A report from the 2005 ANS Topical Meeting on Decommissioning, Decontamination and Reutilization

D&D around the World

Several sessions at the 2005 American Nuclear Society Topical Meeting on Decommissioning, Decontamination and Reutilization, held in Denver this past August, focused on international decontamination and decommissioning (D&D) efforts, including projects in the United Kingdom, France, Canada, Romania, Bulgaria, and Lithuania, to name but a few.

World Overview

Dennis Reisenweaver, from the International Atomic Energy Agency (IAEA), reported that the IAEA's estimate of the decommissioning liability worldwide over the next 50 years (for both commercial and weapons facilities) totals some $1 trillion. As a result, the agency is directing extra funding to raise the profile of decommissioning within the IAEA. In fact, he said, decommissioning is now considered a major component of a facility's life cycle. The agency has also increased the staffing in his department, he added—"It's gone from one to two." And, he commented wryly, the agency is looking for someone to help with decommissioning some 100 sites in Iraq.

Decommissioning does not start at facility shutdown, Reisenweaver said. It starts at initial design and planning. ("People are starting to get it!" he stated.)

Among other agency opinions Reisenweaver mentioned, the IAEA thinks that the entombment option is a good strategy for some countries (for example, those that have only a research reactor and a few medical facilities and do not have a disposal facility).

Right now the agency is looking for a site for a decommissioning demonstration project, Reisenweaver said. However, the IAEA cannot pay for the actual decommissioning, and a lot of countries they would like to use cannot fund the decommissioning themselves. A decision on a site might come by the end of September, he said.

Also due within the next six to nine months are new IAEA decommissioning safety requirements, Reisenweaver noted. In addition, the agency is planning a conference on lessons learned in decommissioning, to be held in December 2006 in Athens, Greece.

United Kingdom

Paul Woollam, from British Nuclear Group, asked the question "Why is it so important that we get legacy waste management right?" His answer: "Because if we don't, no new nuclear plants will be built—at least not in Europe. However, we cannot maintain oil and gas forever," he continued, "and without nuclear we cannot maintain our current lifestyle. We have to show the public we can clean up after ourselves."

Paul Woolam

In Europe in general, he continued, decommissioning work is focusing on the first generation of reactors, primarily gas-cooled reactors. In the case of gas-graphite reactors, the problem is managing the graphite.

In the United Kingdom, the decommissioning strategy is to leave nuclear plants in a SAFSTOR condition for up to 100 years, Woollam said. This strategy is driven primarily by the lack of disposal facilities for waste and by a lack of funding. However, he stated, this strategy is not popular with the public nor with regulators.

The U.K.'s new Nuclear Decommissioning Authority is preparing a new strategy document, which is due to go to the government in December. It is "highly likely," Woollam said, that this strategy will recommend a different way to deal with the old Magnox sites, possibly recommending that they be decommissioned within 25 years instead of 100 years. There are 26 Magnox plants in the United Kingdom, Woollam said, and they are "huge" compared with pressurized water reactors, with likewise huge amounts of decommissioning waste. This material is not highly radioactive, he said, but it is contaminated, and there is nowhere in the United Kingdom to put this material at the moment.

David Reed, from British Nuclear Group, pointed out that the Sellafield site, located in the Lake District in northwest England, makes up about 60 to 70 percent of the country's civil nuclear liability. The 2-square-mile site, location of an ordnance factory during World War II, holds 1000 buildings having a great age range. Among the facilities at the site is the Calder Hall power station and the reprocessing plant. A few miles away is the Drigg low-level waste disposal facility (also a former ordnance factory).

Michael Mills, from the U.K.'s Atomic Weapons Establishment, discussed the decommissioning of the high-energy reactor at Aldermaston. The research reactor, used for neutron research, was built in the 1950s and operated between 1960 and 1988. The decommissioning plan was developed in 1996 and approved in 2000. The goal of the decommissioning is to put the reactor in a safe dry state until around 2038, at which time final decommissioning will take place. (However, Mills noted, there has been some recent pressure to decommission the reactor before then.)

