricity production. There is concern in Member States about the availability of human resources with appropriate skills and knowledge to ensure good management of nuclear power plants. A more active collaboration between nuclear power utilities, nuclear research centres and educational institutions through the development of a network of national, regional and collaborating training centres is essential. The increasing requests from developing Member States related to the application of Agency guidance for the development of the necessary infrastructure for the application of nuclear power will be met through technical co-operation projects.

Objective: To enhance Member State capabilities for planning, implementation and/or expansion of nuclear power programmes, improving human performance and strengthening quality and technical infrastructure by utilizing proven engineering and management practices developed and transferred by the Agency.

Outcome
— Increased use by interested Member States of proven engineering and management practices developed and transferred by the Agency for improving human performance, quality and technical infrastructure.
Performance Indicator
— Number of specialists in Member States trained under regular and technical co-operation programmes using Agency guidance on proven engineering and management practices for improving human performance, quality and technical infrastructure.

Programme changes and trends: This subprogramme focuses mainly on technical infrastructure for NPPs, quality assurance and human performance, an area distinct from, although intimately related to, Subprogramme A.1. Activities of 2002–2003 related to the establishment of a training infrastructure to enable training and qualification of nuclear power personnel using the Systematic Approach to Training (SAT) methodology, the use of control room simulators for training NPP personnel, and the preparation of a document to identify measures to overcome weakened infrastructure caused by transformation to market economies in the countries in transition will be completed and phased out. Activities in 2002–2003 regarding the comparison of Agency QA standards with those of ISO, and the development of an action plan for the harmonization of the Agency and ISO standards for QA and quality management, will be completed and will lead to the inclusion in 2004–2005 of activities to implement the action plan. Other areas of focus during 2002–2003, including identification of the factors affected by the changing electric supply markets, and on developing guidance on an integrated approach to nuclear power planning,

will be completed as planned. The activities for 2004–2005 build upon the progress achieved in the previous biennium and, in addition to the items already mentioned, will include: review of the QA standards; information and communication management; contract and procurement management; infrastructure development for countries which do not have existing nuclear programmes; co-operation in the use of regional infrastructure; human resource development; and proven practices and methods employed in successful nuclear power operating organizations for the integration of all aspects that have an impact on human performance. An international conference on “Fifty years of nuclear electricity — the next fifty years?” will be organized in 2004 to review the lessons learned from fifty years of nuclear electricity generation and how to apply these to future nuclear power programmes.

Resource changes and trends: The proposed resources for Subprogramme A.2 amount to \$1 201 000 in 2004, reflecting a decrease in the budget of \$49 000, or 3.9% compared with 2003. The decrease in 2004 results from a reduction of funds for some activities in the areas of strengthening national and regional nuclear power infrastructures and effective training to achieve excellence in the performance of NPP personnel. There is an increase of \$36 000, or 3% in 2005 compared with 2004 resulting from the restoration of the decrease in the area of effective training to achieve excellence in the performance of NPP personnel.

Financial resources (2003 prices)

A.2	2003	2004	2005
Reg. budg.	1 250 000	1 201 000	1 237 000

Project A.2.01: Strengthening and harmonization of NPP quality assurance/quality management principles

Main outputs: The main outputs of this project will be reviewed quality assurance standards in IAEA Safety Series 50-C/SG-Q; IAEA standards and guides harmonized with ISO standards; updated Agency guidance on quality management for nuclear power plant operation and regulatory inspection of the implementation of QA programmes; integrated and consolidated QA/QM documents; and trained personnel in the field.

Unfunded activities/means of implementation: Documentation of experience in the implementation of Agency QA standards and their effectiveness.

Duration: 2004–2005

Ranking: 1 ex aequo

Project A.2.02: Strengthening national and regional nuclear power infrastructures

Main outputs: The main outputs of this project will be: guidance documents on various aspects of integrated planning and development of nuclear

power programmes, socioeconomic and environmental implications of continued NPP operation or early decommissioning, infrastructure requirements for introducing innovative nuclear power plants, and regional sharing of infrastructure facilities. There will be a joint study (with OECD/NEA) on projected costs of electricity generation. The project will also produce revised and updated Agency guidebooks on the above areas taking into account the changing environment in the power supply sector.

