

# KYT 2010 Review Report

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2/2008



TYÖ- JA ELINKEINOMINISTERIÖ  
ARBETS- OCH NÄRINGSMINISTERIET  
MINISTRY OF EMPLOYMENT AND THE ECONOMY

Michael Apted – Tönis Papp – Rainer Salomaa

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MINISTRY OF EMPLOYMENT AND THE ECONOMY

Aleksanterinkatu 4  
FIN-00170 Helsinki  
FINLAND

P.O. Box 32  
FIN-00023 GOVERNMENT  
Helsinki FINLAND

Tel. +358 10 606 000  
Telefax +358 9 1606 2166

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Authors		Date	
Michael Apted, Monitor Scientific LLC, United States Tönis Papp, RWS Consulting, Sweden Rainer Salomaa, Helsinki University of Technology, Finland		February 2008	
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Title			
KYT2010 Review Report			
Abstract			
<p>Public Nuclear Waste Management Program KYT2010 is a research program which is organised according to the Nuclear Energy Act for the period 2006–2010. The research programme is directed by a Steering Group, appointed by the Ministry of Trade and Industry. The Steering Group coordinates the program administration and general trends in research. A Support Group functions as reinforcement for the Steering Group.</p> <p>The KYT2010 research program was established to ensure that the authorities have such sufficient and comprehensive nuclear engineering expertise and other facilities at their disposal that are needed for comparisons of the various ways and methods of carrying out nuclear waste management. The research themes are divided in three areas: strategic studies of nuclear waste management, long-term safety of disposal of spent nuclear fuel, sociological studies.</p> <p>The Ministry of Trade and Industry decided to evaluate the scientific output of the Finnish Nuclear Waste Management Programme KYT in 2007 and asked a panel of three members to carry out the task. The evaluation was based on material supplied by the Ministry and interviews of relevant stakeholders. Those interviewed were members of the Steering Group or of the Support Group or representatives of research projects or financiers. The interviews were carried out 29.10.–2.11.2007.</p> <p>According to the Evaluation Panel, the achieved results are in balance with the funding in general, the expertise covers the field and the programme is balanced to different fields in nuclear waste management. As far as the reorganization of the funding is concerned in general, the research program is in balance but maintaining the balance might require broadening of integration and interaction. In addition to these general remarks, the Evaluation Panel makes several comments and recommendations.</p> <p>Contact person within the Ministry of Employment and the Economy: Finance: Energy Department/ Jaana Avolahti, tel. +358 9 010 606 4836</p>			
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# Table of Contents

<b>Acknowledgments</b> . . . . .	5
<b>Table of Contents</b> . . . . .	6
<b>Introduction</b> . . . . .	9
Background . . . . .	9
Methodology . . . . .	10
Outline of Report . . . . .	10
<b>Results</b> . . . . .	11
General Conclusions . . . . .	11
Response to MTI Questions . . . . .	12
Are the achieved results in balance with the funding? . . . . .	12
How well does the expertise cover the field? Is the entire KYT programme balanced to different fields in nuclear waste management? . . . . .	13
Has the 2004 reorganization of the funding been successful? . . . . .	14
<b>Observations and Recommendation</b> . . . . .	16
Research Neutrality . . . . .	16
Comparison of Options . . . . .	16
National Plan for Education on Nuclear Waste Management . . . . .	17
Safety Assessment Methods . . . . .	19
Building on KYT Success . . . . .	21
New Centres of Excellence . . . . .	22
Integrated R&D . . . . .	23
<b>Appendix A</b> Terms of Reference provided to the Evaluation Panel . . . . .	24
<b>Appendix B</b> List of reference documents provided to the Evaluation Panel . . . . .	25
<b>Appendix C</b> Persons interviewed by the Evaluation Panel . . . . .	26





# Introduction

## Background

The Nuclear Energy Law of Finland stipulates that the nuclear waste produced in Finland must be handled and disposed of in Finland, and that the producers of the waste are responsible for their safe handling, management and disposal. This responsibility includes the needed R&D and all costs arising from that mission. The task for planning and implementation of the facilities required for this, including the needed R&D, is given to Posiva Oy a company jointly owned by Teollisuuden Voima Oy and Fortum Power and Heat Oy.

The Ministry of Trade and Industry (MTI) has the overall leadership and control in nuclear energy matters in Finland and the Radiation and Nuclear Safety Authority, STUK, is the regulatory body. STUK has also the responsibility to carry out all the R&D needed for their regulatory decisions.

Beside the research activities of Posiva and STUK, there has also been Finnish publicly financed and administrated research programmes in nuclear waste management. The first one of such a series of R&D programmes, JYT took place in 1989-1993 and it was followed by JYT2 in 1994–1996. The International Atomic Energy Agency set up a team of four experts to review the overall Finnish nuclear waste management programme within the auspices of International Atomic Energy Agency's (IAEA's) Waste Assessment and Review Programme (WATRP). This evaluation was conducted in 1993 and as a part of that review, JYT activities were also considered. As another important milestone, MTI put in 1996 an independent Ad Hoc Group to plan the continuation of the two previous JYT programmes and, in particular, to discuss the programmatic needs to support authorities. As a result, first the JYT2001 (1996–2001) programme was established, and thereafter KYT 2002–2005 and its present successor KYT 2010, launched in 2006 and running until the end of 2010, were implemented.