The decommissioning workers have encountered "lots of asbestos," Mills said. Any facility built in 1954 will have lots of asbestos, he said, but they found more than expected. There was also more lead than expected. At the time of the conference, workers were focused on demolishing the spent fuel storage facilities.

In the end, Mills concluded, there is no reason to decommission the reactor early at Aldermaston; the site will still be there, as opposed to the Harwell site, which is proving to be valuable for business development.

France

France has nine decommissioned units undergoing "deconstruction," according to Phillippe Convert, from the Decommissioning and Environmental Engineering Department of Electricité de France. These include one pressurized water reactor (Chooz A), one heavy water reactor (Monts d'Arrée in Brenilis), six gas-graphite reactors (at Chinon, Saint-Laurent, and Bugey), and one fast breeder reactor (Creys-Malville). These are being dismantled so that they can be replaced with new operating reactors in the 2020 time frame, Convert said.

The dismantlement program of these nine reactors will produce 670 000 tons of conventional waste and 330 000 tons of radioactive waste, which will be conditioned and stored.

Convert said France is currently developing new facilities for two types of waste: long-lived medium-level waste (a facility will be needed by 2007–2008) and graphite (a disposal facility is expected to be operating by 2009–2010). The sodium from Creys-Malville will be treated onsite, producing 80 000 tons of concrete blocks containing soda with very low levels of activity, Convert said.

In addition to its own decommissioning projects, Convert concluded, France is also involved in helping with D&D activities and projects in Eastern Europe, as well as supporting nuclear power plant safety enhancements in Eastern Europe.

Canada

Michael Stephens, from Atomic Energy of Canada Limited (AECL), noted that his country is "around 10 years behind the United States" in its decommissioning program.

Currently, AECL is decommissioning the Whiteshell Laboratory in Manitoba. Originally, the D&D project was supposed to be conducted in three stages, but AECL is now rethinking that plan, looking at doing the project all at once to cut down on maintenance expenses.

The Underground Research Laboratory near Whiteshell is currently being shut down. AECL is planning a "recap" of that facility to demonstrate the technology for this type of decommissioning to the world.

Decommissioning work at the Chalk River facility in Ontario is being done to gain valuable space on the site for additional facilities. The strategy at Chalk River, Stephens said, is to tackle the easy buildings first to gain confidence to handle the "bad ones." The problems at Chalk River stem primarily from funding. It's hard to gain economies of scale from such a small program, Stephens said. However, he added optimistically, more money has finally been appropriated for the project, and while in the past AECL has been doing the decommissioning work itself, in the future more of the jobs may be contracted out.

Lithuania

Lithuania, which gained its independence from Russia in 1990, inherited two 1500-MWe RBMK reactors at Ignalina, which provided about half of the country's electricity at the time, according to Birute Teskeviciene, from the country's Economic Ministry. The "ticket" for Lithuania's admission into the European Union, she said, is shutting down the Ignalina plants. One unit was shut down last December, and the second will be shut down by 2010.

Two strategies were considered for decommissioning these plants: immediate dismantlement and deferred dismantlement. The country has decided to go with the immediate dismantlement program, which will cost nearly 1 billion euros ($1.23 billion) (which does not take into account the cost of disposing of the spent fuel). The costs (through the year 2020) can be broken down as follows:

- Predecommissioning (including construction of a spent fuel storage facility and waste treatment facilities), 240 million euros ($295 million).
- Unit decommissioning, 416 million euros ($512 million).
- Radioactive waste disposal (including disposal in landfills and near-surface repositories), 146 million euros ($180 million).

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• Nuclear safety–related costs, 79 million euros ($97 million).

Sources of financing include the European Bank for Reconstruction and Development, as well as the European Union's International Ignalina Decommissioning Support Fund. In addition, Lithuania itself will be funding some of the costs.

In France, shutdown plants are being dismantled so that they can be replaced with new operating reactors in the 2020 time frame.

