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Olkiluoto 3 testaa Suomen ydinenergialain mukaisen luvituksen toimivuuden

Valtioneuvosto myönsi Teollisuuden Voima Oy:n (TVO) Olkiluoto 3-laitosyksikölle rakentamisluvan helmikuun 17 päivänä 2005. Tämä oli ensimmäinen "uuden" ydinenergialain mukaisesti myönnetty rakentamislupa Suomessa. Aikaisemmin on valtioneuvosto tehnyt neljä periaatepäätöstä ja myöntänyt kaksi käyttölupaa. Lisäksi kauppa- ja teollisuusministeriö on antanut viidestä ympäristövaikutusten arvioinnista YVA-lain mukaiset lausunnot.

Nykyinen ydinenergialaki tuli voimaan vuonna 1988. Siispä meni 17 vuotta ennen kuin koko laki tuli testatuksi luvitusmielessä. Ensivaikutelma on, että laki on toimiva ja riittävä. Parannettavaa on toki aina, mutta mielestäni nyt välipäätöksen saanut Olkiluoto 3-prosessi on osoittanut, miten ydinlaitoksen luvitus on toimiva valvonnan väline.

Olkiluoto 3:n rakentamislupahakemusta käsiteltiin noin vuoden ajan. Lausuntokierroksella KTM sai 70 lausuntoa tai mielipidettä. Tärkein niistä oli Säteilyturvakeskuksen (STUK) tammikuussa antama lain edellyttämä lausunto ja turvallisuusarvio. STUK toteutti rakentamisluvan käsittelyssä mittavan työn, jonka toteutuksessa se sovelsi tehokasta projektityöskentelyä. STUK tarkasti, että hakija rakentaa turvallisen ydinvoimalaitoksen. Tämähän on lain tarkoitus ja rakentamisluvan myöntämisen edellytys.

Sen sijaan monissa muissa lausunnoissa ja mielipiteissä otettiin kantaa ydinvoiman hyväksyttävyyteen. Ja näinhän näyttää tapahtuvan luvitusprosessin kaikissa vaiheissa. Kuulemisprosessit ovatkin tärkeitä varoventtiilejä sen ohella että päättäjät saavat niistä tärkeitä tietoa lausujilta jokaista lupaa varten. Ydinlaitoksenhan on oltava yhteiskunnan kokonaisedun mukainen koko elinkaarensa ajan. Toisaalta päällekkäiset tai liian usein toistuvat kuulemiset voivat syödä ihmisten ja organisaatioiden intoa osallistua niihin.

YVA-laki on rinnakkainen ydinenergialain kanssa. Kaikki viisi Suomessa tehtyä YVAa ovat osoittautuneet erinomaisiksi keskustelufoorumeiksi ja ohjauskeinoiksi ydinvoimahankkeissa. Kahden lain liittymäkohdaksi lainlaatija on ottanut YVA-selostuksen liittämisen osaksi periaatepäätöshakemusta. Tässä kohdassa julkisten kuulemisten päällekkäisyys on ilmeinen. On myös varottava, ettei enää luoda lisää rasitteita lähes vuosikymmenen kestävälle luvitusprosessille ilman päteviä syitä. Yhdestäkään ydinenergialain mukaisesta luvasta ei ole vielä valitettu siten, että valitus olisi edennyt korkeimman hallinto-oikeuden varsinaiseen käsittelyyn. Nyt kun Århusin sopimus on viety ydinenergialakiin, tulee mukaan kuvaan aivan uusia muutoksenhakumahdollisuuksia, jotka eivät vielä koskettaneet Olkiluoto 3:a. Mahdollisen tulevan ydinlaitoksen rakentajan on kuitenkin tehtävä aikatauluunsa rakentamisluvan myöntämisen jälkeen varaus lisäajasta.

Nyt Olkiluoto 3:n rakennustyöt ovat täydessä käynnissä. Konkreettisen rakentamisen rinnalla TVO jatkaa laitoksen lisensiointia, sillä käytännössä se toimittaa jatkuvasti ennakkotarkastusaineistoja Säteilyturvakeskuksen hyväksyttäväksi. TVO:n suunnitelmissa on jättää käyttölupahakemus valtioneuvostolle vuonna 2007, jotta se voisi saada käyttöluvan syksyllä 2008. Silloin on suunnitelmissa ladata laitoksen reaktori.

Fortum on ilmoittanut tänä keväänä, että sillä on tarkoitus hakea Loviisan molemmille voimalaitosyksiköille noin 20 vuoden käyttölupaa vuonna 2006. Posivan käytetyn polttoaineen loppusijoitustilan rakentamislupahakemus on mahdollisesti vuorossa vuonna 2012. Siten kokemukset ydinenergialain mukaisesta luvituksesta lisääntyvät, hyvät käytännöt vakiintuvat ja löydetyt puutteet pyritään korjaamaan. Linjakas päätöksenteko ja yhteiskunnan kokonaisedun mukainen turvallinen ydinvoiman käyttö ja tehokas valvonta ovat tärkeitä tekijöitä suomalaisessa energiahuollossa. ■

Jorma Aurela

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Olkiluoto 3 tests the applicability of licensing under the Nuclear Energy Act

The Government issued a construction licence for Teollisuuden Voima Oy's (TVO) Olkiluoto 3 plant unit on 17 February 2005. This was the first construction licence granted under the "new" Nuclear Energy Act in Finland. Earlier, the Government had made four decisions-in-principle and issued two operating licences. Furthermore, the Ministry of Trade and Industry has given statements on five environmental impact assessments in accordance with the Environmental Impact Assessment Act.

The present Nuclear Energy Act was drafted in 1987 and it entered into force the following year. Thus it took 17 years until the Act was tested in view of licensing. The first impression is that the Act is sufficient and functions well. There is, naturally, always room for improvement, but I think that the Olkiluoto 3 process, which just obtained an interim decision, has shown that licensing of a nuclear power plant is an expedient supervision tool.

The licence application for the construction of Olkiluoto 3 was handled for about one year. During the round of statements, the Ministry of Trade and Industry received a total of 70 statements or opinions. The most important of them was the statutory statement and safety assessment that the Radiation and Nuclear Safety Authority (STUK) gave in January. STUK did an extensive job in handling the construction licence, applying efficient project teamwork. STUK ensured that the applicant would construct a safe nuclear power plant. After all, this is the purpose of the Act and the precondition for issuing a construction licence.

In many other statements and opinions a position was taken as to the acceptability of nuclear power. In fact, this seems to be the case in all the stages of the licensing process. Besides that the hearing processes give decision-makers important information for a given licence, they are also major safety valves, as a nuclear power plant must meet the overall interest of society during its whole life cycle. On the other hand, it is true that overlapping or too frequent hearings slacken the participation interest of individuals and organisations.

The Environmental Impact Assessment Act is a parallel act with the Nuclear Energy Act. All the five environmental impact assessments (EIAs) carried out in Finland have proved excellent discussion fora and steering instruments in nuclear power plant projects. To link the two acts together, the legislator has chosen to integrate the EIA report into the application for a decision-in-principle. In this, the overlapping of the public hearings is obvious.

One must also be cautious of not creating further stress on the licensing process, which takes nearly ten years, without a good reason. Not one of the licences under the Nuclear Energy Act has been appealed, so that the appeal would have been taken to the ordinary handling before the Highest Administrative Court. Now that the Aarhus Convention has been included in the Nuclear Energy Act, wholly new appealing possibilities, which have not yet touched upon Olkiluoto 3, enter the picture. The constructor of the possible future nuclear power plant will have, however, to make a reservation for additional time after the construction licence will have been issued.

The construction of Olkiluoto 3 is now in full swing. Along with the construction in practice, TVO continues the licensing of the plant, because it keeps delivering pre-inspection material for STUK's approval. TVO plans to submit an application for an operating licence to the Government in 2007, so that it could get a licence in the autumn 2008. The loading of the fuel to the reactor of the plant is scheduled for the same period of time.

Fortum announced last spring that it aims to apply for an operating licence for approximately 20 years for the both Loviisa power plant units in 2006. Posiva's application for a licence for constructing a final repository for spent fuel is likely to be next in turn in 2012. Thus experiences of licensing under the Nuclear Energy Act will increase, good practices will become established and any deficiencies found will be repaired. Consistent decision-making, safe use of nuclear power in line with the overall interest of society and efficient supervision are essential elements in Finnish energy management.

■

UUTISIA

Olkiluoto 3 rakentaminen -teemanumero

ATS Ydintekniikka -lehden numero 3/2005 on OL3:n rakentamista käsittelevä erikoisnumero. Lehden painos on huomattavasti normaalia suurempi, ja lehti jaetaan mm. kansanedustajille ja kirjastoihin. Pääosa lehden sisällöstä on toimitettu englanniksi, koska lehden tarkoituksena on tiedottaa myös kiinnostuneita ulkomaalaisia projektin ja suomalaisen ydinvoiman tilanteesta.

Ydinvoima säästää saman minkä henkilöautot tuottavat EU:ssa

Ydinvoimalla tuotettu sähkö vähensi Euroopan Unionin hiilidioksidipäästöjä arviolta 704 miljoonaa tonnia (Mt) vuonna 2003, arvioi FORATOM tuoreissa laskemissaan. Laskelman perustana on käytetty ydinvoiman tuotantoa v. 2003 (973,67 TWh), yleisesti käytettyjä lukuja fossiilisten polttoaineiden CO_2-päästöille ja EU:n nykyistä jakaumaa eri energiantuotantomuotojen välillä. Vähennys vastaa karkeasti EU:n yli 200 miljoonan henkilöauton vuotuisia CO_2-päästöjä 722 Mt.