The objectives and mechanism for funding of the nuclear research was revised in the Nuclear Energy Law amendment in 2004. In the nuclear waste management area, the law defined the aim of the public research as “ensuring that the authorities have such sufficient and comprehensive nuclear engineering and other readiness at their disposal as needed for comparisons of the different ways and means of implementing nuclear waste management”. As a consequence the National Nuclear Waste Management Research Programme, KYT, was redefined and a framework programme for the research period 2006–2010 was published as “KYT 2010, Public Nuclear Waste Management Programme in Finland”.

In the summer 2007 the MTI decided to evaluate the first two years of the KYT 2010 programme. Besides the WATRP review, the publicly administrated waste disposal programmes have not been externally.

## **Methodology**

The Ministry of Trade and Industry (MTI) nominated and constituted an Evaluation Panel to provide a formal review of the KYT 2010 programme, in accordance with the Terms of Reference cited in Appendix A of this report. The Evaluation Panel was provided background documents on the KYT 2010 Programme via CD prior to the formal review. These documents are listed in Appendix B. The field mission of the review was conducted the week of October 29th to November 2nd, 2007 at the MTI and STUK offices in Helsinki.

Individual interviews were organized by Jaana Avolahti of MTI, including representatives of the MTI, members of the KYT Steering Group (“Steering Group”), members of the KYT Support Group (‘Support Group’) and technical leaders of KYT research projects. The interviews were conducted in 30- to 60-minute meetings in which the interviewees were invited to present their own information and insights on the KYT programme, followed by a question-and- answer dialogue with the Evaluation Panel. A complete listing of interviewees is given in Appendix C.

It is important to stress that these interviews focused on organizational, operational, and achievement aspects for the current KYT 2010 projects, as instructed in the Terms of Reference from MTI (Appendix A); there was no detailed, technical review of the merits or specific results of KYT 2010 research projects.

## **Outline of Report**

This summary report of the findings of the KYT 2010 Evaluation Panel is divided into the following sections:

- General Conclusions
- Responses to MTI Questions
- Observations and Recommendations

The observations and recommendations may be viewed at going beyond the exact conditions of the Terms of Reference for the Evaluation Panel, however, the evident success of the current KYT 2010 programme presented possible opportunities that did not seem prudent to ignore.

# Results

## General Conclusions

When looking at the aims and objectives given by the legislation for projects supported by KYT 2010, and at the practical guidance provided by the KYT Steering Group, a number of competing aims and objectives can be found.

To achieve the overriding goal – to provide unbiased and appropriate capacity for future evaluations of the acceptability of the Finnish waste management when compared to other possible and realistic waste management approaches – the KYT-programme must be based on a suitable balance between these potentially conflicting ambitions. The Evaluation Panel is aware of the difficulties involved in such a procedure, and the need for recurrent revisions as the Finnish waste management programme advances and new external circumstances might develop.

As a general conclusion, the Evaluation Panel has found that the KYT 2010 Programme, as implemented and guided by the Steering and Support Groups, provides a reasonably balanced programme in areas supporting in a generic way the current Finnish nuclear waste management programme, the development and preservation of new competence, and possible alternative options.

Some of the competing constraints, such as

- the wish to address only areas of importance for the waste management vs. the need to keep away from the R&D focused to the ongoing implementation and licensing, and
- the need for basic educational efforts vs. the requirement for only supporting research of high scientific standard

as well as possible operational definitions of competence centres and optional alternatives in waste management, will be discussed in the section Observations and Recommendations.

## Response to MTI Questions

*Are the achieved results in balance with the funding?*

The Evaluation Panel has looked at how the various activities of the KYT 2010 programme support the basic needs to be able to provide unbiased and appropriate capacity for future evaluations of the acceptability of the Finnish waste management and concluded that the achieved results are in reasonable balance with the aims expressed in the law that established the fund.

The achievements regarded as most important include:

- Preserving / enhancing existing competence in key technical areas. Reasonably substantial support has been given for the completion of PhD and MS degree holders.
- Development of important technical areas and capabilities. Many activities have been directly focused on bringing in techniques for measurement and characterization into the Finnish waste management, e.g., rock stress characterisation by acoustic emissions, molecular biological methods for evaluating microbial activity in the bedrock, advanced methods for measurement of deformation mechanisms in copper.
- Maintaining awareness of alternative fuel cycles/waste management options. The continuity in the monitoring of the international development on partitioning and transmutation (P&T) is important for keeping a minimum level of know-how in this area. The awareness of potential and realistic alternatives within the system presently under development in Finland will be further discussed in the section Comparisons of Options.
- Maintaining a high scientific standard and quality control in the funded activities. Although it is difficult to discuss the quality of an educational process in terms of scientific quality, the fact that dissertations have been supported and degrees have been given is encouraging, as is the fact that numerous articles presenting KYT-supported research have been published in peer reviewed periodicals. Quality assurance procedures, similar to those used in the SAFIR programme to assure full and proper acknowledgment of KYT funding and oversight, also could be applied.

