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ATS:n TOIMIHENKILÖT

MAAILMAN ENERGIAKONFERENSSIN SANOMA: TARVITSEMME YDINENERGIAA

Syyskuussa tänä vuonna pidettiin Münchenissä joka kolmas vuosi uusiutuva Maailman Energiakonferenssi (W.E.C.). Kokous voidaan luonnehtia varsin huomattavaksi energiatilanteen katselmukseksi. Paitsi noin 80 jäsenmaan kansallisia raportteja käsiteltiin niitä selvitystuloksia, mitä W.E.C.-organisaation noin 10 ad-hoc komiteaa lähes 300 asiantuntijan voimalla oli aikaansaanut viimeisten kolmen vuoden aikana.

Keskeisenä teemana oli maailman energiatase ja sen kehittyminen vuoteen 2020 mennessä, eli kuinka energian tarve ja tuotanto voidaan saada tasapainoon. Tässä probleemassa tulee näet tuotannon aikatekijä huomattavana "pullonkaulana" eteen kuten samoin infrastruktuurin luomisen ja markkinoiden sopeutumisen hitaus, ympäristösuojelun vaatimukset, taloudelliset ja poliittiset esteet ym.

Varsin tärkeä toteamus on kehitysmaiden energiantarpeen odotettavissa oleva valtava kasvu, johtuen osittain suuresta väestönkasvusta näillä alueilla ja osittain kehitysmaiden oikeutetuista pyrkimyksistä korkeampaan elintasoon. Yksityiskohtaisen analyysin tulokset voidaan tiivistää seuraavasti:

	1976			2020		
	Asukasluku mrd	Energia per capita toe	Energian tarve mrd.toe	Asukasluku mrd	Energia per capita toe	Energian tarve mrd.toe
Teollisuusmaat	1.1	4.4	5.0	1.5	6.4	9.6
Kehitysmaat	3.0	0.6	1.7	6.8	1.5	10.4
Koko maailma	4.1		6.7	8.3		20.0

Kehitysmaiden tarve on lähinnä tyydytettävä öljyllä, joka vaatii vähäistä jakeluorganisaatiota ja on helppo käyttää. Kuitenkin maailman öljyvarat ovat rajalliset ja öljyn tuottajamaat eivät voi eivätkä aio lisätä tuotantoaan, joka nykyisestä 3,5 mrd.ton/v voi nousta vielä 4 mrd:iin lähivuosina, jonka jälkeen se vähenee. Maakaasu seuraa samaa kehitystä vain 20 vuotta jäljessä. Nämä tosiasiat jättävät huomattavasti pienenevän öljymäärän teollisuusmaiden käyttöön, josta vielä osa menee öljyspesifiikkiseen kulutukseen (petrokemia ja liikenne).

MITEN TÄMÄ YHTÄLÖ VOIDAAN RATKAISTA ?

W.E.C. esitti scenaarion, jossa ratkaisu löytyy. Todetaan, että kaksi energialähdettä on teknisesti valmiina yhdessä ottamaan tämän haasteen, so.

- Kivihiili, niin suuressa määrin kuin aikatekijät sallivat. Pulmakysymyksinä SO_2, CO_2 ja lentotuhkan haitalliset aineet
- Ydinenergian laajamittainen käyttö teollisuusmaissa. Pulmana on yleisön suhtautuminen ja ydinaineiden käytön estäminen sotilaallisiin tarkoituksiin

Näiden lisäksi on tietenkin myös kehitettävä pienempien lähteiden käyttöä, joilla on paikallista merkitystä (vesi- ja geoterminen energia), uutta teknologiaa (öljysynteesit, öljyliuske ja öljyhiekka), uusiutuvien lähteiden käyttöä kaupalliselle tasolle (aurinko, tuuli, biomassa) sekä energian säästöteknologiaa.

Maailman tulevaisuuden energianhuolto on ratkaistavissa, mutta se vaatii koordinointia ja poliittista tahtoa kaikkien osapuolten, niin teollisuus-, kehitys- kuin öljyntuottajamaiden taholta (vaihtoehto: puute ja kaaos). Jokaisen on kannettava kortensa kekoon, ja teollisuusmaiden osalle tulee mm. ydinenergian laajamittainen ja nopea kehittäminen.

Sven O. Hultin

14.7.1980 1 (4)

SUOMEN ATOMITEKNILLISEN SEURAN LAUSUNTO
YDINENERGIALAKITOIMIKUNNAN OSAMIETINTÖÖN I

Suomen Atomiteknillinen Seura esittää pyydettynä lausuntona kunnioittaen seuraavaa.

1
LAUSUNNON LAATIMISEN TAUSTA

Vuonna 1966 perustetun Suomen Atomiteknillisen Seuran tarkoituksena on edistää ydinenergian käyttöä Suomessa toimimalla alalla toimivien henkilöiden yhdyssiteenä ja välittämällä alan tietoa jäsenilleen ja ulkopuolisille. Seuraan kuuluu tänä päivänä runsaat 400 henkilöä eli valtaosa Suomessa ydinenergia-alalla toimivista asiantuntijoista. Seura on pyrkinyt perustamaan lausuntonsa jäsentensä ydintekniikan asiantuntemukselle ja kokemukselle riippumatta jäsenten taustayhteisöistä.

Lausunnon laatimista varten Seuran johtokunta on pyytänyt koko jäsenkunnalta jäsenkirjeessä kommentteja mietinnöstä, asettanut työryhmän, joka laati lausuntoehdotuksen, sekä kokouksissaan käsitellyt ja hyväksynyt lausunnon.

Seura ei ole osallistunut lakitoimikunnan työhön eikä toimikunta ole kuullut Seuraa mietintöä valmistellessaan.

2
YDINENERGIAN ASEMA MAAILMASSA JA NYKYTILA

Energian tuottaminen ydinenergialla on vakiinnuttanut paikkansa tänä päivänä eräänä mahdollisuutena vastata maailmanlaajuisesti yhä lisääntyvään energiankysyntään. Lukuisissa maissa ollaankin käyttämässä ja rakentamassa yhä lisää ydinvoimaa huolimatta siitä, että toisaalta eräissä maissa osittain puutteelliseen tiedon välitykseen ja tiedon tasoon sekä sosiaalisiin ja poliittisiin ongelmiin liittyen ydinvoiman käyttöön on kohdistunut laajaakin vastustusta.

Tämän vastustuksen ja liikehdinnän perussyyt ovat pääasiallisesti olleet muualla kuin puhtaasti ydinenergian käytön tekniikkaan ja turvallisuuteen rationaalisesti liittyvissä seikoissa. Joissakin maissa vastustajat ovat pyrkineet käyttämään lainsäädännössä olevia valitusmahdollisuuksia ja epätarkkuuksia hyväkseen ja onnistuneetkin näin hidastuttamaan ydinvoimaohjelmien toteuttamista.

3 TAVOITTEET YDINENERGIALAINSÄÄDÄNNÖLLE

Suomen Atomiteknillinen Seura katsoo, että ydinenergialainsäädännön tulee luoda selkeät puitteet ydinenergian hyväksikäytölle siten, että ydinenergia asetetaan tasavertaiseen asemaan muihin energiamuotoihin nähden. Samalla on taattava viranomaisille riittävä valvontamahdollisuus, jotta kansalaisten turvallisuus taataan ja ydinenergian tuottamisesta aiheutuvat riskit pidetään pieninä verrattuina muihin yhteiskunnassa esiintyviin riskeihin.

Lainsäädännön on otettava huomioon ydinenergia-alan piirissa tapahtuva nopea kehitys. Toisaalta lainsäädännössä ei pitäisi näkyä liian selvästi erilaisten mielipiteiden kausivaihteluita. Lain tulisikin olla luonteeltaan pitkäaikaisesti käyttökelpoinen ja joustava puitelaki, jota täydennetään asetuksilla ja muilla alemmanasteisilla säännöksillä. Suomalaisen ydinenergialainsäädännön on sopeuduttava sekä Suomen olosuhteisiin että Suomen asemaan ydinenergian käytön kansainvälisessä kentässä.

Suomen tekemillä kansainvälisillä sopimuksilla on huomattava vaikutus kansalliseenkin toimintaan. Toisaalta on todettava, että Suomen ydinvoimalaitosohjelma on kansainvälisesti pieni, vaikkakin kansallisesti merkittävä, sekä ajallisesti huomattavasti myöhemmin käynnistynyt kuin ydinenergian pioneerimaissa. Tutkimus-, kehitys- ja suunnittelutyössä Suomessa ei ole alaan suunnattu suuria resursseja vaan pyritty hankkimaan tänne ulkomaista tietoa ja taitoa.

Erityisesti ydinenergia-alan turvallisuutta leimaa tietty konservatiivisuus, pyritään pitäytymään tunnettuihin ratkaisuihin. Sama ohje pitäisi ottaa myös lainsäädännössä huomioon.

4 YLEISKOMMENTIT MIETINNÖSTÄ

Toimikunta on Seuran mielestä tehnyt perusteellista työtä ja saanut aikaan seikkaperäisen lakiehdotuksen perusteluineen.

Johdantotekstiin ja perusteluihin on jäänyt, mahdollisesti kiireestä johtuen, epätäsmällisiä sanontoja ja jopa suoranaisia asiavirheitä.

Voimassa olevaan lakiin verrattuna ehdotus korostaa ydinenergian käytön valvontaa. Ydinenergian käytön muut näkökohdat kuten koulutus ja tutkimus sekä ydinenergian käyttöön olennaisesti liittyvät kansainväliset yhteydet, on jätetty täysin huomiotta. Nämä näkökohdat tulisi ottaa mukaan ainakin vastaavassa muodossa kuin nykyisessä laissa.

Korostettaessa ydinenergian käytön valvontaa tulisi samalla selvittää ydinenergialainsäädännön suhde säteilysuojelulainsäädäntöön. Tässä yhteydessä tulisi Seuran mielestä huolehtia siitä, että myös ydinpolttoainekierron alkupäähän liittyvät toiminnat tulisivat lainsäädännössä asianmukaisesti käsitellyiksi.

Ehdotuksen rungoksi toimikunta on luonut uusia käsitteitä ja määritelmiä, kuten esimerkiksi "ydinenergian käyttö", joka poikkeaa arkikielessä käytetystä tai "ydinlaitos", joka ei ole aikaisemmin tunnettu ja jolla ei ole kansainvälistä vastinetta. Näiden käyttöä on puolustettu lakiteknisillä perusteilla. Seuran käsityksen mukaan olisi pitäydyttävä tunnetuissa käsitteissä ja määritelmissä, jotta tahattomat tai jopa tahallisetkin väärinkäsitykset vältettäisiin.

Keskeisen kohdan esityksestä muodostaa toiminnan pitäminen laajasti luvanvaraisena ja lupakäsittelyn siirtäminen hallinnollisesti ylöspäin sekä vapaa harkinta kaikissa lupien myöntämisvaiheissa ja -tasoissa. Seuran mielestä ydinenergialainsäädöksillä ei tulisi epätarkoituksenmukaisesti ja keinotekoisesti hankaloittaa alan normaalia toimintaa, jota tulisi säädellä Suomessa muilla aloilla voimassaolevan viranomaiskäytännön mukaisesti hakijan ja alan erityisviranomaisen välillä niin, että lupa on myönnettävä, jos hakija täyttää asetetut vaatimukset. Valtioneuvoston tasolla tapahtuvaa harkintaa tulisi käyttää ainoastaan suurten ydinvoimalaitoshankkeiden alkuvaiheessa tehtävän periaatepäätöksen yhteydessä.

Toimikunnan ehdotuksessa on myös ydinenergia asetettu muita energiamuotoja huonompaan asemaan siinä suhteessa, että vaikka toimintaa rajoitettaisiin tai jopa se kiellettäisiin luvan haltijasta riippumattomista syistä, ei korvausta ilman muuta maksettaisi.

Seura ei pidä tarpeellisena soveltaa Suomen käytäntöön nähden uutta julkista, osanotoltaan rajoittamatonta kuulemistilaisuutta. Tällaiset "public hearings" -tilaisuudet eivät Seuran käsityksen mukaan edistä tarkoituksenmukaisella tavalla lähiseutujen asukkaiden mielipiteiden esille tuloa mutta antavat mahdollisuuden julkisuuden väärinkäyttöön ja saattavat johtaa epäasialliseen julkiseen väittelyyn.

Edelleen Seura on kiinnittänyt huomiota ehdotettuihin yleisiin periaatteisiin, joista tärkeimmät ovat Suomessa uusi käsite "yhteiskunnan kokonaisetu" ja turvallisuustason määritelmä. Seuran mielestä olisi pitäydyttävä tunnettuun käsitteeseen "yleinen etu" ja yritettävä pysyä ns. ALARA-periaatteessa, jota paremmin vastaa prof. Vuorisen eriävässä mielipiteessään esittämä teksti.

Seura katsoo myös, että lakiehdotuksessa ja mietinnössä on tarpeettoman voimakkaasti korostettu ydinaseiden leviämisen estämistä. Suomen olosuhteissa pitäisi riittää viittaukset kansainvälisiin sopimuksiin ja niistä aiheutuviin velvoitteisiin.

Lakitoimikunta ei ole selvittänyt, kuinka uudet säännökset vaikuttavat Suomessa jo käytössä tai käyttöönotossa olevien reaktorilaitosten lupatilanteeseen. Seuran mielestä tulisi siirtymäsäännöksillä selvittää tilanne siten, että uusi lainsäädäntö ei heikennä näiden toiminnan ja ydinjätehuollon edellytyksiä.

Yksityiskohtaisemmat pykäläkohtaiset kommentit Seura on esittänyt liitteessä.

5
SEURAN KANNANOTTO

Edellä esitettyyn viitaten Suomen Atomiteknillinen Seura katsoo, ettei toimikunnan esittämä lakiehdotus ole riittävän kypsä ja harkittu annettavaksi eduskunnalle. Koska kyseessä on näin mittava uudistustyö, pitäisi Seuran mielestä lakiehdotuksen valmistelua jatkaa ottaen huomioon mm. edellä esitetyt periaatteet ja kommentit samanaikaisesti kun valmistellaan ehdotusta ydinjätelaiksi.

Sen jälkeen tulisi vielä näin laaditut lakiehdotukset yhdessä asetusluonnoksineen saattaa lausuntokierrokselle ennen eduskunnalle annettavia lakiesityksiä. Seura on valmis antamaan kannanottoja asiasta valmistelutyön edistyessä.

LIITE Yksityiskohtaiset kommentit ydinenergialakitoimikunnan osamietintöön I. Suomen Atomiteknillinen Seura, muistio 14.7.1980.

Olli J. A. Tiainen
ATS:n nimeämä ENS:n
Steering Committeen jäsen

ENS:N STEERING COMMITTEEN KOKOUS 13.9.1980 MÜNCHENISSÄ

1 Yleistä

Vuonna 1975 perustettu European Nuclear Society (ENS) on Euroopan eri maiden ydinteknillisten seurojen yhteiselin. ENS:n tarkoituksena on mm. edistää ydinenergia-alan kehitystä ja tiedonvaihtoa sekä harjoittaa julkaisutoimintaa. ENS:ssä on 15 perustajajäsentä, joista yksi on Suomen Atomiteknillinen Seura (ATS). Steering Committee on ENS:n hallintoasioita käsittelevä komitea. Allekirjoittanut on ATS:n edustaja ENS:n Steering Committeessa.

ENS:n Steering Committee piti tämän vuoden toisen kokouksensa Münchenissä lauantaina 13.9.1980. Müncheniin oli myös kaavailtu ENS:n yleiskokouksen (General Assembly) pitämistä ENS:n sääntöjen ja toimintaohjeiden muuttamiseksi sellaisiksi, että Euroopan ulkopuoliset ydinteknilliset seurat voisivat osallistua ENS:n toimintaan liitännäisjäseninä (associate member). Muutoksiin liittyy myös muutamia käytännön esille tuomia tarkistusvaatimuksia. Muutosehdotusten lopullinen kaikkien jäsenseurojen hyväksyttävissä oleva muoto ei ennättänyt kuitenkaan valmiiksi. Näin sääntömuutosten hyväksyminen siirtyy keväällä 1981 pidettävään yleiskokoukseen. Vireillä olevan sääntömuutosasian vuoksi mitään uusia henkilönimityksiä ei tehty.

2 ENS:n Steering Committeen kokous

2.1 Osanottajat ja käsitellyt asiat

Münchenin kokouksessa 13.9.1980 oli edustajia lähes kaikista ENS:n jäsenseuramaista. Poissa olivat ruotsalaisen ja kreikkalaisen seuran edustajat. Kokouksessa oli paikalla myös ENS:n muiden, Steering Committeelle asioita valmistelevien, komiteoiden puheenjohtajia esittelemässä komiteoidensa saavutuksia. Lisäksi kokoukseen osallistuivat ENS:n tilintarkastajat.

Käsiteltävinä asioina olivat esityslistan hyväksyminen, edellisen Berliinissä 25.3.1980 pidetyn Steering Committeen kokouksen pöytäkirjan hyväksyminen, ENS:n puheenjohtajan italialaisen prof. Carlo Salvettin katsaus ENS:n toimintatilanteeseen, ENS:n uuden Bernin toimiston tehtävät, ENS:n sääntöjen ja toimintaohjeiden muuttaminen, Eurooppaparlamenttia varten tarkoitettu informaatiotoimisto Strassburgissa, ENS:n komiteoiden puheenjohtajien raportit ja komiteoiden tehtävät, uudet

ENS:n tukemat ydinteknilliset kokoukset, maailman ydinteknillisten seurojen yhteistyö (mahdollisesti uuden yhteistyöjärjestön International Union of Nuclear Societies, IUNS puitteissa) ja muut asiat.

2.2 Edellisen kokouksen pöytäkirja ja uudet ENS:n jäsenet

Edellisen kokouksen pöytäkirjan tarkastamisen yhteydessä otettiin esille Jugoslavian ydinteknillisen seuran (ETAN:in jaosto) jäsenhakemus ENS:lle. Hakemuksensa tueksi Jugoslavian ydinteknillinen seura oli liittänyt käännöksen säännöistään. Allekirjoittanut puolsi jäsenyyttä ja esitti samalla, että nykyistä voimakkaammin pyrittäisiin saamaan myös Euroopan sosialistisia maita mukaan ENS:n toimintaan. Päätettiin, että jugoslavialainen seura hyväksytään jäseneksi, mikäli kukaan Steering Committeen jäsenistä ei lähitulevaisuudessa esitä vastustavaa kantaa tutustuttuaan sääntöihin perusteellisesti. Sosialististen maiden liittymisen kohdalla esitettiin huolta siitä, että ydinteknilliset seurat saattavat olla valtion hallinnon alaisia.

Jäsenasioiden kohdalla todettiin, että Euroopassa on suuntauksena maiden omien ydinteknillisten seurojen perustaminen. Täten tietyissä maissa toimivien American Nuclear Societyn (ANS) jaostojen merkitys pienenee. Tämä on ENS:n kannalta toivottava suuntaus. Esimerkkinä suuntauksesta on kansallisen seuran perustaminen äskettäin Itävaltaan.

2.3 ENS:n puheenjohtajan raportti ja sääntömuutosasia

Ensimmäisenä asiana puheenjohtajan raportissa käsiteltiin ENS:n toimistotehtävien antamista Bernissä sijaitsevalle General Accounting Company Ltd:lle (ATAG). ATAG:n toimintoihin, joita käsiteltiin myös omana kohtanaan, kuuluvat maksuliikenteen hoito, kirjeenvaihdon hoito ja talouden seuranta. ENS:n puheenjohtaja avustajineen hoitaa suoraan Roomassa puheenjohtajalle kuuluvat asiat. Rahoitustilanne todettiin tyydyttäväksi, vaikka neljällä jäsenseuralla oli maksamattomia jäsenmaksuja. Kaksi tapausta selvinnee sillä, että ENS lähettää muodoltaan pyydetyn jäsenmaksulaskun. Kaksi muuta maksamattomuustapausta johtunevat seurojen taloudellisista vaikeuksista. Suomen ATS:n jäsenmaksujen maksamisen moitteettomuus todettiin positiivisena. Sen sijaan pahoiteltiin sitä, ettei Suomesta ole ENS:n kannatusjäseniä. Vm. seikka johtuu ATS:n pidättyvästä kannasta ENS:n kannatusjäsenkysymyksen eteenpäinviemisestä Suomessa.

ENS:n sääntö- ja toimintaohjemuutoksien lopullinen muoto on lähes valmis. Suunnittelukomitean tekemiä muutosehdotuksia olivat etukäteen kommentoineet saksalainen yhdistys KTG, englantilaiset yhdistykset BNES ja I Nuc E, italialainen SNI ja ATS. Muutosehdotus on periaatteessa kaikkien mielestä paikallaan. Kommenteissa toivotaan lähinnä kieliasullisia korjauksia. Ennen kokousta allekirjoittanut keskusteli mm. ENS:n suunnittelukomitean puheenjohtaja Dr. G. Brownin kanssa. Keskustelussa tuli esille, että on hyvä sääntöihin kirjoittaa periaate, että varsinaiset jäsenet voivat olla vain eurooppalaisia ja euroopan ulkopuoliset vain liitännäisjäseniä.

2.4 ENS:n komiteoiden puheenjohtajien raportit ja niihin liittyvät asiat

Raha-asioiden komitean (Finance Committee) puheenvuorossa toivottiin kannatusjäsenten hankkimismenettelyjen selkeyttämistä niin, että kannatusjäseniä tulisi kaikista maista, joissa on ENS:n jäsenseuroja. Allekirjoittanut kertoi ATS:n aikaisemminkin esittämän kannan, että yrityksiltä haettava tuki koottaisiin jäsenseurojen välityksellä. Näin vältyttäisiin ristiriidoilta, jotka syntyvät kun jonkin yrityksen tukea toivotaan erikseen kansalliselle ja eurooppalaiselle seuralle. Allekirjoittaneen mielestä ENS:n kannatusjäsenkysymykseen täytyy edelleen Suomessa suhtautua varovasti, jottei kavenneta ATS:n tuloksellisiksi osoittautuneita toimintamahdollisuuksia.

Informaatiokomitea (Information Committee) suunnittelee ENS:n kannaottojen julkaisemista ajankohtaisista asioista. Seuraava kannanotto koskenee ydinjätteiden mereen upotusta. Kannanotot julkaistaan Steering Committeen jäsenten ne hyväksyttyä. Allekirjoittanut kertoi informaatiokomitean puheenjohtajalle tri B. Pellaudille ATS:n informaatiokirjasen julkaisemisesta ja antoi hänelle kappaleet "Energiahuolto ja ydinenergia"- ja "Energiförsörjning och kärnenergi"-kirjasta.

