HARRY F. BYRD, JR.
VIRGINIA

United States Senate

WASHINGTON, D.C. 20510

March 9, 1981 s

My dear Mr. Kammerer:

A constituent of mine has recently brought to my attention the attached article which appeared in the November 10 issue of Business Week magazine entitled "Downsizing Nuclear Plants."

The piece raises several interesting and innovative policy questions relative to nuclear energy. I would appreciate receiving from the Commission a commentary on the article itself and the referenced "downsizing" research in Canada, the Soviet Union, France, and some countries of Scandinavia.

Your expeditious attention to this request will be appreciated.

Sincerely,

Harry F. Byrd, Jr.

Mr. Carlton Kammerer
Director, Congressional Affairs
Nuclear Regulatory Commission
Washington, D. C. 20555

Enclosure

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Downsizing nuclear plants

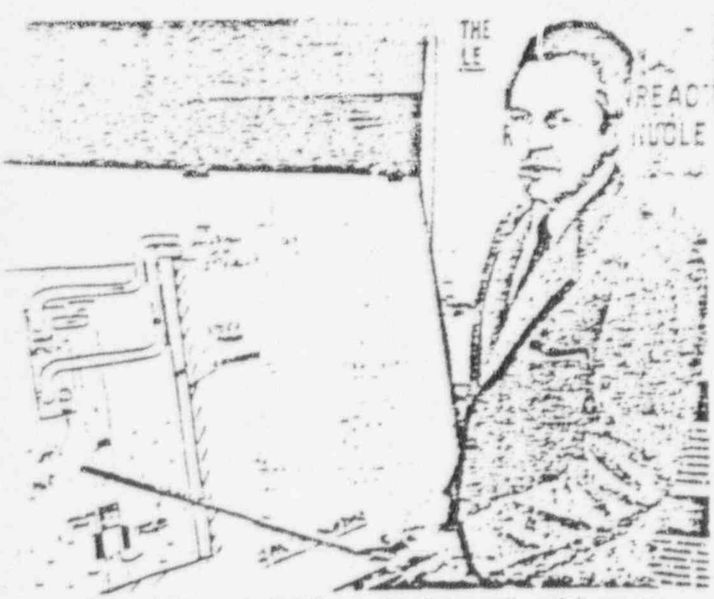
Over the years, the nuclear industry has built larger and larger reactors to produce electric power. Such reactors require elaborate safety systems because they operate at high pressures and contain large amounts of radioactive material. But now Canada's government-owned nuclear company is going in the opposite direction. It is developing the cheapest and smallest reactor ever designed for commercial use. Instead of producing superheated steam to turn electrical generators, it will produce hot water to heat buildings. The Canadians claim that it is so safe it can literally be put in basements to replace conventional furnaces.

The reactor, known as Slowpoke, is being developed by Atomic Energy of Canada Ltd. (AEC), which has also successfully marketed a power reactor known as the Candu. But Slowpoke, which stands for "safe low-power critical experiment," will generate a scant 2 thermal Mw of power—just enough to heat a large hotel or building complex.

The idea of using small reactors to provide heat is also being explored in France, Scandinavia, and the Soviet Union, and has been used in some military applications. But AEC believes that Slowpoke is the safest and least expensive system under consideration. Although the concept is still in the test stage, the company estimates that it can build the reactor for as little as $650,000. That works out to $325 a thermal kw, compared with $400 to $565 for equivalent power generated by conventional nuclear reactors. "If their numbers hold up, it could be practical," concedes one Canadian utility executive.

Extreme simplicity. The key to both the low cost and safety of the system is its extreme simplicity of design. The reactor is modeled after small, pool-type research reactors used at many universities. Its vessel is a 25-ft.-deep concrete-lined pool dug in the ground. The small fuel core is immersed directly in the water-filled pool. The nuclear reaction heats the water in the pool to 190F, and the heat is removed through a double loop of heat exchangers that isolate the heated water from the radioactive core.

Unlike commercial power reactors, Slowpoke does not generate the high temperatures typical of large reactors. As a result, the reactor does not need to be pressurized, eliminating the need for expensive and potentially faulty safety systems such as the one that failed at Three Mile Island. Nor does the fuel contain enough plutonium to be practical for weapons production.



Project Slowpoke's Hilborn: An "inherently safe" reactor.

"If we want to put reactors close to people, they have to be inherently safe without engineered safety systems and simple enough to be understood by the public," argues John W. Hilborn, Slowpoke project manager. Hilborn says that Slowpoke is designed so that the reaction cannot continue unless hydrogen atoms present in the water reflect nuclear particles back into the fuel rods. If the water would overheat and begin to boil, the bubbles formed would reduce the amount of water around the core, and the reaction would slow automatically. Moreover, if the water would boil completely away, he adds, the nuclear reaction would be unable to continue, and the remaining heat could be dissipated into the air without any additional cooling.