Since this review was conducted at an early state of the KYT 2010 programme, and since many approved projects have had a duration of many years the Evaluation

Panel has also used the documentation in the final report of the 2002–2005 period when forming the above conclusions. The Evaluation Panel finds the continuity and stability created by having the opportunity to continue projects over many years important, especially in the educational process. See further discussion in the National Plan/Education section.

*How well does the expertise cover the field? Is the entire KYT programme balanced to different fields in nuclear waste management?*

The Evaluation Panel regards the KYT programme, as illustrated by the list of projects approved for 2007, as reasonably well balanced when also taking into account the earlier KYT 2002-2005 projects. It is neither possible nor wise to try to cover all different fields when taking into account that the KYT funding is limited, and that not all fields are of high significance with respect to KYT objectives and its mandate.

Thus, the KYT-programme has given a good coverage of the

- areas that are important for the needed competence,
- areas that are of high safety importance,
- emerging areas relevant to waste management, and
- development in alternative options to direct geological disposal of spent nuclear fuel.

The Evaluation Panel has seen a change in balance from the focus on far field studies earlier to the present focus on near field studies for 2007. Such changes are a natural consequence of changing emphasis as the Finnish programme evolves and matures, and are also expected to take place in the future.

The low involvement on social issues is noted with regard to the role of the KYT programme as a funding source supplementing the goal-oriented funds of Posiva and STUK. The possibility of addressing social issues within the KYT programme might deserve a greater emphasis in calls for proposals as the time for the application for a construction license is approaching. See further discussion in the Comparisons of Options section.

To provide a good transparency in how the selection of important areas for build-up and preservation of competence, the Steering Group should consider compiling an action plan with an overview of the competence situation in Finland today and for the coming 10-year period. Due regard should be given to expected retirements both in the groups directly involved with the Finnish waste management programme and in relevant departments of Universities and Research Institutes.

*Has the 2004 reorganization of the funding been successful?*

The amount of funding of the publicly administrated nuclear waste research has evolved since its beginning rather predictably, but the change of the nuclear law in 2004 has consolidated the continuous allocation of resources. The maximum amount of funding for KYT equals 0.08% of the annually determined liability of the nuclear waste. The money is collected by the utilities in contrast to the previous annual government budget. After the amendment of the law the organisation of the research programme was refocused to emphasize the main objectives expressed in the law. Earlier programmes had rather large steering groups consisting of all stakeholders and representatives from the research institutes involved. Presently the Steering Group makes the strategic decisions and gives its final recommendations for the suggested project proposals after the scientific and technical evaluation done by the Support Group. The final decisions are made by MTI after considering the comments by STUK and by the Advisory Committee on Nuclear Energy.

It is clear that the continuity of the funding has had a positive stabilizing effect, in particular in regard to the long-term commitment of the activities involved in nuclear waste management. Individual projects are funded on an annual basis, but in principle the Steering Group can provisionally reserve resources for projects lasting longer than one year. The rule of the “0.08%-liability” takes into account inflation, but otherwise the rather fixed funding level is rigid and may be an inflexible constraint if an even higher national level of ambition (see later sections of this report) and matching R&D opportunities evolved for the future KYT programme. For launching of future KYT projects and initiatives, and in particular of new areas, the resources generated by the “0.08% liability” might be insufficient. It is not obligatory to use all the allocated KYT money, but in practice all the funding is already earmarked in the beginning of the year and only seldom not fully used during the year. Some small financial administrative difficulties have been encountered, as for instance the de minimis rule and the value added tax of the co-ordination, but these problems have been tolerable.

The new programme organisation consists of a Steering Group with members from STUK, Posiva, TVO and Fortum, the National Technology Agency of Finland (Tekes) and MTI. The Steering Group oversees the planning of the research programme and monitors the quality of the research results.

The Support Group has five members from STUK and four members from industry, Posiva, Fortum Nuclear Services, TVO, and Saanio and Riekkola. The Support Group makes a detailed assessment of the project proposals and monitors the advancement of the projects.

Neither the Steering Group nor the Support Group includes researchers involved in the programme. This situation ensures neutrality of the project proposals, but makes a challenge to obtain sufficient technical expertise to review proposed projects – especially because of the widely multidisciplinary areas that have to be discussed. As a comparison the Finnish Nuclear Safety Research Programme, SAFIR2010, has eight support groups for rather distinct research areas (from reactor physics and thermal dynamics to organisational issues) and in each group the research institute representatives are also present.

Before KYT 2010, the co-ordinators came from VTT and they were senior experts in the nuclear waste issues. Final reports were professionally done and obviously the co-ordinators made large contributions to the reporting. The present co-ordinator was chosen in competitive bidding and his role is for the moment mainly administrative. As suggested later in this review report, the KYT Steering Group could take a more active role to discuss and guide integration of the diverse individual KYT projects, as well as to promote a wide dissemination of results.

As regards the networking of the researchers and stakeholders and administrative bodies, the present KYT organization is still regarded as an administrative tool for funding and reporting. The possibility of more interaction with the various partners, both within and outside of Finland's nuclear energy industry, is discussed in a later section of this review report. In general, the present KYT organization has achieved a balanced programme satisfying the customer needs, although the suggested broadening of integration and interaction with other Finnish partners could aid in maintaining this balance.