Lähde:
FORATOM, www.foratom.org

Loviisan voimalaitos hakee käyttölupaa 20 vuodeksi

Fortum on ilmoittanut aikeista hakea valtioneuvostolta Loviisan voimalaitoksen käyttöluvalle 20 vuoden jatkoa aina vuoteen 2030 saakka. Yhtiön mukaan laitoksen strategiaan kuuluu molempien laitosyksiköiden osalta valmius saavuttaa vähintään 50 vuoden käyttöikä. Esimerkiksi käynnissä olevalla automaation uudistushankkeella laitoksen käytettävyys pyritään turvaamaan pitkälle tulevaisuuteen.

Loviisan voimalaitoksen nykyinen, tehonkorotuksen yhteydessä 1998 myönnetty käyttölupa kestää vuoden 2007 loppuun. Käyttölupahakemukseen liittyen Fortum toimittaa Säteilyturvakeskukselle laajan turvallisuuden väliarvion, jossa esitetään mm. laitoksen käyttöiän jatkamisen tekniset perusteet.

Lisätiedot: Voimalaitosjohtaja Arvo Vuorenmaa, arvo.vuorenmaa@fortum.com

ATS Young Generation kokosi alan kesäharjoittelijat yhteen

Atomiteknillisen Seuran Young Generation järjesti ydinvoima-alan korkeakouluharjoittelijoille ja ATS YG:n jäsenille yhteisen kesäriehan. Elokuun puolivälissä pidettyyn tapahtumaan osallistui noin 70 harjoittelijaa ja YG-ikäistä työntekijää alan yrityksistä ja korkeakouluista.

VTT:n virkistäytymismajalla Espoon Soukanniemellä iltapäivän ohjelmaan kuului järjestävien tahojen esittely ja tapahtumakatsaus. Päällimmäisenä tilaisuuteen kutsutut puhujat korostivat alan hyviä työllisyysnäkymiä ja toivoivat nuorten hankkivan kesätyökokemusta monipuolisesti eri yrityksistä. "Vaihtakaa joka kesä työpaikkaa, jotta tiedätte minkälaista missäkin tällä alalla on olla töissä", STUK:n **Juhani Hyvärinen** korosti.

Tapahtuma onnistui hyvin myös säiden puolesta. "Saimme pitkän sadejakson jälkeen aurinkoisen ja lämpimän sään", ATS YG:n puheenjohtaja **Atte Helminen** kiitteli.

Sini Paananen, Teollisuuden Voima

Abstract

On December 18, 2003, the Framatome ANP/Siemens Consortium was awarded a turnkey contract by the Finnish utility Teollisuuden Voima Oy (TVO) to build a new nuclear power plant at the Olkiluoto site, where two nuclear units are already in operation. The new unit – Olkiluoto 3 – will be an EPR, a third-generation pressurized water reactor (PWR). Within the consortium Framatome ANP, an AREVA and Siemens company, is supplying the entire "nuclear island", i.e. the reactor with all nuclear safety and auxiliary systems, while Siemens Power Generation is building the "conventional island" comprising the turbine and generator together with all necessary auxiliaries. Framatome ANP, which is head of the consortium, is responsible for overall project management as well as technical and functional integration. TVO started preparing the construction site as soon as the contract had been signed. The actual construction work was started in the spring of 2005. Commercial operation is scheduled to begin in 2009.

Development of the EPR was started in 1992 by Framatome and Siemens within a Franco-German partnership. Since 2001, this work has been continued by Framatome ANP, which was formed when the two companies merged their nuclear businesses. (The French world market leader in nuclear technology, AREVA, holds a 66% share in Framatome ANP, with Siemens owning 34%.) From the very start, development of the EPR was focused on making plant safety and economics even better than at existing units. The new reactor's development was jointly financed together with the leading power utilities of both countries.

An EPR nuclear power plant has a rated electric capacity of around 1600 MW, depending on specific site conditions. Being the product of intense bilateral cooperation the EPR combines the technological accomplishments of the world's two leading PWR product lines – France's N4 and Germany's Konvoi. At the same time it incorporates a new class of safety: its highly advanced safety systems represent a further enhancement of the high safety level already provided by nuclear plants currently in operation in Germany and France.

To attain the specified safety goals, measures have been taken to further reduce the probability of occurrence of core damage states and also ensure that all consequences of a (hypothetical) accident involving core melt remain restricted to the plant itself. The EPR has additionally made great progress in terms of low power generating costs, conservation of natural resources and minimization of waste volumes. From the viewpoint of the European nuclear community, it therefore demonstrates nuclear energy's excellent prospects for the future as an economical option for carbon-dioxide-free base-load power generation in our liberalized power markets.

Background to decision

In November 2000, TVO applied to the Finnish Ministry of Trade and Industry for a decision in principle according to the Finnish Nuclear Energy Act. This had been preceded by environmental impact assessments prepared for the two candidate sites – Olkiluoto in southwestern Finland and Loviisa on the south coast – and reviewed by the Ministry. In January 2002, after an extensive official consultation procedure, the Finnish Government's Council of State reached its decision in principle in favor of a new nuclear unit. The decision was ratified by Parliament in May of that year.

International competition

In October 2002, four months after ratification by Parliament, TVO issued a request for proposals for Finland's fifth nuclear unit, which called for a PWR or a boiling water reactor (BWR) with a rated capacity of between 1000 and 1600 MW.

On March 31, 2003, TVO received proposals from various vendors, including Framatome ANP that had formed a consortium with Siemens. After carefully evaluating these proposals and clarifying further technical aspects with all of the bidders, TVO announced on October 18, 2003 that the Framatome ANP/Siemens Consortium was the preferred bidder.

On December 18, 2003, the contract was signed in Helsinki. It officially came into effect on January 1, 2004. In parallel with this, the documentation required for obtaining a construction license under the Finnish Nuclear Energy Act was submitted to the Finnish Radiation and Nuclear Safety Authority (STUK) and initial preparation of the construction site was commenced. After reviewing these documents, STUK concluded in its safety assessment for the Finnish Ministry of Trade and Industry that it did not see any safety-related issues opposing issuance of the nuclear construction license. STUK emphasized that the evolutionary design

The EPR Becomes Reality at Finland's Olkiluoto 3

Affordable climate protection: the EPR will become a reality at Olkiluoto in Finland in 2009.

of the EPR had been further improved by AREVA compared to the previous product lines. This led to the Finnish Government granting the construction license on February 17, 2005.

Project organization

Framatome ANP's scope of supply and services encompasses the nuclear island, including the design, procurement and delivery of all of its mechanical and electrical equipment, installation and initial startup, the fuel assemblies for the first core and an EPR simulator. Furthermore, the company is responsible for overall project coordination as well as for func-

TECHNICAL DATA:

Reactor thermal output:	4300 MW
Net electric output:	approx. 1600 MW
Main steam pressure:	78 bar
Main steam temperature:	290°C
Reactor pressure vessel height:	13 m
Reactor core height:	4.2 m
Number of fuel assemblies:	241
Uranium inventory in reactor:	128 t UO_2
Number of control rods:	89
Containment height:	63 m
Containment inside width:	49 m
Outer Containment wall thickness:	2 m

tional and technical integration of the overall plant, and is also head of the consortium.

Siemens is responsible for supplying the conventional island, including the design, procurement and supply of all of its electrical and mechanical equipment, as well as the turbine and generator protection and control systems, and installation and initial startup of the turbine generator set.

A significant proportion of the engineering, construction and erection work, as well as the supply of mechanical and electrical equipment, will be placed with subcontractors after an international bidding process. Of course, Finnish companies will also be able to participate in this bidding. If their proposals should prove to be competitive at an international level they will likewise be given consideration during the proposal evaluation phase so that a large portion of the supplies and services for the project could be remaining in the country. Quite appreciable work packages have already been contracted out to Finnish companies. They are also profiting from the fact that orders awarded to companies outside Finland lead, in turn, to work being placed with Finnish subcontractors so that, in the end, a substantial portion of the total project value will be remaining with Finnish industry. Further requests for proposals are scheduled to be issued in the course of this year as well as at the beginning of the next year.

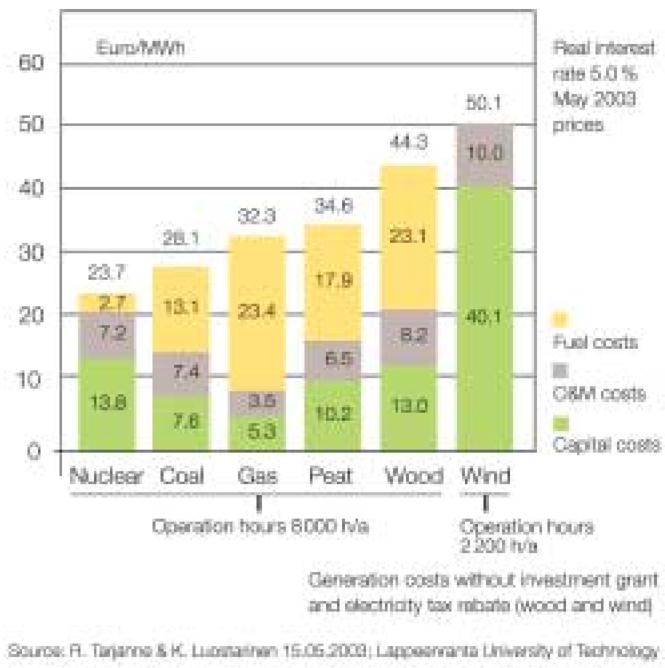
Current project status

Following completion of the excavation work that had been carried out by Finnish contractors employed by the customer, the Framatome ANP/Siemens Consortium took over the site on February 1, 2005.