Untended. The Canadians are banking on the inherent safety of the reactor design to pare operating costs. They argue that constant, on-site monitoring—which typically accounts for 25% of the operating costs of a reactor—is not necessary with Slowpoke. "An untended reactor is safer in many ways than one to which people have access," says Hilborn. AEC hopes to gain approval for a system in which several sealed heating reactors could be inspected weekly but monitored from a single remote control board.

Still, the public is not likely to take readily to the idea of having radiation sources in building basements, however safe the reactor. "Can you imagine the response of the public if we start putting reactors in basements all over Ottawa?" asks one Canadian energy official. And the remote monitoring concept is almost certain not to fly in the U.S., where the Nuclear Regulatory Commission requires constant surveillance for operating reactors and where public opposition to nuclear power is intense.

But AEC is eying the world market, where it has already built a solid reputation for its 600 Mw Candu reactor. The Slowpoke could shore up AEC's sales, which have been hurt by rising fears over nuclear safety. With a scant 3.1% profit on sales of $432 million last year, the company badly needs new products, and it expects to have a prototype of the heating reactor ready by 1984. That would give it a product at the opposite end of the spectrum that could have strong sales appeal in the face of rising prices for oil and natural gas.

Canada's Slowpoke will be just big enough to heat a large hotel

Acceptance. There are indications that the world will be receptive to the Slowpoke concept. The Soviets, not bothered by public opposition, started up a 5 Mw heating reactor in the small town of Dmitrovgrad last January and now they are building two much larger pressurized units to supply heat to the cities of Gorki and Novovoronezh. And the French are developing a pool-type reactor called Thermos. That reactor, which produces 100 Mw of thermal energy, is being considered for heating up to 30,000 homes in Grenoble. If the project is approved next summer, the reactor could be in place as early as 1985 at an estimated cost of $100 million. In addition, a similar project is being pursued jointly by Sweden and Finland.

Officials at the Canadian company point out that their Slowpoke system does not require the elaborate core-cooling safeguards of the larger reactors, and it eliminates the need for district distribution systems required for the French and Soviet approaches. Hilborn maintains that inexpensive Slowpoke will offset the economies of scale of the bigger projects. And he foresees its use in many parts of the world where petroleum is expensive and district heating systems are not practical. "We're not trying to build an elaborate machine," he says. "We're trying to go back and rediscover the Model T Ford." ■

Nuclear Power Development in the U.S.S.R.

Tomiichiro Shirasawa
Chairman
Japan Atomic Power Co.

I went to the U.S.S.R. on July 23 and spent about ten days there, with Chairman Hiromi Arisawa of the Japan Atomic Industrial Forum. We had been invited by Chairman A. M. Petrosiants of the U.S.S.R. State Committee for the Utilization of Atomic Energy (GKAE).

We spent our time mainly in Moscow, Leningrad and Yerevan, where, under very well planned and thoughtful arrangements by GKAE, we visited GKAE, the Ministry for Power and Electrification (MINENERGO), two nuclear power stations (RBMK; large scale graphite-moderated boiling water-cooled reactor and VVER; PWR type), five research institutions under GKAE, and a nuclear component plant under the Ministry of Power Machinery Production (MEM).

The total installed capacity of power generation in the U.S.S.R. at present is 250 GWe, thermal power providing 182 GWe, hydroelectricity 42 GWe, and nuclear power 10 GWe, about 4 % of all. According to information from MINENERGO, large-scale nuclear power is planned in European Russia with capacity to be doubled every five years.

Two Nuclear Power Plants

The stations we visited are in Leningrad and Armenia. The Leningrad Nuclear Power Station is on Finland Bay, to the west of Leningrad, at a distance of about 2.5 hrs by car. Two RBMK reactors are operating there, each of a capacity of 1,000 MWe. No. 1 Reactor started operation in December, 1973, No. 2 in July, 1975, and two more are under construction. Since this is the first nuclear station in the U.S.S.R. of the 1,000 MWe RBMK type, construction and operation are both conducted by GKAE.

In the Leningrad Nuclear Power Station, periodical inspection is carried out over a period of two months every two years. GKAE is proud of the very high capacity factor, which was 73 % in 1978 (with total output of 13,000 GWh) and 78 % in the first half of this year. The exposure dose of workers is 0.85 rem/year on the average and 3 rem/year at the maximum.

The plant operates on a five-shift system, each shift comprising 20 workers. We were informed that in the U.S.S.R. employees of nuclear power plants generally receive more favorable treatment than those working at hydro or thermal power plants in terms of wages, working hours, meals, qualifications for pensions, etc. But the qualification criteria for nuclear reactor operators are very strict. In the case of Leningrad Station, after passing the operators' examination, they are required to complete a three-year on-the-job training course, and then to pass on to the next-phase examination before they can become regular operators. Even after becoming regular operators, they must take an examination every year. Furthermore, after an operator has leave from the plant for two weeks or more, he must submit documents to his supervisor for inspection and return to his job site.