# Observations and Recommendations

## *Research Neutrality*

The research conducted under KYT 2010 should be ‘neutral’ in the sense that issues directly related to, or contributing toward, licensing of a deep geological repository are to be excluded. At the same time, KYT research is to emphasize topics of national importance. These two objectives are obviously met by KYT projects addressing options outside of direct geological disposal (e.g., partitioning and transmutation, uranium mining). The Evaluation Panel felt it was important, in addition, to affirm that the scope of other KYT repository-oriented projects also conform to these two objectives. The key goal of the KYT 2010 is to finance research and training ensuring that the authorities have sufficient and comprehensive knowledge on topics relevant to all aspects of nuclear waste management. Based on our review of the KYT programme, we find that this goal has been well met by the KYT Steering Group, who have implemented a reasonable approach for interpreting proposals that honors the intent of ‘neutrality’, while achieving relevance and usefulness for all nuclear stakeholders in Finland.

## *Comparison of Options*

The Finnish law gives the aim of the KYT fund as “to provide unbiased and appropriate capacity for future evaluations of the acceptability of the Finnish waste management when compared to other possible and realistic waste management approaches.” This need for appropriate capacity is further elaborated in the Framework Programme that defines areas where technical competence and manpower should be developed.

As a consequence, the KYT programme, besides following international developments of partitioning and transmutation, is mainly oriented towards basic competence in areas of high importance to waste management without being directly related to a specific design or licensing issue in the Finnish programme today. No current KYT studies have been focused on the question, “What (if any) are the realistic options or alternatives to the Finnish system today?” There is a risk that the role of the KYT fund will evolve into a minor extra funding source for basic nuclear waste management competence in addition to the bigger research programmes funded by Posiva/STUK and by basic Finnish support to their universities and technical institutions.

The Evaluation Panel is aware of the difficulties to define realistic high-level options and alternatives to waste management beside those focused on international-

ly (e.g., P&T, reprocessing, advanced fuel cycles, etc.). This is especially true when the KBS-3 type repository concept developed for the geologic environment existing in Fennoscandia has been studied for many decades, in many countries. Obviously the realistic options within the basic approach at this stage – deep disposal in a geological repository – are of more limited nature, consisting mainly of different materials used in barriers, different designs, different fabrication or emplacement methods, etc. Retrievability is also an issue worth deeper scientific scrutiny.

The Evaluation Panel observes that many of these lower-level options will be closed in Finland around 2012 when an application for a repository construction license will be submitted by Posiva and reviewed at STUK. We also recognise the fact the acceptance of a design also involves an understanding that an obviously better or more suitable concept for constructing the repository is not available. Such alternative concepts are sometimes strongly coupled to the actual selection of design parameters, and thereby naturally belonging to the Posiva and STUK responsibilities

Optimisation of Posiva's repository concept, however, can be expected over the many decades envisioned for construction and waste emplacement of a repository, arising from new developments in basic science and engineering. Assuming that such optimisation of present repository concepts is acknowledged as likely by the KYT Steering Group, it would be useful for the Steering Group to explicitly identify various realistic options (hence, potential research areas) that exist in relation to future stages of implementation the Finnish programme. This would aid in maintain and highlight the neutrality of the KYT programme and direct it to areas where new developments might require re-evaluation of initial concepts, or where new methods and techniques could be utilized.

### *National Plan for Education on Nuclear Waste Management*

According to the Finnish nuclear law, the operators are obliged to participate in financing of research aimed at ensuring that the authorities have such sufficient and comprehensive nuclear engineering expertise and other readiness at their disposal as needed for comparisons of their different ways and means of implementing nuclear waste management. As new experts are needed to replace retiring experts, a clear objective of the programme is to train new professionals for the nuclear waste management field. In this regard, KYT serves, in part, the educational needs for both authorities directly and Posiva and other nuclear stakeholder indirectly.

Action plan for education and training: The need of new professionals has to be identified and an action plan to satisfy these needs should be made. In KYT the Steering Group ought to take the lead in developing such an action plan as the basis

for a longer-range, goal-oriented training and education programme for waste management. Some recommendations and selected ideas to be included in such an action plan are presented throughout this report. The resources needed to materialize these activities are not specifically addressed.

**A national waste management seminar:** In the KYT programme, young researchers with different backgrounds and educational degrees participate in scattered locations. The annual KYT research seminar gives KYT participants an overview of the activities. A more in-depth introductory seminar on waste management, however, would be useful to help put the diverse KYT projects into a broader, integrated perspective with respect to nuclear waste management. Such a seminar could describe the central research issues of various subfields and to comprehend the time-scales and relative importance of the entity. Some ingredients of such seminar material can be found from the National Safety Course YK, and also from the rather comprehensive training course currently conducted by Posiva for its new staff. In the five subsequent YK courses, lasting 5–6 weeks, more than 50 students in each have been trained. A basic seminar on nuclear waste management does not need such a large enrolment and time commitment, and a seminar with a critical mass of KYT participants might be organised every other year, for example.