Early in the summer of 2004, the consortium had already placed several major orders with Finnish companies. These orders covered the batching mixing plant and the detailed design of the base slab of the reactor building complex as well as construction of the common raft foundation. In addition to this, supplies for the site infrastructure (office building and canteen, etc.) were also ordered from Finnish companies. The batching plant, which was erected directly on site, will have supplied a total of around 250,000 cubic meters of concrete via permanently installed pipelines and concrete mixer trucks by the time construction is finished. It was placed in operation in the spring of 2005 so that work could be started on pouring the leveling concrete.

In 2004, an order was also placed for a heavy-lift crane with a load-carrying capacity of 1600 metric tons required for the construction and erection work.

The largest single orders for construction work went to companies based in France and Germany. However, significant portions of these volumes of work will be coming back again to Finnish contractors.



Power generating costs of new nuclear power plants according to Professor Risto Tarjanne, Lappeenranta University of Technology.

Birth of the EPR and its development goals

Framatome of France and Germany's Siemens began developing the EPR in 1992 on behalf of and with significant support from the French national utility Electricité de France (EDF) and leading German utilities. The project was closely monitored and supported by licensing authorities and independent inspection agencies in both countries to ensure the EPR's licensability in France and Germany. Through the Olkiluoto 3 project, the EPR is now being licensed for the first time by the Finnish authorities.

The EPR builds on proven technologies deployed in the two countries' most recently built nuclear power plants – the French N4-series units and the German Konvoi-series plants – and constitutes an evolutionary concept based on these designs. This enables full use to be made of all of the reactor construction and operating experience gained not only in France and Germany – with their total of 2070 reactor operating hours – but also worldwide. Guiding principles in the design process included the requirements elaborated by European and US electric utilities for future nuclear power plants, as

On July 15, the first sections of the metallic liner for the inside of the reactor containment building arrived by sea at the Olkiluoto 3 construction site.

well as joint recommendations of the French and German licensing authorities. The key development goals were:

• To further increase safety and, at the same time,

• To further improve economic performance.

Even greater safety

Safety levels at nuclear power plants have been constantly improved in the past. The EPR, a nuclear reactor of the third generation, represents yet another step forward in terms of safety technology, offering in particular the following features:

• Improved accident prevention, to reduce the probability of core damage even further,

• Improved accident control, to ensure that – in the extremely unlikely event of a core melt accident – the radioactivity is retained inside the containment and the consequences of such an accident remain restricted to the plant itself,

• Improved protection against aircraft crash, including large commercial jetliners.

Measures providing superior accident prevention capability include a larger water inventory in the reactor coolant system and the steam generators, a lower core power density, and high safety-system reliability thanks to quadruple redundancy and strict physical separation of all four safety system trains. The plant design also incorporates state-of-the-art digital instrumentation & control (I&C) systems along with optimized man-machine interfaces.

If a core melt accident should occur despite all of the accident prevention measures deployed, the molten core material (corium) will be collected and cooled in a specially designed corium spreading area located underneath the reactor pressure vessel but still inside the containment. The extremely robust double-walled containment will reliably keep radioactivity confined inside the building.

Probabilistic safety analyses were incorporated from the outset into the design process in order to determine those accident sequences capable of leading to severe core damage or significant releases of radioactivity, to evaluate their probability of occurrence and to implement design features that would further reduce their contribution to the overall risk.

Enhanced competitiveness

The following factors contribute towards making the EPR's power generating costs even lower than those of the most recently built nuclear power plants currently in operation:

• Larger net electric output of around 1600 MW: this leads to lower specific construction costs

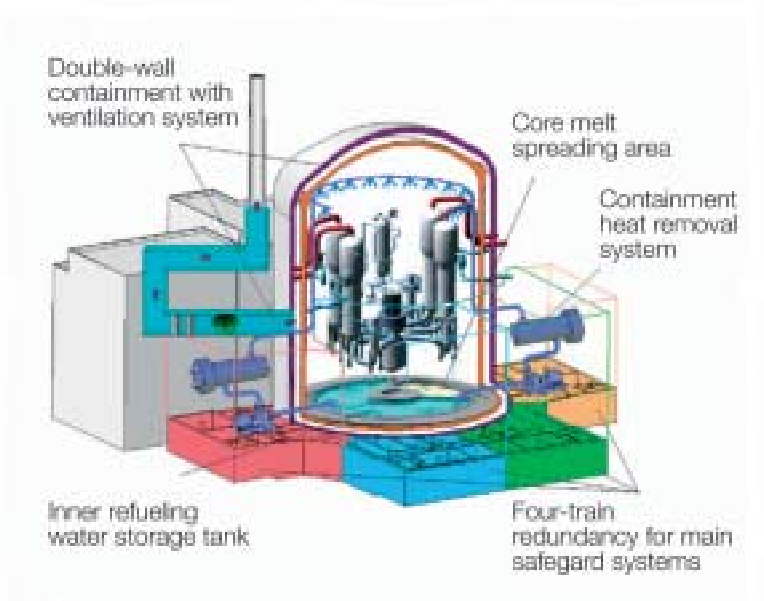
• Higher secondary-side pressure of 78 bar: this in conjunction with an optimized turbine design results in an efficiency of more than 37% under Finnish conditions – the highest efficiency of any light water reactor plant in the world

• Shorter construction period of 48 months

• Extended design plant service life of 60 years

• Possibility for higher fuel utilization with a discharge burnup of more than 60 GWd/t: this means reduced uranium consumption and lower spent fuel management costs

• Greater ease of maintenance thanks to improved accessibility and standardization, with preventive maintenance being possible while the plant is on line



Major safety features of the EPR.

• Shorter refueling outages leading to higher plant availability.

Factors aimed at ensuring the longest possible periods of uninterrupted power operation with minimal downtime comprise:

• Fuel operating cycles of up to 24 months

• Short refueling outages, even when extensive maintenance work is necessary

• Plant availability ratings of more than 90 %.

The EPR design

The reactor building and other relevant buildings, will be of double-walled design to enable them to withstand the loads induced by natural and external man-made hazards (particularly aircraft crash).

The EPR has a slightly higher reactor thermal output than other PWRs currently in operation. The deployment of steam generators with economizer sections along with an advanced steam turbine design will lead to higher efficiency. In addition, core coolant flow has been maximized based on operating experience.

Safety systems directly connected to the reactor coolant system which serve to inject coolant into the system in the event of a loss-of-coolant accident (LOCA) are designed with quadruple redundancy.

The emergency core cooling systems comprise four passive accumulators as well as four low- and intermediate-pressure safety injection systems.

In addition to the systems for residual heat removal that are connected directly to the reactor coolant system, a further system designed to assure heat removal in the event of loss of normal feedwater supply is connected to the secondary system. This consists of a four-train emergency feedwater system that supplies water to each steam generator. The emergency feedwater system on the secondary side is equipped with electric-motor-driven pumps that can be powered, if necessary, by the unit's four large emergency diesel generators. In addition, the plant is also equipped with small, separate diesel generators to ensure that feedwater supply to the steam generators is guaranteed even in the event of simultaneous failure of all four of the large emergency diesels.

In the steam generators, the heat generated in the reactor is used to produce steam for driving the turbine. This steam is then condensed in the turbine condenser. If the condenser should be unavailable due to loss of the main heat sink, the excess steam can be directly discharged to the atmosphere from the steam generators.

The in-containment refueling water storage tank serves to store water for emergency core cooling and accommodates any leakage water discharged via a pipe break in the reactor coolant system.

Enhanced safeguards

To meet the requirements of the nuclear safety authorities, additional provisions for preventing beyond-design events were incorporated right from the start into the EPR design. These comprise, in particular, backup functions deployed on a systematic basis to further enhance safeguards for accident prevention. If an entire accident control function should fail, diverse actions will be implemented to achieve the same safety objective. What does this mean in concrete terms? For example, if all four redundant intermediate-pressure safety injection trains should be lost after a small-break LOCA, the residual heat from the reactor core can alternatively be removed via the secondary system, and the pressure reduced to a level at which the passive accumulators and low-pressure safety injection pumps can feed emergency coolant into the reactor. Hence, even in the extremely unlikely event of complete loss of all four redundant subsystems, the accident can still be controlled in such a way that destruction of the core is ruled out.

The safety authorities require that, despite all enhancements incorporated into the EPR design for accident prevention, provisions nevertheless be made to control all events that could possibly lead to melting of the core following a postulated loss of all safety systems, the aim of this being to prevent catastrophic impacts on the environment. In the case of the EPR this primarily meant providing engineered safeguards that would prevent destruction of the containment in the event of a postulated (hypothetical) core melt accident. These safeguards comprise, in particular,

Summer 2005: Situation on site looking at the basemat of the reactor building.

reactor coolant system depressurization, a special reactor pit design, core melt stabilization, the design of the containment, containment heat removal and hydrogen reduction.