We drove about one hour from Yerevan, the capital of the Armeria Republic and arrived at Armeria Nuclear Power Station, built on a hill. The reactors are VVERs of 440 MWe. No. 1 Reactor started operation in 1976, and No. 2 Reactor is under construction. The reactor has six loops of six horizontal type steam generators. The plant is designed without a container, a special feature of Soviet design. The gross generated output was 1,090 GWh, which seems rather low for the high availability factor of 85 % of

last year. This is because full power has not yet been attained. Since this plant is the first in the U.S.S.R. to be located in an earthquake-prone area, a number of tests are being made and operations are conducted with extra care.

Periodical inspection of reactors and turbines are carried out once every four years (for about thirty days), and the fuel is exchanged every year, the fuel exchange taking about 10 ~ 30 days, including maintenance works. The reactor was undergoing fuel exchange when we were there. The water for the plant comes from a river 8 km away, because the neighboring land is farm land. There are two pumping stations. There are two cooling towers for the condenser, two towers for one reactor. The staff work in six shifts, each of 42 workers. The qualifications and training of the operators at this plant are somewhat different from those of the Leningrad Atomic Power Station, but we found that here too they are very strict, with examinations and training conducted constantly. The exposure dose of the employees here is 0.8 ~ 0.9 rem/year at the highest, and the average is 0.08 ~ 0.09 rem/year. The plant is equipped with horizontal steam generators and many loops, and no container. We exchanged views on these points, and the view of the Soviet plant staff is that "efforts for safety should be concentrated on prevention of an accident rather than protection after the occurrance of an accident. With adequate safety precautionary measures, a container is not necessary." We were interested to hear these views, which reveal a different concept for safety measures from ours. The aseismic equipment, such as the shock absorber of the plant, was manufactured in Japan.

Most of the planned nuclear power plants in the U.S.S.R. are to be located in European Russia, and according to the latest survey revealed that the seismic areas have been further extended over a wide range. The Soviet specialists with whom we talked showed great interest in Japanese aseismic technology, and asked many questions of us.

Comments on TMI Accident

We asked the Soviet specialists to comment on the Three Mile Island accident in the U.S.A. Their comments were as follows: After replying with a serious look "this could even be considered as an intrigue by the oil majors" and went on saying "The structure of nuclear reactors, operational systems, the aspects of quality and quantity of operators in the Soviet nuclear power plants are quite different from those in the U.S.A. Therefore, an accident like the TMI could never happen in the U.S.S.R. Nevertheless, the TMI accident was a very good lesson for us, to the effect that we must take special care in new technologies." Concerning the Soviet plan to use atomic energy for district heating, as reported by a Japanese newspaper recently, we were informed that a plan to construct nuclear reactors in the vicinity of major Soviet cities is being prepared, and that reactors to serve Odessa and Gorki each with a population of 1 million are being designed. We were very interested in this bold plan to provide reactors adjacent to these cities, and look forward to the successful outcome.

Fast Breeder Reactors

The fast breeder reactor, BN-350 (loop type) was in operation at Shevchenko at 65% of planned output. It is a dual-purpose reactor, i.e. for power generation and for production of fresh water from seawater. BN-600 is a tank-type reactor with 600 MW electric power output, now at the final stage of construction, with the necessary sodium already filled and the fuel about to be loaded. The design of BN-1600 (tank type) is now going on. The choice of the type for the future, tank or loop, has not yet been made, as technical evaluation is not completed, and it will take some time to reach a decision. But it appeared to us that most of the designers favor the tank type. The real introduction of the FBR as the base load is taking longer than the initial forecast, and fuel-scale operation may start around the year 2000.

Nuclear Waste; A Painful Issue

The management of radioactive waste, especially high-level waste from the reprocessing of spent fuel, is a focal issue in the U.S.S.R. as in many other countries. Spent fuel is now being stored in the U.S.S.R., but storage is for a relatively short period of time. It will soon become necessary to reprocess such fuel. Various aspects of high-level radioactive waste treatment and disposal have been studied, but there are still some technical solutions to be found.

The heavy machinery plant in Izhora in the suburbs of Leningrad mainly manufactures primary components of nuclear reactors, and production of the reactor pressure vessels with projected nozzle

would reduce the cost of electricity to ratepayers and impr ve the utilities' cash flow position and the ability to obtain long-term financing for the cleanup of TMI-2, the staff states. The inclusion of unit 1 in the rate base would permit the utilities to recover fixed operation and maintenance costs and interest charges on the nuc r fuel of about $26-million and fixed cost on investment of TMI-1 of about $70-million, according to staff calculations.

The report, "Potential Impact of Licensee Default on Cleanup of TMI-2," has not been reviewed by the commission.