**International opportunities:** Within KYT, more detailed issues could be discussed by seminars or topical lecture courses whenever enough networking between the universities can be found and a critical mass of students can be assembled. Numerous courses related to EU projects on nuclear and radiation safety and waste are organised as summer schools, and generally European students may take part in these at a reasonable fee. The courses have quality assurance and can be accepted as the student's academic requirements. To mention some the EU co-ordination actions, CETRAD, ESDRED, and ENEN-II, are directly related to geological waste disposal, while EUROTRANS and ACTINET-6 both have key goals for training an education etc., and similarly for the technology platform CARD. Information about the EU opportunities and matching to KYT research interests is required, and some travel money would need to be allocated to participate in the courses.

An international (summer) course held in Finland on selected key research topics is an interesting possibility. The country can offer excellent lecture facilities, travel attractions, and an outstanding marketing niche due to the highly interesting and relevant Finnish nuclear projects. The organisational planning and resources are, of course, an issue, but on the other hand this would offer visibility of the KYT and overall Finnish programme, promote broader networking between KYT and international colleagues, and provide a challenging training experience, too.

With respect to individual training opportunities, the education of individual research students is, of course, the responsibility of the university, but some co-or-

dination and assistance could be obtained from KYT. When the goal is to educate a professional in the field, an individual study plan of the students activities within KYT should be done and discussed together with the student, the supervisor and a mentor from the Support Group. In KYT projects, resources should be reserved to finalise the results in an archival journal paper that is also part of the student's thesis. Currently, many of the projects produce a technical report or a conference abstract. To raise the visibility and impact of KYT studies, a study plan could also include participation in a national seminar as mentioned above, as well as consideration of international opportunities as well.

The short-term funding of KYT students is an obstacle that is further emphasized by the considerably better salaries paid by the private sector. A longer several year commitment, say, might remedy the situation. Another possibility is to consider co-training, where the student starts in an academic research laboratory and closer to graduation moves to a new unit, such as an industry or research institute, for example. This assumes that both workplaces would allow for integration of the research project and the student is able to finish such co-funded studies to the satisfaction of all funding sources.

In conclusion, in KYT programme the training and education activities can further be enhanced and more systematically co-ordinated. There are many possibilities and flexible alternative available that usually do not require excessive new resources.

### *Safety Assessment Methods*

Both in the MTI letter regarding the acceptance procedure for project proposals and in the Framework Programme for the KYT-2010, safety assessments and performance assessment (SA/PA) are recognized as a pivotal area for the KYT research. Many projects in the present KYT 2010 programme, and earlier, have been addressing safety related processes taking place in various barriers and their role in the total repository safety. As long as they focus on critical safety issues and basic know-how, the Evaluation Panel finds them well within the mandate of the KYT programme. But the reviewers have found few activities that have addressed the key topic of Safety or Performance Assessment Methodology, as such. This is viewed as a missed opportunity in the current KYT, and that MTI and the Steering and Support Groups should explore means of soliciting future proposals in the SA/PA area.

In fact the methods for evaluating long-term safety of a repository system in its natural geologic setting are essential for the general understanding of the safety issues in nuclear waste management. They also constitute necessary tools for evaluating the acceptability of potential new nuclear fuel-cycles, as well as for compa-

ring existing ideas for disposal with possible alternative designs for repository systems or the barriers involved. Although many of the techniques used are standard procedures in risk and safety assessments of large technical systems (e.g. modeling of various process, probability assessments, methods for uncertainty/sensitivity analysis, etc), there are also methods that has been specifically developed for the long-term evaluation of deep geologic disposal of high level radioactive waste. These include, for example, the development of bounding scenarios for addressing effects from processes that are too complicated to model, the characterization of natural features that can only be statistically described, and evaluating the consequences of natural events that only can be modeled in stochastic terms today. And there is also the need to compare potential releases and their consequences with existing regulations taking due account of the timescales and their impact on humans and the environment.

During the last decades there has been an increased interest in utilizing this assessment methodology in other areas, such as disposal of wastes containing dangerous chemicals or heavy metals, and a growing interest globally for risk evaluation of possible consequences from natural calamities like extreme flooding, winds or earthquakes. The Evaluation Panel thinks there is now a good possibility to compare the methods used in nuclear waste management with those in the new types of evaluations, and at the same time educate a new generation of safety PA/SA competence. The benefits of such an effort would be threefold, all within the mandate of the KYT programme:

- A further possibility for testing and development of the assessment methodology.
- An enlargement of the relatively small group of individuals involved with these type of assessment within Posiva and STUK with people that have a different educational background.
- A possibility for creating a broader understanding in the society in general of the issues involved in the safety aspects of nuclear waste management, the methods available for evaluating them, and the quality and limitations of them.

The Evaluation Panel is aware of the fact that the Steering Group has clearly announced their willingness to support project proposals with a focus on safety assessment methodology in their recommendations for areas for year 2008. Should no such proposals be found when the proposals are received, the Evaluation Panel recommends that an active effort be made within the KYT programme to define the outline for such an activity of comparison and education, and to solicit a suitable organization for its realization.

*Building on KYT Success*

The General Conclusions of our KYT 2010 review are favorable with respect to accomplishments within the current budgetary and technical constraints of the programme. The KYT 2010 programme serves as a “common well” from which all stakeholders involved in nuclear waste management in Finland can expect to benefit. Based on our interviews with participants at all levels of the programme, however, we also detected a belief that perhaps even greater benefits could be attained by raising the various levels of contribution.

