APPENDIX C

STATUS OF NUCLEAR WASTE MANAGEMENT PROGRAMS IN OTHER COUNTRIES

[NOTE: Much of the information herein was derived from a 2009 report of the U.S. Nuclear Waste Technical Review Board (NWTRB) on the status of international repository programs. This appendix may therefore not reflect more recent developments, although we have attempted to update the information below based on information provided to the Commission. For nations covered herein but not covered in the NWTRB report, the information was gathered by BRC staff].

Canada: Canada currently has 18 operating nuclear power plants, which together account for nearly 15% of the country's total electricity production. Responsibility for managing nuclear waste rests with the Nuclear Waste Management Organization (NWMO), a private corporation formed by nuclear plant owners. The Organization's key policies and decisions must be approved by the government, which regulates nuclear waste management activities through the Canadian Nuclear Safety Commission. Similar to the approach taken in the United States, owners of nuclear power plants pay into a Nuclear Fuel Waste Act Trust Fund. Canada does not reprocess commercial used nuclear fuel. The Organization's "Adaptive Phased Management" (APM) plan is guided by five fundamental values: Integrity, Excellence, Engagement, Accountability, and Transparency. It consists of a technical method and a management system. The technical method envisions disposal in an appropriate geologic formation with the option of shallow underground storage at the disposal site. It includes the potential for retrievability, continuous monitoring, flexible design, and an ongoing technical and social research program. The management system calls for collaborative and phased decision making; continuous learning; open, inclusive and transparent engagement; and pursuit of a willing and informed host community in one of the four nuclear provinces. Currently NWMO is in the early stages of the siting phase and a number of communities have expressed interest in learning more about the program in order to inform a decision about their interest in volunteering to host such a facility. The proposed process for selecting a deep geologic repository site does not contain a firm schedule for completing this process or an anticipated start date for repository operations.Canada does not have an independent, centralized interim-storage facility for used nuclear fuel.

Finland: Finland currently has four operating nuclear power plants, which together account for nearly 30% of the country's total electricity production. Responsibility for waste management rests with Posiva Oy, a joint company created by Finland's two nuclear utilities in 1995. The government's Radiation and Nuclear Safety Authority serves as independent regulator. Nuclear power generators pay into a nuclear waste management fund; their annual obligation depends on the gap between estimated waste disposal and plant decommissioning costs and the level of the fund at that point in time. Finland does not reprocess commercial used nuclear fuel. In 2000, the government approved Olkiluoto, a migmatite site in the municipality of Eurajoki, for a deep geologic repository. (Two of Finland's four existing nuclear reactors and a new reactor that is currently under construction are also located at Olkiluoto.) The site was subsequently approved by Finland's Parliament (in 2001) and is currently being characterized at depth using an underground research tunnel known as Onkalo (construction of the tunnel began in 2004). Selection of the Olkiluoto site has the support of the host community, which could have exercised veto power over the government's decision (instead, the Eurajoki Municipal Council approved a positive statement about the site). The community had negotiated a benefits package with Posiva Oy in 1999. Key decisions concerning long-term health and safety requirements, the design of engineered barrier systems, and the methodology to be used for demonstrating compliance with post-closure standards have been taken; details are available from the NWTRB report and other sources. Earlier regulations stipulated that waste emplaced at the site be retrievable in the future; this requirement was lifted in 2008 but Posiva is still obliged to present a plan and cost estimate for waste retrieval when it applies for a license to construct the Olkiluoto repository. The anticipated start date for repository operations is 2020. Finland does not have an independent, centralized interim-storage facility.

France: France has 58 operating nuclear plants, which together account for 76% of the country's total electricity production. A new 1.6 GW plant is currently under construction. Responsibility for managing and disposing of nuclear waste falls to the National Agency for Radioactive Waste Management, a government-owned public service agency which reports to the government's Ministries of Environment, Industry, and Research. France's Nuclear Safety Authority is the independent regulator. In France,