Informaatiokomitean ja julkaisukomitean (Publication Committee) yhteisenä asiana käsiteltiin uudentyyppisen ENS-tiedotteen julkaisemista. Lisäksi keskusteltiin American Nuclear Societyn ja ENS:n yhteisestä Nuclear Technology -lehdestä. Lehdelle toivotaan lisää kirjastotilauksia sekä kirjoittajia ENS:n piiristä.

Ohjelmatoimikunta suunnittelee uusia kokouksia sekä Eurooppaan että Yhdysvaltoihin. Ensi vaiheessa Eurooppaan tulisivat kokoukset, jotka käsittelevät käyttöhenkilökunnan koulutuksen merkitystä

turvallisuudelle sekä turvallisuutta ja reaktoriautomaatiota. Ensimmäinen kokous päätettiin antaa Espanjalle keväällä 1982 ja jälkimmäinen Iso-Britanniaan. Lisäksi päätettiin ENS:n tuesta American Nuclear Societyn syksyllä 1981 New Yorkissa järjestämälle riskikonferenssille. Muiden lähinnä polttoainekiertoa koskevien kokousten kohdalla oltiin varovaisia, ettei vaaranneta keväällä 1983 Brightonissa järjestettävää suurta ENC'83-konferenssia. Tämän konferenssin järjestäminen alkaa piakkoin järjestelykomiteoiden nimeämisellä.

2.5 Yleismaailmallinen ydinteknillisten seurojen yhteistyö

ENS:n Steering Committeen jäsenille esitettiin jo ennen Münchenin kokousta luonnos maailman ydinteknillisten seurojen yhteiselimeksi (International Union of Nuclear Societies, IUNS). Asiaa on viety eteenpäin lähinnä yhdysvaltalaisten toimesta. Yleiset kannanotot asiasta olivat Steering Committeen kokouksessa varauksellisia. IUNS:sta lähetetään pian ENS:n seuroille lisämateriaalia, johon pyydetään kansallisten seurojen kommentteja. Allekirjoittaneen käsityksen mukaan, jos tällainen yleismaailmallinen elin perustetaan, on vaadittava, että sen hallinnossa ovat edustettuina itse kansalliset seurat. Jos kansalliset seurat ovat edustettuina maanosa-alueellisten yhteiselinten kautta, tulevat vaikutusmahdollisuudet liian pieniksi. Jos yleismaailmallinen järjestö perustetaan, täytyisi ENS:n asema, tehtävät ja tarpeellisuus harkita uudelleen.

3 Muuta

Seuraavaa ENS:n Steering Committeen kokousta kaavaillaan Firenzeen 8.5.1981. Samana päivänä pidettäisiin myös yleiskokous (General Assembly). Steering Committeen kokouksen jälkeen allekirjoittanut keskusteli Espanjan ydinteknillisen seuran (Sociedad Nuclear Espanola) edustajan Miguel Barandiarán Alcortan kanssa ATS:n mahdollisuuksista tutustua Espanjan ydinenergiateollisuuteen syksyllä 1981. Mahdollisuudet näyttävät hyviltä, joten sovittiin menettelyistä, joilla tutustumismatka-ajatusta voidaan viedä eteenpäin. Vuotuiset tutustumismatkat ulkomaiden energia- ja ydinenergiaalan kohteisiin ovat kuuluneet ATS:n toimintaan.

Olli J. A. Tiainen
Dosentti, tekniikan tohtori
ATS:n kansainvälisten asioiden sihteeri

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Decommissioning of the Nuclear Ship OTTO HAHN

After more than ten and a half years successful operation, the nuclear ship OTTO HAHN will be dismantled. The ship and its nuclear steam generator were built by the shipyard "Kieler Howaldswerke AG" and the companies INTERATOM and Deutsche Babcock and Wilcox, in the years 1962-1968, in cooperation with the GKSS-Research Centre Geesthacht. Since then it has been used as an ore carrier, mainly for the transport of iron ores, phosphates and coal. Extensive research work has been performed on board ship to gain experience with its self-pressurised reactor (PDR), first of its kind.

Thirty three different ports have been visited in twenty two countries even though a general international agreement on port licensing has not yet been reached. The decision for not installing a third core was taken because most of the experience needed to build a larger prototype nuclear ship had been already obtained. It is the first time for a nuclear ship such as the OTTO HAHN to be completely dismantled, and a major test programme for functional tests and materials research on the main reactor components after a long period of operation can be performed after dismantling.

Prof D Bünemann, GKSS

Editor's Note The writer of this editorial is modest about the part played by the team of reactor physicists he leads at Geesthacht in the design and analysis of the OTTO HAHN. Her laying up means that until the Japanese ship is fully commissioned, there are no civilian nuclear ships now operating other than the USSR icebreakers. Both the OTTO HAHN and her eponymous physicist will be remembered for the distinguished work they did in the nuclear field.

THE SWEDISH REFERENDUM

A Convincing Victory for the 12 Reactor Programmes **58.1%** *versus* **38.6%**

The recent Swedish referendum followed the crippling of the Swedish nuclear industry, cost the country some $G2 due to the two years delay in commissioning 6-7 nuclear plants and resulted in a far from optimal energy policy with damaging international consequences. The industrial disputes that took place shortly after the nuclear referendum are evidence that Sweden needs to think long and carefully about how it is to maintain its enviable standard of living.

The results of the Referendum.

At a voting attendance of 74.5% (which can be compared with the 90.7% turnout for the general election last fall), 18.7% voted for Alternative 1 (the Conservative backed most pronuclear alternative), 39.3% voted for Alternative 2 (the 12 reactor programme of the Social Democrats and Liberals), 38.6% voted for Alternative 3 (put forward by the Centre Party and Communists and was essentially NO to nuclear power) and 3.3% voted blank in protest at the Referendum. Alternatives 1 and 2 therefore represented the YES to nuclear power with Alternative 2 coming out as the winner. This alternative stressed the point that the 12 current reactors will be phased out when they have served their useful lives of 25 years. It stresses also the need to socialize major power installations (although, of the existing nuclear plants, only Oskarsham has a private share majority).

It was particularly interesting to note that 67% voted pronuclear at Oskarsham itself and over 70% around Baresback, the plant the opposition wants to close first because of its nearness to to Malmo, Lund and Copenhagen. The Referendum showed generally that large cities were more positive to nuclear power (and therefore to nuclear district heating).

The party leaders and campaign managers were interviewed right after the results were available late on March 23. The interview disclosed that Falldin will remain Prime Minister with his government committed to the 12 reactor programme and that all party leaders except Rohman (Conservative) stressed their determination to phase-out nuclear power within twenty five years.

Reino Ekholm has provided us with this brief summary of the Swedish Referendum. A regular correspondent for the Newsletter, Mr Ekholm is a past president of the Local Section of the ANS in Central Europe (member of the ENS) and Technical Coordinator of the OECD-NEA coordinated Gas Cooled Fast Reactor project

INTERNATIONAL NUCLEAR ISSUES - THE NEXT TEN YEARS

by M. Achille Ferrari

I will go straight to my subject. The content may seem restrictive, being limited to France's nuclear situation, but the steady development of nuclear energy in France while the rest of the industrial world is still under doubt and hesitancy, is in itself an International Nuclear issue.

I shall first recall that France posses very limited indigenous fossil energy resources. These amount to a few years of consumption only, less than five. French people have been, for long, aware of this situation if we except the ten years of oil euphoria.

But the 1973 shock reminded us of the fragility of the oil source; we became aware that no law of nature states that oil has to be cheap and inexhaustible, contrary to the illusions that spread out in the '60s.

The oil crisis gave rise to an acceleration of our nuclear programmme. The VI th quinquennial plan (which covered the period 1971-1975) had decided to build 8 GWe.

In 1973 five plants of 900 MWe were being constructed, and an increase of the programme was planned. At the beginning of 1974 the Messmar Plan (named after the then Prime Minister) was launched; it involved the decision to commit for construction 13 nuclear units during the two years 1974 and 1975, and stated an indicative goal of 50-55 GWe for 1985.

One should confess that at the same time the antinuclear contest, more than shy until then, began to raise its voice, but it never reached the political level. Indeed in 1975, during the debate in Parliament, there was no voice raised against the nuclear option and since that time 3 of the 4 main political groups have supported the nuclear programme, whereas the fourth group decided, after a lot of wavering, for a middle position. And the nuclear issue was never raised during the 1978 electoral campaign.

We have today 15 nuclear units operating and 3 in starting stage (8 older units + the Phenix FBR prototype + 9 PWR of 900 MWe)representing a total of 11 GWe. Nuclear power provided in 1979 16% of electric energy and 4.5% of total energy needs; 32 units are presently being built, 22 MWe PWR of 900 MWe, 9 PWR of 1300 MWe and last but not least, the 1200 MWe fast breeder Superphenix (the owner of which is a multinational corporation, NERSA). These units represent 32 GWe which will begin industrial service from 1980 to 1986.

Thus, in 1986, France's Nuclear Power should amount to 43 GWe and to about 60-65 GW in 1990, providing then some 30% of our energy needs.

On what basis did this continuity rely? In three points:

(a) our acute energy dependency, more especially as regards oil (108 from 193 Mt oil equivalent, most of which - 75% - is imported from the Middle East).

(b) strength of our nuclear situation: technical knowledge and industrial infrastructure.

(c) firm belief that the era of cheap and abundant oil was ended (and that the relief period which followed 1973 was only transitory).

The above arguments are still quite valid - the second oil shock will result in significant pressures on our balance of payments. The oil bill which was 15 GF in 1973 increased to 55 GF between 1974 and 1978, it amounted to 75 GF in 1979 and will exceed 110 GF in 1980. This is about 5% of our GNP.

Moreover the nuclear choice is firmly founded on economics. Present time evaluation of prospective costs of electric energy in 1990 gave, per kWhr: nuclear 13.5 cF, coal 25 cF and oil 36 cF.

To be logical and efficient, a nuclear policy must cover the whole fuel cycle. This is exactly what has been achieved in France with:

- an active uranium exploration policy.
- construction of an isotope separation plant, in order to put an end to the monopoly of the two Super Powers.
- preparing the back end of the fuel cycle.

I emphasise two points which are more particularly related to the international context: the question of uranium supplies and the question of the back end of the fuel cycle.

There are three ways to look at the uranium problem:

(a) Reserves versus cumulative consumption

(b) Annual production versus projected annual needs

(c) The geopolitical situation

In my opinion, all three point to the same conclusion: UNCERTAINTY.

The situation is not tragically worrying but neither can we be complacent. One cannot feel secure about long term supplies. Before drawing the logical conclusion from this statement, I would like to say a few words about the back end of the cycle.

Our view in France is that the indefinite (or final) storage of PWR irradiated fuel as it stands is a difficult matter and its feasibility is not demonstrated. On the other hand, the separation of fission products and their vitrifaction allow interim storage, possibly final storage, under easier conditions. Additional advantages are: it allows better use of resources since it is possible to use the residual uranium (a reprocessing plant like La Hague equals a nice mine - more than 1000 t/year)- and, moreover, it seems wise to separate plutonium, the half-life of which is considerably longer.

I said the uranium supply is characterised by uncertainty. In a situation of uncertainty, common sense advises us to subscribe to an insurance; assurance means developing the BREEDER. In our view, reprocessing is required for safety consideration and the breeder gives a good use for plutonium.

In the field of the FAST BREEDER, we have progressed with continuity and regularity, and today the problem is no longer a technical one (feasibility of the reactor is proven and closing the fuel cycle is demonstrated); it is an economic problem. Will the breeders be competitive with the present reactor types (LWR essentially)? In order to check this point, we are considering launching a small numer of breeders, a mini seris of around 4, and building at the same time the corresponding fuel cycle facilities. The dossier is presently under review and the programme should be launched before 1985. Such a programme would allow us to get the benefit of a significant scale effect and to determine the economic prospects of the whole system.

We are developing actively the breeder but we are not working alone. We pooled our efforts with European partners, a complete set of agreements has been signed with the Federal Republic of Germany, and previously with Italy while the FRG is linked with Belgium and the Netherlands. This set of countries represents a potential market sufficient to allow economical diffusion of a new electricity generating system.

In summary, France, lacking fossil fuel resources, is forced to develop Nuclear Energy for economy, equilibrium of the balance of payments and for security of supplies. NUCLEAR ENERGY should account for 30% of our energy supply in 1990, enabling us to limit oil dependency to 55%.

World supply of uranium is uncertain. So we develop actively the Breeder, which offers the additional advantage of using the Pu produced by the fuel reprocessing which we feel to be the reasonable solution for the back end of the cycle.

But we are puzzled somewhat at the paradox of the present situation; the threats to our energy supply are as present as ever (with the exception of those price increases that have already taken place!), the much talked over solutions (coal, alternative energy sources, even conservation) will take time to be implemented, if they are achieved at all. And none the less, Nuclear Energy (in most of the Western World) faces reluctance and is stopped! Surely we should be happy to have thus a chance to suppress part of the disadvantage of our lack of natural resources?

We are grateful to M. A Ferrari, Manager of Programmes in the Commissariat a l'Energie Atomique, for this editorial, based on his speech presented to the recent International Energy Economists Association meeting in Cambridge, June 1980.

FUTURES

The summer season sees little apparent progress, but passes quickly enough with holidays. Perhaps few of us are so lucky as to be on our vacations the whole summer; it only seems that other people are away when we try and make progress in the period. Yet on our return in October, the October of a new decade, what can we see of progress this season and what futures lie ahead of us?

Three futures spring to mind: nuclear power, the European Nuclear Society, and this Newsletter. They are connected not in having equal importance of course but because the health of the first and second dictate in sequence the health of the third.

A current picture of the present and projected role of nuclear power taken across the world shows very different circumstances in different countries; it is hard to see *scientific* principles at work in such apparently random results. The picture has been well placed in context by the Munich World Energy Conference. It appears that nuclear power is a commitment that is being carried out in the Centrally Planned Economies with little evidence of questioning or doubts, though even here one notes that more resources are being applied to safety of plant and population, and that it would seem that the independent Czechoslovakian effort is being relegated in favour of the USSR PWR.

In the third world of developing countries, those with industrial ambitions (Brazil, Argentina, Korea, Libya etc) are moving forward and ignoring some of the political attempts to restrain their interest in nuclear power. Even these political restraints have been applied equivocally, as in the cases of supply of enriched fuels to India and Iraq.

The industrialised Western World presents a more varied 'patchwork'. France would seem to be the only clearly committed country to develop its nuclear power programme; Germany, like Denmark, Sweden, Austria, The Netherlands, etc, seems to have second thoughts with difficulties exemplified in obtaining authority to operate SNR-300 and waste disposal plants. The United Kingdom has a more equivocal position; less vocal and less virulent opposition is largely attributable to the slow pace of developing nuclear power over the last ten years anyway. In this respect, it is notable that an objective costing by the Central Electricity Generating Board (as objective one feels as is available in a world of conflicting pressure groups) shows the clear advantage to the UK of nuclear electricity over coal and oil-fired stations.

Across the Atlantic, it is noteworthy that in the United States, after the *de facto* moratorium post-TMI, stations are now being licensed to operate. In Canada, however, there is a holding back of plans to further nuclear generation despite the success of the dedicated persual of the CANDU concept. From the same country comes an interesting sidelight on the question of public acceptability from Professor Archie Harms, of MacMaster University, writing in a recent issue of *Annals of Nuclear Energy*. He uses the Thom/Zeeman 'catastrophe' theory, a topological argument, to suggest that where nuclear opposition has become dominant, the hysteresis effect will require more than just the recovery of lost ground to reinstate nuclear power as publically acceptable. There will be a need for a larger swing in the perceived benefits of nuclear power and the diminution of nuclear dangers, before regaining acceptability. This hysteresis effect means that merely a return to the state where nuclear power had previously been accepted by the public will be insufficient to bring about a switch to acceptability.

Clearly the healthy future of the European Nuclear Society depends on a healthy nuclear power programme, nationally and internationally. Yet this is not the only factor governing our Society's future; much else is within our own grasp. It is time, as suggested by our Planning Committee, that we reviewed both our purpose and our organisation. Are we to remain a loose federation merely accommodating each others different goals? Do we grow and develop activities in a coordinated way, for a coordinated purpose, or will these activities, such as our interest in Nuclear Technology, have an independence of action - once brought into the world, to become their own masters. A significant move to strengthen the financial organisation of our Society has been brought about in the appointment of the Swiss accounting firm, ATAG, as our formal Secretariat, details being given elsewhere in this Newsletter. In the longer term, a coordinated Society will need to be served by a Secretary-General. Other initiatives suggested by the Planning Committee, however, have foundered on points of detail which seem to have clouded the fundamental issues.

Finally, and no doubt in third priority, the ENS Newsletter itself. This is currently distributed to the committees of our Organisation Members, to our Supporting Members and more recently, to to members of ENS Committees reviewed from time to time in successive issues. Certainly the purpose of cementing the ENS Officers and Committees by a relatively informal exchange of news, views and activities, must help to develop a sense of identity internally, an *esprit de corps*. But it has done little, in this limited circulation, to promote the ENS amongst some 10 000 individuals and nothing in the external world.

As Editor, I am bound to say that the Newsletter is not good enough; it can be made better if we have more cooperation and more input from *all* Organisation Members. I am grateful for the nomination of some half a dozen correspondents but I seek a fuller representation and a greater input of news and views.

Our potential circulation of 10 000 (similar to that of the American Nuclear Society *Nuclear News*) holds out possibilities of interest. Perhaps direct access to this membership would bring forward more volunteers to take part in our activities, particularly in the technical sphere where one might say the ENS has not made its mark. Such a circulation would also attract commercial advertising to our fifteen or so nuclear power countries that might make the enlarged Newsletter self-financing or even profitable! Both the Planning Committee and the new Chairman of Publications, Mr Reino Ekholm (who has already given much personal support to the Newsletter) are looking into these prospects now. From the Editorial Chair, we can hope their deliberations are wise and potent; we remain ready to implement changes to the benefit of a growing and effective ENS.

J D Lewins
September,
1980

We record with regret the death of Dr Willard F Libby, 8 Sep 1980. Dr Libby was most well known scientifically for his exploitation of the information inherent in radioactive carbon-14, now a well established method of chronology. Libby's Nobel Laureate given in 1961 for Chemistry, was proper acknowledgement of his work. Libby was also first of the United States of America's Atomic Energy Commissioners and has played a notable part over developing nuclear energy throughout the world.

NATIONAL AND INTERNATIONAL NEWS

The USSR have reported the start up on 6 April of the BN-600 fast reactor at Beloruss. This 600 MWe pool type sodium cooled fast breeder is thought of as the prototype of the 1000 MWe commercial fast reactors to be introduced in Russia by the Ministry of Electricty. Construction work on the BN-600 was reported to have commenced in 1969.

Sir Denis Rooney has been appointed Chairman of the UK National Nuclear Company. The appointment has been made after some delay in which the role of the General Electric Company (who have the present management contract for NPC) was in doubt whilst decisions were awaited on further Advanced Gas Cooled Reactors and the protype PWR. It is to be hoped that a realistic commitment to the next phase of nuclear power in the United Kingdom has now been made and that the much reorganised design and construction industry can be given a lead. It is anticipated that the two-tier company structure will now be replaced with a single R&D company.

Dr Harry Lawroski, President of the American Nuclear Society, visited Europe in May. On 5 May, in Rome, he chaired a conference on Three Mile Island. On 15 May, at the Royal Naval College, Greenwich, he gave a public lecture on Three Mile Island.

In an announcement from the Italian Committee for Nuclear Energy (CNEN), the seismic safety of the proposed Montalto di Castro nuclear power plant (now under construction) was confirmed. The construction plans have now been referred to the Regional Administrative Tribunal.

The Guidelines for the Fourth CNEN Five-Year Plan have been approved in Italy.

Announcements were made in April that confirmed the decision to commence construction of two Advanced Gas Cooled Reactors, one in Scotland at Torness and the other at the Heysham site, in England. The Central Electricity Generating Board has also issued a letter of intent to the Nuclear Power Company to design and construct the prototype PWR. A site has not been confirmed but is likely to be at Sizewell, beside the existing Magnox reactor, on the Suffolk coast of England.

The French Commission of enquiry considering the location of nuclear power in Brittany has met and recommended the use of Plogoff site, Cap de Raz at the tip of Brittany. There has been a certain amount of local and national opposition but the logic of the case for Brittany to produce some part of the electricty she consumes has, with gallic precision, won the day. The Plogoff site should accomodate some 5200 MWe in all.

The Cap de Hague reprocessing plant suffered a setback in April when a fire in the control room led to a temporary loss of power supplies including coolant. This follows a series of small leaks in and around the plant which have led to some controversy. There was no immediate danger and temporary pumps were brought to site to deal (if necessary) with the incident but it shows that care in design and redundancy in essential services are important in the processing plant as in the reactors themselves.

We congratulate our former ENS President, Professor Dr Karl Beckurts, on his new appointment as Vice President for Research in the prestigous Siemens organisation.

PUBLICATIONS OF INTEREST

Goldberg M L, Nuclear Power: Issues and Choices. The author, member of the Kemeny Commission, has been appointed to the Presidential Nuclear Safety Oversight Commission in the USA.

The OECD are publishing two new Newsletters on specialist topics, available from from OECD, 38, boulevard Suchet, 75016 Paris. They are *"Radionuclides Migration in the Geosphere"* and *"R and D in Uranium Exploration Techniques"*

The international standard ISO/DIS 6215 describes Total Quality Assurance Programs for Nuclear Power Plants. The equivalent national version in the UK is the British Standard BS 5882 which takes into account both the ISO and the various matters covered by Appendix B of the USA Code of Federal Regulations 10 CFR 50, the American National Standards Institute (ANSI) N 45.2 and the International Atomic Energy Code of Practice.

The European Energy Association (EEA) publishes a bulletin expressing its generally pro-nuclear views. The Association seeks further national pressure-group membership. The Bulletin may be obtained from the Editor:
B.L.Anderson, R.E.O. Hesletorvet 1a, DK 4000, Roskilde, Denmark

Nero A.V. Jr, A Guidebook to Nuclear Reactors, U Cal Press, 1979 ISBNO-520-0334822-1. This book has a bias to light water reactors, reflecting both US and international trends of course. It is valuable as a source of comparative data on fully engineered reactors.

Curran S C and Curran J S, *Energy and Human Needs* , Scottish Academic Press, Edinburgh 1979. The senior author, until recently Principal of the University of Strathclyde, has provided a well thought out introduction to comparative energy studies.

Richardson J A, *Summary of Current (1978-1979) US Total Cost Projections for 1,200 MWe Power Plant,* , Inst Nuclear Engineers £1.

Use of Argillaceous Materials for the Isolation of Radioactive Waste, (English and French): Proceedings of the NEA Workshop, Paris, September 1979, Nuclear Energy Agency/OECD.

NATIONAL AND INTERNATIONAL NEWS

The Nuclear Energy Agency of the OECD have issued their eighth activity report for the period 1979 (available from 38 boulevvard Suchet, 75016 Paris). One significant fact: at the end of 1979, there were in the world some 232 working nuclear power plants with a capacity of some 119 GWe.