At the highest level, it is suggested that the MTI itself could raise its own ambition level with respect to maintaining the specific technical competencies that are within the KYT scope, and for developing new and independent competencies. Higher levels of ambition would necessarily imply higher levels of available resources or perhaps a more focused use of available resources. As suggested elsewhere in this report, the Steering Group could develop an explicit identification of realistic alternative options in the Finnish programme, a greater emphasis on safety assessment methodology, and a longer-range action plan for the training and education and future expertise. This information would then provide a concrete basis for discussion on the need for any programme redirection or enlargement.

With an increase in national ambition level, there could also be a corresponding increase in the participation level in building and maintaining core competencies in Finland related to nuclear waste management. Much of the current equipment and background training used in KYT projects were funded in large part by non-nuclear R&D programmes, including mining, civil engineering, and corrosion testing. The facilities, equipment and staff of KYT projects, in general, are shared with these non-nuclear programmes over the course of a year. Broader co-participation and planned coordination of other governmental and industrial partners with KYT projects could allow new or expanded technical capabilities to be formed in Finland. Such partnership, if achievable, would also allow for greater flexibility in assuring continuity in support of KYT students and staff who are funded on a year-to-year basis.

Thirdly, it was remarkable that a high percentage of KYT researchers expressed an interest in having higher expectation levels set for them by the Support and Steering Group. While past and current KYT projects have produced technical journal articles of their research, the actual annual reporting requirements for KYT are rather perfunctory compared to requirements from comparable technology programmes. If aided by a more active mentoring role by the Steering and Support Groups to better help them understand the context and implications of their results, many KYT researchers felt greater production of high quality internal and technical journal reports can be reasonably expected.

Finally, the impact level and visibility of the KYT could also be raised with respect to technical peers, nuclear stakeholders and the general public in Finland. Although no longer produced, past KYT (and KYT fore runner) programmes did compile individual summary reports from researchers into an annual research report. While the distribution, hence impact, of such past reports seemed limited, greater impact might be achieved in several ways. A compiled KYT annual report in the future might also contain overview sections contributed by the KYT Coordinator and cognizant Support Group members to better place the KYT results into the larger context of nuclear waste management in Finland. Furthermore, a year-end KYT Workshop could be convened, with invitations to nuclear stakeholders both in and outside of Finland, as well as to the Finnish public. Important impacts from such an open forum would include (1) disseminating KYT results to a wider audience, and (2) giving KYT students and researchers valuable experience in making technical presentations. A more detailed KYT web site containing the compilation of current and past KYT studies could also enhance the visibility and impact of the overall programme.

### *New Centres of Excellence*

Several KYT researchers stressed that their KYT programme and capabilities in Finland were at the forefront of technical centres of excellence in Europe. Other KYT researchers, however, noted that part of their programmes involved utilizing special capabilities at centres of technical excellence outside of Finland in Europe and elsewhere. This included facilities such as synchrotron sources, tomographic imaging, and biological processing. Such networking between KYT and centres outside Finland is a mark of well-conceived and well-managed R&D proposals, because Finland obviously cannot be a leader in all technical endeavors associated with building and maintaining costly, specialized research equipment and facilities.

It might be beneficial, however, for the KYT Steering Group with its broad-based representation to critically examine if there are technical and SA/PA areas related to nuclear studies in which Finland might be able to develop new centres of excellence. The MTI could aid this effort by taking a proposed topical list from the Steering Group (perhaps part of a larger action plan), and surveying other ministries, universities, and industry sources for comment and expressions of mutual interest. The organization and possible timing for such an exploration of new centres of excellence may not conform with the current waste management schedule in Finland, but the merits of a periodic solicitation and survey of new opportunities for centres of technical excellence should be considered.

*Integrated R&D*

There are currently about 20 well-focused KYT projects being conducted in 2007, and a new round of solicited proposals indicates that this number may grow in 2008 and beyond. As noted elsewhere in this review report, the KYT projects seem reasonably distributed among key areas related to nuclear waste management, with an increase in projects related to the key safety components of the engineered barrier system (EBS). The range of measurement and analytical techniques is also notably broad, including physical, chemical, geological, and most recently biological methods.

A perceived weakness in such a widely distributed set of methods and approaches applied to narrow technical issues is that the results cannot always be readily interpreted as to their consequence on the performance of a multiple-barrier repository system. One suggestion, discussed throughout this report is for greater mentoring of the KYT students and staff by the Support Group and Coordinator to help place KYT studies into a system-wide context. Another suggestion is to specifically solicit and select some future KYT proposals that involve a more integrated approach on areas of key importance, either by consideration of multiple barriers or coupled processes, or use of multiple, complementary methods. Indeed, several KYT proposals seem well conceived to take advantage of several independent techniques that can be combined.

There are numerous impediments to development of more widely integrated KYT proposals. Firstly, identification of such integrated R&D issues implies a reasonably high-level of understanding of the safety functions of a multiple barrier geological repository or the multiple and diverse factors associated with non-disposal options. This level of understanding is generally not well understood outside of repository implementing and regulatory groups, so active mentoring by such repository groups (as represented on the Steering and Support Groups for example) would be required. Secondly, even after there is an understanding of integrated R&D, there would be a need for finding the right network of complementary skills to form an integrated team of researchers. This would be another area in which guidance by the Support Group would be needed. Thirdly, analysis of integrated systems typically involve greater costs and longer time scales for useful results to be obtained; these conditions seem to conflict with current funding constraints on KYT.