Better radiation protection for personnel

In the course of designing the EPR, improvements were also made to the protection of operating and maintenance personnel against radiation. The target is a collective radiation dose of less than 0.4 man-Sieverts (manSv) per reactor unit and year (by way of comparison: up until now the limit in the West has been 1 manSv).

Nuclear power has a future

The construction of Olkiluoto 3 in Finland has sparked off discussions about new construction projects in other European countries as well. The decision made by the private investor TVO to build a new nuclear power plant underscores the fact that nuclear technology plays an important role in liberalized power markets as an economical solution for CO2-free base-load power generation. The French utility Electricité de France (EDF) likewise decided – in October 2004 – to construct an EPR at Flamanville in Normandy. The key concern in France is to ensure the availability of a reliable energy technology in the long term: the project at Flamanville is to serve as a basis for a new series of nuclear units to replace French plants reaching the ends of their service lives from 2020 onwards.

The USA is following a similar strategy and has made a long-term commitment to nuclear energy. The service lives of many of its nuclear power plants are currently being extended and in addition the Bush Administration, together with the US utilities, is actively pursuing plans to launch the construction of a new nuclear unit before the end of this decade. In Asia, too, nuclear energy's share of the power-generating market is being deliberately expanded: China alone is planning to construct more than 30 GW of additional nuclear-based power-generating capacity by the year 2020, which means around 20 new state-of-the-art reactors.

Energy experts predict that the demand for new and replacement generating capacity in the Central and Western European power plant market will reach 400 000 MW by 2020, with the demand for new capacity set to reach similar levels in Eastern Europe. A significant proportion of this additional capacity will be needed for base-load service. Thanks to its economic efficiency, climate-friendliness and long-term reliability, nuclear power will continue to play a crucial role in the energy mix.

With the EPR, AREVA is in an excellent position to meet the needs of this large market, just as the Finnish contract – won in the face of stiff international competition – has demonstrated.

■

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Challenge of the main heavy components in OL3

Olkiluoto 3 plant comprise about 35 000 mechanical components from small ball valves up to the main components weighting few hundreds tons, like thesteam turbine and the reactor pressure vessel. Requirements differ from conventional technology in order to achieve high safety features and high performance, especially in the reactor building. The turbine island follows more conventional solutions where the systems are not related to nuclear safety. The first step in a nuclear plant project is starting the design and manufacturing of the main primary components. Usually, first decisions for manufacturing are made before the plant contract, which gives extra challenge to them. The manufacturing of main components takes about 3 years and time schedule follows the critical line throughout the entire project.

The OL3 plant unit is based on the French-German European Pressurised Water Reactor (EPR) concept belonging to the group of light water reactors. The planned thermal power is 4 300 MW and the planned service life is 60 years. The home of the main components – primary circuit is designed to remove the heat produced in the reactor.

The primary circuit consists of a reactor pressure vessel and four loops. Each loop has a steam generator, main coolant pump and pipelines connecting them to the reactor pressure vessel. The pressurizer is connected to one of the primary loops.

The operating pressure of the primary circuit is 155 bar (abs) and the steam pressure in the secondary circuit is 78 bar (abs). The height of the reactor pressure vessel is about 12.7 m, the inner diameter is about 4.9 m and its wall thickness is 250 mm.

The OL3-project started with the primary loop components manufacturing. All these components belong to safety class 1 and thus, they are the most important for the nuclear safety.

Assured quality

The nuclear power plant has some special components, for example big forgings, that can be manufactured only in few places in a the world. These forgings started the OL3 component procurement. The biggest forgings can weigh about 500 tons. In the OL3-project these big forgings are delivered by Japan Steel Work, that have a long history related to the reactor pressure vessel, steam generator, turbine and generator forgings. Other forging and casting deliveries come from Creusot Forge France and Lucchini Italy. Earlier, they have delivered materials for the existing nuclear power plants in Europe.

The assembly work of heavy components by welding is an essential phase related to component properties. There are more possible manufacturers for heavy component assembly work in the world compared to heavy forging procurements. In OL3-project the reactor pressure vessel assembly is done in Mitsubishi Heavy Industries in Kobe (Japan) and steam generators and pressuriser are welded in Chalon (France).

TVO as an owner, Radiation and Nuclear Safety Authority in Finland (STUK) and Consortium Framatome-Siemens (CFS) have evaluated the manufacturers to be sure that they are capable to deliver components with high quality. The evaluation concerns quality management system, technical competence, manufacturing facilities and personnel.

Manufacturing with French rules

Design and manufacturing of primary loop components are based on the French RCC-M –standard. This code is originally based on ASME, but during the years the French have developed it taken into account French practices. Additionally, some design and manufacturing details are also defined in the plant supply contract and in the Finnish legislation like YVL-guides, which are above the standard requirements.

Materials rest on operating experience

The primary loop components are based on forgings, except for the reactor coolant pump casings, which are castings. This material manufacturing method guarantees the required properties like homogeneity, strength of material and fracture toughness.

Materials used for components are low alloyed carbon steels for reactor pressure vessel, steam generator and pressurizer. Stainless steel is applied for pump casing and main coolant lines. These material selections follow the normal principles of the pressurized water reactors. The main development has been in impurities, which are minimized in very low level like phosphorus, sulphur and copper.

In the OL3-project the main forgings have already been manufactured but some pressurizer forgings and pump casing castings – are still going on.

Weldings

Component assembly work started immediately after the forgings were available. Reactor pressure vessel assembly work started in Mitsubishi Heavy Industry with welding qualification work. Similarly, the steam generator manufacturing started at Framatome Chalon works. The first welding was a cladding operation where the carbon steel forgings cladded with stainless steel. This cladding is performed where the parts deals with primary coolant.

The assembly continues with the main girth welds. Up to now, the first ones are already carried out both for reactor pressure vessel and steam generators.

Trust but verify

The essential part of manufacturing is inspections. The inspections guarantee

Steam generator consists of nine forgings. In the picture the first two shells are welded together in Chalon factory France.

COMPONENT	FORGINGS/CASTINGS	ASSEMBLY
Reactor pressure vessel	Japan Steel Work (7 pcs)	Mitsubishi Heavy Industry
Steam generators (4 pcs)	Japan Steel Work (4x9 pcs)	Chalon Factory
Main coolant pumps (4pcs)	Lucchini/Creusot Forge (4x1 pcs)	Jeaumont
Pressurizer	Creusot Forge (5 pcs)	Chalon
Main coolant pipelines	Creusot Forge	Chalon/Mannesmann

Steam Generator tubesheet is welded to the lower shell.
Heat transfer tubes 5980 pcs will be welded to tube sheet in Chalon factory France.

that the equipment has the properties, which are defined in the design documents.

The inspections include both destructive (DT) and non-destructive (NDT) testing. NDT is methods like penetrant testing, magnetic particle testing, eddy current testing, radiographic and ultrasonic testing are used for welding qualification tests and component acceptance testing.

Additional to that, DT-tests are used for welding qualification, production weld tests and material testing. For example the DT-test can define the material tensile strength, hardness and fracture mechanical properties.

All the NDT and DT testing laboratories used in OL3-project for the safety classified components shall be accepted by the Finnish authority – STUK. The detailed requirements related to quality system, personnel and testing equipment are defined and specified in Finnish regulator guidance.

Plenty of supervision

The primary components play the key role in nuclear safety and have also very important influence on the plant lifetime. That is the reason why TVO as an owner and STUK pay special attention to these components.

TVO has permanent inspectors supervising primary components manufacturing in Japan and in France. STUK's inspectors are supervising both the manufacturing itself and also TVO's activities. An independent inspection organization is supervising the qualification and most important manufacturing steps. Addition to that, the manufacturer has its own supervision system.

Thus, in many cases there are four supervisors behind a welder or NDT-inspector to justify that the work is performed according to accepted procedures in a correct way.

Ship transport

The finished and accepted main components will be shipped to Finland directly from Japan and France. The installation work for primary components will start at the end of 2007 after three years manufacturing. The installation work is also based on international RCC-M-standard. Also during installation at Olkiluoto site there will be quite heavy acceptance and testing procedure like during the manufacturing phase. ■