THE EUROPEAN INVESTMENT BANK HAS ANNOUNCED ADDITIONAL LOANS FOR CONSTRUCTION of two nuclear power stations in Belgium totaling about $172-million. The funds will be divided equally to support work at unit three of the Doel station near Antwerp and the second unit at Tihange near Liege. The 15-year loan was made at 10.35% interest to Belgelectric Finance, a company set up by the Belgian utilities.

HEATING GREATER STOCKHOLM WITH HOT WATER FROM FORSMARK-3 HAS BEEN RECOMMENDED by the Swedish State Power Board and municipal power companies. In a report to the government, they say using hot water from the reactor, located 75 miles north of Stockholm, for heating would be more economical than using existing oil-fired heating plants and building two new large coal-fired plants in the city, providing the nuclear heating system can be used for at least 10 years.

The project would cost about $1-billion for pipelines, two-thirds of which would be in underground tunnels, plus $200-million to $400-million for heat exchangers and other equipment at the reactor, which is now in the early stages of construction. The system which could be in operation in 1988 if a go-ahead is given next year, would reduce Greater Stockholm's oil consumption by about 1-million tonnes/yr, or the equivalent of some $250-million at current prices.

Utilizing reactor-supplied heat has been proposed before, but the State Power Board, which owns 75% of the Forsmark nuclear station, has been lukewarm to the idea since it would mean a reduction in electrical production capacity. However, based on slower national electrical consumption forecasts plus a projected "surplus" of electricity due to voter approval this spring of putting as many as 12 reactors on stream in Sweden, the State Power Board is now more favorable. In addition, the governmen is anxious to reduce fossil fuel consumption to help cut the nation's heavy balance-of-payments deficit.

Forsmark-3, which was originally intended to be a 1,050-Mwe reactor, has been scheduled to be in operation in 1985. There are two other reactors at the station, both of them 900 Mwe. They are now being started up.

The report to the government proposed two different configurations for adapting Forsmark-3 into a unit producing both heat and electricity. The first is a so-called direct heating system which would have capacity of 2,000 Mwth plus 300 Mw of electricity. The second version would have back-pressure turbines, which could produce as much as 2,400 Mwth with no electrical output, or 1,700 Mwth plus 500 Mwe. The final configuration selection would depend on future power and heat forecasts for the nation and Stockholm area.

The Forsmark heating system would be in operation until national electric power demands require the unit to be converted to full electrical output. This could mean that the heating system would be used for as little as six years, which would not make it economical compared to the cost of building the new coal-fired plants in Stockholm and the continued use of existing oil-fired plants. However, if used for 10 years, the Forsmark heat system would be economically feasible. These forecasts depend on oil and coal price developments. The report recommended that a coal-fired cogeneration plant, consisting of two units, each with a capacity of 1,000 Mwth and 500 Mwe, be built near the Forsmark nuclear station for use when the unit is needed for electricity in the future. Existing oil-fired heating plants in the Stockholm region would be maintained as a reserve heat supply or for peak loads.

Despite Sweden's urgent need to reduce oil consumption, the report's proposal will undoubtedly be opposed by antinuclear forces who object to nuclear power being made more essential than it is. Prime Minister Thorbjoern Faelldin, head of the antinuclear Center Party, has expressed doubts that the proposed project would be economical. — *Bob Skole, Stockholm*

FRANCE'S CEA IS AGAIN PLANNING TO BUILD A MINI-REACTOR PROTOTYPE for urban heating. The Commissariat a l'Energie Atomique, which was forced to shelve earlier plans for its 100-Mw Thermos mini-reactor prototype (NW, 10 Nov '77, 5), now is trying to sell the notion of nuclear-produced heating to Grenoble in southeast France. Grenoble – a city of 100,000 – is looking seriously at the idea, but city officials say strong doubts persist. One is whether Thermos is capable of the job. The mini-reactor heats water to 120 C but officials maintain that on the coldest days they need water as hot as 180 C for effective home heating.

CEA officials are unperturbed. "There are lots of systems that function at this [120 C] level," says Jean-

Claude Michel, CEA's director of Project Thermo. Obviously eager to exploit the Grenoble opportunity, CEA officials at the Centre d'Etudes Nucleaires de Grenoble (Ceng) are nevertheless studying ways to adapt the re-cooling system to attain higher water temperatures.

Grenoble officials, for their part, are staying objective until they receive more technical data from Ceng. This could take at least several months. Provided technical solutions can be found and approval of local residents won – neither of which is certain at this point – Thermos might at last see reality. But one CEA official concedes it is "difficult to envisage" construction authorization much before 1982.

If Grenoble chooses to extend its existing oil- or coal-fired heating facilities, the French government may still help finance a Thermos prototype at CEA's site at Saclay. What has helped resurrect the beleaguered Thermos project after two years of dormancy is skyrocketing fuel oil prices, French officials say. But they can give no hard cost comparisions until a prototype is built.