## Appendix A

### **Terms of Reference provided to the Evaluation Panel**

On 16 August 2007 the Ministry of Trade and Industry invited a team in an evaluation of the scientific output of the Finnish Nuclear Waste Management Programme “KYT”. The evaluation of KYT addressed the following main questions:

- a. Are the achieved results in balance with the funding?
- b. How well does the expertise cover the field? Is the entire KYT programme balanced to all different fields in nuclear waste management?
- c. Has the 2004 reorganisation of the funding been successful?
- d. Challenges and recommendations.

The Ministry supplied the evaluators with material concerning the history, status and strategy of KYT. The evaluators made a site visit to the Finnish Counterparts of KYT and interviewed the management and personnel of the different participating organisations of KYT, in an organized manner.

## Appendix B

### **List of reference documents provided to the Evaluation Panel**

Government proposal to Parliament for a law concerning amendment of the Nuclear Energy Act

Government bill for amendment of the Nuclear Energy Act

The Finnish Research Programme on Nuclear Waste Management “KYT2010” in 2006; Project Proposals. Call for proposals for projects.

The Finnish Research Programme on Nuclear Waste Management (KYT) 2002–2005, Final Report. VTT Research Notes 2337, Espoo 2006.

KYT2010 Public Nuclear Waste Management Programme in Finland, Framework Programme for 2006–2010. [www.ydinjatetutkimus.fi](http://www.ydinjatetutkimus.fi)

Research projects 2007. Project descriptions and main achievements. [www.ydinjatetutkimus.fi](http://www.ydinjatetutkimus.fi)

## Appendix C

### Persons interviewed by the Evaluation Panel

Lasse Ahonen, Geological Survey of Finland  
Markku Anttila, Technical Research Center of Finland  
Jari Aromaa, Helsinki University of Technology  
Pertti Auerkari, Technical Research Center of Finland  
Jorma Aurela, Ministry of Trade and Industry  
Jaana Avolahti, Ministry of Trade and Industry  
Esko Eloranta, STUK  
Aimo Hautojärvi, Posiva Oy  
Hannu Hänninen, Helsinki University of Technology  
Jussi Heinonen, STUK  
Karl-Heinz Hellmuth, STUK  
Kaisa-Leena Hutri, STUK  
Riku Huttunen, Ministry of Trade and Industry  
Pirkko Hölttä, University of Helsinki  
Merja Itävaara, Technical Research Center of Finland  
Jukka Juutilainen, University of Kuopio  
Ilpo Kallonen, Fortum Power and Heat Oy  
Markku Kataja, University of Jyväskylä  
Maarit Kelokaski, University of Helsinki  
Rainer Laaksonen, Technical Research Center of Finland  
Jarmo Lehtikoinen, STUK  
Heikki Leinonen, Carrum Oy  
Mira Markkovaara-Koivisto, Helsinki University of Technology  
Olli Okko, STUK  
Markus Olin, Technical Research Center of Finland  
Risto Paltemaa, STUK  
Eero Patrakka, Posiva Oy  
Kari Rasilainen, Technical Research Center of Finland  
Mikael Rinne, Helsinki University of Technology  
Esko Ruokola, STUK  
Timo Saario, Technical Research Center of Finland  
Pekka Särkkä, Helsinki University of Technology  
Marja Siitari-Kauppi, University of Helsinki  
Margit Snellman, Consulting Engineers  
Juhani Suksi, University of Helsinki  
Olli Taivainen, Teollisuuden Voima Oy  
Jussi Timonen, University of Jyväskylä  
Jari Tuunanen, Teollisuuden Voima Oy  
Tero Varjoranta, STUK  
Juhani Vira, Posiva Oy  
Seppo Vuori, Technical Research Center of Finland