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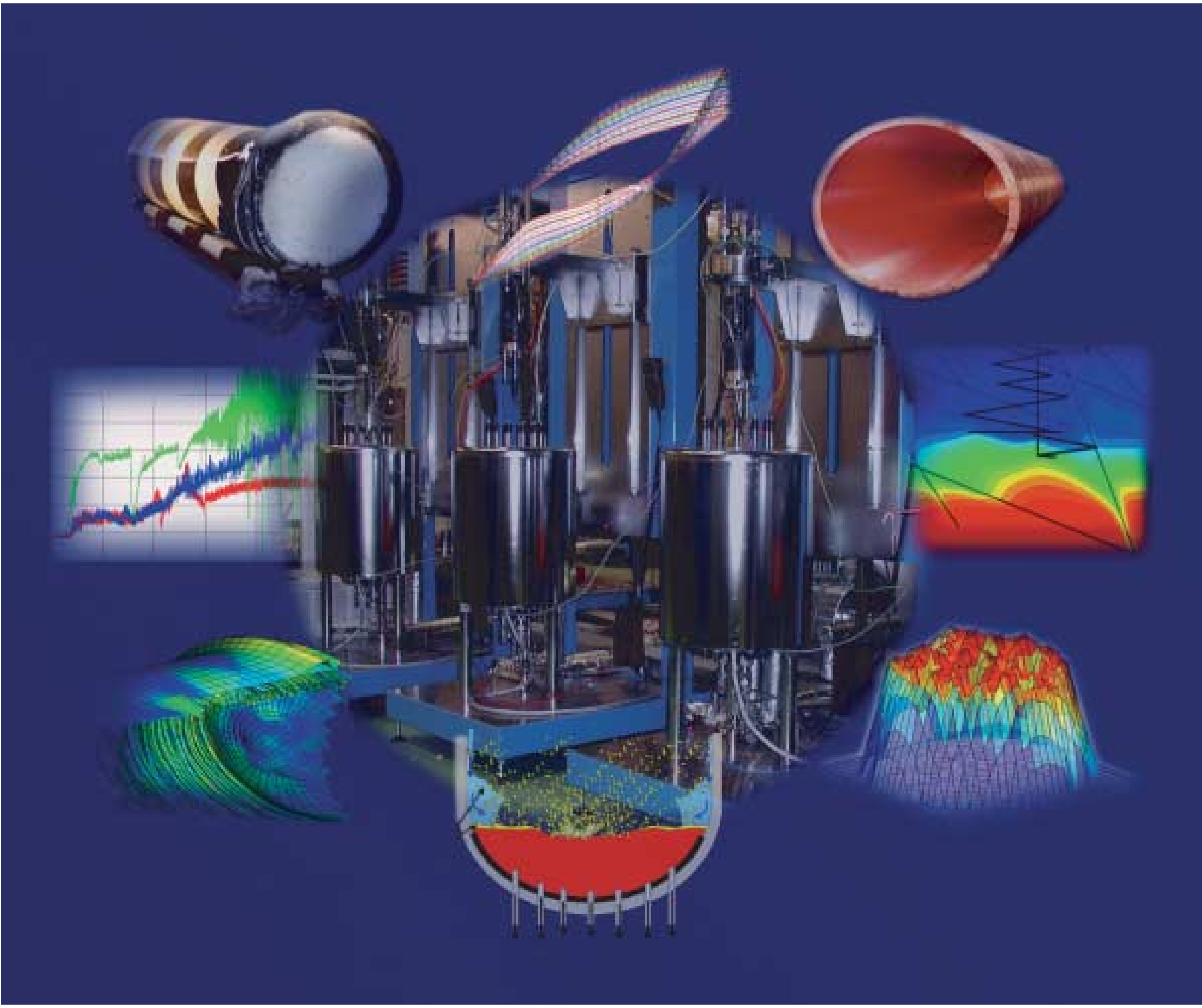
VTT's R&D for Safe and Reliable Nuclear Energy



VTT Technical Research Centre of Finland is the leading research institute in Scandinavia. In nuclear energy research we have had a major role as impartial expert organization in power upgrades and plant life management of the current Finnish plants. VTT's experiments support severe accident management of these plants. Our strong involvement continues in the construction and licensing of a new nuclear power plant unit, plant life extension of the existing plants,including modernisation of the I & C systems and improved fuel utilisation by higher burn-up. VTT is carrying out research on nuclear waste management for the industry and the authorities in Finland. With our expertise, proven tools and experienced staff we are ready to serve domestic and foreign customers.

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Safety considerations in the instrumentation
and control system solution of Olkiluoto 3

A nuclear power plant has special protection and back-up systems, which are designed to keep the plant in a safe state. The safety systems are divided into different groups according to their safety importance and their role in the functional safety design of the plant. Olkiluoto 3 has a functional and hierarchical design structure of instrumentation and control (I&C) systems, which helps the designer, operator as well as licensing authority to understand the safety importance of the complicated systems and the safety importance of each part of the systems.

The OL3 plant unit is based on the French-German European Pressurised Water Reactor (EPR) concept. Olkiluoto 3 has a planned thermal power of 4300 MW and net electric power output of approximately 1630 MW.

The Olkiluoto 3 nuclear power plant unit is designed as a base load station. Therefore the normal power control method of the plant is based on the average temperature of the primary circuit cooling water flow. Reactivity and power changes in the reactor core during the operation are compensated in the long term by changes in boron concentration of the reactor coolant. The axial reactivity oscillations in the reactor core are controlled with the control rod groups.

The foundation for the safety design is the defence-in-depth principle, which allows the management of various operating and accident conditions, even in cases of damage to critical structures or equipment.

The defence-in-depth principle means that all probable cases should be prevented in advance – the preventing in advance means that all probable disturbances are taken into account and prevented by design.

The terms, which are used later on in this article are as follows: preventive function, protection function and design extension function. The prevention function actuates in case of a mild transient and disturbance and prevents the start of protective function.

Functional design of automation

The automation signals and their actuation points are designed according to the accident analysis of the actual plant. The preliminary design is based on operating experiences and design features of reference plants. The functional design of safety features and analyses of the Finnish solutions are done in the conceptual design phase.

The main safety barrier is the protection I&C, which starts and controls the main safety systems (control rods which stop the reactor, emergency core cooling systems, etc). Olkiluoto 3 plant has four redundant safety systems, and therefore also four protection channels in the protection I&C. In the Olkiluoto 3, the diversity principle has been applied to those safety functions and protection channels that are needed in the anticipated operational transients and the postulated accidents. The preventive safety functions are performed in the control and transient limitation system.

The Finnish licensing procedure requires detailed analysis and verification of the safety functions in the system design phase. The regulatory guides also require that the quality in design and fabrication should be in a high level. Also the redundancy and diversity principles are very important for the I&C design in Finland. The work for detailed design of I&C systems in Olkiluoto 3 is still going on.

Levels of I&C system

According to the defence-in-depth principle, the main I&C systems can be divided into operational systems (used during normal operation), the protection system used in operational transients and accidents and the supplementary safety automation system. In addition, a hardwired hardware back-up system is provided for the loss of all computerized software based I&C. The setpoints of the triggering functions in the hardwired backup will become effective later than those of other computerized software based I&C.

The plant is brought from the safe state to cold shutdown with the supplementary safety automation system. The supplementary safety automation system also includes backups for certain protection system functions for situations such as design extension conditions and functions supporting such Safety Class 2 systems that do not change their state to mitigate the accident.

The purpose of the plant's I&C systems is to cater for the monitoring and control of the plant's required process systems, and in cases of various operational disturbances and accidents. The main I&C systems are divided into process automation, control and transient limitation system, instrumentation controlling the safety systems, protection systems, instrumentation and control for severe accidents, and hardwired backup system for the protection system. In addition to these, there are separate smaller I&C systems that carry out their tasks independently.

The main I&C systems consist of programmable automation technology based on two main technologies: Teleperm XP is used in safety classes 3, 4 and EYT, and Teleperm XS in safety classes 2 and 3. Teleperm XS is an I&C system used at all levels from control room applications to field devices. Teleperm XP is an I&C system, which is designed as a general power plant I&C system. Software failures are avoided in the implementation phase of Olkiluoto 3 by the use of different application development tools and basic programming languages between the two I&C technologies.

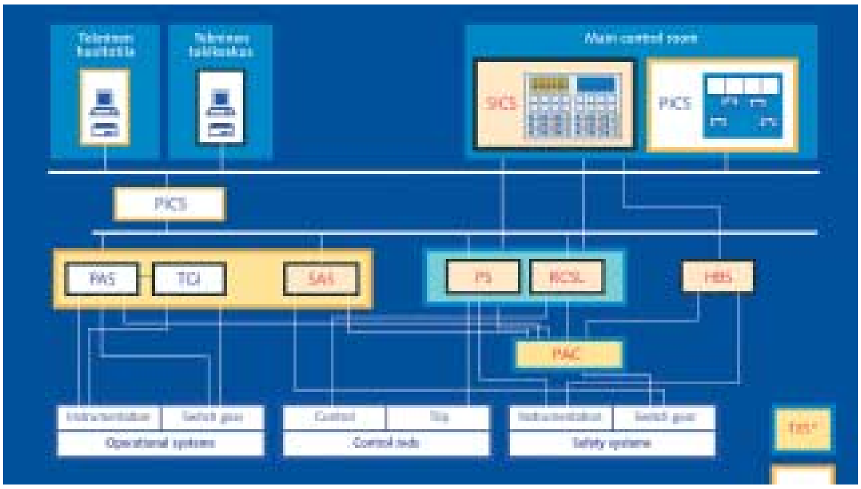
Design extension cases

The design extension functions, which support and validate the protection system functions are performed in a separate I&C for design extension cases. The design extension sequences consist in initiating events with simultaneous multiple failures of safety systems (e.g. due to common cause failures). According to the defence-in-depth concept implemented in the EPR, the design of the plant includes measures against the consequences of such event sequences in order to reduce the probability of severe core damage. The majority of design extension event sequences are mitigated by manual actions or by passive means.

Hard-wired back-up

The hardwired back-up I&C is a system defined in order to prevent core damage in case of total loss of all software-based computerized systems combined with a transient situation or a relative frequent accident event. The design goal of the hard-wired backup I&C system is to stabilize the plant in hot shutdown conditions before recovery of some parts of the normally used I&C.

System	I&C	Safety class
Normal operational measurements and control	Computerized	4
Process I&C for operation	Computerized	4
Management and control I&C for design extension cases	Computerized	3
Control and transient limitation system	Computerized	3
Plant protection system	Computerized	2
Independent hard-wired protection	Hardwired digital	3



Structure of Olkiluoto 3 automation systems (preliminary ideas).