Besides urban heating, CEA officials say an additional potential use of Thermos is desalting seawater, though there are no current plans to use it for this. Another mini-reactor developed by CEA may be used by Canada to power an icebreaker (NW, 2? Feb, ?). Named "Chaudiere Avance de Serie" or System CAS, this reactor can range from 40-125 Mw. France's Alsthom Atlantique, under license from CEA, is in a joint venture with Canada's Canatom to sell the mini-reactor. But aside from the specific proposal to supply the reactor system for the Canadian icebreaker, the joint venture has no formal plans yet for marketing it elsewhere.

– Tim Keeley, Paris

PRIMARY SYSTEM PRESSURE DROPPED LOWER THAN PREDICTED during the first 500 seconds of loss of fluid test simulating a break in a small pipe connected to a large pipe supplying cooling water to the nuclear fuel core. The test is the third in a series on small pipe breaks – similar to those that caused the Three Mile Island accident – being conducted in the 50-Mwth Loft reactor located at DOE's Idaho National Engineering Laboratory.

The transient occurred during the first part of the test when pressure was dropping rapidly and the coolant approached the saturation – or below boiling – point. The flow from the break was discovered to be higher than expected, a discrepancy that is still unexplained, according to an NRC source. If it is found to be in the computer code, it will probably lead to a change in the code for small pipe leaks, says the source. Another possibility is there could be additional leakage of water through other valves which could be repaired, he noted.

Throughout the experiment, which lasted seven hours, all instruments functioned as expected and all significant events occurred in the expected sequence. The experiment began with the opening of a valve simulating a small pipe break. The reactor and the primary coolant pumps shut down at the initiation of the break. Steam and water were slowly discharged through the break to a suppression tank where the steam was condensed. In response to the changing system pressure, emergency core cooling systems were activated, as expected.

The tests are part of NRC's program of confirmatory research designed to study the effectiveness of systems intended to provide emergency core cooling in case of pipe break accidents. Data from the experiments is being used to increase NRC's ability to confirm independently the margins of safety that have been estimated during licensing reviews.

Austrian, Finnish, German and Japanese scientists observed the experiment and will assist in the detailed analysis of the tests, the source says.

WASTE HEAT FROM TWO TEST REACTORS WILL BE USED TO HEAT BUILDINGS at the Commissariat a l'Energie Atomique's Centre d'Etudes Nucleaires de Cadarache this fall, replacing a coal-fired heating system. A $1.5-million installation being built now will save heat the reactors normally waste through their cooling towers. The heat will warm the buildings, saving 6,020 metric tons of oil equivalent per year.

Being built by CEA subsidiary Technicatome, the system depends on a 30-Mw heat exchanger that will run on the steam generated from the reactors' secondary cooling circuits. The steam is generated by two experimental reactors built within the last 15 years at Cadarache. They are the Prototype a Terre (Pat) for submarines, and the Chaudiere Avancee Prototype (Cap). A Technicatome official at Cadarache called the heating system "the future," not only for installations like Cadarache but also petrochemical and chemical plants which create much waste heat. The Cadarache system should pay for itself in energy savings in three years, CEA estimates. The Technicatome official also noted that a similar system using nuclear-generated heat for domestic home heating is still under consideration by residents of Grenoble, France.

FIVE STATES COULD HAVE NUCLEAR INITIATIVES ON THEIR BALLOTS IN 1980, a new survey by the Atomic Industrial Forum shows. The survey states that citizens groups in Maine and South Dakota have succeeded in qualifying initiatives for nuclear power bans. The Maine initiative, if it passes either the state legislature or is passed by the electorate, would result in the shutdown of the Maine Yankee nuclear power plant.

The other states in which petitions are being circulated are Washington, Missouri and Arkansas. The Arkansas petition is being circulated by the Dogwood Alliance and needs 42,[illegible] signatures by July 4. It would authorize the state Department of Energy to order the cold shutdown of nuclear plants due to emergencies and order nuclear power curtailment if there are economic alternatives or if waste disposal facilities aren't available. The Missouri initiative, which needs 150,000 signatures, prohibits the operation of nuclear power plants until a permanent waste disposal site is in operation. The Washington petition prohibits importation and storage of nonmedical radioactive wastes unless permitted by an interstate compact. It needs 123,711 signatures.

DOE READY WITH REMEDIAL PROGRAM TO CLEAN UP AEC-MED PROJECT SITES

DOE's office of general counsel is forwarding this month to the Office of Management & Budget proposed legislation authorizing the remedial program to decontaminate sites formerly used by the Atomic Energy Commission and the Manhattan Engineering District (MED) project and subsequently released for unrestricted use without complete radiological clearance. The program – estimated to cost from $150-370-million – also includes sites that were decontaminated and then released for unrestricted use, but have been found to require further remedial action to comply with more stringent criteria the Environmental Protection Agency is promulgating, DOE sources say.