Unfunded activities/means of implementation: Information exchange on, and I&C contribution to, issues related to delayed NPPs; guidance on feasibility studies, and on contract and procurement project management activities, for new NPP projects, the conference on fifty years of nuclear power, intended to provide historical perspectives on benefits from nuclear energy use and possible future applications, is partially unfunded. The organization of a high level conference on nuclear power in the 21st century to consider issues at a strategic level and the measures needed to carry forward the positive momentum witnessed by nuclear power in recent years, is unfunded.

Duration: 2004–2007

Ranking: 1 ex aequo

Project A.2.03: Effective training to achieve excellence in the performance of NPP personnel

Main outputs: The main outputs of this project will be guidance on proven practices and methodologies including the following: systems and processes to maintain high standards of personnel performance, improvement of inspection methodologies, self assessment and external assessment, training standards, managing an ageing workforce, core competencies, nuclear knowledge management and outsourcing without compromising safety.

Unfunded activities/means of implementation: CRP on development of guidelines for the evaluation of NPP training activities and use of training performance indicators.

Duration: 2004–2005

Ranking: 1 ex aequo

Subprogramme A.3. Co-ordination of International Collaboration for the Development of Innovative Nuclear Technologies

Rationale: The long term outlook for nuclear energy should be considered in the broader perspective of future energy needs and environmental impacts. In order for nuclear energy to play a meaningful role in the global energy supply in the foreseeable future, innovative approaches will be required to address concerns about economic competitiveness, safety,

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waste and potential proliferation risks. Work on evolutionary and innovative approaches to nuclear reactor design and fuel cycle concepts is, therefore, proceeding in several Member States.

The General Conference in 2000 invited “all interested Member States to combine their efforts under the aegis of the Agency in considering the issues of the nuclear fuel cycle, in particular by examining innovative and proliferation-resistant nuclear technology” [GC(44)/RES/21 and GC(44)/RES/22]. The International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) was launched in 2001 as an extrabudgetary activity in response to that invitation and is implemented by cost free experts and the Agency staff under the guidance of a Steering Committee. INPRO is concentrating on the establishment of user requirements and has no overlap with other international efforts in innovative technologies.

First progress of INPRO was reported at the General Conference in 2001, which adopted a resolution on “Agency Activities in the Development of Innovative Nuclear Technology” [GC(45)/RES/12, Tab F], recognizing the unique role that the Agency can play in international collaboration in the nuclear field. It invited the interested Member States to contribute to innovative nuclear technology activities at the Agency and the Agency to continue its efforts in these areas. These statements were further affirmed through resolution GC(46)/RES/11C. UN General Assembly resolution A/RES/56/94 of 2001 also emphasizes the unique role that the Agency can play in developing user requirements and in addressing safeguards, safety and environmental questions for innovative reactors and their fuel cycles and stresses the need for international collaboration in the development of innovative nuclear technology.

Most activities in the subprogramme, including activities in support of INPRO, address small and medium sized reactors (SMRs), reflecting their particular importance to the developing countries.

Objective: To increase the capability of Member States to develop innovative nuclear reactor and fuel cycle technologies through the establishment of one (or more) international collaborative projects under the umbrella of the Agency.

Outcomes
— Increased participation of Member States in the development of innovative nuclear technologies for reactors and fuel cycles.
— Agreement reached by Member States on one (or more) international collaborative R&D projects.

Performance Indicators
— Number of Member States co-operating in innovative nuclear technology development.
— Number of Member States participating in INPRO.