Operator actions

As the foundation of the design of the time delays, which facilitate control, have been incorporated among the EUR fundamental requirements. The protection I&C will take care of the design basis accidents (DBA) for 30 minutes without the operator and 60 minutes without local control actions. The user interfaces for the main control room and remote shutdown station include a non-safety-classified user interface system and a safety-classified user interface system. The system is a combination of computerized I&C and traditional hard-wired control panels.

The operator's actions will be needed after the I&C has executed the protection functions. The error possibilities of the operators are reduced with the use of advanced display technique of the I&C and with state oriented operation procedures, which are used together with screen-based control systems. The control systems system and procedures will also support the analysis of symptoms. In addition to screen-based measurement presentation, the operator of EPR has also a group of independent hardwired traditional instruments. The operator procedures will cover severe accidents including core melt cases.

The OL3 Training Simulator

The Olkiluoto 3 power plant full scope replica training simulator has been acquired as a part of the plant supply. Hence, the Consortium is responsible for its realization. TVO has determined the technical specifications and realization requirements for the simulator based on experiences of simulator training and TVO's existing simulator. Finnish Radiation and Nuclear Safety Authority's (STUK) YVL Guides mandate that the control room personnel of the new plant shall have a full year to train with a plant identical training simulator before the reactor core of the actual plant is loaded. In accordance with this schedule, the simulator shall be built so as to have it in operation in Olkiluoto by the end of August 2007. The main purpose of the simulator is naturally to serve in the training of control room personnel, but it will also be used to prove the acceptability of control room solutions and to verify the adequacy and validity of operating procedures before the plant commission.

The basic qualities of the training simulator encompass the possibility to conduct exercises simulating real plant events and abnormal occurrences, which include all postulated accidents and possible severe accidents such as core meltdown. Additionally, the simulator will be used in emergency exercises, in which "plant data" from the simulator will be transferred to the on site and off site Technical Support Centers for the use of the experts working at these locations.

Canadian software work

The German partner of the Consortium FANP GmbH carries responsibility for the simulator realization. The Canadian sub-contractor L-3 MAPPS (former CAE), an experienced supplier of nuclear power plant simulators, will provide basic equipment, programming and realization. The Siemens company provides the actual control room equipment for both the plant and the simulator. This will consist of both traditional control panels and tables as well as of modern technology computer displays and equipment. The simulator specification, design and programming will take place mainly in Montreal, Canada. Plant control room equipment including computer systems will be assembled by a subcontractor in the vicinity of Leipzig in Germany, where also the final factory tests of the simulator will be conducted. TVO shall participate in the testing phases in order to supervise the tests and in order to learn to both operate and develop the simulator.

New simulator room

As a part of the simulator project, the current training center will be expanded with a new simulator control room and auxiliary facilities. The new facilities shall be built west of the existing simulator part of the training center. The new simulator shall be installed in the summer of 2007 and the basic training will be initiated thereafter. The training will continue up to the commissioning of the plant and from there on as annual refresher training sequences.

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Infrastructure development in the Olkiluoto area

The key values of TVO's operation include safety, reliability, economy and respect for the environment. The values are in good use also when TVO operates the two existing plant unit and, on the same island, builds the biggest nuclear power unit of the world. Olkiluoto 3 is the largest construction site in Finland. During the long outage of the existing units, together with heavy construction works of the new unit, there could be more than 4000 workers on the island. Therefore, also a small part of the whole project: the infrastructure development of the Olkiluoto island has many features and it also needs a lot work.

Olkiluoto is a small island at Eurajoki (6 100 inhabitants) on the west coast of Finland, ca. 20 km from Rauma (38 000) and ca. 50 km from Pori (76 600). Total land area managed by Teollisuuden Voima Oy (TVO) at Olkiluoto is about 8.3 km^2 and water area about 2.6 km^2. The island is very flat with highest point about 18 m from the sea level.

Old and new are changing together

TVO operates at present at Olkiluoto two 840 MW BWR nuclear power plant units, Olkiluoto 1 (OL1) and Olkiluoto 2 (OL2), started in 1978 and 1980 respectively. TVO produces electricity to its the shareholders at cost price. OL1 and OL2 produces almost one fifth of all electricity generated in Finland. In addition to the nuclear power plant at Olkiluoto, TVO is a shareholder in the Meri-Pori coal-fired power plant. TVO has two subsidiaries: Posiva Oy, which is responsible for the final disposal project of spent nuclear fuel, and TVO Nuclear Services Oy that provides services based on TVO's expertise.

A new EPR type, about 1600 MW PWR, nuclear power plant unit Olkiluoto 3 (OL3) is under construction and will be in operation in 2009. Total building volume of OL3 will be 950 000 m^3 compared to 958 000 m^3 of OL1 and OL2 together. Total volume of other buildings managed by TVO is ca 1,3 million m^3 including offices, canteen, warehouses, workshops, training centre, interim storage for spent fuel, accommodation village etc.

Interim storage for spent fuel is in operation and construction of the underground research facility ONKALO was started in 2004 by Posiva (5.5 km long tunnel to ca. 500 meters depth which will be a part of the final repository of the spent fuel). The final repository for operating waste (VLJ) has been in operation since 1992. The bedrock at Olkiluoto is 1800-1900 million years old, solid and favourable for nuclear facilities.

After the investment decision of Olkiluoto 3 in December 2003 the site preparation work was started directly. This included a big amount of upgrading of common infrastructure and systems. Now, after almost two years, the plant supplier has taken over the management of the OL3 construction site after site preparation works made by TVO. Anyhow, upgrading of the infrastructure is still going on.

What is infrastructure?

Infrastructure includes all areas, structures, buildings, systems, functions and legal rights a power plant needs for construction and operation. For a new unit, the existing infrastructure helps to make investment decisions by decreasing investment and operation costs for both new and existing units.

There are different owners and partners on the Olkiluoto area and the effective common planning and use of the infrastructure is one of the key issues in optimizing costs and taking into account the needs of others at time. Functional infrastructure with know-how and supporting data and information systems is an essential part of this wholeness.

What, where and when?

The main purpose of the proactive area planning is to ensure the operational preconditions for the main functions (electricity production and nuclear waste management) and to enhance safety, effectiveness and coordination of activities, environmental aspects, public acceptance etc. The proper local land use planning and area reservation plans to far forward assure that the activities of

TVO's new head office. New visitor centre will be on the peninsula to the right from the wind mill. Foto: Hannu Huovila

today do not hinder functions and construction activities in the future. In the Olkiluoto area, possible new plant units, requirements of the spent fuel final repository facility, grid connections and power supplies etc. must be included in the plans.

The most visible changes when arriving at Olkiluoto are the new main road to the site, new gatehouse, gates, fences, access control system, parking places and the 65 m high tower and 30 m blades of the new 1 MW wind mill. Reactor buildings of the existing units with ventilation stacks and the weather mast are rising up to 100-110 m from the sea level. OL3 construction site together with the operating power plant units sets challenges to manage all safety and security aspects when the daily amount of people especially during OL1 and OL2 annual outages, can rise up to 4 000-5 000 persons.

Major building work has included until now new office places, extension of the canteen, OL3 project office and finally the new head office (150 places for TVO and Posiva), which has been taken in use in March 2005. Also the occupational health centre and regulatory bodies have got new facilities.

Logistical improvements include measures on transport arrangements (jetty, transport ways), contractor support functions (prepared building slots to be hired near the site), controlled conventional waste handling (classification and a new vehicle scale), accommodation facilities (new accommodation village), new telephone exchange and upgrading of telephone/data connections.

New view for visitors

Due to the OL3 construction site and extension of the NPP area, the location of the old visitors centre near the training centre became unpractical for 12 000 - 15 000 annual visitors. The new visit centre will be opened in December 2005 on the peninsula to southeast from existing power plant units with excellent and nice view to the Olkiluoto NPP units.

The facilities in the old visitor centre will be modified and connected to the training centre. All these facilities are needed and used for training activities in the near future. Construction work of the OL3 simulator building (interlinked to the existing OL1/OL2 simulator) will be started in 2006.

The volume of new buildings in 2004-2005 is almost 50 000 m^3 outside the OL3 construction site. In preliminary design phase are at the moment extensions of the central laboratory, warehouses, workshops and the spent fuel intermediate storage.

All units need water and power

Most important of system upgrades carried out are on water supply and sewage water treatment including the raw water pumping station and treatment, connection pipes, new 3000 m^3 fire water reservoir and pump station and extension of sewage treatment plant. Redundancies and capacities (margins) have been improved significantly. The water treatment and demineralization plants will be upgraded in 2006. Increasing the raw water reservoir capacity is under construction.

New visitors centre will be opened in December 2005.

Extension of 110 kV switchgear and new supplies on the Olkiluoto area are already finished. New 110 kV connections to the grid will be in use in the beginning of 2006. 400 kV switchgear extension and connections to grid will be done in 2006-2007. Power lines take electricity in three directions from Olkiluoto to the Finnish national grid.

To increase independent power supplies to power plant units and to add fast power reserve in Finland TVO will construct, together with Fingrid Oyj a Gas Turbine plant (ca 100 MW) located at Olkiluoto. There will connections from gas turbine to 110 kV lines and directly to each plant unit. Electrical connections between power plant units will be also upgraded.

Sharing knowledge

Well working functions and systems developed and certified on the existing site can be applied relatively easily also on a new power plant and other units coming to the same site. This functional infrastructure includes also administrative and technical data and information systems.