More than 500 scientists from 36 countries took part in the 8th International Conference on Plasma Physics and Controlled Nuclear Fusion Research, organised by the IAEA and held in Brussels, 1-10 July 1980.

Chairman Glyn England of the UK Central Electricity Generating Board referred favourably to nuclear electricity in the UK recently. The Board's eight Magnox reactors had, by March 1980, saved over 100 million pounds sterling over the comparable coal fired station costs. Referring to the Advanced Gas Cooled Reactors, Mr England pointed out that in the last financial year, Hinkley Point B station generated electricity at 1.32 p per unit compared to the comparable modern coal fired statiop, Drax, at 1.51 pence. The long awaited Dungeness B will be loaded this year and can expect to be brought on line in 1981, the same year for fuel loading in Hartlepool and Heysham, the last of the original five AGRs. Work on the next round of AGRs is already underway in the design office and ground will be broken on the Heysham site this year.

The CEGB now have 230 reactor years experience of power reactors and there is no evidence throughout this of harm attributable to radiation having been caused to any power station worker or member of the public.

The Board of Governors of the IAEA agreed in June to form a committee concerned with assurances to member countries of the supply of nuclear technology, materials and services. This Committee is to study the role of the Agency itself in these matters and to report, in the first instance by February 1981.

So you think you have environmental problems?

When we are so often concerned with the environmental consequences (real or imagined) of nuclear power, it is some relief to find others have problems too. Dr T L Neff has conducted a survey into the environmental consequences of adopting photovoltaic production of electricity under a study sponsored by the US Department of Energy at the MIT Energy Laboratory, Cambridge Massachusetts.

Three types of cell are under consideration: silicon wafers in large plates, cadmium sulphide in flat plates and gallium arsenide in flat-plate or concentrators.

In the manufacturing and use, the latter two of these types have obvious hazards. Cadmium and arsenic are highly toxic and cadmium is a suspected carcinogen. Fine particles of silicon may cause lung and kidney damage. There are evident occupational health risks in the manufacturing side.

Public health risks appear from the gallium and the arsenide devices with some small risk arising from silicon in manufacturing but not probably in use. Most of these risks are evidently smaller than the comparable risks using coal since coal itself releases much of the same pollutants. An exception is the cadmium which might involve ten times the coal emission. Here the unknown affect of cadmium has to be offset against the problems specific to coal or other fossil fuels.

Broader direct environmental effects have to take into account the winning of the specialised materials, the area taken up by the cells in operation, ultimate disposal. A central station of voltaics would occupy some 20 square miles of land in its operation; a similar sized coal fired system would require (if strip mined) some 12 square miles over the lifetime operation. Waste disposal for cadmium and arsenic (infinite halflives!) would require remote and geological secure sites.

The indirect effects including social effects are also of interest, centring perhaps around the labour intensive nature of voltaics. The demand for materials is also large. Neff estimates that in the US a 20-GWe (peak) annual installed capacity in itself would require about 45% of the current aluminium production and 15% of the current steel production. The indirect economic effects of such a demand would be substantial. Furthermore, the energy investment in voltaics is large with a long payback time, considerably larger than a coal fired plant.

Other fascinating insights are found in the study. Smokers have relatively high cadmium levels already and they will be most at risk in a voltaic society. Should that society bear the cost of protecting the health of smokers or the lower costs of non-smokers only? Fire fighting is commonly practiced breaking open roof areas to localise the fire and protect the firefighters; if this roof contains arsenic or cadmium voltaic cells, the technique may have to be banned at cost in life, limb and money during fires. Gains in one area are so often bought at the cost of transferring the liability elsewhere.

The IAEA has announced the signing with Libya of the safeguards treaty persuant to Article III of the Non-Proliferation Treaty.

The announcement is made in Italy of the formation of *Nucleo*, a joint CNEN-AGIP Nucleare company for the treatment and disposal of Low-Intermediate Activity Waste. CNEN has studied for some time the problem of conditioning wastes with a low-intermediate activity and has acquired experience of service activity with special plants at Cassacia. The industrial collaboration with AGIP is seen to lead to an industrially viable partnership.

In particular, while waiting for CNEN's research and development actions to make it possible to find and qualify sites for geological confinement, the definitive confinement of radioactive wastes, with a low and intermediate activity, will be carried out by organizing sinking operations at great depth in the Atlantic Ocean, in the framework of OECD's Nuclear Energy Agency.

Nucleo is to dedicate particular care to satisfying the requirements of small nuclear operators.

CNEN Constitution Proposal. It was announced in July that the Italian Government were to seek a revision of the CNEN constitution that would charge the new body also with responsibility for *alternative energy sources*. Financing for the year 1980 includes a sum earmarked for work in these additional areas.

IAEA Announcement. In its annual report, the IAEA has made the point that in 1979 some 120 GW of installed nuclear power were producing 8% of the world's electricity. INFCE projections take this to some 300 GW and 16% by 1985. One major achievement of 1979 at the International level was the successful conclusion of the Convention on the Physical Protection of Nuclear Materials. Two further states have joined INIS to collect and disseminate worldwide bibliographical data in the field of nuclear energy. This brings the countries now taking part to 62 with 13 international organisations cooperating.

In the UK, the Central Electricity Generating Board announced a programme of installing small wind generators (around 1MW) in suitable flat areas, ie in eastern England. In his announcement, Chairman Glyn England reminded his audience that a previous proposal to establish such generators in the windiest part of Wales, in the 1950s, had been abandoned in the face of environmental opposition. It remains to be seen whether the visual impact, the exclusion area (about 400m radius) and the noise will limit the acceptability of the new proposals.

In the United States, the further review of the biological effects of ionizing radiations (BEIRIII) has been released after some delays and controversy. It effectively revises the estimates of the effects of low level x-rays and suggest a quadratic fit instead of a linear expression. Such a quadratic fit may be taken as a compromise between the linear hypothesis with no threshold and the linear hypothesis with threshold. In these low areas, it suggests that the cancerous effects are less by a factor of about ten than would be taken from a simple extrapolation of high level effects. It remains to be seen whether this model will be unreservedly accepted and whether any changes in ICRP recommended levels will follow.

The OECD Nuclear Energy Agency, 38 Boulevard Suchet, 75016 Paris, has published the first of a series of summary reports of the International Uranium Resources Evaluation Project. This first covers Portugal. Copies, at no cost, are available from the Agency.

The UK National Nuclear Corporation (NNC) saw the new Chairman, Mr Denis Rooney, take over from Lord Aldington, after a protracted period in which it seemed difficult to decide which came first, the new chairman to reorganise the company or the new company organisation to attract a new chairman. It is expected that the old two tier arrangement (NNC and the executive subsidiary NPC or the Nuclear Power Company) will be amalgmated into one. In principle, the new company has plenty of work; finishing three AGRs, building the prototype PWR in England and developing the Fast Reactor. It remains to be seen what time scale will be agreed for these developments that are also to include the further tranche of Advanced Gas Cooled Reactors.

Books Received

Nuclear Power and its Environmental Effects, Samuel Glasstone and Walter H Jordan. Published by the American Nuclear Society, 1980. This book is worthy a detailed review, which we hope to provide in a later issue. Suffice it to say here that once again, the doyen of nuclear pedagogists, this time in collaboration with Walter Jordan of the Oak Ridge National Laboratory, has contributed a timely and substantial text. The book is slanted to the Light Water Reactor (which is anyway the major international type) and the US methods of licensing and regulation. Even this latter chauvenism serves to illustrate the *principles* of licensing. Many lecturers will be grateful for the material put together in this 400 page text. The ANS is also to be congratulated for its initiative.

OECD. *Radionuclides Migration in the Geosphere*. Newsletter No 3.

The UK Central Electricity Generating Board, representing one of the largest utilities in the world and in a unique position to compare on a reasonably free market basis, the relative advantages of coal, oil, nuclear and other generating schemes, have published a small booklet entitled *Costs of Producing Electricity*. This is available free from the CEGB Press Office, Sudbury House, 15 Newgate Street, London EC1A 7AU. Figures are available for the financial year 1979/80 and it is interesting to see the sustained cost advantage of nuclear over both oil and coal fired stations on a net effective cost basis that takes not only capital investment and associated interest, but research and training costs into account.

Criteria Relating to the Approval of Consumer Goods Containing Radioactive Substances: A Consultative Document, Her Majesty's Stationary Office $1.00. This has been prepared by the National Radiological Protection Board in the United Kingdom as a response to the European Commission proposals for legislation.

The Effects on Populations of Exposure to Low Levels of Ionizing Radiations (BEIRIII), National Academy of Sciences, Washington DC (from Nov 1980).

Nuclear and Non-Nuclear Risk - An Exercise in Comparability, European Communities Commission, EUR 6417 EN, ISBN 92-825-1525-4, 1980.

Summary of the ENS-Programme Committee activities after an ENS-PC meeting at Berlin, March 24, 1980

The following ENS-activities were announced by the Programme Committee at their meeting in Berlin:

1. 2nd International Conference on "Engineering Nuclear Energy Systems", ENS-Cosponsorship, Lausanne April 8 - 11, 1980

2. ANS/ENS/AIF International Conference "World Nuclear Energy-Accomplishments and Perspectives", Washington D.C., Nov. 17 - 20, 1980.

3. ANS/ENS Topical Meeting on "Reactor Safety Aspects of Fuel Behaviour" Idaho, August 2 - 6, 1981

It was recommended to perform a topical meeting on operator training and plant operation in Europe. With reference to this recommendation the British society "Institute of Nuclear Engineers" proposed to perform this meeting in Bristol, England 1981.

The following topics were recommended as further ENS activities:

1. Nuclear public relations
2. Society and risk
3. Comparison of environmental effects of power generation
4. Advanced fuel cycles
5. Fast reactor safety

New rules for ENS-sponsorship will be given by the Programme Committee in which 2 steps of approval for the sponsorship are implemented in order to check if the meeting fulfills all ENS-requirements.

The Programme Committee identified the following fields for the corresponding members of the national societies within the ENS:

1. Reactor Physics and Fuel Cycle
2. Mathematics and Computation
3. Nuclear Fuel Technology
4. Nuclear Safety and Radiological Protection
5. Power Systems
6. Components
7. Instrumentation
8. Reactor Operating Experience
9. Material Research and Reactor Chemistry
10. Reprocessing and Waste Management
11. Environmental Aspects
12. Fusion

The corresponding member is supposed to act as active representative in this field on behalf of his national society and has to support the ENS sponsored topical meetings. The same person may be named for different fields. The steering committee agreed to this proposal. It is hoped that this new procedure will help to increase the cooperation between the member societies.

INTERNATIONAL SEMINAR: ANNOUNCEMENT

The Role of Finite Element Methods in Radiation Physics

Imperial College, 23-24 April 1980

London, England

Contact:

Dr A J H Goddard, Nuclear Power Section, Mechanical Engineering Department, Imperial College of Science and Technology, London SW7 2BX, UK.

Background

The great sucess of the finite element method for problems in solid mechanics and fluid flow has stimulated interest in finite element methods for problems of radiation physics arising mainly in nuclear engineering. Methods used for solving the energy dependent Boltzmann equation for radiation transport in complex geometry are also of interest to applied mathematicians, numerical analysts and medical physicists.

This Seminar is intended to be a review of the art and will cover the formulations of finite element methods for radiation physics problems, a survey of the finite element solution of bench-mark problems, their relationship to Monte Carlo and other methods, and applications to practical problems in reactor physics and shielding. It is sponsored by the Institution of Nuclear Engineers and by the Computational Physics Group of the Institute of Physics.

Aims of Meeting

Solution of radiation diffusion and transport problems by finite difference methods is restricted to simple geometries and, at present, complex geometry problems are treated in detail by Monte Carlo calculations. In principle the finite element method has the potential to provide a deterministic solution of problems with complex geometries for comparison with the statistical Monte Carlo solution. This cross checking of solutions for the problems with safety implications is a desirable objective. Alternatively coarse mesh finite element solutions of the adjoint to a given problem can be used as a means of accelerating the Monte Carlo solution.

Methods of solving the Boltzmann equation have to deal with up to three positional coordinates and two directional coordinates for each energy group. The finite element representations proposed either use a finite element structure in 5 dimensional phase space or 3 dimensional elements in conjunction with series expansion in the directional coordinates, which give either continuous or discrete representation of the directional dependence of the solution. The complexity of the finite element representation leads to problems of storing and solving very large numbers of equations, for which some solutions have been found. Comparative trials with finite difference methods show speed and accuracy for the finite element method. The remaining problem is to realise this potential for complex geometries.

AJH Goddard, June 1980

The American Nuclear Society has anounced the appointment of Suzanne Fiorina of Geneva, Switzerland to help market ANS and joint NS/ENS publications in Europe.
Mrs Fiorina has worked with the American Nuclear Society for several years in promoting their activities in Europe and may be contacted at

American Nuclear Society - Geneva office
80 c. Chemin Des Marais
1255 Veyrier, Switzerland telephone:- (22) 42 50 59

Professor Carlo Salvetti has announced that, from 1 July 1980, the financial affairs of the European Nuclear Society and its legal basis will be in the hands of the Swiss General Accounting Company, Ltd, (ATAG), 3001 Berne (Switzerland) Barenplatz 1. ATAG will manage the formal Secretariat of the ENS with the following principal services:
-maintain official records
-act as a selective archival store
-maintain membership records
-invoice accounts and receive payments
-keep financial records and accounts.

The legal seat of the ENS is PO Box 737, 6 rue d'Italie, 1211 Geneve 3. It is important that all official correspondance, not for the President personally or demi-officially, is addressed to the European Nuclear Society at its new secretariat:-
ENS, PO Box 2613, CH-3001 Berne Switzerland

The Programme Committee met in Munich under the chairmanship of Prof D Bunemann on 13 September. Proposals for ENS-sponsored (or run) meetings on Operator Training etc were to be considered together with consideration of Mr Bindler for procedures appropriate to organise such meetings. Another proposal considered initiated with the KTG for a meeting on Environmental Aspects of Power Generation: theoretical modelling and measuring techniques.

The ENS Board and the ENS Steering Committee were due to meet also in Munich, at the time of the World Energy Conference, 18/19 September. It has not, unfortunatly, been possible to agree the detailed agenda for the proposed extraordinary General Meeting to receive proposals for the revised Constitution as prepared by the Planning Committee.

The Planning Committee itself is due to meet in London on 29 Sep and will be taking into account the delay in implementing these changes and further suggestions for the development of an ENS Journal from the present format of the Newsletter.

We welcome Mr Rognon, Swiss Society, as his organization's representative to the Steering Committee. Nevertheless, this means that the previous representative, Mr Peter Tempus, will no longer under the present constitution, be able to hold the office of Vice President. Mr Tempus has, in the words of our President, made an invaluable contribution to the ENS during his period on the Steering Committee and the Board. Fortunately, he is continuing his work for the Society as Chairman of the Editorial Board of Nuclear Technology and, in this capacity, we may hope to see him attend meetings of both the Board and the Steering Committee. Nevertheless, this is a loss to the Society and is an example of the reasons why the Steering Committee have accepted the advice of the Planning Committee to revise the ENS Constitution.

The Board of the ENS will meet on the afternoon of Friday 12 September, in Munich during the World Energy Conference, in preparation for the ENS Steering Committee Meeting on the morning of Saturday 13th September. It is expected that the occasion will provide an opportunity to have useful discussions with officers of the American Nuclear Society on matters of mutual interest that would include jointly owned publications and jointly sponsored meetings.

OFFICERS OF THE ENS

President (1979/81): Sr Professor Carlo Salvetti, CNEN, viale Regina Margherita 125, I-00198 Roma, Italy: telex I 610183

Immediate Past President: Prof K H Beckurts. Vice Presidents: M C.P. L-Zaleski and Dr H Cartwright, CEE Board Members: Dr J D Lewins and Sr M Perello

Published for the ENS by I Nuc E and printed in the UK. Letters and material for publication should be addressed to: Editor ENS Newsletter, Dr J.D.Lewins, Engineering Department, University of Cambridge, Trumpington Street, Cambridge CB2 1PZ. Telex: G 81239 DEPENG. tel: (0223) 66466

Twenty five copies are distributed free to each organisation member and one copy to each supporting member of ENS of record. Further copies may be obtained at cost by these members on enquiry of the Editor or the Institution of Nuclear Engineers.

European Nuclear Society: Book Reviews

The European Nuclear Society, with over 9000 membership in eleven european countries, publishes the ENS Newsletter every two months. The Newsletter includes a 'publications received' section and carries occasional full length book reviews.

Items for this section are welcome and may be sent to the editor, address above. The European Nuclear Society deals with the civil nuclear engineering program (fission and fusion) and all its ramifications in fuel cycles, health physics and radiation safety, non-proliferation politics, etc

Cambridge
July 1980

ENS PLANNING COMMITTEE

Editor's Note: Each issue of the ENS Newsletter carries a matrix showing the names of all committee members. I am glad we should publish more detailed information on each committee in turn and this issues sees the listing of the Planning Committee, showing not only names and counties, but also addresses and telephone numbers. Will Committee Chairmen please provide me with this detailed information for publication in future issues.

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Editor's Note: Each issue of the ENS Newsletter carries a matrix showing the names of all committee members. I am glad we should publish more detailed information on each committee in turn and this issues sees the listing of the Finance Committee, showing not only names and counties, but also addresses and telephone numbers. Will Committee Chairmen please provide me with this detailed information for publication in future issues.

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Finnish correspondent Dr Heikki Reijonen. *UK correspondent (INucE)* Mr Alan Dootson.

THE ENS DIARY

New items in the diary are marked. **

September
19 One day meeting *Directions in Nuclear Engineering Research*, Cambridge. Details from Institution of Nuclear Engineers.

October
30 Lecture by A Gregory (CEGB Barnwood) *Decommissioning Nuclear Power Stations*, Institution of Nuclear Engineers Annual Lecture. **

November
27 Sir Francis Tombs, *Nuclear Energy 1980s: Review of Past, Present and Future*, Inst Nucl Engrs Anniversary Lecture, London **

1981
April
23-24 International Seminar, *Role of Finite Element Methods in Radiation Physics* Jointly sponsored by I Nuc E and Inst Physics. To be held at Imperial College, London. **

August
17-21 SMiRT6 (Structural Mechanics in Reactor Technology) will be held in Paris, under arrangements being made by the French Nuclear Society, SFEN.

September

1 - 5 International Seminar on Nuclear Reactor Safety Heat Transfer, Dubrovnik Yugoslavia PO Box 522 YU-11000 Belgrade. **

3 - 5 Fifth Annual Symposium of the Uranium Institute, London, **

8 - 12 World Energy Conference, Munich (contact WEC 34 St James St London) **

14 - 17 International Fuel Cycles, Amsterdam. Nederland Atoomforum **

19 One day meeting *Directions in Nuclear Engineering Research*, Cambridge. Details from Institution of Nuclear Engineers.

October

6 - 8 Materials for Nuclear Steam Generators, ANS International Conference, Florida

6 - 10 IAEA/NEA Symposium: Impact of Radionuclide Release into the Marine Environment, Vienna.

8 - 9 Nuclear Energy and the Public Seminar, Council of European Industrial Free Enterprise Information Group, Stockholm. **

20 - 24 IAEA Conference, Current Nuclear Power Plant Safety Issues, Stockholm

20 - 21 NAGRA Symposium on Storage of Radioactive Waste, Bern. **

30 Lecture by A Gregory (CEGB Barnwood) *Decommissioning Nuclear Power Stations*, Institution of Nuclear Engineers Annual Lecture.

November

10 - 14 Symposium on Packaging and Transportation of Radioactive Materials, Berlin

16-21 ANS/ENS/AIF Winter Meeting, Washington DC, USA

27 Sir Francis Tombs, *Nuclear Energy 1980s: Review of Past, Present and Future*, Inst Nucl Engrs Anniversary Lecture, London

1981

April

1 - 2 The Environmental Impact of Nuclear Power; Conference organised by British Nuclear Energy Society, London. **

23 - 24 International Seminar, *Role of Finite Element Methods in Radiation Physics* Jointly sponsored by I Nuc E and Inst Physics. To be held at Imperial College, London.

June

7 - 12 ANS Annual Meeting, Miami Beach

July

27 - 31 IAEA Symposium: Migration in Terrestial Environment of Long-Lived Radionuclides from the Nuclear Fuel Cycle, Knoxville, Tennessee, USA. **

August

17 - 21 SMiRT6 (Structural Mechanics in Reactor Technology) will be held in Paris, under arrangements being made by the French Nuclear Society, SFEN.

November

9 - 12 International Conference on Fast Reactor Fuel Cycles, London. Details from British Nuclear Energy Society. **

29 - 4 December ANS Winter Meeting, San Francisco

NAMES AND ADDRESSES OF ENS MEMBER SOCIETIES

1. *Netherlands Nuclear Society*: Secretary - ir P.Brand, N.V.KEMA, Utrechtseweg 310 Arnhem, Netherlands.

2. *American Nuclear Society*: Local sections in Europe:-
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4. *Foreningen Kernteknik*: Birger Almgren, Oskarshamnsverkets Kraftgrupp AB, Box 1746, S-111 87 Stockholm, Sweden.

5. *Hellenic Nuclear Society*: Dr C Apostolakis, General Secretary, Isotopes Department NRC 'Demokritos', Aghia Paraskevi, Attika, Athens, Greece.

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11. *Société Française d'Énergie Nucléaire*: Secretariat; 48, rue de la Procession, F-75015 Paris, France.

12. *Suomen Atomiteknillinen Seura-Atomtekniska Sallskapet i Finland, RY.*(Finnish Nuclear Society): P.Louko, Imatran Voima Oy Eteläinkatu 27/2 SF-00130 Helsinki 13 Finland

TILANNE OLKILUODOSSA 28.10.1980

TVO I

Olkiluodon ensimmäinen laitosyksikkö TVO I on kuluvan vuoden aikana tuottanut sähköä 3555493,1 MWh (27.10. mennessä). Tämä vastaa runsaat 12 % koko maan sähkönkulutuksesta.

Lokakuun aikana TVO I-laitoksella ohitettiin tärkeä virstanpylväs. Laitoksen kokonaistuotanto nousi arvoon 7 terawattituntia (TWh) eli 7 miljardia kilowattituntia.

TVO I-laitoksen käyttökerroin on tämän vuoden aikana n. 75 %. Lokakuun käyttökerroin tähän asti on yli 97 prosentin.

TVO I-laitoksen ensimmäisen varsinaisen vuosihuolto-seisokin jälkeen aloitettiin sähköntuotanto aikataulun mukaisesti 3.7.1980. Seisokissa vaihdetun polttoaineen "totuttamiseksi" laitokseen, tehoa nostettiin normaalia hitaammin ja täyteen tehoon päästiin 20.8.1980. Parin viimeisen tehoprosentin nostoa rajoitti reaktorin suuri pääkiertovirtaus.