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Käyntiosoite

Postiosoite

Aleksanterinkatu 4  
00170 HELSINKI

PL 32

00023 VALTIONEUVOSTO

Puhelin 010 606 000  
Telekopio (09) 1606 2166

Julkaisusarjan nimi ja tunnus

Työ- ja elinkeinoministeriön julkaisuja  
Energia ja ilmasto 2/2008

Tekijät (toimielimestä: nimi, puheenjohtaja, sihteeri)  Michael Apted, Monitor Scientific LLC, Yhdysvallat Tönis Papp, Rws Consulting, Ruotsi Rainer Salomaa, Helsingin teknillinen korkeakoulu		Julkaisu-aika Helmikuu 2008
		Toimeksiantaja(t) Työ- ja elinkeinoministeriö
		Toimielimen asettamispäivä
Julkaisun nimi KYT 2010 Review Report		
Tiivistelmä  Kansallinen ydinjätehuollon tutkimusohjelma KYT2010 on ydinenergiain mukaisesti organisoitu tutkimusohjelma, jonka ohjelmakausi on 2006–2010. Tutkimusohjelmalla on kauppa- ja teollisuusministeriön nimittämä johtoryhmä, joka koordinoi hallintoa ja tutkimuksen yleisiä suuntaviivoja. Johtoryhmän tukena toimii asiantuntijaelimenä tukiryhmä.  KYT2010-tutkimusohjelman tarkoituksena on varmistaa, että viranomaisten saatavilla on riittävästi ja kattavasti sellaista ydinteknistä asiantuntemusta ja muita valmiuksia, joita tarvitaan ydinjätehuollon erilaisten toteutustapojen ja menetelmien vertailuun. Tutkimusaiheet jaetaan kolmeen ryhmään: ydinjätehuollon strategiset selvitykset, ydinjätteiden loppusijoituksen pitkäaikaisturvallisuus, yhteiskuntatieteelliset selvitykset.  Kauppa- ja teollisuusministeriö päätti toteuttaa vuonna 2007 KYT2010-tutkimusohjelman kansainvälisen arvioinnin ja kutsui tehtävään kolmihenkinen arviointiryhmän. Arviointi perustui ministeriön toimittamaan kirjalliseen materiaaliin ja asianomaisten ryhmien haastatteluihin. Arvioinnissa haastateltiin johtoryhmän ja tukiryhmän jäseniä sekä tutkimusprojektien ja rahoittajien edustajia. Haastattelut toteutettiin 29.10.–2.11.2007.  Arviointiryhmä toteaa, että saavutetut tulokset ja rahoitus ovat tasapainossa, eri tutkimusalueet ovat edustettuina ja niitä voidaan pitää riittävinä. Tutkimusohjelman uudelleenorganisoinnista ryhmä toteaa, että tutkimusohjelma on tasapainoinen, mutta tasapainon ylläpitäminen saattaa edellyttää vuorovaikutuksen laajentamista. Yleisten huomioiden lisäksi arviointiryhmä esittää raportissa useita kehittämisehdotuksia.  Työ- ja elinkeinoministeriön yhteyshenkilö: Energiaosasto/Jaana Avolahti, puh. (09) 010 606 4836		
Asiasanat ydinjätehuolto, kansallinen ydinjätehuollon tutkimusohjelma KYT2010		
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MINISTRY OF EMPLOYMENT AND THE ECONOMY

Besöksadress

Postadress

Alexandersgatan 4  
00170 HELSINGFORS

PB 32  
00023 STATSRÅDET

Telefon 010 606 000  
Telefax (09) 1606 2166

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		Uppdragsgivare
		Arbets- och näringsministeriet
		Organets tillsättningsdatum
Titel		
KYT2010 Review Report		
Referat		
<p>Det nationella forskningsprogrammet för kärnavfallshantering KYT2010 är ett forskningsprogram som organiserats i enlighet med kärnenergilagen. Programperioden är 2006–2010. Forskningsprogrammet har en ledningsgrupp som har tillsatts av handels- och industriministeriet och som svarar för samordningen av förvaltningen av programmet och de allmänna riktlinjerna för forskningen. Som stöd för ledningsgruppen finns en stödgrupp som fungerar som sakkunnigorgan.</p> <p>Syftet med forskningsprogrammet KYT2010 är att säkerställa att myndigheterna till sitt förfogande har tillräcklig och täckande kärntechnisk sakkunskap och annan beredskap som behövs vid jämförelse av olika genomföringssätt och metoder för kärnavfallshandlingen. Forskningen är indelad i tre forskningsområden: strategiska utredningar om kärnavfallshandlingen, långtidssäkerheten vid slutförvaringen av kärnavfall, samhällsvetenskapliga utredningar.</p> <p>Handels- och industriministeriet beslutade att genomföra en internationell utvärdering av forskningsprogrammet KYT2010 år 2007 och gav uppdraget åt en utvärderingsgrupp som bestod av tre personer. Utvärderingen baserade sig på det skriftliga material som ministeriet ställt till utvärderingsgruppens förfogande och på intervjuer av relevanta grupper. I samband med utvärderingen intervjuades medlemmarna i ledningsgruppen och stödgruppen samt företrädare för forskningsprojekt och finansiärer. Intervjuerna genomfördes 29.10.–2.11.2007.</p> <p>Utvärderingsgruppen konstaterar att de resultat som uppnåtts och den finansiering som erhållits motsvarar varandra, programmet täcker de ovan nämnda forskningsområdena och de kan anses vara tillräckliga. Vad gäller en eventuell omorganisering av forskningsprogrammet konstaterar utvärderingsgruppen att forskningsprogrammet är välbalanserat men att upprätthållande av balansen kan kräva ökad interaktion. Utöver de allmänna observationerna ovan presenterar utvärderingsgruppen dessutom flera utvecklingsförslag.</p>		
Kontaktpersoner vid arbets- och näringsministeriet: Energiavdelningen/Jaana Avolahti, tfn (09) 010 606 4836		
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# KYT 2010 Review Report

A panel of three members was asked by the Ministry of Trade and Industry (MTI) to evaluate KYT2010, the Finnish research program on nuclear waste management. The panel carried out its evaluation by reviewing copies of relevant documents and, during a one-week period 29 October – 2 November 2007, meeting with key individuals. The results of the panel are provided as general conclusions, responses to questions posed by KTM, challenges and recommendations and comments on specific projects in each subject area. In general the panel was positive about KYT2010 and provided guidance for the program for the future.

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