Existing systems (for example O&M systems) used at OL1 and OL2 can be applied to OL3 and other plant units (ONKALO, Gas Turbine) in quite good extent only with relatively small modifications compared to the acquiring of new systems.

Cost sharing

Principles to build and use common infrastructure avoiding overlaps have been agreed in separate operation and infrastructure contracts and agreements between different owners and partners. The common goal is open information exchange and fair cost sharing profitable to all partners.

A big step in developing the common Olkiluoto infrastructure is the infrastructure agreement between TVO and Posiva Oy starting 1st January 2005. Both are using and developing the infrastructure together as equal partners.

In a good harmony ahead

Appropriate cooling water conditions, grid connections, infrastructure etc. enable to locate 2-3 additional power plant units to Olkiluoto after OL3. Excavation of tunnels for final repository (ONKALO) is going on, construction of the encapsulation plant will start after 2010 and final repository of spent fuel after 2020... today's land use plans reach up to 2050. The look is in the future.

The good structural and functional infrastructure enhances possibilities to keep Olkiluoto NPP as one of the top level NPP's in the word. Safety, effectiveness and nice local environment shall be in harmony with each other.

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Regulatory oversight during construction

The Radiation and Nuclear Safety Authority (STUK) oversees the construction of the new nuclear power plant Olkiluoto 3 (OL3). General requirements for regulatory oversight during construction are set forth in the Nuclear Energy Decree and defined in detail in several YVL guides.

On-site inspection of OL3 reactor basemat structure.

Regulatory oversight includes both the control of the construction and manufacturing of the Nuclear Power Plant (NPP) and the supervision of the project management. The aim of the oversight is to ascertain that the plant is built according to the design and quality criteria approved in the construction license phase, and that the prerequisites for high quality end result exist and the licensee is getting prepared for the commissioning and operation of the plant. Focus of our oversight is on the plant and its licensee, Teollisuuden Voima Oy (TVO). However, also plant vendor and its sub suppliers are inspected when manufacturing components for the new NPP.

Our focus is on safety

The safety significance of a system, structure or a component is defined by its safety class and it corresponds to the safety function that the system, structure or component performs. Safety class is presented in the safety classification document, which STUK approved in the construction license phase.

Safety classification has an essential role as it defines the requirements to be applied in the design, construction, manufacturing, operation and control of a system, structure or component. Therefore, it also defines the requirements and scope of our control activities. In practise main focus of our control is on the primary system and safety systems and components belonging to safety classes 1 and 2.

Verifying the basic design requirements

In the construction license phase STUK approved the principal design of the plant. At the moment the detailed design of the plant is being finalised. We are currently reviewing the detailed design of the systems, structures and components in order to verify that the basic design requirements and criteria are fulfilled. Manufacturing or construction of structures or components is not allowed prior to our approval. When the manufacturing or construction starts we will perform inspections during manufacturing and construction, installation and commissioning of systems, structures and components.

Construction work at the site is in progress. The detailed design documents submitted to STUK have been successfully reviewed in spite of the tight schedule. To complement our review, the Finnish Technical Research Centre (VTT) and some engineering companies have reviewed design documentation of the containment and safeguard buildings. We will continue by reviewing the design of the buildings and structures being build on top of the base slab. In addition, we have been inspecting the construction and installation of concrete and steel structures of the sea water inlet and outlet and the base slab of the nuclear island.

Prior to the concreting of the safety class 2 buildings and structures we will inspect the prerequisites for concreting. Afterwards the quality records will be reviewed and commissioning inspection performed. In lower safety classes we can use judgement on focusing our inspections and also allow inspection companies perform review and inspections.

The control of the manufacturing of the primary components has been ongoing since the first casts for the Reactor Pressure Vessel forgings were done at the end of 2003. The manufacturing of all primary components has now been started, and we are controlling the manufacturing at all sites.

Our control includes inspections on welding, destructive and non destructive testing manufacturer's inspection activities, etc. Since there are many manufacturing sites all over the world, control of the manufacturing has taken a lot of our resources. When manufacturing is completed, we will perform a construction inspection the approval of which is a prerequisite for a shipping release. Once the components reach the OL3 site, the installation and location plans will be inspected and finally installation and commissioning inspections performed. In safety classes 3 and 4 we will perform only commissioning inspections. All other inspections will be performed by approved inspections organisations. This reduces our work load since majority of the mechanical components belong to safety classes 3 and 4. Due to a large number of manufacturers, approval of manufacturers, testing and inspection organisations has also been a major task.

The oversight of electrical and instrumentation and control (I&C) systems is in progress. TVO has recently submitted the first detailed design documents for our review. After system level approval, the approval process of electrical and I&C equipment will start. Our special interest is on safety class 2 and in safety class 3 (accident instrumentation) systems and equipment.

The documentation showing that the equipment is qualified to intended use is the most essential. Especially the use of programmable technology requires special measures and resources from all project parties. We have contracted VTT and a few foreign experts to help us get assurance on the qualification of programmable technology. Our supervision on the manufacturing of equipment will be decided on a case by case basis. For the most essential equipment and systems we will perform installation and commissioning inspections. TVO will also have to submit the commissioning programmes and the commissioning test results to us for approval.

Licensing of the fuel is a major work during construction. According to current information the licensing will start at the end of this year when TVO will submit the licensing documents and analyses to us for approval. Manufacturing of the fuel will start at the beginning of 2007. We will also supervise the manufacturing process.

Our oversight is guided by the requirements presented in the YVL guides. The

YVL guides have been primarily written for the oversight of operating nuclear power plants, but there is no major difference between the oversight of a plant modification on an operating unit and oversight of a unit under construction. However, since the requirements are very strict it has been very challenging to fulfil them in a construction project where manufacturing takes place at many sites at the same time.

Safety through high quality

Our supervision described above is focused on the "hardware" of the plant. Together with the hardware, an essential part of safety is well managed project implementation aiming at high safety and quality. We have established a construction inspection programme to inspect TVO's project progress and implementation. The inspections can be divided in two categories.

The high level inspections are concerned with TVO's project management, handling of safety issues and quality management (to answer the question if TVO doing the right things). Lower level inspections are concerned with TVO's working processes to guarantee high quality in the end result and TVO's preparedness for commissioning and operation (to answer the question if TVO is doing the things right). Inspections are focused on quality assurance, training, consideration of nuclear and radiation safety, among others.

The construction inspection programme is in operation and we have performed inspections on project management, quality management, training and handling of safety issues. Based on this experience it can be said that the programme is a valuable tool in supervising TVO. Inspection results show that TVO's activities can be further developed. In addition to review of documents and inspection programme, observations from resident inspectors and meetings with TVO on a daily basis give feedback on the results and progress of the project.

Inspections on the plant vendor and its sub suppliers have also been carried out, in the form of an audit performed mostly by TVO, and STUK as an active observer. In some cases it has been necessary to perform our own inspections. These have been focused on the utilisation of PSA in the design, consideration of radiation safety aspects and design activities as a whole. These inspections will be continued if necessary.

Our oversight covers the most significant areas

Our oversight possibilities in the project were carefully examined in the construction license phase. Methods were used in practice in the supervision of primary components. After a few "start-up" problems our oversight process has become familiar to all project parties. Our working possibilities at the construction site have been improved since TVO has established excellent facilities for our inspectors.

Requirements for our oversight are strict and covering. Following all those requirements continue to be a challenge. So far we have been able to meet the challenge very well. To be able to do so also in the future, an open dialog is needed between all parties for timely work and resource planning.

■

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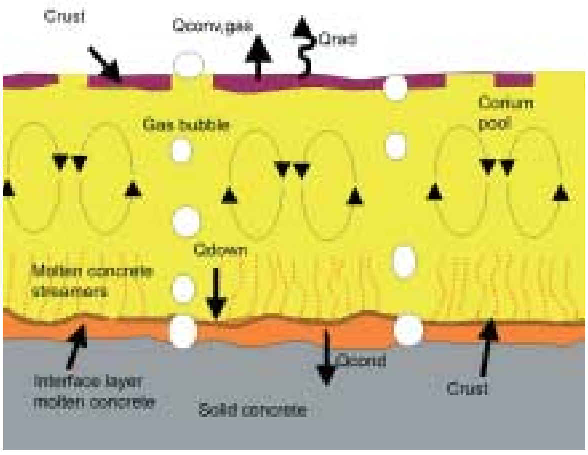
VTT's role in the Olkiluoto 3 project as technical support organisation of STUK

In the construction phase of the Olkiluoto 3 nuclear power plant VTT's role so far has been to support the Nuclear Regulator STUK. VTT's contribution includes deterministic and probabilistic safety analysis, inspection of plant design, materials, component manufacturing, automation systems and fire safety.



The complex heat transfer system during core melt- concrete interaction. The crucial problem is to determine the downward heat transfer Qdown.

In preparing to the treatment of the Construction License, STUK contracted VTT to model the plant behaviour independently. The preparation already started in 2003, but the major task took place in 2004. Four types of plant models were constructed, that aimed at analysis of operational transients, design basis accidents, containment performance and severe accidents. STUK selected a number of accident and transient scenarios for calculation, the results of which STUK then compared to the analyses supplied by the plant vendor and to the acceptance criteria set by the YVL guides.