Programme changes and trends: The previous Subprogramme A.2 (2002–2003) has been extended into Subprogrammes A.3 and A.4 in 2004–2005. Subprogramme A.3 involves activities related to the development of innovative nuclear technologies maturing up to 50 years in the future. Included is the establishment of one or more major international collaborative projects on reactor technologies selected on the basis of the basic principles, user requirements and criteria for future reactors and fuel cycles. Subprogramme A.4 involves activities identified by representatives of Member States as useful for advanced reactor systems. Included are technology developments for improving costs while meeting stringent safety objectives. The activities address the present and the future, and, at the far end of the spectrum, consider innovative aspects. The present focus of INPRO is on the development of user requirements on the demand side for the next five decades (Phase IA), covering both electricity production and non-electrical applications. In 2003, the focus will shift to the identification of preferences in Member States for specific technologies and the examination of those concepts against user requirements using the criteria and methodology developed in the frame of Phase IA (Phase IB of INPRO).

INPRO is expected to continue in 2004–2005 and beyond and will be covered under Subprogramme A.3. INPRO members may start to direct their efforts towards the initiation of international collaborative R&D activities, possibly comprising more than one technology. Activities in support of the co-ordination of such an international collaboration will be carried out under A3.02. In the timeframe particularly beyond 2004–2005, co-operation with other international initiatives will have to be taken into account, and A.3 may host a secretariat for an international collaborative project.

Resource changes and trends: The proposed resources for Subprogramme A.3 amount to \$508 000 in 2004, reflecting an increase in the budget of \$150 000, or 41.9% compared with 2003. There is a further increase of \$51 000 in 2005 compared with 2004. These increases are due to the high interest of Member States in innovative technologies and the need for international co-ordination of related research and development programmes. Most activities in this subprogramme depend on the availability of extrabudgetary funds.

Financial resources (2003 prices)

A.3	2003	2004	2005
Reg. budg.	358 000	508 000	559 000

Recurrent Project A.3.01: Co-ordination of Agency activities for innovative nuclear technologies

Main outputs: The project will result in technical documents on initial results.

Unfunded activities/means of implementation: The CRPs included in this project are unfunded.

Ranking: 1 ex aequo

Recurrent Project A.3.02: Co-ordination of international collaborative R&D for innovative nuclear technologies

Main outputs: This project will produce TECDOCs on the status of SMR designs as well as on progress and results achieved in international collaborative projects.

Unfunded activities/means of implementation: The following activities are partially unfunded: definition of plant safety design options to cope with external events; and review and demonstration of passive design options for SMRs. All other activities in this project are unfunded.

Ranking: 1 ex aequo

Subprogramme A.4. Technology Developments and Applications for Advanced Reactors

Rationale: The future utilization of nuclear power by interested Member States depends primarily on the ability of designers and operators to further improve the competitiveness of NPPs while meeting increasingly stringent safety requirements. The global increase in energy demand, the trend toward deregulated electricity markets and increasingly competitive natural gas mean that nuclear power plants must be built in shorter times at lower capital costs and with simpler and more reliable operation. Sustainability goals require improvements in nuclear fuel utilization and further studies on actinide and long lived fission product transmutation. Member States can benefit from sharing information and knowledge on technology development while developing countries interested in using nuclear energy for electricity generation and non-electric applications (especially seawater desalination) need balanced and objective information on advanced nuclear technologies.

The Agency is the only international organization that can provide a global forum for information exchange and co-operative research, involving both

developing and industrialized Member States. It maintains updated information about advanced reactor technology developments and their applications. This subprogramme brings together high level experts to mobilize R&D resources from national organizations towards common goals. The global forum is provided through an existing structure of Technical Working Groups (TWGs) on major reactor lines and on nuclear desalination. The activities in this subprogramme are planned and implemented under the guidance of these groups.

Objective: To increase the capability of Member States to develop and introduce advanced nuclear technologies in the generation of new nuclear power plants for electricity production, waste incineration, actinide utilization and transmutation, and non-electrical applications.