The costs for spent fuel disposal are unknown, Teskeviciene said. Geological conditions in the country are unfavorable for geologic repositories, so the plan for now is to store the spent fuel for at least 50 years and see what has transpired by then. Perhaps a regional repository will be a viable option at that time, she mused.

In answer to an audience question about what the country is planning to do with the graphite from the reactors, she responded that the graphite will be packaged ("somehow") for storage.

Spain

Spain estimates its total decommissioning liability at 2.4 billion euros ($2.95 billion), with the peak expenditures coming between 2025 and 2040, according to Alejandro Rodriguez, from Empresa Nacional de Residuos Radioactivos SA (ENRESA), the country's waste management and decommissioning organization. Decommissioning of the Vandellos-1 plant was recently completed, at a cost of 94 million euros ($115 million) (up from an earlier estimate of 90 million euros [$110 million]). The decommissioning project took 63 months to complete.

Rodriguez noted that "96 percent of the materials from the decommissioning were recycled or reused," in both the nuclear industry and elsewhere.

Next up for decommissioning is the Jose Cabrera plant, which will be shut down in 2006. Decommissioning on that project should be finished in 2015. Between shutdown and around 2009, the project will be in the planning stage, giving the plant operator time to handle the spent fuel, package the waste, and perform other predecommissioning activities, Rodriguez said.

Bulgaria

Elka Anastasova, from Bulgaria, described the decommissioning work going on at the IRT research reactor, located about 8 kilometers from the Bulgarian capital, Sofia. Built between 1959 and 1961, the unit achieved first criticality in 1961 and was shut down in 1989. In 2000, the government approved a decision to reconstruct the reactor into a low-power research reactor, which would entail a partial dismantling of the existing reactor. Some parts of the old reactor, such as the existing core (subject to full replacement later, Anastasova said), primary cooling system, secondary cooling system, horizontal experimental channels, spent fuel storage, and so on, would be used in the new reactor.

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An existing repository for institutional wastes will be upgraded to be able to hold the decommissioning wastes, she reported. Some category 2 wastes will be decontaminated down to category 1 levels or for free release.

Romania

Cristian Dragolici, from Romania, reported on the decommissioning of the WWR-S Reactor at the National Institute for Physics and Nuclear Engineering (IFIN-HH) near Bucharest. The reactor achieved initial criticality in July 1957, operated for 40 years, and was shut down in December 1997. During that 40-year operating life, Dragolici said, the unit received no major modifications, no major improvements, had no incidents or accidents, and experienced no events (leaks) that had a hazardous impact on personnel, the public, or the environment.

The decision to decommission the reactor was made in 1998, and the government approved the decommissioning plan and agreed to provide the funding in 2002.

The plan calls for three stages of decommissioning. Work at the Stage 1 level is currently being performed; Stage 3 is scheduled to start a minimum of 12 years after shutdown (that is, in 2009). Planning and development of the project have been done in conjunction with the U.S. Department of Energy and Argonne National Laboratory.

The work currently in progress is primarily characterization work, Dragolici said, to allow more realistic planning of the D&D work and to estimate the amount of waste, the costs, and worker exposure. In addition, water has been removed from the biological protection tank, empty water tanks have been removed and are waiting for recycling, paraffin and concrete bricks have been removed and are being used elsewhere in the institute or at other institutes, and lead bricks have been removed and stored for future needs. With those elements removed, they have more space and can do a better job of characterization, Dragolici explained.

All waste will be packaged and treated onsite at the waste treatment plant and then sent to final disposal in an old uranium mine.

Asked if the institute will be getting a new research reactor, Dragolici replied that he wishes they would but the government thinks it will be too expensive.

Germany

Mark-Constantin Steifensand, from Germany's Grafenrheinfeld KKG, reported that 15 nuclear reactors are in various stages of dismantling or SAFSTOR in the country. His presentation centered primarily on the decommissioning of the KRB A plant at Gundremmingen.

The steam generators were filled with water and then frozen, which fixed the tubes for reliable sawing. The steam generators were cut up using the ice sawing technique. Eleven cuts were made for each steam generator.