Vuosihuollon jälkeen TVO I:n tuotantokeskeytyksiä ovat aiheuttaneet generaattorin roottorille neljän viikon välein tehdyt tarkastukset kullakin kerralla viikonlopun ajaksi. Muista lyhytaikaisista tuotannon keskeytyksistä mainittakoon kaksi reaktoripikasulkua heinäkuun lopulla. Ensimmäisellä kerralla laukaisi korkea huonelämpötila turpiinilaitoksella laitoksen verkosta. Syynä oli helteinen sää ja meriveden korkea lämpötila. Toisella kerralla salaman sytyttämän tulipalon aiheuttama maasulku valtakunnan verkossa erotti laitoksen verkosta ja verkon jännitevaihtelujen takia seurasi reaktorin pikasulku.

Muutoin laitoksen tuotanto on jatkunut häiriöttä. Tuotannon tehokkuutta haittasivat loppukesän aikana vallinnut meriveden ajankohtaankin nähden korkea lämpötila, korkeimmillaan 22°C, välitulistimen eristysventtiilin viallinen toiminta ja höyryn kasvanut kosteusarvo korkeapaineturpiinilla. Generaattorin roottorille on tehty loppukesän aikana kolme tarkastusta. Tarkastukset ovat olleet kullakin kerralla viikonlopun aikana.

Tähän mennessä ei TVO I:n generaattorin roottorissa ole havaittu sellaista, mikä estäisi tuotannon jatkamisen. Ruotsissa tällä hetkellä olevaan roottoriin

tehdään samat muutostyöt kuin TVO II generaattorin roottoriin on tehty. Lähiaikoina TVO I-laitokseen vaihdetaan tämä roottori.

TVO II

TVO II koekäyttöä jatkettiin 16. pnä lokakuuta 60 % tehotasolta lähtien. Koekäyttö on ollut keskeytyksissä laitoksen generaattorin roottorin oltua Ruotsissa valmistajan luona eräitä muutoksia varten. Roottori saapui Västeråsista laitospaikalle suunniteltua aikaisemmin, 30.9.1980. Roottorin runkoa on lyhennetty, terävät kulmat ja muut epätasaisuudet pyöristetty ja hiottu. Roottorin värinätarkkailua on tehostettu.

Koekäytön kolmanteen vaiheeseen kuuluvat voimalaitoksen eri laitteiden yhteistoimintakokeilut. Samoin tutkitaan reaktorinsydämen ominaisuuksia sekä laitoksen säätöominaisuuksia. Parhaillaan tehdään laitoksella laakeritarkastuksia ja poistetaan tähän mennessä havaittuja puutteita.

Koekäytön loppuvaiheessa tehdään kokeet 80 - 100 prosentin tehoilla. Myös tähän vaiheeseen liittyy runsaasti erilaisia toimenpiteitä mm. kuormanpudotuskokeet ja joukko verkkokokeita.

Uusi keskuskonttori

TVO:n pääkonttoritoiminnot ovat siirtyneet hoidettavaksi Eurajoelta Olkiluotoon rakennetusta keskuskonttorista käsin. Rakennus sijoittuu laitosyksiköiden eteläpuolelle, Olkiluodonveden rannalle.

Kaksikerroksisen rakennuksen kuutiotilavuus on 15100 m^3 ja kerrosala 3600 m^2.

Keskuskonttorissa työskentelee noin 100 henkilöä. Teollisuuden Voima Oy:n henkilökunnan määrä Olkiluodossa on runsaat 350. Yhtiön Kilon konttorissa Espoossa on noin 70 henkilöä.

Juha Kilpi

8

403/0 1.78

SÄTEILYTURVALLISUUSLAITOKSEN RAPORTTI SUOMEN YDINVOIMALAITOSTEN KÄYTÖSTÄ HUHTI-KESÄKUUSSA 1980

Yksityiskohtaisinta julkista tietoa Suomen ydinvoimalaitosten käytöstä sisältänevät säteilyturvallisuuslaitoksen neljännesvuosiraportit. Raportti toimitetaan mm. STT:lle. Koska raportit valmistellaan hyvin huolellisesti, niiden ilmestymisviive on melko pitkä. Nyt referoitava v. 1980 toisen neljänneksen raportti tuli jakeluun syys-lokakuun vaihteessa. Tulevaisuudessa viive uskotaan saatavan lyhyemmäksi.

Neljännesvuosiraporteissa pyritään antamaan yleiskuvaus Suomen ydinvoimalaitosten käytöstä ja erikoisesti reaktoriturvallisuuteen liittyvistä tapahtumista kunkin tarkastelujakson aikana. Raporteissa käsitellään tarkemmin niitä tapahtumia, joita valvontaviranomainen, säteilyturvallisuuslaitos, pitää turvallisuuden kannalta merkittävinä.

Tämän lisäksi raporteissa on selvitetty erikseen reaktorien pikasulut, seisokit ja tehonalennukset. Merkinnät ko. tapahtumista löytyvät myös liitteinä olevista reaktorien tehodiagrammeista.

Raportteihin on sisällytetty myös maininnat tärkeimmistä korjauksista ja muutoksista sekä yhteenvedot käytettävyydestä ja tehonkehityksestä.

Ohessa julkaistaan v. 1980 toisen neljänneksen raportin sisällysluettelo, yhteenveto sekä näytteitä käyttötiedon taulukoista ja tehodiagrammeista.

SISÄLLYSLUETTELO

YLEISTÄ

Ydinvoimalaitosten tuottaman sähkön määrä oli vuoden alkupuoliskolla 3311 GWh eli noin 14 % edellisvuoden vastaavaa arvoa suurempi ja vastasi noin 17 % Suomen koko sähkönkulutuksesta. Ydinvoimalaitosten tuottaman sähkön osuus kulutuksesta oli suurimmillaan huhtikuussa, jolloin se oli noin 23 % kokonaiskulutuksesta.

Suomen ydinvoimalaitosten sähköntuotanto keskeytyi kokonaan toukokuun puolivälissä, kun Loviisa 1 ja TVO I laitokset pysäytettiin polttoaineen vaihtolatausta ja vuosihuoltoa varten. TVO I laitos käynnistettiin uudelleen kesä-heinäkuun vaihteessa, mutta Loviisa 1 laitoksella seisokki jatkuu suunniteltua kahta kuukautta pidempään reaktoripaineastian haurastumisominaisuuksia koskevien jatkoselvitysten ja höyrystimessä esille tulleiden vikojen johdosta. TVO II laitoksen ydintekninen koekäyttö oli keskeytyksissä koko tarkastelujakson ajan generaattoriin tehtävien korjausten ja muutosten johdosta. Valtioneuvosto teki Loviisa 2 laitoksen käyttöä koskevan päätöksen toukokuussa ja polttoaineen lataus suoritettiin toukokuun jälkipuoliskolla STL:n annettua luvan latauksen aloittamiseen. Laitoksen käynnistys siirtyi kuitenkin myöhempään ajankohtaan höyrystimistä löydettyjen vikojen johdosta.

Ydinteknisen turvallisuuden kannalta merkittävät tapahtumat keskittyivät laitosten vuosihuoltojen yhteyteen. Tapahtumat eivät merkittävästi vähentäneet laitosten turvallisuutta eivätkä aiheuttaneet vaaraa laitosten henkilökunnalle tai ympäristön asukkaille. Työsuojelun kannalta merkittävä tapaus oli Loviisa 1 vuosihuollon aikana sattunut rikkihappo-onnettomuus, jossa kaksi työntekijää sai palovammoja.

LOVIISA 1

Loviisa 1 laitosta oli tarkastelujakson aikana lupa käyttää nimellisteholla, mutta pitkitetyn käyttöjakson eli ns. strech-out-ajon johdosta reaktorin teho laski noin 95 %:sta 75 %:iin ennenkuin kolmas polttoaineen vaihtolataus ja vuosihuolto aloitettiin 10.5.1980. Muita seisokkeja tai huomattavia tehonalennuksia ei tarkastelujakson aikana ollut. Sähköntuotannon käyttökerroin oli vuoden alkupuoliskon osalta 0,68. Henkilöstön saama kollektiivinen säteilyannos tarkastelujakson aikana oli mittaustulosten mukaan noin 75 manrem aiheutuen suurimmaksi osaksi vuosihuollosta.

Vuoden 1980 vuosihuollon yhteydessä suoritettiin suunnitelmien mukaisesti reaktoripaineastian sisäpuolinen tarkastus. Tämän vuoksi poistettiin polttoaine ja sisäosat reaktorista. Pinnoitteen pyörrevirtatarkastuksissa todettiin muutamia virheitä. Näistä kolme suurinta olivat sellaisia, että ne poistettiin hiomalla.

Seisokin aikana esiintulleita merkittäviä ydintekniseen turvallisuuteen liittyviä asioita olivat höyrystimien varoventtiilien toimintaviat, korkeapainebooripumppujen viat, primaaripiirin ja syöttöveden lämpötilaeron nousu yli sallitun, yhden polttoainenipun vaurio, pääkiertopumppujen kansien säröt, ja seisontajäähdytysjärjestelmän yhden haaran tukkeutuminen.

Lisäksi höyrystimien kollektorien määräaikaistarkastuksiin kuuluvissa hitsisaumojen isotooppikuvauksissa havaittiin vikoja, jotka on alustavasti luonnehdittu valmistuksen aikana syntyneiksi hitsausvirheiksi. Vikojen luonnetta ja jatkotoimenpiteitä selvitellään edelleen.

Seisokissa toteutetaan myös reaktorisydämen osalta muutos, jossa ulommaisten polttoainenippujen tilalle asennetaan pelkästä teräksestä valmistetut niput pienentämään paineastiaan kohdistuvaa neutronisäteilyä. Muutos tehdään, koska reaktoripaineastiaan sijoitettujen materiaalinäytteiden tutkimukset ovat osoittaneet, että säteilyn aiheuttama paineastiamateriaalin haurastuminen tapahtuu oletettua nopeammin. Lisäksi korotetaan hätäjäähdytysveden lämpötilaa, jotta reaktoripaineastiaan mahdollisessa hätäjäähdytystilanteessa kohdistuvat rasitukset pienentyisivät.

Joidenkin em. asioiden keskeneräisyydestä johtuen tarkempi selvitys esitetään vasta seuraavassa neljännesvuosiraportissa.

TVO I

TVO I laitosta oli tarkastelujakson aikana lupa käyttää nimellisteholla. Reaktorin käyttö ja sähköntuotanto keskeytyivät tarkastelujakson alkupuoliskolla kaksi kertaa. Reaktorin käytön keskeyttivät molemmilla kerroilla pikasulut. Lisäksi tapahtui muutamia 20 ... 40 % suuruisia tehonalennuksia lähinnä venttiilien määräaikaiskokeiden ja yksittäisten pääkiertopumppujen pysähtymisen johdosta. Laitos ajettiin 16.5.1980 suunnitellusti alas ensimmäistä polttoaineen vaihtoa ja vuosihuoltoa varten. Reaktori käynnistettiin uudelleen 27.6.1980, jonka jälkeen suoritettiin neljä pikasulkukoetta pienteholta. Reaktorin käyttö keskeytyi lisäksi vielä kerran kesäkuun lopulla pikasulun seurauksena. Sähköntuotanto aloitettiin 3.7.1980. Sähköntuotannon käyttökerroin oli vuoden alkupuoliskolla 0,69. Henkilöstön saama kollektiivinen säteilyannos oli tarkastelujakson aikana mittaustulosten mukaan noin 40 manrem aiheutuen lähes kokonaan vuosihuollosta.

Ydinteknisen turvallisuuden kannalta merkittäviä tapahtumia ei ollut tarkastelujakson aikana.

TVO II

TVO II laitoksen koekäyttö oli tarkastelujakson aikana edelleen keskeytyksissä generaattoriin tehtävien korjausten ja muutosten johdosta. (Laitoksen koekäyttö keskeytettiin helmikuussa 1980 sen jälkeen kun 50 % tehotasolla suoritettavat kokeet oli saatu päätökseen). TVO II generaattorin roottori samoinkuin TVO I alkuperäinen roottori ovat Asean tehtaalla Ruotsissa tutkittavana ja korjattavana, koska roottorien kiilaurien pohjalla on todettu säröjä.

LOVIISA 2

Loviisa 2 laitoksen käynnistystä pitkään viivästyttäneet reaktoripaineastian sisäpuolisen pinnoitteen tarkastukset ja korjaukset saatiin suoritetuiksi tarkastelujakson alkupuolella loppuun. Valtioneuvosto teki Loviisa 2 laitosyksikön käyttöä koskevan päätöksen 15.5.1980 sen jälkeen kun asianmukaiset lausunnot mm. STL:n Loviisa 2 laitosta koskeva lausunto ja turvallisuusarviointi oli toimitettu lupakäsittelyä varten. Suoritettuaan laitoksen katsastuksen STL antoi päätöksen 19.5.1980 polttoaineen lataukseen ryhtymisestä ja latauksen loputtua päätöksen 2.6.1980 reaktoripaineastian kannen sulkemisesta.

Reaktoria ei kuitenkaan voitu käynnistää tarkastelujakson aikana, koska Loviisa 1 laitoksen höyrystimien kollektoreiden histisaumoissa todettiin virheitä ja kyseisten paikkojen tutkimista edellytettiin myös Loviisa 2 laitoksella. Tutkimuksissa löydettiin vastaavia virheitä. Virheiden tarkastuksia ja korjausten suunnittelua jatkettiin molemmissa laitosyksiköissä seuraavalle tarkastelujaksolle asti.

LOVIISA 1
KÄYTTÖTIETOJA 1980

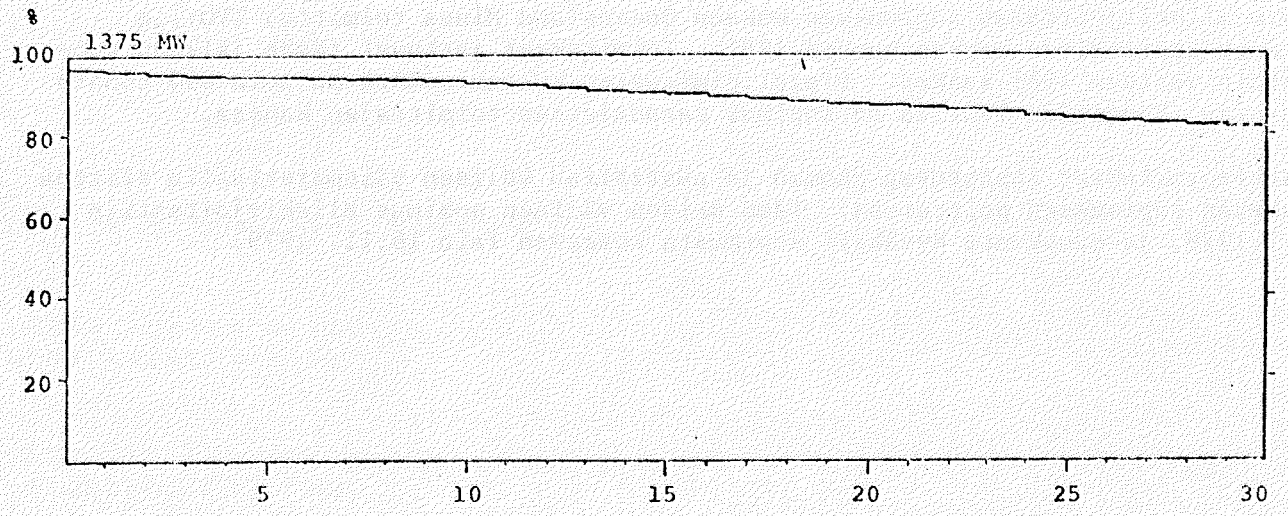
	huhti	touko	kesä	1980
Reaktorin lämmönkehitys (GWh)	891,48	220,90	-	4095,95
Reaktorin käytettävyys (aika kriittisenä)	1.000 (720 h)	0,300 (223,4 h)	- -	0,716 (3127,4 h)
Reaktorin käyttökerroin (perusteho 1375 MW)	0,901	0,216	-	0,682
Reaktorin keskiteho (MW)	1238,2	296,9	-	937,7
Laitoksen sähkönkehitys (GWh)				
- brutto	299,75	72,16	-	1390,38
- netto	283,32	61,18	-	1310,28
Laitoksen käytettävyys (generaattori verkossa)	1.000 (720 h)	0,289 (215,0h)	- -	0,714 (3119,0 h)
Laitoksen käyttökerroin				
- brutto (perusteho 465 MW)	0,895	0,209	-	0,685
- netto (perusteho 440 MW)	0,894	0,187	-	0,682
Laitoksen keskiteho (MW)				
- brutto	416,3	97,0	-	318,3
- netto	393,5	82,2	-	300,0

TVO I

KÄYTTÖTIETOJA 1980

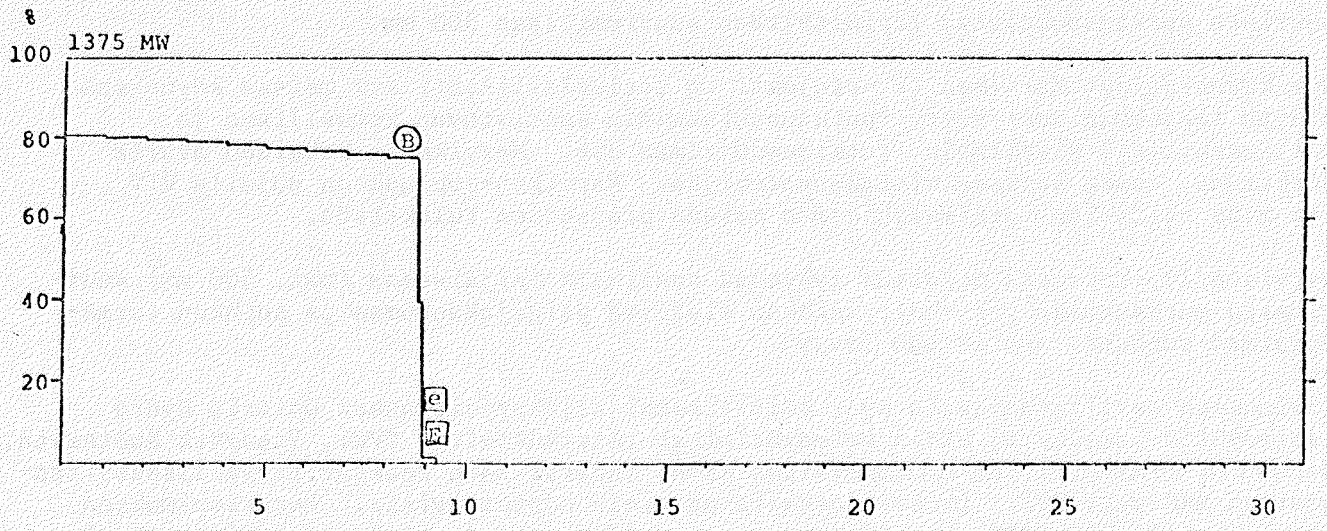
	huhti	touko	kesä	1980
Reaktorin lämmönkehitys (GWh)	1348,62	731,16	10,04	6136,54
Reaktorin käytettävyys (aika kriittisenä)	0,975 (701,7 h)	0,513 (381,7 h)	0,096 (68,9 h)	0,757 (3305,2 h
Reaktorin käyttökerroin (perusteho 2000 MW)	0,937	0,491	0,007	0,702
Reaktorin keskiteho (MW)	1873,1	982,7	13,9	1404,0
Laitoksen sähkönkehitys (GWh)				
- brutto	454,19	241,88	-	2054,79
- netto	439,15	233,64	-	1987,23
Laitoksen käytettävyys (generaattori verkossa)	0,958 (689,6 h)	0,512 (381,2 h)	- -	0,718 (3137,2 h
Laitoksen käyttökerroin				
- brutto (perusteho 683 MW)	0,924	0,476	-	0,689
- netto (perusteho 660 MW)	0,924	0,476	-	0,689
Laitoksen keskiteho (MW)				
- brutto	630,8	325,1	-	470,6
- netto	609,9	314,0	-	455,0

NUCLEAR POWER PLANT LOVIISA 1
THERMAL POWER, APRIL 1980



Strech-out -ajo

NUCLEAR POWER PLANT LOVIISA 1
THERMAL POWER, MAY 1980



9.5. Alasajo vaihtolataus- ja vuosihuoltoseisokkiin
10.5. Booripumppujen vikaantumiset
10.5. Kylmän veden pumppaus kuumiin höyrystimiin

TVO OSTAA URAANIA AUSTRALIASTA

Teollisuuden Voima Oy on 13.8.1980 allekirjoittanut Sydneyssä uraanin tomitusta koskevan sopimuksen australialaisen Queensland Mines -yhtiön kanssa. Sopimus on esitetty Australian hallitukselle muodollista hyväksymistä varten. Australiasta hankittu uraani väkevöidään Neuvostoliitossa. Väkevöidystä uraanista valmistettua polttoainetta käytetään TVO:n ydinvoimalaitoksessa Olkiluodossa.

TVO:n allekirjoittaman sopimuksen mukaan Queensland Mines toimittaa TVO:lle uraania ensimmäisen kerran vuonna 1981. Toimitukset jatkuvat tämän jälkeen vuosittain vuoteen 1989 saakka. Uraanitoimitusten kokonaismäärä on noin 690 tonnia uraania. Ennestään TVO:lla on sopimus kanadalaisen toimittajan kanssa.

Uraanitoimitukset tapahtuvat Suomen ja Australian välisen ydinmateriaalin siirtoa koskevan sopimuksen puitteissa. Tämä maiden välinen sopimus allekirjoitettiin 20.7.1978, ja eduskunta hyväksyi sopimusta koskevan lain 16.11. 1979.

MARVIKENIN NELJÄS KANSAINVÄLINEN REAKTORITURVALLISUUSTUTKIMUSPROJEKTI KÄYNNISTYI

VTT allekirjoitti kesällä sopimuksen osallistumisesta Ruotsissa Marvikenin käytöstä poistetulla ydinvoimalaitoksella suoritettavaan vesi-höyrysuihkun törmäysvoima (Jet Impingement Tests) -projektiin. Marvikenin laitoksella on vuodesta 1971 lähtien suoritettu olennaisesti täyden tehoreaktorimittakaavan lämpö- ja virtausteknillisiä kokeita. Marviken I ja II -projekteissa aiheena oli BWR-laitoksilla käytettävän lauhdutussuojarekennuksen lämpö- ja virtausteknillinen käyttäytyminen onnettomuustilanteissa. Tämän vuoden keväällä päättyneessä III-projektissa tutkittiin vesi-höyry -seoksen kriittistä ulosvirtausta suurista purkausaukoista, läpimitaltaan suurimmillaan 500 mm.