DOE is preparing to request proposals from contractors to manage the program, a source notes. DOE will also use contractors to prepare environmental impact statements which will be required on some projects.

Some former AEC-MED projects are already undergoing cleanup because DOE has been clearly identified as having authority under the Atomic Energy Act of 1954 in that the contamination was the result of work done entirely for AEC, the source says. National Lead of Ohio is a contractor for a project in Middlesex, N.J., where work is beginning this June. Envirosphere, a subsidiary of Ebasco, is conducting a cleanup at a site in Jersey City, N.J. DOE has an authorization of $10-million for FY-80 for the current decontamination projects. For FY-81 it requested $14-million, but President Carter cut the budget for the current two projects to $11-million, the source says. If DOE's proposed legislation is enacted, expenditures would be increased to eventually cover another 28 sites, he notes.

The legislation would extend DOE jurisdiction to all former AEC-MED projects where responsibility has not been established as clearly DOE's, the source says. It would also provide authority for DOE to work

FRANCE'S CEA HAS REDUCED TECHNICAL OBSTACLES TO THE MINI-REACTOR PROTOTYPE for urban heating. The Commissariat a l'Energie Atomique, which hopes to build a 100-Mw Thermos mini-reactor prototype to heat a portion of Grenoble, says it has succeeded in raising the reactor's water exit temperature by 10 degrees to 130 C. This provides a greater heating capacity and thus could make the system more economically attractive in small villages (NW, 13 March, 14).

Jean-Pierre Perves, a Thermos project engineer at the CEA's Centre d'Etude Nucleaires de Grenoble (CENG), says two basic technical design changes in the prototype were responsible for the water temperature boost. First, the primary heat exchangers will rely on straight tubes instead of U-shaped tubes as in standard French (and Westinghouse-type) PWRs. Second, engineers have decided to use three primary pumps instead of two. The first change adds about 5 degrees to the water temperature and the second another estimated 4 or 5 degrees. Other minor changes nudge the temperature up slightly more, Perves said.

Some Grenoble officials maintain that on coldest days water as hot as 180 C is needed for effective home heating. But CEA officials reply that many systems function at the 120 C level, and that the additional 10 degrees makes the nuclear urban heating system that much more attractive.

Nevertheless, the 100-Mw prototype will cost an estimated $62.5-million to build out of a total investment (including circulation pipes for the village) of roughly $100-million. Even with major state aid for the prototype project, Grenoble Mayor Hubert Dubedout remains unconvinced that Thermos is the best option

for his city's heating needs. "The CEA project must not cost one cent for the people of Grenoble," Dubedout said.

City officials estimate the nuclear heating unit could save Grenoble 26,000 metric tons of oil equivalent per year. CEA says that figure is low, and that actual savings could be between 30,000-35,000 MTOE per year. The CEA is continuing work to refine technical and economic aspects of the proposed project and expects to present a full dossier to the city of Grenoble by early next spring. A public inquiry will follow, after which Grenoble city officials will take a final decision.

One drawback, ironically, is that CEA wants the prototype built within CENG, on Grenoble's outskirts, for technical study during operation. But this site is not ideal for the portion of the city that would receive the heat, and will mean the need for longer supply pipes and add $12.5- to $15-million in building costs. CEA officials look on this as the expected extra costs involved with prototype projects. And Perves notes that, with the new French law passed this summer which encourages the development of French urban heating, Thermos could find a large potential market in provincial France if the Grenoble project comes to fruition.

otherwise sensible earthquake codes. One small example: in mixing concrete, contamination of the gravel and cement by earth can seriously weaken the structure. Often, suitable building materials are hard to come by. Wood, reinforced concrete and mild steel are good materials; bricks and prestressed concrete are not suitable for earthquake zones.

Although the frontiers of seismic engineering are full of unresolved controversies, there is a lot of sound, practical advice that engineers can give. In California, it is standard procedure to make a building flexible enough to absorb the energy of shock waves from an earthquake. California has withstood recent earthquakes well. Different pieces of a building are connected by materials that can retain their strength when their shape is altered. Loads are distributed round the building, which absorbs shocks much as the so-called monocoque shell of an aircraft does.

In a country with experienced engineers, that is easy to do. One can predict accurately how a given structure will behave, given the forces that will act on it. What the experts cannot tell so easily is the forces that will be unleashed by a given size of earthquake. Predicting earthquakes themselves is still largely guesswork. Moral: it is better to err on the safe side in building.

Nuclear reactors

French model

PARIS

While most western nuclear industries are responding to public pressure to site reactors as far from built-up areas as possible, France's nuclear agency, the Commissariat à l'Energie Atomique (CEA), is pressing ahead with a reactor called Thermos specially designed to be embedded in towns. Intended to produce not electricity but heat—eg, to feed into urban hot-water networks—the reactor is small: only 100 megawatts. Nor has it yet got past the drawing board. But last month the Socialist-Communist-run town of Grenoble agreed that Thermos would be a technically feasible answer to its heating problems.