all owners of a nuclear license are responsible individually for assessing costs of decommissioning their plants and for the long-term management of the waste and spent fuel—which is not considered "waste" in France. They are also responsible for establishing the necessary financial provisions and for ear-marking the necessary assets for the exclusive coverage of those costs. They are individually responsible for managing those assets, which will be disbursed when the relevant decommissioning and long-term management activities start on an industrial basis. The necessary R&D for long-term waste management is financed through an additional tax on nuclear installations, which is transferred to a fund that goes to the National Waste Agency. France requires reprocessing in the fuel cycle; accordingly, only high-level waste and long-lived intermediate-level waste are authorized for disposal in a deep geologic repository. In 1999, construction began on an underground research facility in argillite rock at a location near the village of Bure in the Meuse area located at the boundary of the Haute-Marne region; the area was subsequently approved for a long-term repository site in 2006. The National Agency has recently identified a 30 square kilometer area to locate the repository. The selection of this area was carried out in consultation with the mayors and authorities from both the Meuse and Haute Marne region. Consultations continue on where to locate surface facilities and the lay-out of the underground facility and its access. Local government in the Meuse and Haute-Marne area have been associated with the site-characterization program in various ways, and both can expect to benefit from a series of measures designed to support their development, funded through a dedicated tax on basic nuclear installations. France has established health and safety requirements for a deep repository site, identified a methodology for demonstrating compliance with post-closure standards, and decided on the design of engineered barrier systems at the site (the plan is to place vitrified waste in stainless steel packages). Current policy stipulates that the repository must be designed to be "reversible" for at least 100 years, a concept that implies technical retrievability. Specific conditions for meeting this requirement will be prescribed by the French Parliament after a license application has been submitted. France currently expects its repository to become operational in 2025. All commercial high level waste is slated for disposal and is stored in a special facility within the spent fuel reprocessing complex at La Hague.

Japan: Japan has 53 nuclear power plants, which prior to the disaster at the Fukushima-Daiichi nuclear power station together account for nearly 25% of the country's total electricity production. In addition, three new nuclear power plants (totaling 3.7 GW) are under construction. The Nuclear Waste Management Organization, a private, non-profit entity formed by nuclear power plant owners, is responsible for waste management. The Nuclear and Industrial Safety Agency, a unit within Japan's Ministry of Economy, Trade, and Industry, is the independent regulator. The Ministry maintains two funds to cover costs associated with radioactive waste management: nuclear power plant owners pay into a High-Level Waste Fund; owners of reprocessing plants and mixed-oxide fuel fabrication plants pay into a TRU Waste Fund. Commercial spent nuclear fuel from Japan has been reprocessed in France and the United Kingdom; in addition, reprocessing takes place in Japan at a small facility in Tokai. A large new reprocessing facility at Rokkasho Village is expected to open in the next few years pending the results of pre-service testing. Two underground research laboratories to investigate deep geologic disposal (in granite and sedimentary rock) are under construction, but no decision has been reached in terms of selecting a site for a long-term repository. Requirements for such a repository (with regard to health and safety, retrievability, design of engineered barriers, etc.) have also not been established. The Nuclear Waste Management Organization has adopted a transparent, voluntary approach to identifying potential sites—thus, both the mayor of the host community and the governor of the prefecture must agree to participate. Localities that agree to be included in an initial survey can receive up to $18 million; if they subsequently agree to participate in surface-based site investigations they can receive up to $65 million. One town (Toyo-cho) initially agreed to participate but later withdrew. The national government has since indicated that it may play a more proactive role in the site selection process going forward. Japan had been constructing an independent, centralized interim-storage facility at Mutsu in Aomori Prefecture but those plans have been put on hold in the aftermath of the March 2011 earthquake and tsunami. Japan has not projected a date for opening a permanent repository.

Russia: Russia currently has 33 nuclear reactors in operation (including a 600 MWe fast breeder reactor) which together account for nearly 16% of the country's total electricity production. Another 9 reactors are under construction (including a 800 MWe fast breeder reactor). Radioactive waste management and spent fuel waste management are divided into two different programs. Radioactive waste management is the responsibility of the newly created federal state enterprise "RosRAO" within the structure of

the federal corporation Rosatom (which runs the country's nuclear power complex) and Rosatom itself. The new Federal Law on Radioactive Waste Management (came into force in 2011) establishes a legal framework for radioactive waste management in Russia and requires creation of a unified state system for radioactive waste management. Among other provisions, the law authorizes a single-purpose organization (so-called "national operator" – currently Rosatom) to conduct main activities related to waste management activities (e.g. receiving, storing, securing and disposing of radioactive waste); decision-making regarding siting, construction, commissioning etc. of waste-management facilities remains the responsibility of the Federal Government. The law also establishes a framework for a new funding mechanism (analogous to the Nuclear Waste Fund in the United States). Some federal budget resources have also been allocated for the program (the total for 2016 to 2020 is $13 billion in U.S. dollars). Meanwhile, a system for managing spent nuclear fuel is being developed by Rosatom. It is not clear whether implementing this system will be the responsibility of Rosatom or one of its subsidiaries. The pending Federal Law on Spent Nuclear Fuel Management will provide the legal framework for the national program. As work continues on drafting this legislation, Rosatom has gone ahead with developing plans for the construction and commissioning of an underground rock laboratory by 2015 and a final repository by 2021. Several sites have been proposed as candidates for such a facility, including a granite site on the Kola Peninsula (in the Murmansk region), Krasnokamenks in Chita (4,300 miles east of Moscow), and the Nignekamensk Rock Mass in the Krasnoyarsk Territory of Siberia. Site selection efforts are currently underway on the Kola Peninsula. Russia plans to close its fuel cycle as much as possible and use plutonium in MOX fuel in fast breeder reactors. However, current reprocessing capacities are limited to about 100 metric tons per year. A new reprocessing plant in the city of Zheleznogorsk (in the Krasnoyarsk Territory) is being redesigned from a previous version and is expected to commence operations in the 2025–2030 timeframe.