Nyt käynnistynyt Marviken IV -projekti on tosiasiallisesti eri maissa käynnissä olevan laajemman vesi-höyry -purkaussuihkuihin kohdistuvan kokeellisen ja mallinkehitystä sisältävän tutkimusohjelman osa. Marvikenin kokeiden avulla tutkitaan ennen kaikkea mittakaavatekijää. Marviken-sopimuksen nojalla VTT saa myös valtaosan tutkimusohjelman muiden projektien tuloksista.

Marviken IV -kokeissa mitataan lyhyestä suurihalkaisijaisesta (max. 500 mm) suuttimesta purkautuvan vesi-höyrysuihkun sisäistä painejakautumaa ja suihkun törmäysvoimaa suihkuun asetettuun levyyn.

Sopimuksen osallistumisesta ovat toistaiseksi allekirjoittaneet Ontario Hydro -voimayhtiö Kanadasta, USA:n voimayhtiöiden tutkimuslaitos EPRI, Studsvik Ruotsista, Hollannin voimayhtiöiden tutkimuslaitos KEMA, Yhdysvaltain reaktoriturvallisuusviranomainen NRC sekä VTT. Lisäosanottajia on vielä odotettavissa. Perussopimuksen rahoituksella (18 MSEK) kyetään suorittamaan 8 koetta ja lisäosanottajat mahdollistaisivat 3...5 kokeen täydennyksen. Perusohjelman mukainen projekti päättyisi vuoden 1981 loppupuolella.

VTT suorittaa osallistumismaksunsa täysin työpanoksena. Marvikeniin on jo sijoitettu lämpö- ja virtaustekniikan alueen tutkija sekä ATK-asiantuntija.

YDINTEKNIIKAN TUTKIMUS VUODEN 1981 BUDJETTIESITYKSESSÄ

Alla esitetään vierekkäin vuosien 1980 ja 1981 budjettiesityksien momentin 32.44.21, "Energiatalous: Eräät energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menot", käyttösuunnitelmat sekä perustelut.

1980

Maassamme lähivuosina harjoitettavan energiapolitiikan perustaksi hyväksytyssä energiapoliittisessa ohjelmassa asetetaan tavoitteeksi erityisesti energian nykyistä tehokkaampi ja tarkoituksenmukaisempi käyttö sekä kotimaisten polttoaineiden käytön lisääminen muun muassa tehostamalla energiateknologiaa tutkimustoimintaa sekä avustamalla kotimaisen energian käyttöä lisääviä investointeja. Energian kulutuksen kasvun hillitseminen on tarpeen energian tuonnista maksutaseelle aiheutuvan rasituksen vähentämiseksi ja fossiilisten energialähteiden, ennen kaikkea öljyn tuonnin häiriöalttiuden vuoksi. Käynnissä olevat ja lähivuosina valmistuvat ydinvoimalaitokset edellyttävät ydinenergiatutkimuksen suuntaamista erityisesti turvallisuus- ja ydinjätekysymysten selvittämiseen.

21. Eräät energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menot (siirtomääräraha)

Luvun perusteluun viitaten momentille ehdotetaan lisäystä 12 500 000 mk etenkin energiansäästöön ja energiatalouden omavaraisuuden nostamiseen liittyvän tutkimustoiminnan tehostamista varten. Erityistä huomiota kiinnitetään konkreettiseen tuote- ja laitekehittelyyn, jonka tuloksia voidaan nopeasti hyödyntää

Käyttösuunnitelma:	mk	
Energiansäästötutkimus	12 500 000	
Kotimaisten energialähteiden tutkimus	8 000 000	
Muun energiateknologian tutkimus	2 000 000	
Energiatalouden suunnitteluun liittyvät selvitykset	900 000	
Ydinenergian perustutkimukset ja erityissovellutukset	1 000 000	
Ydinvoimalaitosten käyttöselvitykset	300 000	
Ydinvoimalaitosten turvallisuus- ja ympäristöanalyysit	2 200 000	
Reaktoriteknilliset tutkimukset	1 900 000	
Polttoainetekniset tutkimukset	300 000	
Polttoainekiertoon ja ydinjätehuoltoon liittyvät selvitykset	2 200 000	
Kotimaisen teollisuuden ydinenergia-alan tutkimus-, kehitys- ja suunnittelutoiminnan edistäminen	2 300 000	
		10,2 Mmk
Atk- ja tilastopalvelut	200 000	
Energiahuollon tutkimus- ja valvontatoiminnan liittyvät matkat	300 000	
Muut energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menot	400 000	
yhteensä	35 000 000	

1980 esitys	35 000 000
1979 menoarvio	22 500 000
1979 II lisämenoarvio	3 000 000
1978 tilinpäätös	18 500 000

1981

Valtioneuvoston vahvistamassa energiapoliittisessa ohjelmassa on maassamme lähivuosina harjoitettavan energiapolitiikan tavoitteeksi asetettu energian nykyistä tehokkaampi ja tarkoituksenmukaisempi käyttö sekä kotimaisen energian käytön lisääminen. Asetettujen tavoitteiden saavuttamiseksi on tarpeen tehostaa energiateknologian tutkimustoimintaa sekä avustaa kotimaisten polttoaineiden käyttöä lisääviä investointeja. Energian kulutuksen kasvun hillitseminen ja energiahuollon kotimaisuusasteen nostaminen ovat tarpeen tuontienergian saatavuudessa esiintyvien epävarmuustekijöiden sekä hinnan noususta aiheutuvien maksutaserasitusten vähentämiseksi.

21. *Eräät energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menot* (siirtomääräraha)

Luvun perusteluihin viitaten momentille ehdotetaan lisäystä 15 000 000 mk lähinnä energiansäästöön ja energiatalouden omavaraisuuden nostamiseen liittyvän tutkimustoiminnan tehostamista varten. Erityistä huomiota kiinnitetään tavoitteellisten ja pitkäjänteisten tutkimuskokonaisuuksien toteuttamiseen. Muihin energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menoihin osoitettavasta määrärahasta ehdotetaan käytettäväksi enintään 400 000 mk Suomessa pidettäväksi suunnitellun turvetta käsittelevän YK:n seminaarin kustannuksia varten. Määrärahasta enintään 200 000 mk voidaan käyttää ulkomaan matkoihin.

Käyttösuunnitelma:	mk	
Energiansäästötutkimus	18 000 000	
Kotimaisten energialähteiden tutkimus	14 500 000	
Muun energiateknologian tutkimus	2 000 000	
Energiatalouden suunnitteluun liittyvät valtakunnalliset selvitykset	1 000 000	
Energiatalouden suunnitteluun liittyvät alueelliset selvitykset	1 000 000	
Ydinenergian perustutkimukset ja erityissovellutukset	1 100 000	
Ydinvoimalaitosten käyttöselvitykset	400 000	
Ydinvoimalaitosten turvallisuus- ja ympäristöanalyysit	2 500 000	
Reaktoriteknilliset tutkimukset	2 100 000	
Polttoainetekniset tutkimukset	900 000	
Polttoainekiertoon ja ydinjätehuoltoon liittyvät selvitykset	2 600 000	
Kotimaisen teollisuuden ydinenergia-alan tutkimus-, kehitys- ja suunnittelutoiminnan edistäminen	2 600 000	
		12,2 Mmk
Atk- ja tilastopalvelut	200 000	
Energiahuollon tutkimus- ja valvontatoiminnan liittyvät matkat	300 000	
Muut energiahuollon tutkimus-, suunnittelu- ja valvontatoiminnan menot	800 000	
Yhteensä	50 000 000	

1981 esitys	50 000 000
1980 menoarvio	35 000 000
1980 I lisämenoarvio	6 000 000
1979 tilinpäätös	25 500 000

Ydintekniikan tutkimukseen ehdotetut varat kasvavat siten vain 10,7 Mmk:sta 12,2 Mmk:an eli 14%, mikä vastaa ainoastaan kustannustason nousua. Kahteen edelliseen vuoteen verrattuna tilanne on kuitenkin lievästi parempi, sillä vuosina 1979 ja 1980 reaalirahoitus laski. Koko energiatutkimusmomentin määrärahat kasvavat ehdotuksen mukaan 35 Mmk:sta 50 Mmk:an eli 43%. Vuoden 1980 ensimmäisessä lisämenoarviossa on tosin myönnetty lisää 6 Mmk, lähinnä säästöön ja kotimaisille polttoaineille.

ENNAKKOTIETOJA ENERGIATALOUDEN KEHITYKSESTÄ
TAMMI - KESÄKUUSSA 1980

Lähde:
ENERGIAKATSAUS 2/80
KTM, Energiaosasto

Energian kokonaiskulutus

Energian kokonaiskulutuksen kasvu on hidastunut kuluvana vuonna. Kuuden ensimmäisen kuukauden aikana energian kulutus on kasvanut 2 % viime vuoden vastaavasta ajamkohdasta. Huhti-kesäkuussa kulutus jopa supistui. Koko viime vuoden kulutuskasvu oli keskimäärin 5 %.

Myös sähköenergian kulutuksen kasvu on taittunut. Tammi-kesäkuussa sähköä kulutettiin 4,4 % enemmän kuin viime vuoden alkupuolella. Viime vuoden keskimääräinen kasvu oli ollut vielä 7,5 %.

Sekä kokonaisenergian että sähköenergian kulutuskasvu on alkuvuonna jäänyt selvästi jälkeen talouskasvusta. Kehitys on maamme energiapoliittisen ohjelman mukainen.

Tuontienergian kokonaiskulutus supistui

Tuontienergian, ennenkaikkea öljyn, viimeaikaiset hinnannousut ovat vaikuttaneet tuontienergian kulutukseen ja osuuteen kokonaisenergiasta. Kaikkiaan tuontienergialla peitettiin kokonaisenergiasta tammi-kesäkuussa 71 %,,eli koksi prosenttiyksikköä vähemmän kuin viime vuoden vastaavana ajankohtana.

Öljyn kulutus supistui alkuvuonna 4 %. Keskimääräistä enemmän supistui sekä kevyen että raskaan polttoöljyn kulutus.

Kivihiilen kulutus kääntyi nousuun toisella vuosineljänneksellä. Kulutuksen kasvu aiheutui siitä, että sähköä jouduttiin tuottamaan suunniteltua enemmän lauhdutudvoimalla ydinvoimalaitosten seisokkien vuoksi.

Energian tuonnin arvo kaksinkertaistui

Maahamme tuotiin tammi-kesäkuussa energiaa 7,1 miljaardin markan arvosta. Lisäystä edellisen vuoden vastaavasta ajankohdasta oli 3,5 miljaardia markkaa eli energian tuontilasku lähes kaksinkertaistui. Energian tuonti edusti alkuvuonna neljännestä kokonaistuonnistamme.

Energian tuontilaskun nousu aiheutui pääasiassa raakaöljyn tuontihinnasta. Raakaöljystä maksettiin tammi-kesäkuussa 889 mk/tonni edellisen vuoden vastaavan hinnan oltua 463 mk/tonni. Raakaöljyn tuonti lisääntyi edellisestä vuodesta 2.9 miljaardilla markalla, josta osa aiheutui kuitenkin myös tuontimäärän kasvusta.

Kivihiilen tuonnin määrä ja hinta nousivat. Kivihiilen tuontihinta on noussut kuluvan vuoden kesäkuuhun mennessä 28 % viime vuoden kesäkuusta. Kun kivihiilen kulutus oli alkuvuonna suurempi kuin tuonti, kivihiilivarastot supistuivat viime vuoden lopun tasolta.

Maakaasun tuontihinta on noussut öljyn hintojen myötä. Nousua edellisen vuoden tammi-kesäkuun hinnasta oli 74 %.

Energiaa - öljytuotteita ja sähköä - vietiin alkuvuonna 1,4 miljaardin markan arvosta. Merkittävin vientituote oli moottoribensiini, jota vietiin lähes 0,5 miljaardilla markalla, valtaosan mennessä Ruotsiin.

Sähkön tuotanto nousi 3 %

Maassamme tuotettiin sähköä tammi-kesäkuussa 20 miljaardia kWh, mikä oli 3 % enemmän kuin viime vuonna vastaavana aikana. Tuotannon kasvu oli toisella vuosineljänneksellä pienempi kuin ensimmäisellä, koska sähkön tuonti lisääntyi ja vienti supistui edellisestä vuodesta ja myös kulutuksen kasvu hidastui.

Ydinvoimalla tuotettiin sähköstä 16,6 %. Osuus jäi jonkin verran odotettua pienemmäksi ydinvoimaohjelman viivästymisen vuoksi. Kesäkuussa päättyneen 12 kuukauden jakson aikana ydinvoimalla oli tuotettu sähköä 6,8 miljaardia kWh, mikä vastaa polttoaineena lähes 3 miljoonaa tonnia kivihiiltä.

TAULU 1: ENERGIAN KOKONAISKULUTUS ENERGIALÄHTEITTÄIN, 1000 toe [1]

	ÖLJY Olja Oil	HIILI Kol Coal	MAAKAASU Naturgas Natural gas	YDINVOIMA[2] Kärnkraft Nuclear power	SÄHKÖN NETTOTUONTI[2] Nettoimport av elenergi Net imports of electr.	TUONTIENERGIA YHT. Importerad energi, totalt Imported energy, total	VESIVOIMA[2] Vattenkraft Hydro power	TURVE Torv Peat	MUUT KOTIMAISET Övriga inhemska bränslen Other indigenous fuels	KOTIMAISET YHT. Inhemsk energi, totalt Indigenous energy	ENERGIAN KOKONAISKULUTUS Totalförbrukning Total consumption	BUNKRAUKSET Bunkringar Bunkers
1973	12674	1951	-	-	1080	15705	2602	39	4400	7041	22746	179
1974	10987	1998	394	-	785	14164	3127	43	3990	7160	21324	171
1975	11139	1799	653	-	997	14588	3008	43	3620	6671	21259	238
1976	12095	2559	766	-	1004	16424	2336	78	3450	5864	22288	288
1977	11810	2549	778	628	223	15988	3000	119	3420	6539	22527	357
1978	11731	3509	844	770	319	17173	2412	291	3724	6427	23600	398
1979	11800	3200	849	1597	161	17607	2665	427	4070	7162	24769	717
I-VI/79	6330	1890	432	729	- 73	9308	1181	270	1950	3401	12709	215
I-VI/80	6100	1970	372	825	- 61	9206	1413	300	2020	3733	12939	326

1) toe = ekvivalenttinen öljytonni = 11,28 MWh = 40,6 GJ

2) tuotettu sähköenergia muunnettuna vastaamaan sitä määrää raskasta polttoöljyä, joka tarvitaan vastaavan energian tuottamiseen tavallisella lauhdutusvoimalla

Tilastoissa esitetyt luvut vuosien 1978, 1979 ja 1980 osalta ovat osittain ennakkotietoja tai arvioita

TAULU 2: SÄHKÖENERGIAN HANKINTA, GWh

	VESIVOIMA	TEOLL. VASTAPAINEVOIMA	PROSESSILAUHDEVOIMA	KAUKOLÄMPÖVOIMA	LAUHDUTUSVOIMA	YDINVOIMA	PERUSKAASUTURB.-VOIMA	VARAKAASUTURB.-VOIMA	TUOTANTO	+TUONTI	-VIENTI	YHTEENSÄ
1973	10409	5634	550	1515	6544	-	-	286	24938	4556	237	29257
1974	12506	5638	540	1561	6191	-	-	88	26524	3615	475	29664
1975	12032	4710	486	2005	5688	-	135	78	25134	4146	159	29121
1976	9342	5207	542	2547	9877	-	305	65	27885	4088	73	31900
1977	12000	5242	546	2980	7971	2510	291	23	31563	1393	502	32454
1978	9646	5824	495	3723	10874	3079	227	3	33871	1554	277	35148
1979	10658	6356	473	3749	9250	6388	277	3	37151	2233	1588	37796
I-VI/79	4723	3312	244	2147	5914	2917	126	1	19384	706	997	19093
I-VI/80	5651	3364	221	2292	5235	3301	99	10	20173	774	1019	19928

Lähde: Sähkötilasto

RUOTSIN YDINVOIMAYHTIÖT PERUSTIVAT UUDEN YHTEISTYÖKOMITEAN TURVALLISUUTTA EDISTÄMÄÄN

As a further step to promote nuclear safety the four Swedish nuclear power utilities - Vattenfall, Forsmark, Oskarshamn and Sydkraft - have formed the NUCLEAR SAFETY BOARD which started its activities on April 1, 1980. The board shall promote coordination and cooperation between the utilities in their nuclear safety work. It shall also sponsor safety R&D work done by external consultants, universities, and other R&D organizations. The staff of the board should also to some extent perform assessment and analysis work.

One of the main tasks of the nuclear safety board will be to collect information about incidents and accidents in Swedish and foreign nuclear power stations and to assess and analyze that information. The main working areas of the nuclear safety board will be

- Safety analyses, research and development with the emphasis on systematic evaluation of operating experience
- Training of operators and other staff of the nuclear power stations
- Quality assurance
- Emergency planning
- Exchange of operating experience between the utilities.

The work of the board will be performed with openness to the public and with possibilities for politicians and the press to have an insight in the activities of the board, thus contributing to build up a public confidence in the nuclear safety work of the Swedish utilities.

Lähde: Swedish Nuclear News No 1,
May 1980

ST. HELENS -TULIVUOREN RADIOAKTIIVISUUSPÄÄSTÖ HUOMATTAVA

An extensive study by Battelle Pacific Northwest Laboratories of the ash from Mount St. Helens estomates that up to 3 million curies of radon gas were released in the eruption of May 18. The report, "Mount St. Helens Ash Characterization: Chemical, Physical, Mineralogical, and Biological Properties," will appear in Science magazine.

Prallels can be drawn between radioactive releases from the eruption and radioactive releases from the accident at Three Mile Island. The President's Comission to investigate TMI (Kemeny Commission) estimated that a total of abour 2.5 million curies of noble gases, mostly xenon, were released over the course of the accident. Both radon and xenon are noble gases and as such are chemically and bilogically inert.

However, radon decays to form a whole series of radioactive "daughter" elements that are both chemically and biologically active. Because of this, the health effects from radon on a curie-for-curie basis are about a thousand times more extensive than those from xenon. On this basis alone, the radioactive release from Mt. St. Helens was many times more significant than that from TMI-2.

But in addition to estimating the release of radon gas from the volcano, the Battelle study measured the radioactivity from other radioisotopes, including radium-226, potassium-40, Thorium-232, polonium-210, and lead-214, at various points across the state of Washington. The amounts were significant as far away as Spokane (227 miles). The report also notes that "newly fallen ash was found to contain rather high concentrations of the short-lived radon daughters lead-214, bismuth-214, and polonium-214... The concentrations (of these elements) are comparable to concentrations found in uranium tailings material... These concentrations are extremely high compared with the radium-226 content of the ash."

Thus, the radioactive release from Mount St. Helens was many times more significant than that from TMI-2.

Lähde: NSAC Industry Report, nr. 7

OECD:N YDINENERGIAJÄRJESTÖN (NEA) TOIMINTAKATSAUS V.1979

1. The OECD Nuclear Energy Agency (NEA) announced today the publication of its Eighth Activity Report covering the year 1979. This was the year when the full extent of the world's interdependence in matters of energy supply and security became more generally recognised and one in which there were three major developments influencing the evolution of nuclear programmes.

2. The political crisis in Iran has drawn attention to the fragility of energy supply lines and the consequent vulnerability of the world economic structure. The analysis completed in the International Nuclear Fuel Cycle Evaluation (INFCE) has clarified the possibly conflicting priorities in avoiding proliferation of nuclear weapons; and the accident at the Three Mile Island nuclear power plant has created an increased awareness of the safety dimension in nuclear programmes. In their respective ways, these and other influences have re-emphasised the indispensable contribution of international co-operation in overcoming the impediments to nuclear programmes which are increasingly recognised as a vital component in assuring the required energy supplies.

3. The work of NEA is directed towards achieving this co-operation, essentially at governmental level and between other national institutions. The attached Summary highlights the main features of the year's work.

LÄHDE: OECD PRESS RELEASE, PARIS, 4TH JULY, 1980

REVIEW OF NEA 8TH ACTIVITY REPORT

(1st January 1979 - 31st December 1979)

TRENDS IN NUCLEAR POWER

At the end of 1979 there were 232 civilian nuclear power plants in operation throughout the world, representing approximately 119,000 Megawatts (electrical) of capacity. An additional 229 were under construction or on order (including 115 in the USA and 31 in France). There were 23 countries equipped with nuclear power plants while 13 more countries had plants under construction or on order.

During 1979 the 555 Terawatt hours of electricity produced from nuclear sources in OECD countries was equivalent to about 130 million tonnes of oil (approximately 2.5 million barrels per day) or about 10% of oil imports. Projections of this comparison in the Table below show that the share of nuclear electricity could increase to the equivalent of 23% of OECD oil imports in 1985 and to 40% in 1990, if the high estimates are achieved. However, if the present trend of delaying nuclear construction continues, it is very doubtful whether even the low numbers would be realized and the pressure for increased oil imports beyond the projections would be likely to grow accordingly.

OECD oil imports and oil equivalent of nuclear electricity production

(in million barrels per day)

	1979	1980	1985	1990
OECD oil import projections	27*	25	29	31
Nuclear electricity production INFCE low assumptions	2.5*	3.4	5.9	10.3
Nuclear electricity production INFCE high assumptions	2.5*	3.5	6.8	12.4

* Achieved.

At present, over 20% of electricity production in OECD countries is based on petroleum products (~ 4 Mb/d). It is therefore worth noting that each 1,000 MWe nuclear power station corresponds to a potential saving of about 30,000 barrels of oil per day. If about 33 nuclear power stations were to be

substituted for the equivalent capacity of oil-fired stations, a saving of 1 million barrels of oil per day would result. The construction of nuclear power stations in this range is well within the capability of the nuclear industry each year in OECD countries.

In reality, the situation is somewhat different from what these figures suggest. Although world consumption of nuclear electricity increased by 27.5 per cent on average in each year from 1968 to 1978, the increase in the OECD area was only 2.2 per cent in 1979. There are indications that this trend could last for several years. The long lead times in nuclear plant licensing and construction (5 to 10 years) and uranium mine development (10 to 15 years) could therefore mean that the availability of the nuclear option would be diminished if no action is soon taken to counter this trend.

There is thus no doubt that a considerable potential contribution could be made available from nuclear power to decrease the dependence of industrialised countries on oil imports, provided that clear decisions and strong political leadership are applied.

ECONOMIC AND TECHNICAL STUDIES ON NUCLEAR DEVELOPMENT

The extent to which other resources can compensate for limitations in oil supply depends on the availability of those resources. The analysis of the availability of uranium and the promotion of the technology for uranium exploration and exploitation continue to be a major part of the NEA programme.