And an acceptable one? The final decision will not be taken till April next year. The CEA hopes Thermos can capture sales—and give France's nuclear industry a lead—in two markets. One is the market for heat for homes, factories and offices, typified by Grenoble: a 100-megawatt system ought to be able to provide heat enough for 50,000 to 70,000 people (assuming 10% of peak demand is met by supplementary local heating).

The second is the growing market for desalination plants. With its eyes on the Middle East in particular, CEA has designed Thermos to serve this purpose as well. A standard 100-megawatt model could provide 30,000-40,000 cubic metres of drinking water.

No wonder CEA is keen that the Grenoble project should go ahead as a showpiece for Thermos. Arguing their case, the reactor's designers make the following points:

- **Safety.** The reactor incorporates well-tried technologies, will use CEA's new low-enriched "Caramel" fuel, will be built (inside the agency's existing Grenoble premises) largely underground and will be covered by an anti-missile dome. Demands on its components will be well below what the components are designed to withstand. Further, the reactor vessel will be submerged in a pool so that—if the worst did happen—the pool would provide emergency cooling and confine any leak to a small area.
- **Fuel economy.** A third of France's primary energy consumption in 1979 went into heating its residential and office sector; 30% of the country's oil imports go on heating. One Thermos would save at least 26,000 tonnes of oil a year while burning only one tonne of uranium.
- **Operating costs.** Even at present price levels, the operating costs of Thermos look significantly lower than those of fossil-fuel-fired plants. In future, the cost comparison should look better still.

Critics of Thermos, however, can marshall strong counter-arguments. Take investment costs. To build the first Thermos and adapt the CEA's Grenoble site to use hot water from the reactor will cost roughly Ffr250m ($60m). On top of that, connection (and modifications) to Grenoble's existing town-heating network will cost a further $36m. The CEA has also had to modify the output temperature of Thermos to allow it to use the town's old, narrow pipes.

These additional costs are worrying, considering that Grenoble is virtually the only French town that boasts an existing hot-water-distribution system of any size at all. What would be the economics of Thermos in towns that would have to build up district-heating systems from scratch? Grenoble is a considerable conurbation. A more typical French town might need to build up its heat load progressively over time before reaching a level that would justify using Thermos. In the interim, presumably, it would have to use, eg, oil-fired district heating.

The critics argue that, even in Grenoble, the money needed to install Thermos could save twice as much energy if used instead on insulation of buildings. Nor, they maintain, is Thermos even the best nuclear option: on the whole, it might make more sense to build reactors to generate electricity to drive electric heat pumps.

New vaccines

A possible hat trick

Vaccines are close to becoming available that promise to hold at bay three particularly nasty bugs—the prolific virus that causes the dangerous liver disorder, hepatitis B; the elusive herpes viruses that produce cold sores, certain genital diseases (and even, on occasion, brain damage); and those artful dodgers of antibiotics, the bacteria that cause gonorrhoea. None of these vaccines would have been possible without the explosion of knowledge and technical virtuosity wrought by biochemists in recent years.

Vaccines work by exploiting the body's ability to recognise foreign invaders and produce antibodies against them. In theory, all you need to prime the body to produce antibodies are the distinctive markers of identity—the antigens—carried on the surface of the offending organism. In practice, most vaccines serve up these surface antigens with the whole organisms, having grown the nasties in the laboratory and then killed or weakened them in some way to ensure they are no longer infectious. Not so the new vaccines against the hepatitis B and herpes viruses. Taking full advantage of modern purification and separation techniques, these vaccines serve up the surface antigens alone. For good reasons.

Research teams trying to develop vaccines against hepatitis B have faced a major headache: how to get sufficient supplies of antigen, given that the virus refuses to grow lustily in ordinary laboratory cultures? One answer is to extract antigens from the blood of persistently infected people: there are an estimated 200m carriers round the world. This is the source that a team of researchers, led by Dr Maurice Hilleman, at the Merck Institute for Therapeutic Research in Pennsyl-

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 12, 1981

MEMORANDUM FOR: Commissioner Gilinsky
Commissioner Hendrie

THRU: William J. Dircks
Executive Director for Operations

THR for W.J.D.

FROM: James R. Shea, Director
Office of International Programs

SUBJECT: CONTAINMENT OF SOVIET REACTORS

In my August 18 memorandum answering Commissioner Gilinsky's questions on the containment of the Soviet-built Loviisa Reactor in Finland, I gave a short summary of reactor containment practice in the USSR. Later, Commissioner Hendrie discussed this subject during his visit to Finland. The following is some additional information on Soviet containment practice.