The models developed and the analyses performed may be regarded preliminary. Now, when the construction license has been granted and the plant construction is well in progress, a lot of more accurate system information is being obtained from the detailed design process. Therefore also the computer models need to be upgraded. This process is under way, and the next goal is to evaluate the Final Safety Analysis Report of the plant, that will be needed for the Operation License.

STUK has also contracted VTT to evaluate material related to the design phase probabilistic safety assessment (PSA) of the plant. Among others the human reliability analysis parts and the risk-informed assessment of the safety classification of the plant were reviewed.

Automation

The application of modern digital automation systems as a part of NPPs safety functions creates demanding tasks for licensing. The main role of VTT in the licensing and evaluation of automation systems has been to support STUK. The analysis of the structure of validation and verification process as well as the automation systems themselves is the basic task in that work.

Material and structural studies

VTT has also contributed to the evaluation of the technical specifications of materials and manufacturing. In the field of Non Destructive Testing (NDT) inspection guides have been evaluated.

VTT has made expert statements on the design requirements and structural analyses of the containment. The ability of the containment to withstand aeroplane crashes has been tested experimentally and analytically.

In the field of fire safety fire compartment analysis and fires in tunnels with cable conduits have been conducted.

Future roles and tasks

The primary role of VTT in the first part of the project has been to support STUK in its licensing process. VTT has collaborated to a minor extent also with the plant operator in some areas where no conflict of interest with the role as the support organization for STUK exists. During future plant operation VTT will act according to the same principles of impartiality and independence.

■

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COLUMN

Riku Mattila

Engineer philosophy

Engineering may be thought of as the art of optimizing resources in a coordinated manner to obtain the desired goal. If time and money were abundant, engineering would lose part of its charm and fade into science. On the other hand, if no scientific skills were needed, designing could be left to economists. Globally, engineering is the least violent approach when increasing desire for consumption meets diminishing natural resources. As a part of this equation, new nuclear power plants are being considered for construction in several countries.

In practise, however, engineering can often be described as navigating towards the goal in a flood of details. Already at the decision-in-principle phase for Olkiluoto 3, items were considered ranging from subatomic phenomena (half-lives of radioactive nuclides) to global scale (climate change). When thinking of the big picture, it is necessary to dismiss the irrelevancies. The skill to do that without getting lost on side-tracks is closely related to the concept of a good engineer.

A nuclear power plant contains tens of interconnected systems and thousands of components. Based on rather a small number of fundamental principles and phenomena, it is one of the most complex machines ever built. Designing a nuclear power plant is an ultimate challenge for the skill of identifying the correct irrelevancies to be dismissed at each stage. The principles of diversity, redundance and separation are a good help, but there are always a number of interconnected interests. A good example is the fuel assembly design, which is a battle ground between reactor physics, fluid dynamics, mechanical engineering and chemistry (and, of course, economics).

It is an important ambition in engineering to make things as simple as possible (but not any simpler). While this rule is usually methodically applied to the design of the hardware, it is for some reasons often less apparent in the documentation. Goethe has been cited once apologizing for a long letter, saying he had not time to make it short. He would probably have made a decent documentation engineer, had he not chosen to waste his life with matters of secondary importance, such as art and philosophy. ■

COLUMN

Olkiluoto 3 – A Macho of the Finnish energy policy

A hundred years ago Albert Einstein taught us that matter can be transformed into pure energy. Albert produced his first theories as a hobby. In the real life he was a licensing authority: an examiner in the Swiss patent office in Bern. Today, OL3 project shows how matter, which comes from France and Germany, can be transformed into nuclear energy.

In civilian life, Einstein also wanted and enjoyed the company of women, and in the beginning of the century, his intellectual celebrity certainly gave him better chances with the American women than to a nuclear physicist today. Today, ladies do not prefer, or even accept, nuclear power or science, therefore, we face industry-wide problems with recruiting competent youngsters to new projects. It will be a big challenge to a relative small country to provide people with knowledge and skills to ensure the safe and effective operation of a new NPP design.

Finland, a small member of the European union, has now started the worldwide renaissance of nuclear power. So far, Finland has been known as the home of modern-day nobles: ice-hockey players and their blond escorts. The cold Finnish climate is the main reason why the Finnish ice-hockey players, as well as the cumulative load factors of nuclear plants, have been among the best in the world.

The cold climate and forest industry -wooden leg of Finland – are the main reasons for why Finland really needs more energy, which should be produced the cheapest possible way. Being a quite flat country, Finland does not have possibilities to build more hydropower and the green political thinking prevents the use of non-renewable, fossil energy sources. The four operating nuclear plant units produce 25 % of all electricity consumption and the share of net import is 6 %. Electricity consumption increased by about 27 % in the 1990s and the trend is quite similar today. Practical Finns give preference to own new nuclear capacity instead of imported electricity produced in an exotic nuclear plant of a neighbouring country.

Finland has also solved the problem of nuclear waste. A preliminary research tunnel for the final repository is going down and OL3 is going up in the Olkiluoto area. The Finnish solution has been country-wide accepted and peaceful in comparison with Yucca Mountain in California, where the Greens have fought against the work and the licensing process and papers seem to be missing from time to time. Of course, also in Finland, the waste process needs a lot of resources and paper work. Sometimes also the texts inside the documents are written like an official information bulletin of sexual relationships for teenagers. You all know what I mean: A lot descriptive words and roundabout expressions, but the real description were you find the touchable emotions and the practical execution is missing.

In fact, we can describe the story of nuclear power as follows: How many nuclear engineers does it take to change a light bulb? Real answer: Seven – One to install the new bulb, two to make the analysis for licensing the modification work, *Olli Nevander*

two to make quality reviews of the work and work procedures, and finally two to analyse how the old bulb is stored for the next 10 000 years.

OL3 project is going on and foreigners are walking in the narrow streets of Rauma. Prices of some consumables have gone up and hotels and restaurants have got new eager customers. However, the streets of Rauma are still very quiet and there are no signs visible of the Finland's biggest construction site, only 20 km from there. The construction worker today doesn't spend his free time with strong wine and easy women. The modern worker only works every day and in the evenings he uses internet connections and his mobile phone to contact his family at home.

The Finnish regulator has reinforced their resources and worked beside the construction project to get statements and applications ready on time. The practical competence of the Finnish regulator is on a very high level in comparison with many other countries. The good practical knowledge gives the Finnish authority a possibility to understand and approve EPR safety solutions in a very tight time schedule. As a disadvantage, we can mention that sometimes a very competent regulator weakens the quality and visibility of the application documents written by the utility. The open relationships between the experts of the regulator and the utility are sometimes a big surprise for a foreigner.

We can look from the point of view of the society and economy justifiably. The fact that the licensing process of the power plant will take about ten years but a Member of Parliament will get his pension after having suffered at least seven years in the legislative work.

The biggest project in Finland produces various kinds of research information but the technical sponges are inevitable. The Finnish culture includes that a real man does not praise his doings. This Finnish tradition leaves room for foreigners to use "big mouth talks", which belongs to many cultures. However, a worldly-wise lady from East-Europe verbalised this very pertinently: "A Mediterranean man has towering words but he is small in the act, Finnish man has few words but excellent completion." We all hope that this kind of cultural features will not start to cover or even be visible in the Olkiluoto 3 project. ■

TAPAHTUMAKALENTERI

Säteilevät Naiset -seminaari 20.9. 2005, Säätytalo, Helsinki
"Energiasta jätettä – jätteestä energiaa"
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YG:n opiskelijainfo 22.9.2005, Teknillinen korkeakoulu, Espoo
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Jäsenkokous 28.9.2005, Tieteiden talo, Helsinki
Aihe: Ydinvoimalaitosten ohjausmenetelmien automaatio
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Ulkomaan ekskursio 9.-15.10.2005, Venäjä
Ekskursiokutsu lähetetty 16.8.2005
Lisätietoja: Pekka Nuutinen,
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Syysseminaari 23.11.2005, Hotelli Linna, Helsinki
Aihe: Energiantuotannon tulevaisuuden näkymät Venäjällä, Kiinassa ja Ranskassa
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Lisätietoja kaikista ATS:n tapahtumista löytyy internetistä: www.ats-fns.fi.

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VARSINAISET JÄSENET

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Suomen Atomiteknillisessä Seurassa oli 2.9.2005 pidetyn johtokunnan kokouksen jälkeen 627 varsinaista jäsentä ja 47 nuorta jäsentä eli opiskelijaa. Kunniajäseniä oli 10 ja kannatusjäseniä 20. Seuran jäseneksi pääse johtokunnan hyväksymällä hakemuksella. Hakemukseen tarvitaan kahden jäsenen suositus. ATS:n jäsenhakemus internetissä: http://www.ats-fns.fi/info/jasenhakemus.pdf.

SUOMEN
ATOMITEKNILLINEN
SEURA —

ATOMTEKNISKA
SÄLLSKAPET
I FINLAND ry

Kannatusjäsenet

Alstom Finland Oy
Fintact Oy
Fortum Oyj
Kemira Oy, Energia
Patria Finavitec Oy
Platom Oy
Pohjolan Voima Oy
Posiva Oy
PRG-Tech Oy
Pohjoismainen Ydinvakuutuspooli
PrizzTech Oy
Rados Technology Oy
Saanio & Riekkola Oy
Siemens Osakeyhtiö
Soffco Oy Ab
Teollisuuden Voima Oy
TVO Nuclear Services Oy
VTT Prosessit
VTT Tuotteet ja tuotanto
YIT Installaatiot

ATS internetissä:

http://www.ats-fns.fi