During 1979, the latest edition of the joint NEA/IAEA report, "Uranium Resources, Production and Demand" (known as the "Red Book"), published since 1965, was prepared. The new report examined uranium exploration, resources and production on a country-by-country basis and, for the first time, widened coverage of uranium resources with descriptions of some of the high-cost low-grade material and the potential uranium resources (Speculative Resources) likely to exist beyond those Reasonably Assured and Estimated Additional Resources which were also described in the report.

According to the report, world uranium reserves have increased by some 200,000 tonnes in the last two years and now total 1.85 million tonnes uranium. This amount of uranium, even assuming an extremely low growth of nuclear power programmes, will satisfy demand only to around the year 2000. After that time requirements will have to be supplied from resources which can be confirmed as reserves only after further exploration, and from resources not yet discovered. In addition, since it takes on average 15 years for a mine to begin production from start of exploration, successful exploration over the next few years will be required to satisfy longer term demand. Since resources will be increasingly difficult to find and, once found, are likely to be of poorer quality

requiring more expensive processing techniques, the Agency is concentrating efforts on the technology of uranium exploration and uranium extraction.

Consumer demand is one of the factors affecting uranium supply and this, in turn, is a function of the development of the complete fuel cycle and the type of reactors adopted. The Agency's analyses of supply and demand of fuel cycle services was covered in an earlier publication entitled "Nuclear Fuel Cycle Requirements and Supply Considerations, Through the Long-Term" (February 1978 - known as the "Yellow Book"). This report is now being updated.

Assessment of Speculative Uranium Resources - IUREP

In order to stimulate exploration, particularly in areas where little prospection has occurred, the International Uranium Resources Evaluation Project (IUREP) was established in 1976 by the NEA/IAEA Steering Group on Uranium Resources. The first phase of the Project, a systematic review of world geology and an inventory of uranium occurrences, was completed in 1978 and the report "World Uranium Potential: An International Evaluation", published by OECD. During 1979, NEA put into motion the IUREP Orientation Phase. In this phase, evaluation missions are being sent to several countries which have been identified as being likely to contain significant quantities of uranium and in which insufficient exploration had been carried out to realise this potential. Portugal, Austria, Colombia, Finland, Madagascar, Norway, Turkey and Zambia have all requested that missions be sent to them during the Orientation Phase.

THE HARRISBURG ACCIDENT - ITS INTERNATIONAL IMPACT

The March 1979 accident at the Three Mile Island (TMI) nuclear power plant in the United States had no measurable public health consequences. However, it has confirmed the importance of all safety research and development programmes and has highlighted the value of collaborative efforts.

To ensure that the lessons learned from the U.S. investigations are applied in all interested countries as expeditiously as possible, NEA organised special meetings of its main nuclear safety and radiation protection committees, for briefing by U.S. authorities. Resulting international discussions have led to increased attention being focused on many NEA projects and to incentives for new co-operative activities; for example:

- A new Incident Reporting System (for nuclear facilities) has been put into operation for a two year trial period in order to strengthen the NEA system for notifying and keeping Member countries informed of accidents and malfunctions;

- Projects dealing with the performance of equipment under accident conditions and with emergency response planning are being strengthened;

- Experiments designed to study the particular type of accident that occurred at TMI will be conducted;

- International participation in examination of the damaged fuel from the TMI reactor will be arranged;

- Special tests on fuels under accident conditions like those that occurred at TMI will be conducted at the OECD Halden Reactor Project in Norway;

- NEA programmes concerning human factors in reactor operation, during both normal and non-routine circumstances, are being expanded.

NUCLEAR SAFETY RESEARCH

Following the TMI accident there has been a growing commitment among Member governments to developing NEA's nuclear safety programme, particularly light water reactor safety research. As illustrated at TMI, the loss-of-coolant accident is a rare, complex and dynamic type of event that is difficult to study without the use of major research facilities and complex analytical techniques. For several years NEA has been devising special international "tools" to optimise the use of these resources. One of these tools, the international "standard problem" exercise, is now being used to analyse the type of loss-of-coolant accident (LOCA) that occurred at TMI.

Another reactor safety concern is the integrity of the pressure vessel, made from very thick (12 in, and more) welded steel plates. The non-destructive examination (NDE) of these plates by ultrasonic techniques is a major method for detecting and monitoring flaws in the plates, and consequently a great deal of work is being done to perfect the technique. The major contribution of NEA in this field has been the round-robin programme of tests on three thick-welded steel plates, co-ordinated by the Plate Inspection Steering Committee (PISC). This programme was completed during 1979 and the first part of the results published. The plates, containing deliberately implanted flaws, were examined ultrasonically by 34 organisations in ten countries. Following the success of this exercise, a second one of the same type will be undertaken.

NEA expert groups have been putting substantial efforts into the study of plant and operator behaviour. Their work has included:

- A two-year study, completed in 1979, of factors involved in predicting the reliability of reactor mechanical equipment such as large relief and safety valves, and estimating the probability of failure of different structures;

- A compilation of failure statistics for small-diameter pipework (the TMI LOCA resulted from a small pipe break);

- An experts' review of compilations of abnormal event reports from Member countries to evaluate the quality of human error information and to try to identify recurrent modes and causes of human error involved in routine testing procedures;

- A specialist meeting to review experience of the behaviour of off-gas and ventilation systems in accident conditions, covering the performance of such systems during the TMI accident.

RADIOACTIVE WASTE MANAGEMENT

Over the years, NEA has developed a comprehensive programme dealing with the management of radioactive waste. One of the recognised problems in discussing nuclear waste is that there is a wide range of relevant factors, many of which are highly technical. It is therefore difficult for those not directly involved to understand clearly the basic features of waste management options and the reasons and justifications behind them. Partly to clarify this, the Agency initiated two studies, one on fundamental concepts applicable to radioactive waste disposal and the other on legal, administrative and financial questions of long-term management of radioactive waste.

For disposal of high level waste, the option on which most effort is devoted is the emplacement of solidified waste into deep geologic formations. The Agency held a symposium on the subject at Otaniemi during 1979*. The consensus of experts was that there are many geologic environments capable of and suitable for safe isolation of all types of radioactive waste. In support of this conclusion, NEA is sponsoring an international research programme at the Stripa Mine in Central Sweden.

During 1979 NEA also initiated international collaboration in other problem areas of radioactive waste management, such as the decommissioning of nuclear facilities at the end of their working lives.

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* NEA/IAEA International Symposium on the Underground Disposal of Radioactive Waste, 2-6 July 1977, Otaniemi, Finland.

Surveillance of Radioactive Waste Sea Dumping Operations

Disposal of packaged low-level radioactive waste by dumping into the deep ocean is governed by the London Convention*. OECD Member countries further must conform to the terms of a Multilateral Consultation and Surveillance Mechanism established in 1977 by the OECD Council. Under NEA surveillance, two separate dumping operations were carried out in the summer of 1979. As part of its responsibilities in this area, NEA also sponsored a study examining the suitability of the present dump site.

RADIATION PROTECTION AND PUBLIC HEALTH

In the area of radiation protection, NEA's attention has focused on questions related to nuclear fuel cycle operations, from the mining of uranium ore to the disposal of radioactive waste.

The potential long-term effects of long-lived gaseous effluents were studied from the point of view of the problems and costs associated with their control, retention and disposal. A report on the four major radioactive gases chosen for thorough analysis - tritium, carbon-14, krypton-85 and iodine-129 - was nearing completion by the end of 1979.

As the nuclear industry has matured, considerable volumes of mill-tailings from uranium mining and milling operations have accumulated. If not properly managed, these could become sources of low-level radiation exposure. As Member countries account for more than half of world uranium production, NEA has devoted substantial effort to developing techniques to reduce the impact of mill tailings on the environment and to establishing an internationally accepted methodology for their long-term management.

The general level of safety of nuclear plants is continually being enhanced. However, some improvements have required increased use of plant workers which, if compensatory measures are not taken, could lead to higher occupational radiation exposures. The possibly conflicting requirements of plant safety, radiation protection and economic constraints have been examined in an NEA study. The results of the study should enable identification of the "critical" operations and plant systems and components for which improvements in design and operational procedures could be most effective in reducing the hazard of exposure of workers.

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* Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

LEGAL AFFAIRS

The Agency sponsored and still administers two international Conventions, the Paris Convention on Third Party Liability in the Field of Nuclear Energy (1960) and the Brussels Convention supplementary to it. During 1979, basic agreement was reached for updating these conventions to take account of developments in the industry and to increase the amounts of compensation to take account of the change in price levels since they were first established.

NUCLEAR SCIENCE

Nuclear science requires large investments in major research facilities and also in computer equipment needed to store and handle the massive amounts of data. For many years, the Agency has been concerned with co-ordinating nuclear physics research in Member countries and developing supporting information services to make certain that the necessary nuclear data and computer programmes are available for nuclear energy applications. In 1978 the Agency implemented its project to concentrate and expand its resources into the "NEA Data Bank" established at Saclay. During 1979 the Data Bank was consolidated in its new mode of operation and now represents a tool of considerable potential for participating Member countries.

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Esitelmä ATS:n kokouksessa
22.9.1980

THE GERMAN RISK STUDY FOR NUCLEAR POWER PLANTS

In August 1979 results of the "German Risk Study for Nuclear Power Plants" were published. The "Main Report", in which approach and results of the study are documented, has been available since the end of the last year.

It was the charter of the study - which has been performed on behalf of the Federal Minister of Research and Technology -, to apply as far as possible the methods of the U.S. Reactor Safety Study (WASH-1400) to German plant and site conditions.

A direct transfer of WASH-1400 results has not been deemed justified mainly for the following reasons:

- There is quite a number of differences between the design of the reference plants of WASH-1400 (Surry 1, Peach Bottom 2) and German nuclear power plants.
- The mean population density in the Federal Republic of Germany is more than ten times that of the United States. In the vicinity of nuclear power plants the ratio is about 3:1.

The "Gesellschaft für Reaktorsicherheit" was the main contractor and performed most of the plant analysis. The "Kernforschungszentrum Karlsruhe" performed the calculation of accident consequences. In matters of health effects of radiation assistance came from the "Gesellschaft für Strahlen-und Umweltforschung". Further institutions have contributed to special problems.

As the reference plant for the technical part of the analysis Biblis B has been used. Biblis B is a KWU-type PWR with 3750 MW thermal power, which started commercial operation in March 1976.

To calculate the collective risk resulting from reactor accidents, a total of 25 plants at 19 different sites in the Federal Republic of Germany have been considered. This included all plants with 600 MW or more electrical output which were in operation, under construction or in the licensing process on July 1, 1977. As an approximation to the real situation it has been assumed that all 25 plants are technically identical to the reference plant.

Methods and Results of the Study

Each risk can be characterized by probability and extent of potential damages. With respect to nuclear power plants, neither of these components can be determined from direct experience. In more than 25 years of reactor operation, there have been many operational incidents and also a number of serious accidents. However, no one has been killed or injured outside a plant by a nuclear accident.

Therefore, the only way to estimate the risks which remain in spite of extensive safety measures is by analytical means.

The safety concept applied in nuclear power plants ensures that accidents do not cause dangerous release of radioactive material into the environment as long as a minimum number of redundant engineered safeguards are properly operating. Hence, a risk analysis must deliberately assume failures of safety systems, since only those events may lead to fission product release and therefore can contribute to the risk.

A rough survey of the radioactive inventory of a nuclear power plant indicates, that, on time average, fission products in the reactor core constitute about 95 % of the total inventory. Therefore, it is justified to consider mainly such events, which could lead to serious releases of fission products from the core.

For an estimation of risk, releases can neglected as long as damages to the core and especially a meltdown of the core are prevented. Therefore risk analysis must deal with severe overheating of the core, the prevention of which is a central task of reactor safety.

"Initiating events", potentially leading to core damage by insufficient cooling, usually are grouped into two types:

- loss-of-coolant accidents, initiated by a leak or a break in the reactor coolant system
- transients leading to an imbalance between the heat generated in the core and the heat removed from the core, caused by events different from loss-of-coolant accidents.

It is most probable that after an initiating event the plant will be brought to a safe state by means of control and safety systems. However, if systems would fail which are essential to maintain sufficient core cooling, overheating and finally meltdown of the core would result. Depending on the specific initiating event, this may require successive failures of a number of different systems. Considering operational transients, function of safety systems would generally be necessary only if control systems fail. More severe events, however, require an immediate function of safety systems.

In order to clearly record the possible event sequences induced by an initiating event, "event trees" have been established. The trunk of an event tree is standing for the initiating event. The tree is branched at points, where the event is influenced by success or failure of the various systems. Consequently, the branches of the tree are representing the possible accident sequences. The frequency of occurence of the respective accident sequence is given by the frequency of the initiating event and by the probability of success or of failure of the systems involved.

The frequency of transients is estimated mostly on the basis of operation experience. For loss-of-coolant accidents, data have been obtained from literature.

Safety systems in nuclear power plants are designed to perform with high reliability. As a consequence, the probabilities of failure of those systems are generally not known from direct experience. Therefore, they have been calculated by means of fault tree analyses. By a fault tree the functional interaction of system components is translated into a logical structure. According to this structure the probability of system failure can be calculated starting from the unavailability of components. In principle, also the influence of human actions and of external impacts can also be taken into account.

In the reliability analysis of a redundant system it must be assessed which part would be sufficient to perform the required function. For this purpose the study relied upon the safety analysis of the licensing procedure. A redundant system has been assumed to fail totally if less subsystems are available than have been considered for the safety analysis. There are good reasons, that in a real situation also degraded system function could maintain core integrity.

It has already been mentioned, that for the risk analysis mainly those events which lead to meltdown of the reactor core need to be traced. Large amounts of fission products could be released only for these cases.

To calculate core melt frequency the study has considered about 70 accident sequences to some detail. Summing up all relevant contributions an overall core melt frequency of about 9×10^{-5} per year has been calculated. Table 1 summarizes the results of event tree and fault tree analyses. Fig. 1 shows the relative influence of different initiating events on the overall core melt frequency.

A loss of main coolant through a small leak in a reactor coolant pipe dominates all other contributions, mainly for the following reasons:

- Small leaks may occur more frequently than medium or large breaks.
- The secondary system is necessary to remove the decay heat and to cool down the reactor. In the reference plant, the function of this system must be initiated and controlled by the operators. This reduces the system reliability significantly.

The second largest contribution results from transients with the loss of offsite power playing an important role.

For many transients an increase of the primary system pressure has to be expected. The actuation of pressurizer relief or safety valves could become necessary to protect the system from undue overpressure. In this case, a transient can develop into a small leak, if a valve would fail to close after it had opened. This sequence played a dominant role, when interim results of the study were published in November 1977. Plant improvements reduced its probability considerably.

It is not surprising that the contribution of a large break is quite small. This accident has been studied very extensively for many years as a design basis accident. Engineered safeguards have been optimized to cope with this accident.

After fission products have been released from the core, deposition processes in the containment atmosphere and the state of containment integrity are important for the amount of fission product release into the open atmosphere.

During meltdown molten material will fall down into the lower plenum of the pressure vessel. Decay heat, generated in the molten fuel, is assumed to be sufficient to melt through the lower head of the reactor pressure vessel and even to melt into the concrete structures of the reactor pit and the containment foundation. Meltthrough of the reactor building foundation has been calculated to occur about 100 hours after accident initiation.

During meltdown and melt-through not only parts of the radioactive core inventory are released, but also large amounts of steam and hydrogen are generated, resulting in an increase of the containment pressure and temperature. It has been calculated, that about 25 hours after an accident initiation the containment will fail because of overpressure.

Prior to this "late overpressure failure", containment integrity may be lost due to the failure of containment isolation or by a "steam explosion". When the molten core falls into the water in the lower plenum, a rapid evaporisation of the water takes place. However, an energy release sufficiently large to endanger primary system integrity would require very fine fragmentation of large parts of the molten core.

By combining results of core melt analysis and of the analysis of containment behaviour, the amount and frequency of fission product release from the plant to the atmosphere are obtained.

To simplify the remaining analysis, accident sequences resulting in the same containment failure mode are grouped together into one of several release categories.

Typical data of these categories are shown in Table 2. Categories 1 through 6 comprise core melt accidents. The probability is about 95 % that a core meltdown will be followed by a "late overpressure failure" of the containment. These events are comprehended by the categories 5 and 6. In category 5 additional failure of filter systems prior to "late overpressure failure" of the containment is assumed.

Categories 2 through 4 comprise core melt accidents with failure of containment isolation, openings ranging from a large leak (300 mm equiv. diameter) to a small leak (25 mm equiv. diameter). Fission product releases in these cases, particularly for the large leak, are significantly higher than for categories 5 and 6.

Category 1 contains the most severe releases. It has been assumed that the reactor pressure vessel and the containment are seriously damaged by a steam explosion after core meltdown. The present state of analytical and experimental evidence shows, that such an event is extremely unlikely. As a very cautious assumption, similar to WASH-1400 a two percent probability has been assigned to the event that a core meltdown leads to a steam explosion, destroying the containment integrity.

The study has also analyzed loss-of-coolant accidents, assuming sufficient core cooling by the emergency core cooling systems. These events are grouped into categories 7 and 8. Fission products are released only because of postulated cladding failures. For category 7 the failure of containment isolation by a large leak is assumed.

Subsequent to the technical part of the analysis, the dispersion of fission products by atmospheric transport and diffusion has been analyzed. Weather conditions have been assumed according to records of actual data for different meteorological areas. Finally the resulting radiation exposures, health effects from radiation exposure and - according to the population data - the number of individuals affected by health damage have been calculated.

For this calculation emergency procedures have been taken into account based on government recommendations existing in the Federal Republic of Germany.

The main results of the consequence calculations are compiled in the following paragraphs.

Fig. 2 shows the correlation between number and frequency of acute fatalities which could be caused by radiation exposure to the public after a core melt accident. With 25 plants in operation, a frequency of about 10^{-5} per year has been estimated for accidents which can result in acute fatalities. It can be concluded from the figure that large consequence events are extremely unlikely.

The study has attempted to quantify confidence intervals for the results. These are shown at selected points.

The very low frequencies, calculated by the study, result from the product of several factors (fig. 3).

Considering 25 plants, calculations show a core melt frequency of 1 to 400 per year. Given a core meltdown, in most cases fission product release to the open atmosphere is limited by the containment very effectively. There is only a 1 out of 16 chance that potentially lethal doses would appear after severe containment failure. In this case the consequences depend on weather conditions and population distribution. The chance is 1 out of 10 that acute fatalities might occur after severe containment failure.

Altogether, the probability is more than 99 % that a core melt accident will not cause acute fatalities. A great number of fatalities could occur only if adverse weather conditions coincide with unfavourable site characteristics and the most severe accidents. This results in a very low probability of large consequence events.

With respect to late health effects the situation is different. Considerable numbers of late fatalities are calculated also for less severe accidents (fig. 4). It has to be born in mind that a linear dose-risk relationship has been used in the study. That means that even the smallest radiation exposure is assumed to cause an increase of risk of cancer.

Late health effects, ensuing from radiation, would appear after a delay time of 10 to 20 years and spread over many decades and over large areas.

As an average about half of the effects may occur outside the Federal Republic of Germany. This emphasizes the international importance of reactor safety.

It seems appropriate to put the number of late health effects calculated by the study into perspective. So, it can be calculated by applying the linear dose-risk relationship used in the study that about half a percent of all cancer fatalities are caused by natural radiation. Although this is a relatively small percentage, the absolute figures amount to more than 50000 for Germany and about 600000 for Europe, if the whole period of life is considered.

Conclusions

Risk analyses are a rather new, yet effective way to assess the level of safety of large technological systems. Although uncertainty margins of results are considerable, valuable informations can be gained from the analysis, provided that the interpretation regards the limitations of the methods. As a result of this study a number of possible system improvements in the reference plant have been identified. In some cases a significant reduction of core melt probability could be realised by minor modifications of the plant design.

The overall results of the risk study allow a rough comparative evaluation of risks from different sources. Although large consequence nuclear accidents cannot be ruled out absolutey on a theoretical basis, the study has calculated that the potential extent of health effects is not beyond that possible from other natural or man-made hazards. However, the probabilities for a nuclear catastrophe are very low. This is in agreement with the results of WASH-1400.