In 2002, the internals of the reactor pressure vessel were cut up under water with plasma arc cutting. The cutting took place at a water depth of more than 20 meters, Steifensand said—a first in the nuclear industry. The biological shield was segmented using diamond wire cutting. Some 30 percent of the material from this operation could be recycled; the rest was handled as radwaste.

The cost of decommissioning, Steifensand said, is directly influenced by the amount of waste. Chemical decontamination enabled them to clean contaminated waste to release levels. In fact, several thousand tons of waste were treated. That operation has not yet been completed, but Steifensand said they hoped to complete the job in one to two years. As a result, 54 percent of the waste was cleaned to free-release levels, 32 percent was cleaned to restricted recycling levels, and the remaining 14 percent will have to go into final waste storage.

Chornobyl

A session on Chornobyl explored topics including waste management and disposal needs in the exclusion zone around the damaged plant, the new Shelter Implementation Plan, the need for shoring up the existing shelter, and other issues.

The damaged plant itself remains a pretty hot zone, with the dose rate in some places in the existing shelter averaging about 100 rem per hour, and in the "lava" zone (areas containing molten, then resolidified, fuel), up to 1000 rem/h, according to Valery Batiy, department head at the Ukrainian Institute for Safety Problems in Ukraine Nuclear Power Plants. The radiological danger is from gammas, he said.

An international project to design and build a new shelter to fit over the existing shelter over the destroyed Unit 4 at the site was described by Dan Couch, from Battelle Memorial Institute. Ukraine approved the design in July 2004, he reported, and final bids were due by the end of August 2005. A contractor to construct the shelter should be selected by the end of 2005, with construction starting next year.

The IAEA thinks that the entombment option is a good strategy for some countries (for example, those that have only a research reactor and a few medical facilities and do not have a disposal facility).

The design, as described in these pages previously, consists of a self-supporting arch that will be constructed next to the existing shelter and then slid on rails over it. Four football fields could fit into the space under the arch, Couch said. Once the new shelter, which will have a 100-year life, is in place, the existing shelter can be carefully dismantled. The project is being paid for by the Chornobyl Shelter Fund, an international fund administered by the European Bank for Reconstruction and Development. Some 22 nations have contributed to the fund, with the largest donations coming from the G-7 nations.

Eric Schmieman, from Pacific Northwest National Laboratory, reported on efforts to prevent the original shelter from collapsing before the new shelter can be put in place. Ukraine wants to remove the fuel and dispose of it properly, he said, which will be much harder if the shelter collapses before they can remove the fuel.

The "no fly" zone (for heavy jets) will continue to be in force over the plant for some time the future, even after the new shelter is in place. There is no other way to guard against a jet crash into the shelter, Schmieman said.

However, the 30-km exclusion zone around the plant may be contracted into a 10-km zone in the future, Schmieman continued. That zone, "more elliptical than round," around the plant is all within Ukraine.

Other activities at the site include quantifying all existing waste (solid and liquid) and all new waste expected to be generated by 2050 and evaluating all facilities (both existing and planned). Schmieman reported that of this waste, some 97 percent is expected to be intermediate- and low-level waste (short-lived). Only less than 3 percent of the waste is expected to be high-level waste or long-lived ILW. Of this, half will be generated by the decommissioning of Units 1, 2, and 3; 13 percent is existing waste; and about 35 percent will come from the new shelter and activities associated with it.

Among new facilities needed, Schmieman listed the following:

- A new liquid waste treatment facility, with a capacity of 600 m^3 per year.
- Two buffer storage facilities for solid waste, one a 20 000-m^2 facility for short-lived waste, and a 3000-m^2 facility for long-lived I/LLW.
- A solid I/LLW management facility for treatment of waste.
- A facility for storage of category 3 radwaste (mostly soils).

Locations at the Chornobyl site have been identified for these facilities, he said. In addition, a geologic repository will be needed for the fuel-containing materials, which were not included in the afore-mentioned estimates.

These facilities will also be funded out of the Chornobyl Shelter Fund.—*Nancy J. Zacha, Editor* ■