Outcomes
<ul style="list-style-type: none"> — Technology advances in various reactor lines in Member States resulting in improved NPP economics and safety. — Increased use by Member States of information provided through the Agency for development and applications of advanced reactors.
Performance Indicators
<ul style="list-style-type: none"> — Extent to which Member States develop and implement advanced reactor technology for improved economics and safety of nuclear power plants. — Extent to which Member States use Agency provided information and expertise for development and application of advanced reactor programmes.

Programme changes and trends: The projects in previous Subprogramme A.2 (2002–2003) on technology developments and applications for advanced reactors are being regrouped in this new Subprogramme A.4. In the light of the General Conference resolution on nuclear desalination, emphasis continues to be given to this project. On the basis of completed generic studies, its focus is being shifted to country specific projects (CRPs and technical co-operation projects).

Resource changes and trends: The proposed resources for Subprogramme A.4 for 2004–2005 remain unchanged compared with 2003. One major CRP on desalination deals with the coupling of desalination processes with high temperature gas cooled reactors and it has therefore been partly reflected in project A.4.03. Many activities in this subprogramme depend on the availability of extrabudgetary funds.

Financial resources (2003 prices)

A.4	2003	2004	2005
Reg. budg.	1 721 000	1 721 000	1 720 000

Project A.4.01: Technology advances in water cooled reactors for improvements in economics and safety

Main outputs: The project will produce the following documents: status report on advanced LWR designs; a draft document on advanced applications of water cooled NPPs; TECDOC on intercomparison of techniques for pressure tube inspection and diagnostics; TRS report on “Advances in HWR Designs and Technologies”; technical document on “Advances in HWR Plant Management and Licence Extension”, working material reports of TWG meetings presenting advances in national programmes and expressed interests in common areas for collaboration; and a document on natural circulation phenomena, modelling and reliability of passive safety systems based on natural circulation. It will also result in distribution of software for PC based reactor simulators for educational purposes as well as trained personnel from developing countries.

Unfunded activities/means of implementation: Documentation of strategies and technical approaches for the reduction of capital costs, including recent construction and start up experience of evolutionary water cooled reactors; and a report on simulation results for abnormal transients in medium sized HWRs.

Duration: 2002–2005

Ranking: 1 ex aequo

Recurrent Project A.4.02: Technology advances in fast reactors and accelerator driven systems (ADS)

Main outputs: The main outputs of the project will be: updated databases related to information on fast reactors and ADS; TECDOCs on progress and results achieved in fast reactor and ADS development and on comparative assessment of nuclear systems for transmutation of waste; and reports on options for incineration of radioactive waste and on ADS related neutronics.

Unfunded activities/means of implementation: Handling of sodium from shutdown or decommissioned nuclear facilities, and CRPs on:

operational experience with fast reactor systems, calculational uncertainty of LMFR reactivity effects, and unified methodology of thorium fuel in emerging nuclear systems.

Ranking: 1 ex aequo

Project A.4.03: Technology advances for gas cooled reactors (GCR)

Main outputs: TECDOCs will be published reporting results: on core physics and thermal hydraulic code validation against experimental data; on graphite behaviour under conditions of high temperature and high fluence; and on fuel technology development. An up-to-date online knowledge base on HTGR technology will also be made available.

Unfunded activities/means of implementation: TECDOC on emerging HTGR plants and applications; CRP on “Prospects of potable water co-generation with HTGRs”; development of an HTGR simulator.

Duration: 2002–2006

Ranking: 1 ex aequo

Project A.4.04: Support for demonstration of nuclear seawater desalination

Main outputs: The project will result in: technical documents on the status of and results achieved in nuclear desalination; improved software for economic assessment of desalination systems; information on non-electrical applications via the Power Reactor Information System (PRIS), and a CRP on “Prospects of potable water co-generation with HTGRs”.

Unfunded activities/means of implementation: Assistance to and training for Member States for DEEP (Desalination Economic Evaluation Programme).

Duration: 2002–2007

Ranking: 1 ex aequo