ACCIDENT INITIATING EVENT	PROBABILITY OF OCCURRENCE OF THE INITIATING EVENT PER REACTOR YEAR P_1	FAILURE PROBABILITY OF REQUIRED SAFETY FUNCTIONS P_2	PROBABILITY OF OCCURRENCE OF CORE MELT PER REACTOR YEAR $P_3 = P_1 * P_2$
LARGE LOCA	$2.7 \cdot 10^{-4}$	$1.7 \cdot 10^{-3}$	$5 \cdot 10^{-7}$
MEDIUM LOCA	$8 \cdot 10^{-4}$	$2.3 \cdot 10^{-3}$	$2 \cdot 10^{-6}$
SMALL LOCA	$2.7 \cdot 10^{-3}$	$2.1 \cdot 10^{-2}$	$5.7 \cdot 10^{-5}$
LOSS OF OFF-SITE POWER	$1 \cdot 10^{-1}$	$1.3 \cdot 10^{-4}$	$1.3 \cdot 10^{-5}$
LOSS OF MAIN FEEDWATER SUPPLY	$8 \cdot 10^{-1}$	$4 \cdot 10^{-6}$	$3 \cdot 10^{-6}$
EMERGENCY POWER CASE WITH SMALL LEAK AT PRESSURIZER	$2.7 \cdot 10^{-4}$	$2.6 \cdot 10^{-2}$	$7 \cdot 10^{-6}$
OTHER TRANSIENTS WITH SMALL LEAK AT PRESSURIZER	$1 \cdot 10^{-3}$	$2 \cdot 10^{-3}$	$2 \cdot 10^{-6}$
ATWS-EVENTS *)	$3 \cdot 10^{-5}$	$3 \cdot 10^{-2}$	$1 \cdot 10^{-6}$

*) ANTICIPATED TRANSIENTS WITHOUT SCRAM

Table 1: SUMMARY OF THE RESULTS OF EVENT TREE ANALYSIS

REL.C. NO.	DESCRIPTION	TIME OF RELEASE H	PROBABILITY *) PER REACTOR YEAR (MEAN)
1	CORE MELT, STEAM EXPLOSION	1	2×10^{-6}
2	CORE MELT, LARGE CONTAINMENT LEAK (300 MM Ø)	1	6×10^{-7}
3	CORE MELT, MEDIUM CONTAINMENT LEAK (80 MM Ø)	2	6×10^{-7}
4	CORE MELT, SMALL CONTAINMENT LEAK (25 MM Ø), LATE CONTAINMENT OVERPRESSURE FAILURE	2	3×10^{-6}
5	CORE MELT, LATE CONTAINMENT OVERPRESSURE FAILURE, FAILURE OF FILTER SYSTEMS	25	2×10^{-5}
6	CORE MELT, LATE CONTAINMENT OVERPRESSURE FAILURE	25	7×10^{-5}
7	DESIGN BASIS ACCIDENT, LARGE CONTAINMENT LEAK (300 MM Ø)	0	1×10^{-4}
8	DESIGN BASIS ACCIDENT	0	1×10^{-3}

REL. C. 7 AND 8 ARE NO CORE MELTDOWN ACCIDENTS

*) PROBABILITIES ARE CALCULATED INCLUDING 10 % CONTRIBUTIONS FROM ADJACENT RELEASE CATEGORIES

Tab.2: TIMES OF RELEASE AND PROBABILITIES OF THE RELEASE CATEGORIES

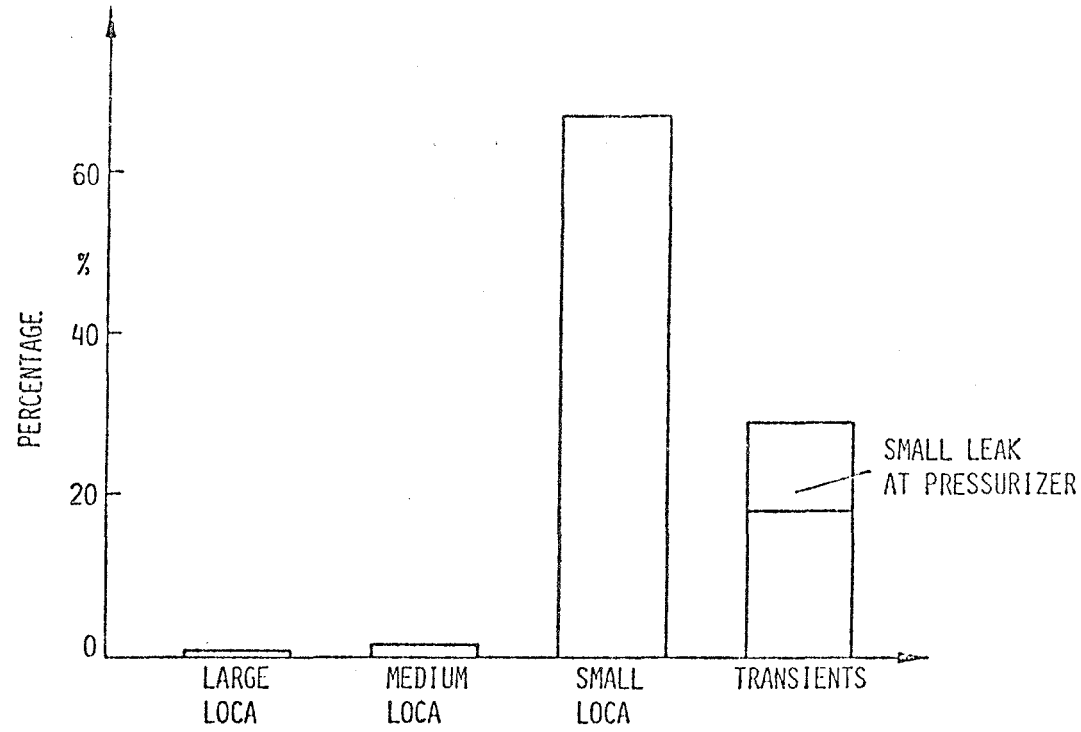


Figure 1: RELATIVE CONTRIBUTION OF VARIOUS ACCIDENT INITIATING EVENTS TO THE PROBABILITY OF CORE MELT

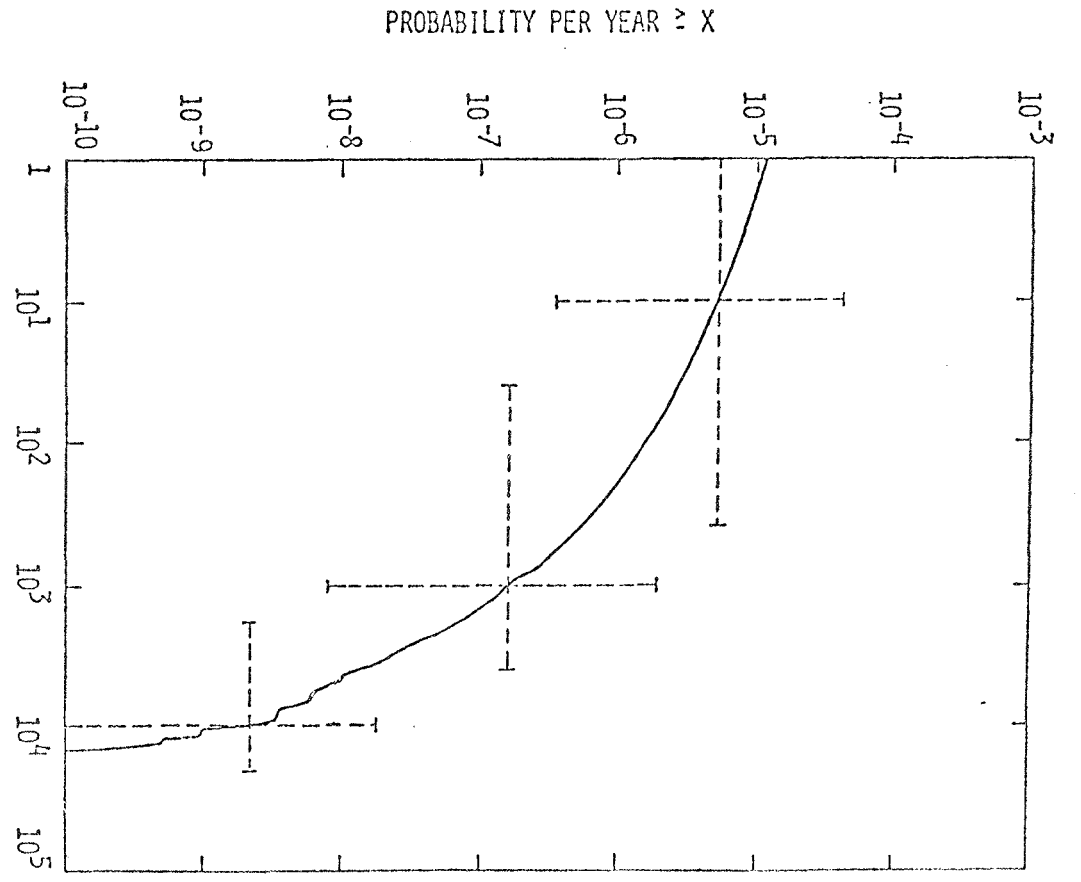
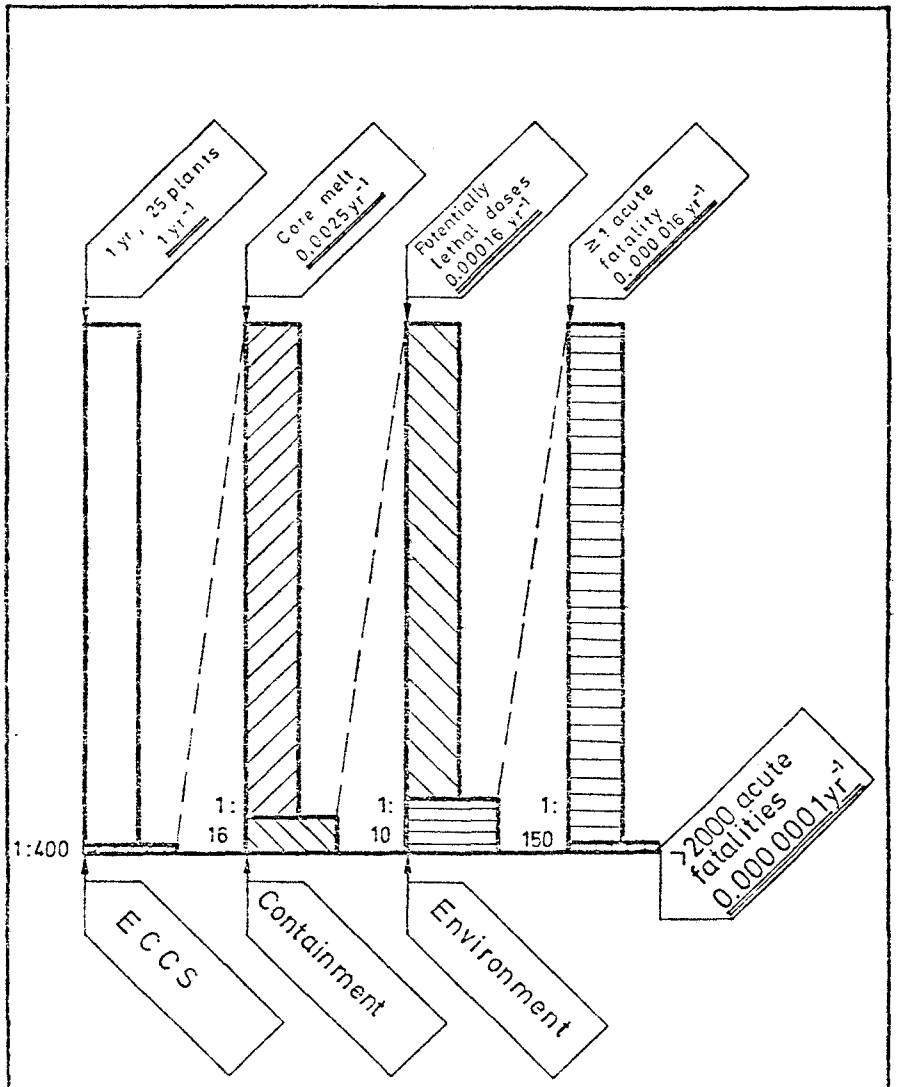


Figure 2: COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION FOR EARLY FATALITIES PER YEAR FOR 25 PLANTS
THE DASHED BARS INDICATE 90 % CONFIDENCE LIMITS



FREQUENCY OF ACCIDENT CONSEQUENCES
(per year, 25 plants)

Figure 3:

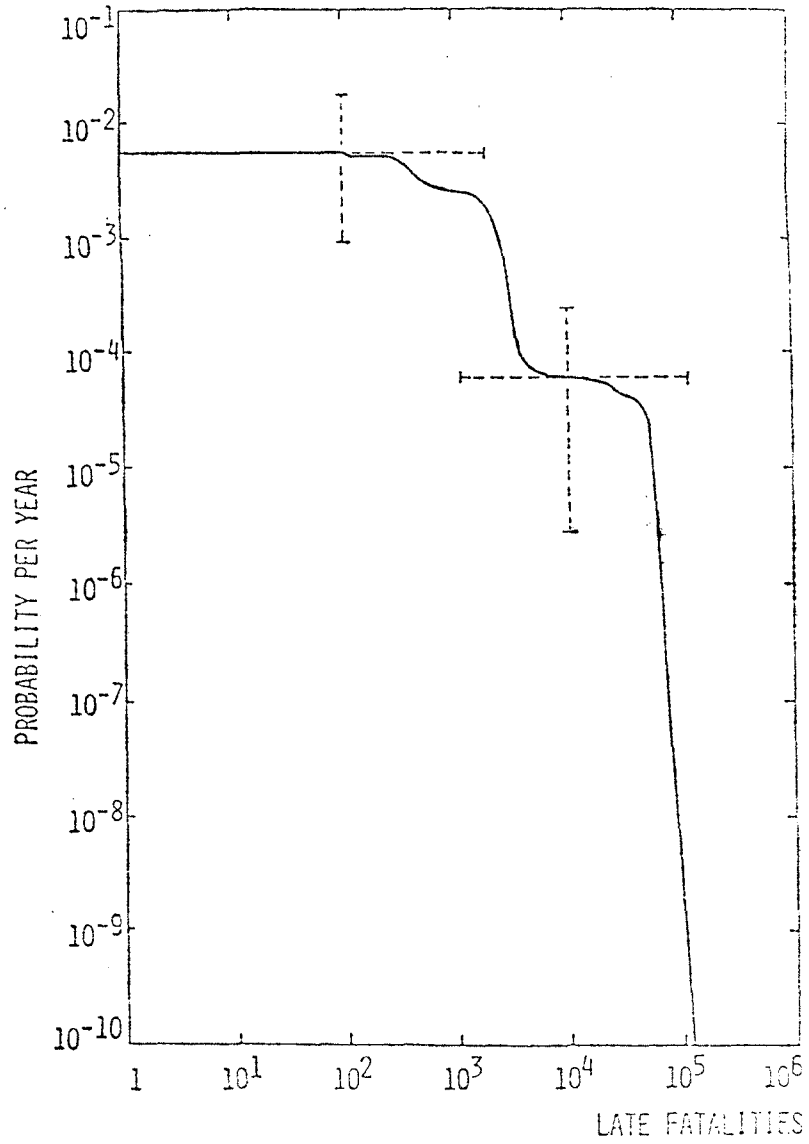


Figure 4: COMPLEMENTARY CUMULATIVE DISTRIBUTION FUNCTION FOR LATE FATALITIES PER YEAR FOR 25 PLANTS

(DASHED LINES INDICATE 90 % CONFIDENCE LIMITS)

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KANSAINVÄLINEN REAKTORITURVALLISUUDEN ASIANTUNTIJOIDEN SEMINAARI OTANIEMESSÄ

Otaniemeen kokoontui syyskuun ensimmäisellä viikolla 1 - 4.9. lähes sata reaktoriturvallisuuden asiantuntijaa seminaariin, jonka aiheena oli ydinreaktoreiden polttoaineen käyttäytyminen reaktoreiden käytön aikana mahdollisesti esiintyvissä häiriötilanteissa sekä laitosten suunnittelun perustaksi määritellyissä onnettomuustilanteissa. Kokouksen sisältöä sävytti ymmärrettävästi viime vuoden keväällä Harrisburgin ydinvoimalaitoksella tapahtunut onnettomuus, jossa reaktorissa ollut polttoaine kärsi huomattavia vaurioita, mutta laitoksen suojarakennusjärjestelmä toimi suunnitellulla tavalla ja kykeni siten rajoittamaan laitokselta ympäristöön päässeen radioaktiivisten aineiden määrän merkityksettömäksi.

Ydinpolttoaineen luotettava toiminta on keskeisessä asemassa ydinvoimalaitosten turvallisuuden kannalta, sillä valtaosa ydinreaktorin käytön aikana ketjureaktiossa syntyvistä radioaktiivisista aineista jää uraanidioksidista valmistettuihin polttoainenappeihin. Polttoainesauvat suunnitellaan siten, reaktoria käytetään niin ja laitoksilla on sellaiset turvallisuusjärjestelmät, että polttoainesauvojen laajamittainen vaurioituminen on erittäin epätodennäköistä. Ydinvoimalaitosten lupakäsittelyn ja käytön aikaisen suorituskyvyn arvioinnissa käytetään konservatiivisia olettamuksia, mistä on usein aiheutunut laitosten käytölle erilaisia rajoituksia ja siten myös huomattavia taloudellisia menetyksiä. Nyt esillä olleessa seminaarissa pyrittiin osaltaan tunnistamaan ne tutkimuskohteet, joiden tulosten perusteella voidaan tarkentaa turvallisuustarkasteluissa käytettäviä menetelmiä ja arviointiperusteita.

Kokouksen pääjärjestäjänä toimi taloudellisen yhteistyö- ja kehitysjärjestön (OECD) ydinenergiaelin Nuclear Energy

Agency, NEA. NEA:n toiminta rakentuu usean pääkomitean ja niiden muodostamien alakomiteoiden ja työryhmien varaan. Nyt esillä olevan seminaarin järjesti Ydinlaitosten turvallisuuskomitea (Committee on the Safety of Nuclear Installations, CSNI), jossa Suomea edustaa johtaja Antti Vuorinen Säteilyturvallisuuslaitoksesta. Kokouksen järjestelyihin osallistui myös YK:n alainen Kansainvälinen atomienergiajärjestö (IAEA). NEA ja IAEA toimivat yleensäkin laajasti yhteistyössä.

Kokouksen teknillisestä sisällöstä vastaavaan asiantuntijaryhmään kuului Suomesta laboratorionjohtaja Jarl Forstén VTT:ltä. Käytännön järjestelyistä huolehti VTT:n metallilaboratorio ja ydinvoimatekniikan laboratorio.

Seuraavassa on koottuna seminaarin viidestä eri istunnosta puheenjohtajien laatimat yhteenvedot:

Summary of Session I - System Effects in Transients

M. Ishikawa and D.O. Pickman

H. Ollikkala (VTT) reported on a study of small break transient behaviour of the Loviisa Nuclear Power Plant, arising out of the TMI-2 accident.

NORCOOL-1 code calculations were used to study various core uncovery situations. Cooling was very effective below the swell level in the core and peak clad temperature for a hot assembly reached about 1000°C with 35% of the core covered. The swell is reduced at higher pressures and higher clad temperatures are predicted. Only oxidation as a fuel failure mechanism is examined, since ballooning seems unlikely, and a 17% clad oxidised criterion would be exceeded in about 3 h assuming only single sided oxidation.

Experiments or the behaviour of loop seals are also reported. With the decay heat generation steam flows into the cold leg and downcomer only through one of the six loop seals. The final part of the paper is concerned with a study using RELAP4/MOD6 of a small break transient with system pressure higher than accumulator pressure. It is concluded that the worst case is for a break size of 40 mm diameter, and that core uncovery is narrowly avoided, the danger period being terminated at about 1800 s when steam reaches the break and the primary system is rapidly depressurised.

I. Depisch (KWU) reported on the temperatures reached in fuel and cladding in condition II to IV events in KWU PWR's. The codes used were the KWU LOOP7 and BRUSEK. The 3 events selected to represent such accidents were (a) turbine trip caused by loss of condenser vacuum, (B) the same but without scram, and (C) rupture of a main steam line. The KWU PWR has four parallel ECC systems, each having both hot and cold leg injection. The paper also analyses the consequences of a double ended guillotine break in various positions, as well as a variety of cold leg break sizes.

In terms of possible fuel damage, the worst cases are the large cold leg breaks, where the mean clad temperature is in the region of 900°C for about 100 s.

H. Bonet of Belgo-Nucleaire described best estimate calculations with probability evaluations of fuel rod behaviour during operational transients as an alternative to the evaluation models. RETRAN was used to analyse a PWR steam line break accident, and the variation in total power, reactivity and DNB ratio in the early stages, for UO_2 and mixed UO_2/PuO_2 fuelled cores, was calculated. Various sensitivity analyses are reported and the general conclusion is that UO_2/PuO_2 cores lead to worse conditions, although for a 30% Pu loading safety margins are adequate.

K. Wiehr (KfK) discussed the influence of thermal hydraulics on fuel behaviour in a LOCA. 5 x 5 PWR bundles (3 x 3 pressurised rods) were tested in the REBEKA facility. It is claimed that larger axial and azimuthal temperature gradients develop if most of the clad deformation occurs during refill when the cooling is mainly by superheated steam flow. On the other hand if the deformation occurs during reflooding, cooling is mainly by a non-equilibrium 2-phase mixture, in this case spacer-grid effects induce large axial temperature variations and eccentric positioning of pellets large aximuthal variations. The result is small rupture strains.

Barzoni (CISE) presented a theoretical model for prediction of heat transfer coefficients in post dry-out dispersed flow conditions. It calculates quality as a function of several variables and uses a correlation to calculate convective heat transfer coefficients for superheated steam. Experimental measurements were also reported and agreement between prediction and measurement was good over a wide range of conditions. A comparison with other well known prediction methods shows that all have some limitations.

Conclusions and Recommendations

We can conclude from the papers presented in this session that the lessons of TMI-2 have been learnt and that much more attention is now being paid to the more probable range of reactor transients. We do not however think that the large break LOCA can be disregarded, although it may be that because of the large uncertainties in predictive methods only large scale integral experiments will ultimately give complete re-assurance. We are glad to note that some such experiments are in progress or planning (Phebus, NRU, Super-Sara, IFA511).

Although we support the use of best estimate calculation methods, we think it is essential that upper and lower bounds of uncertainty should be given, and that calculations cover a wide spectrum of fuel rating and burn-up. The fuel behaviour specialists are wholly dependent on the work of colleagues in these areas to provide a basis on which they can predict likely fuel behaviour.

We strongly recommend that the work of these groups of people, the thermal-hydraulics and heat transfer experts, the code developers and the fuel specialists be closely integrated. Indeed we would like to see a new breed of expert coming along who combined these skills to a greater extent than appears to exist at present.

Leading on from this, we recommend that more effort should be devoted to the development and verification of combined thermo-hydraulic/fuel behaviour codes, in which the feed-back of fuel behaviour on thermo-hydraulics is accounted for.

Summary of Session II - Zircaloy Deformation and Rupture Studies

A. Mann

The papers fell into sub-groups [numbers] which are separately reported on as follows:

A. Zircaloy deformation in LOCA's

Conclusions and recommendations

1. The basic mechanisms governing the deformation of cladding are now understood in principle, although clarification of existing knowledge and its extension in some directions are still needed. In any given situation where the cladding is subjected to stress, the chief factor governing the magnitude of deformation is the temperature of the cladding. This determines its mechanical properties, including the significant effects which result from change in phase. Deformation is also governed by rate of heat-up and time spent at given temperatures. The distribution of temperature both axially and azimuthally determines the shape of the deformation. In particular the azimuthal variation of temperature is a key factor in determining burst strain. In turn the temperature distribution is determined by the heat transfer mechanisms which operate during the transient - both internally from fuel to cladding and externally from the cladding to the coolant and to surrounding structures. In multi-rod assemblies the temperature distribution is also strongly affected by rod-to-rod interaction, and by the presence of control-rod guide tubes and spacer grids.

2. We note that in-pile single rod tests in FR2 and PBF confirm comparable out-of-pile tests. All out-of-pile experiments, and the single-rod in-pile experiments so far performed are basically separate-effects tests. Direct extrapolation of results obtained from such tests to predict the behaviour of assemblies in power reactors is possible only by paying great attention to boundary conditions.

3. Theoretical models and codes should continue to be developed, and experimental data obtained to test them, so that separate effects can be combined and extrapolated. The ultimate trial of such codes must be against in-pile experiments where the whole range of significant factors can be represented. The aim of such codes must be the prediction of the behaviour of the whole core to losses of coolant covering a wide spectrum of break sizes. The further development of codes for this purpose is strongly recommended. Two papers asserted that the behaviour of a multi-rod system is predictable from the properties of its constituent parts, but there was no general agreement on this topic. We recommend that this subject should be discussed further. In particular we recommend the mounting of in-pile experiments using multi-rod assemblie in realistic conditions of heat transfer. This implies the use of full-length assemblies.

4. We note that in every out-of-pile multi-rod test so far performed the resultant deformation did not impair the coolability unacceptably. However, we recommend the continuance of experimental determinations of the effects of large blockage on the coolability in larger assemblies (7 x 7 or larger). It also remains to be shown that rod-to-rod interaction does not produce unacceptable propagation of distortion across large assemblies.