Enclosure 1 is a copy of a translation of a 1978 article from the journal Teploenergetika entitled "A System for Localizing Damage Should There Be a Fracture in the Main Pipelines of Nuclear Power Stations with VVER-440 Reactors," written by A. M. Bukrinskiy and several other members of the staff of the All-Union Heat Engineering Institute. The article describes a "damage control system," which has an interesting capability to purge some air from the compartments surrounding primary equipment and piping, in the early stages of the blowdown, thus enabling a vacuum to be established by quenching the steam remaining in these compartments, in order to prevent outward leakage. It is not clear whether venting of the air follows, after a 40-50 hour design vacuum period.

The article indicates that such a system had been designed in the USSR by November 1978, and that such systems were being installed in the USSR and in other socialist countries. You may recall that an NRC team visited the USSR in February 1978. We saw the Armenian 440-MWe units, one in operation (since 1976) and the other being tested for startup early in 1979. The gas scavenging and cleanup system of the second unit, as described to us at that time, involved only collection by blower, condensation, filtering, and release. No mention was made of holding the collected air for optional release.

The 1000-MWe PWR prototype reactor being built at Novovoronezh (with several more planned) is being built with a classic cylindrical containment building made of prestressed concrete. As noted in the enclosed summary of the August 1980 regulations for nuclear district heating stations, district heating reactors also will have containments (Enclosure 2). Prestressed concrete containment buildings are planned for these units, prototypes of which

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are under construction at Gorkiy and Voronezh. On the other hand, we have no indication that the large, graphite-moderated, pressure-tube boiling water reactors now being built (several in operation), have any containment provisions.

The 440-MWe VVER's and the pressure tube BWR's constitute most of the new nuclear electric capacity to be commissioned in the USSR during the next few years. It appears that the more modern designs (the 1000-MW PWR's and the district heating reactors), which are the reactors expected to be exported and installed in the USSR starting in the late 1980's, will be built in containment structures.

Joe Lewin, at ORNL, who has been following safety developments in Soviet journals, provided us with the documentation used in the two enclosures and did the informal translation of Enclosure 2.

James R. Shea, Director
Office of International Programs

Enclosures:
1. 1978 article from Teploenergetika
2. Translation from Aug. 1980 journal Atomic Energy

cc w/enclosures:
Chairman Ahearne
Commissioner Bradford
W. J. Dircks
V. Stello
H. Denton
R. Tedesco
L. S. Tong
J. Meyer
J. Lewin
SECY
OPE

In the August 1980 issue of the Soviet journal <u>Atomic Energy</u> there appeared the following:

"<u>Official Documents</u>

<u>Regulations for siting of nuclear district heating stations and nuclear cogeneration stations for radiation safety</u>.

(Supplement to 'General rules for safety of nuclear power stations during design, construction, and operation.')

This was promulgated on 5 October 1978 and is now part of the 'General Rules' that we received in April 1978.

A summary of the salient points follows:

<u>Nuclear Heat Supply Stations</u> (Nuclear Boilers)

1) Minimum of <u>2 km</u> from predictable near term city boundary (actual settled area), with possible modification for Arctic cities.

2) Routine operational dose to the public $\leq$ 20 mRem/yr. exclusive of the thyroid glands for which $\leq$ 60mRem/yr. for kids, while integral population dose $\leq 10^4$ Rem-man/yr.

3) Under DBA individual dose beyond the station exclusion area $\leq$ 10 Rem excluding children's thyroid glands. The integral population dose $\leq 10^5$ Rem-man under worst weather conditions.

<u>Cogeneration Stations</u>

1) Minimum distance to cities in accordance with population of

city (10^{-3}) ⟶	>100	>300	>500	1000-2000	>2000
Distance to city limits, km	10	12	18	25	*

*for over 2,000,000 population each case is judged individually.

Supplementary safety criteria for both boiler stations and cogeneration stations:

1) ECCS for any primary pressure envelope break

2) External catastrophic events must be considered for DBA's

   a) Airplane disaster - 20-tonne airplane @ 700 km/hr on a $7m^2$ area - with fuel burnup

   b) Blast wave - $\leq 0.5\ kg/cm^2$ ($\sim$7.4 psi bp) for [illegible] uses

   c) One RPS channel must remain operative and one containment boundary.

3) Containment, with possible ruptures, must be testable in operation so that 'last boundary' integrity is demonstrable

4) (a) 5-yr period of radio waste storage must be in the design and provisions for wastes removals, treatment, and for disposal.

   (b) liquid wastes must be cleaned up to H_2O recycle.

5) Fuel integrity limits are stricter than for APS.

6) Before startup - a final SAR that includes preop test data must be approved.

Heat Grid Protection

1) Intermediate loop - with mechanical HX from primary to intermediate to grid - all HX on station territory.

2) Pressure must ascend through HX surfaces to Grid.

3) Primary loop activity $\leq$ 10X MPC in accordance with NPB-76 (Radiation Safety Stds.-76).

4) Grid must be shut off auto. when 2 limits are approached."