B. The development of rupture criteria

Conclusions and recommendations

We note that this is an actively developing area, with rupture criteria being developed based on several different concepts. These include stored energy, a modified Monkman-Grant life-fraction relationship, a strain-fraction relationship, and empirical methods (the latter two are in papers in Session V). An accepted rupture criterion is highly desirable, and we recommend that the various workers should be encouraged to develop their concepts for experimental verification. We recommend the approach of the Standard Problem as used for example in the field of thermohydraulics.

C. The effects of intruding chemical elements on the deformation behaviour of Zircaloy

The chemical effects of fission products, oxygen and hydrogen are becoming well understood. Fission-produced iodine may lead to a low-ductility failure by stress-corrosion cracking up to ~850°C. A critical iodine concentration must be exceeded for this to occur. This depends on temperature and in a fuel rod is unlikely at temperatures above 750°C.

There has been some success in predicting the advance of the alpha/beta interface in cladding which is being oxidised in steam between 1030°C & 1400°C. The saturation of the beta-phase above 1100°C is accompanied

by the growth of incursions producing a non-uniform alpha-beta boundary. The kinetics of advance may be modelled using an averaged boundary location incorporating the incursion volume.

We consider that oxidation kinetics are now well understood.

Work was reported on the thermal shock failure characteristics of Zircaloy cladding tubes burst and oxidised in steam, on thermal quenching and subsequent axial loading. A correlation was given of the boundary of thermal shock failure, which indicated that under LOCA conditions the mechanical integrity of tubing is likely to be maintained. We consider this topic is now well understood.

Progress in the experimental simulation of fuel rods

Conclusions and recommendations

The use of electrically heated fuel rod simulators is now widespread, although the possible difference in behaviour between a rigid heater and a fragmented pellet stack is recognised. We note the development of chemical heat sources by Buchilin and co-workers, and recommend the further assessment of this technique as a simulator of stored energy.

Session III

In-Reactor Fuel Damage Experiments

P.E. MacDonald and M. Chagrot

The first paper was presented by H. Nackaerts and was entitled "Compact Pressurized Water Loop For Disturbed Fuel Rod Operation in the BR-2 Reactor". This paper described the features of a new compact cooling circuit which can be used to investigate the behaviour of PWR fuel rods during off-normal and accident conditions. Power transients can be imposed by means of a variable He^3 neutron flux screen. The coolant flow rate may be varied and modest pressure transients can be introduced using a feed and bleed system. Fuel rods up to 15 mm in diameter and 1000 mm long can be tested at typical PWR coolant conditions.

The second paper was entitled "Safety and Licensing Issues That Are Being Addressed By The Power Burst Facility Test Programs" and was presented by P.E. MacDonald. The experimental program originally planned for the Power Burst Facility will be completed during 1980. A total of thirty-eight tests will have been performed. The results of the Power Cooling Mismatch tests have shown that (a) there is significant margin between the present NRC criteria and actual fuel failure theshold (b) a coolable geometry can be maintained following a severe PCM (c) energetic molten fuel-coolant interactions do not occur during a PCM and (d) rod-to-rod departure from nucleate boiling and fuel rod failure propagation is unlikely. The experimental results obtained from the PBF reactivity initiated accident tests indicate that the present USNRC criteria may be nonconservative but that light water reactors are safe because of their relatively low control rod worth. The data obtained from the PBF-loss-of-coolant tests performed to date (two tests remain in the original program) are in reasonable agreement with previously published data from out-of-pile tests. The authors suggest that, therefore, co-planner blockage resulting from preferential cladding ballooning at a given axial location is unlikely.

This paper raised many questions and comments. V.I. Langman wondered weather 1 meter long test rods were adequate. (The authors think that they are.) P. Hofmann wanted more information on fission product release. S. Raff questioned the suggestion that the PBF test results support the conclusion that co-planner blockage during a double-ended cold leg break LOCA is unlikely. A. Markovina noted that only one collapsed cladding test has been conducted. F. Depisch asked how the PBF results compared with the correlation of Mayers and Power (that comparison has not yet been performed). And, H. Mogard wondered how much, if any, accumulated damage would be expected during multiple BWR anticipated transients (the authors suggested that there would be little damage).

The third paper was entitled "TRIBULATION High Burnup Behaviour of Fuel Subjected To Transients" and was presented by H. Bairiot. PWR fuel will be irradiated to 20-40 Gwd/t in the BR-3 plant and then subjected to power transients in the BR-2 test facility. Some of this fuel will then be re-irradiated in the BR-3 power plant to about 70 GWd/t. Other rods will destructively examined after transient testing in the BR-2. Still other rods will remain in the BR-3 to burnups of 70 GWd/t and then be destructively examined. The fuel rod design parameters which will vary include: pellet length to diameter ratio, annular versus dished pellet shape, cladding thickness and rod internal pressure.

The fourth paper of Session III was entitled "Recent CANDU Transient Fuel Behaviour Data From Research Reactor Irradiations" and was presented by V.J. Langman. The results of recent Canadian research reactor experiments of post-dry out fuel behaviour with molten UO_2; fuel element interactions with unheated loop components; fuel element inter-

actions with adjacent fuel elements; intentionally defective fuel; and, previously irradiated fuel were presented. There was no release of UO_2 to the coolant at the time of failure or during subsequent rewetting during the partially molten fuel dry out tests. Contact of high power test rods with unheated zircaloy loop components resulted in dryout and rod failure. Contact of two test rods at 30 to 70 Kw/m resulted in localized sheath overheating, oxidation at temperatures below 550°C, and failure of one rod. The deterioration of defective fuel elements operating in post-dryout was shown to be slow when cladding temperatures were below 1105 K. However, fuel loss to the coolant can eventually occur due to UO_2 oxidation during prolonged exposure. For the burnups tested, prior irradiation does not affect post-dryout fuel behaviour.

V.J. Langman also discussed a new in-reactor coolant depressurization (LOCA) test program which is just now beginning in the NRX facility at Chalk River. P.E. MacDonald noted that 550 C was a low temperature for complete oxidation through a sheath wall and asked if they were sure that no beta was present.

The fifth paper was presented by L. Sepold and entitled "In-pile Tests on Fuel Rod Behaviour Under LOCA Conditions In the Karlsruhe FR2 Reactor". The FR-2 tests are being conducted with fuel rods irradiated to burnups ranging from 2500 to 35000 MWd/t and with fresh rods. As in the case of the PBF data, the FR2 cladding deformation data (burst temperature, burst pressure and burst strain) is in general agreement with the previously published data from out-of-pile tests using fuel rod simulators. An influence of burnup on the zircaloy cladding deformation behaviour was not observed. The tests performed with previously irradiated fuel rods did result in fuel pellet fragmentation and relocation of the fragments outward and downward into the ballooned region. However, the pellet fragmentation did not influence the deformation process. Similar pellet fragmentation was observed in the PBF tests.

T. Healey and A. Mann questioned the papers conclusion and suggested that there might be a difference between the in-pile and out-of-pile zircaloy deformation data within the alpha to beta phase transition region. Sepold explained that the apparent difference is probably due to error or uncertainty in measuring burst temperatures in-pile. A representative from the USSR also asked a question.

Bruet, from the CEA's metallurgy division in Grenoble described the FLASH loop, the experimental procedure and the main results of the first test in a paper called "PWR Fuel Behaviour Under Accidental Conditionsa - In-Pile Tests FLASH". This program, which is complementary to PHEBUS, is a blow-down experimental program oriented toward measuring fission product release rates from pre-irradiated fuel rods failed under LOCA conditions. One of the main features of the device is that it is flushed with helium to depressurize the system during the loss of coolant. The loop is inserted in the SILOE reactor. Only the fission products present in the gap and plenum prior to the transient were released into the coolant during the first test.

The seventh paper was entitled "RIA Fuel Behaviour in the NSSR Tests" and was presented by M. Ishikawa. This paper discussed failure thresholds and modes of unirradiated light water reactor fuel subjected to a severe reactivity-initiated accident. Incipient failure of LWR fuel rods is due to cladding melting and then brittle fracture during quench and occurs at about 260 cal/g UO_2. The threshold energy for fuel failure is generally insensitive to fuel design variations. However, variations in cooling conditions do influence the failure threshold. Fuel failure at very high energy deposition was caused by gross UO_2 melting and a rapid increase in rod internal pressure. Fuel rods with cold internal pressures greater than 0.6 MPa failed due to ballooning and rupture of the cladding. The NSRR burst temperature, burst pressure and burst strain data is in good agreement with the out-of-pile LOCA test data. Low temperature cladding burst was observed when the rods were previously waterlogged.

Japanese light water reactors must now be designed so that a reactivity initiated abnormal transient will not result in a radial average fuel enthalpy greater than 170 cal/g UO_2 and a worst case RIA will not result in a radial average fuel enthalpy greater than 230 cal/g UO_2. The latter value is below the present USNRC criterion, and in agreement with the PBF results.

The eight paper was entitled "Assessment of light Water Reactor Fuel Damage During a Reactivity Initiated Accident" and was presented by P.E. MacDonald. The results from recent computer simulations and Power Burst Facility RIA tests were presented and a progression of fuel rod and cladding damage events was suggested. High strain rate deformation of relatively cool irradiated cladding early in the transient may result in fracture at a radial average peak fuel enthalpy of approximately 140 cal/g UO_2. Volume expansion of previously irradiated fuel upon melting may cause deformation and rupture of the cladding, and coolant channel blockage at higher peak enthalpies. When cladding temperatures reach values near but below the melting point, variations in coolant conditions around and along the rod cause thickening and thinning of the cladding. The regions of cladding wall thinning are subsequently reacted to brittle oxygen-stabilized alpha zircaloy dioxide, and fracture during quench when the radial average peak fuel enthalpy is 250 cal/g CO_2 or above. The mode of rod failure is strongly affected by previous irradiation and peak fuel enthalpy.

P.E. MacDonald was asked a number of questions. I. Grifoni was interested in RIA tests of GdO_2 containing rods (no such

tests have been conducted). V.J. Langman wondered whether Zr/U reaction layers were observed on the previously irradiated rods (they were). P. Hoffman was interested in the cladding temperature at which the pellet-cladding mechanical interaction failures occured (below 1105 K) and the role of the corrosive fission products. (The author was and is unsure about the role of the corrosive fission products.)

A paper called "Interpretation of Fissio Product Release During Off-normal Modes of a Power Reactor Operation as Compared to the Normal Mode" from the BHABBA nuclear center in INDIA was presented by the chairman. The authors have analysed fission product release rates under steady state as well as transient conditions in a BWR power reactor. Their main conclusion is that more sophisticated monitoring systems are needed to allow a better characterization of failed rods.

A. Manin, from CEA's metallurgy division in Saclay, presented in association with the Nuclear Safety Division, a paper on the PHEBUS program in CADAEACHE called "Studies on Fuel Behaviour Under LOCA Conditions". He described the main features of the experimental loop and test train, as well as the precalculation method that is being used to control thermohydraulic loop operating conditions. First tests have been carried out with unpressurized fuel, for calibrating the loop response. An outline of the fuel behaviour program was also presented; the program will include tests at and above the temperature limits imposed by the USNRC.

The eleventh and final paper of Session III was presented by C. Vitanza and entitled "Fuel Thermal Behaviour During Steady State Transient Operation". Selected results of the in-reactor, in-fuel, thermocouple measurements in the OECD Halden reactor and the associated computer code calculations were presented to illustrate and guantify the influence of fuel rod design variables and operating conditions on the thermal response of LWR fuel rods. The author showed that the onset, rate and magnitude of a fuel temperature rise during a power increase are intimately connected to the fission gas release within rods prefilled with 0.1 MPa helium. Pre-pressurized rods were generally resistant to fission gas release and thermal feedback behaviour. The transient heat transport and delay of the stored energy following a reactor scram was also discussed. Fuel diameter, gap size and gas composition in the gap all influence the transient thermal behaviour of a LWR fuel rod. The Halden Computer models tend to overpredict the temperature drop following scram, expecially in large gap and xenon filled rods.

Comments were provided by J.C. Janvier and H. Bonet reguarding the last point.

Summary and conclusions of Session IV - TMI 2 Interpretations

H. Bairiot

1. The session consisted in one paper from NSAC, which could not be delivered by the author himself

2. The behavior of the fuel, as the TMI accident proceeded, can only be inferred from deductions based on a limited amount of recorded data. Better definition of how the core damage progressed will only be possible after detailed examination of the core. Even then, the analysis may well never cast a definitive light on the sequence of damage accumulation.

3. A reasonable scenario has however been presented by NSAC as a result of interpretations up to date. From this scenario can be concluded that:

   - fuel rod failures initiated only 30 min after start of core uncovery, probably when core dryout reached 1/2 to 3/4 of core height
   - the core quench resulting from the brief restart of a coolant pump caused a first core disruption
   - it took less than 50 min for 40-70 % of entire core inventory of volatile fission products to be released
   - when high pressure injection flow was restarted, a new core disruption was noticed after 1/2 hr
   - up to 1 hr thereafter, core outlet thermocouples of adjacent fuel assemblies differed by as much as 1000°C
   - no reliable data exist on rate or timing of H production
   - indications are that the temperatures have locally been above the melting points of Ag-In-Cd and even stainless steel, but below the melting point of UO_2, Zry and even cladding-fuel eutectic solutions
   - eventual coolability of the damaged core was demonstrated

4. During the discussion, the following points were mentionned and will be submitted to the author for answer or further comments:

   - the recovery of all the outlet thermocouples, but one, is difficult to correlate with the occurence of temperatures well above the melting point of SS

- since the contribution of the highly exothermic Zry oxidation is unknown, it is impossible to evaluate how the fuel would had behaved had it been clad with SS. The fairly rapid oxidation of SS above 1000°C and its lower melting point would be the major damage initiators

- no comments were made about the core pressure drop, while previous statements on this subject were confusing

- the dimensions of the upside-down bell shaped region given in the paper indicate a lower fraction of severely damaged core than the 1/3 assessed by LASL and reported at the ANS Meeting in Knoxville this year

- a possible correlation between the measured Kr 85 release to the environment (lower than expected) and the extent of core damage has not been commented in the paper

- the plans and expected schedule for the examination of the TMI core are of interest to the audience and details should be welcome

- in the "lessons learned", the NRC recommendations and pending licensing issues resulting from TMI, there is no indication that the fuel should be modified to improve its behavior in off-normal and accidents conditions

Summary of Session V - Fuel Behaviour Models and Codes

J. Forstén, C.F. Bilsby

1. RAPTA1, Computer Code for Fuel Behaviour Accident Analysis
F.G. Reshetnikov, I.S. Golovnin, Yu. K. Bibilashvili, V.I. Solyany, N.B. Sokolov

The RAPTA1 code is designed for accident analysis of fuel behaviour in VVER and RBMK type reactors. The fuel cladding is a Zr-1%Nb alloy. Calculations by the code have shown the effect of localized deformation, materials anisotropy, cladding oxidation and oxygen uptake under accident conditions.

2. Analysis of Fuel Behaviour During Loss of Coolant Accidents in the CIRENE Prototype reactor: Calculation method, Validation, Results.
G. Cardosi, G. Valli, G. Corbo and E. Raffaeli

The SPARA Computer Code is a onedimensional axisymmetric computer code especially developed for transient analysis of a segmented fuel rod. The thermomechanical model is supported by out of pile experimental data as well as with in pile data on centre fuel temperatures and fission gas releases in CIRENE elements, which are graphite lubricated and have collapsible cladding.

3. Probabilistic Analysis of Core-wide Fuel Damage During and LWR LOCA
R. Sairanen, J. Vaurio and L. Mattila

The global variables were tackled by the probabilistic response surface method and the local statistics were taken into account by application of the Monte Carlo method. The estimates of the gas release are associated with uncertainties due to the deficient knowledge and randomness. The calculations are based on the probability distributions of input parameters and they result in the statistical characteristics of the consequences. The probabilistic analysis gives the steady state fission gas release to the gap, fraction of fuel rods rupturing, and fraction of I-131 released. The results show that the consequences of the hypothetical design basis LOCA remained small.

4. Local Creep and Burst Models of the KWU Zircaloy Cladding Deformation Code
R. Eberle, I. Distler and F. Wunderlich

In order to describe that behaviour correctly inhomogeneities in radial temperature distributions and radial stress distributions must be considered. The model has been verified by a large number of transient and creep tests, which cover the influence of the main parameters, i.e. temperatures, initial differential pressure, heating rates and holding times. Locally applicable creep and stress models as well as burst criterion are included in CARATE. The parametric studies show good agreement with experimental results.

5. Development of a ZRY Creep and Burst Model Under LOCA Conditions
S. Raff and R. Meyder

The failure criterion in the described NORA model is based on a modified strain fracture rule. The NORA model is based on a large data base from tensile, creep and burst tests. The effects of the phase transitions, the oxygen content and the strain hardening are dominant. Uncertainties in temperature determination may, however, mask the contribution of other main parameters. Further development of the model shows promise of reducing the scatter and enlarging the range of applicability.

6. Analysis of Fuel Behaviour After Loss-of-coolant Accident with the TESPA Code
J. Keusenhoff

A fast-running code useful for licensing purposes which describes clad ballooning and rupture across the core is described. It uses best estimate values for the parameters together with $\pm 2\sigma$ estimates to show the sensitivity of the core response to uncertainties in eg. clad temperature and differential pressure.

7. Transient Behaviour of Fuel Rods: Influence of Prior Operating Conditions and Transient Fuel Pin Modelling
N. Hoppe and J. van Vliet

The latest developments to the COMETHE performance code are described together with bench-marking tests. The importance of initial pin condition on LOCA behaviour is emphasised.

A COMETHE-transient code is presented, which, to reduce computation time, used an extrapolation procedure from step- to-step.

8. Fine Tuning of a Model for Creep of Zircaloy in Steam
K. Malen

In LOCA situation cladding deforms under conditions of phase change and oxidation by steam. This paper sets out recommended equations to be used in the α, (α+β) and β regions. It reports a correction to the equation describing creep rate due to superplasticity in the mixed phase region and an improvement to the expression describing (oxide+α phase) strengthening which takes account of oxide cracking arising from strain below 800°C.

9. The Effects of Hot Spots Upon Swelling and Bow of Zirkaloy Clad, Modelled by the New Code CANSWEL-2
T.J. Haste and J.H. Gittus

This paper describes a code for predicting the creep deformation of a Zircaloy cladding tube, together with some experimental validation of its predictions up to a temperature of about 780°C. A particular feature of the code is its treatment of azimuthal variations of clad thickness and/or temperature, which allow modelling of the overall strain reducing effects of cross-pin variations in tests parameters. A futher feature is that it treats the impingement of the center-pin with any of 9 neighbouring pins, modelling both pin trapping and bulging.

10. Conflicting Helium Filling Pressure Requirements for Optimum PWR Fuel Behaviour Under Normal and Transient Conditions Estimated Using the HOTROD and MABEL Codes
J.H. Gittus and C.F. Bilsby

MABEL-2 is a transient code consisting of heat conduction, can deformation (CANSWEL 2) and thermal hydraulic modules applied to 3 x 3 array of pins, the latter two modules being mutually interactive through coolant channel constriction. This paper inputs initial conditions from a performance code (HOTROD) - rating, internal gas pressure etc - into MABEL which then models one particular large break transient (blow down phase only). The results suggest that start of life transient lead to higher clad distensions than EOL, but the results are, in absolute terms, very sensitive to the heat transfer coefficients used. A reduction in initial filling pressure is shown to lead to lower clad distension.

Recommendations

1. Before experimental tests are performed a prerun of the different models should be made in order to help the experiments. International round robin preruns with different models seem to be very valuable in sorting out the merits of the different codes.

2. There is a continuous need for well characterized experimental fuel behaviour data as well as for detailed operational conditions. Especially, the interrelations between in-pile and out-of-pile experiments must be established. Also the role of relocation and fragmentation of the pellets in transient and LOCA conditions must be clarified.

3. Not only single tests should be performed but also repeated tests in order to establish a "statistical" basis for the modelling work. The methods for a probabilistic analysis of fuel behaviour in transient and LOCA conditions should be further developed.

4. A universally accepted failure criterion for zircaloy at high temperatures must be established. This involves more research on the ultimate metallurgical processes taking place before failure.

KAVALA YDINVOIMA

Kukapa meistä haluaisi atomipommin kotikaupunkiinsa. Juuri tällaisena räjähtävänä pommina monet ydinenergian vastustajat pitävät atomivoimalaa. Mutta onko asia näin?

Maailma tuli tietoiseksi ydinvoimasta ja sen voimakkuudesta ensimmäisen kerran silloin, kun amerikkalaiset pudottivat atomipommin Hirošimaan 35 vuotta sitten. Sen jälkeen alettiin kehitellä energiaa tuottavia atomivoimalaitoksia. Suomessa näitä ydinvoimaloita on kahdessa paikassa, Loviisassa ja Olkiluodossa, kaksi kummassakin.

Usein oudot asiat kammottavat ihmisiä ja niin juuri on ydinvoimankin laita. Tietysti sillä on haittapuolia, mutta esimerkiksi niinkin "turvallinen" tapa kuin halkolämmitys voisi johtaa ennen pitkää suuriin ongelmiin. Jos kaikki Helsingin kokoisen kaupungin talot lämmitettäisiin haloilla, koko kaupunki peittyisi sakeaan savuun. Nykyään on myös tutkittu turpeen polttamisesta syntyvää savua, ja havaittu sen sisältävän muun muassa syöpää aiheuttavia kaasuja.

Maaperän uusiutumattomat luonnonvarat kuten hiili ja öljy eivät riitä loputtomiin. On oltava joku muu ratkaisu. Aurinkoenergia olisi hyvä ajatus, mutta se ei oikein sovellu "kylmään" Suomeen. Täällä ei ole tarpeeksi aurinkoista.

Ydinvoima on huolellisesti käytettynä hyvä asia. Usein talouskilpailu onkin sen pahin vastustaja. Kun yritetään pienentää kustannuksia, aletaan tinkiä turvallisuudesta. Näin luultavasti kävi Harrisburgin tapauksessakin. Onnettomuuden tapahduttua joku tietämätön raukka sanoi: "Mitä hyötyä on edes rakentaa atomivoimaloita. Meillä ainakin sähkö tulee pistorasiasta." Toisena haittana on radioaktiivisen jätteen pitkäaikaissäilytys. Sitä tulee kyllä niin vähän, että ainakaan vielä ei sen kohdalla ole suuria ongelmia.

Atomivoimaa käytetään myös lääketieteellisiin tarkoituksiin. Sädehoidon avulla voidaan tuhota syöpäsoluja. Ydinenergiaa voidaan siis käyttää sotilaallisiin tarkoituksiin, mutta myös ihmiskunnan hyödyksi.

Hanna Kuusi (ikä 14 v.)

(Normaali ei valmisteltu kouluaine oppilaille annetusta otsikosta peruskoulun 9. luokalla)