Although most of Russia's spent nuclear fuel is being stored at reactor sties, there is a centralized interim wet (pool) storage facility located in Zheleznogorsk. Its storage capacity of 7,200 metric tons was recently expanded to 8,600 metric tons, allowing it to safely store/accept spent VVER-1000 (PWR-1000) fuel through 2025. In addition, a dry storage facility for spent RBMK (BWR) fuel with a total capacity of 8,600 metric tons was commissioned in late 2011, also in Zheleznogorsk, with the first SNF is scheduled to arrive in early 2012.

Low-level radioactive wastes and some intermediate-level wastes are processed and stored at 16 sites in Russia (within the structure of the federal state enterprise RosRAO).

Russia currently has a program to "take-back" spent fuel of Russian origin for reprocessing from commercial and research reactors abroad. However, due to limits on available reprocessing capabilities, the spent fuel that has been accepted under this program is being held in wet (pool) storage.

Spain: Spain has eight operating nuclear power plants, which together account for 18% of the country's total electricity production. Management of nuclear waste is the responsibility of the Spanish National Company for Radioactive Waste, a government-owned corporation. The Nuclear Safety Council is the independent regulator, although the Ministry of Industry, Tourism, and Trade is required by law to make a final decision concerning the disposition of used nuclear fuel. Operators of nuclear power plants pay into a nuclear decommissioning fund that was established to cover the costs of both decommissioning plants and managing radioactive waste. Some used nuclear fuel from Spanish reactors has been reprocessed in the past at the La Hague and Sellafield facilities, but current national policy does not contemplate any further reprocessing. No decision has been made regarding a deep geologic repository for high-level waste and used nuclear fuel, but in 2006 Spain initiated a process to site a centralized temporary facility. That process required voluntary participation by potential host communities and resulted in recent selection of a site for a consolidated storage facility in the town of Villar de Cañas, located in the "autonomous community" (the level of government in Spain roughly equivalent to a state) of Castilla la Mancha.

Sweden: Sweden currently has 10 operating nuclear power plants, which together account for 42% of the country's total electricity production. The Swedish Nuclear Fuel and Waste Management Company, a private corporation formed by nuclear power plant owners, is responsible for waste management. The Radiation Safety Authority within Sweden's Ministry of the Environment is the independent regulator. Owners of nuclear power plants pay fees into a nuclear waste fund. The fees vary from year to year and from plant to plant, depending on the estimated costs of disposing of used nuclear fuel and the level of the fund. Small amounts of used nuclear fuel from Swedish reactors have been reprocessed in the past at facilities in France and England (none of the resulting high-level waste was returned to Sweden), but Sweden's

current plans do not include reprocessing. In 2001, the government approved a proposal by the Swedish Nuclear Fuel and Waste Management Company to investigate three potential sites for a long-term geologic repository—at Östhammer, Oskarshamn (Oskarshamn was also the site of an underground research laboratory constructed in the early 1990s) and area in the northern part of Tierp. Later, municipal councils in Östhammer and Oskarshamn consented to further investigation, while Tierp opted-out. The site at Östhammer was selected for a repository in 2009. The value of benefits for communities was estimated as $300 million. The local community at Östhammer, which could have vetoed its selection as a geologic repository site, will receive 25% of the benefits. In addition, the community at Oskarshamn, which was *not* selected, will receive about 75% of the benefits for participating in the siting process. A license application for the Östhammer repository was submitted to the Radiation Safety Authority for review in March 2011. Concurrently, Sweden's Environmental Court will rule on the application. Based on the findings of the Safety Authority and the Court, the Swedish government will decide whether to approve the license application. Regular operation of the repository is expected to begin after several years of trial operation. Current plans call for transporting waste to the site using a specially designed ship and for placing used nuclear fuel in a copper canister that has a cast-iron insert for support and is surrounded by bentonite clay. Details concerning safety standards, post-closure compliance demonstration, and other requirements applicable to the Östhammer repository are available from the NWTRB report and other sources. Sweden currently expects to start repository operations in 2023. Sweden also has an independent, centralized interim-storage facility for used nuclear fuel: the CLAB facility, also located in Oskarshamn, was commissioned in 1985.

United Kingdom: The United Kingdom currently has 19 nuclear reactors that together account for one-sixth of the country's electricity generation. In October 2010, the UK government approved the construction of up to eight new nuclear power stations. All nuclear installations in the UK are subject to regulation by the Office for Nuclear Regulation and by environmental authorities. Responsibility for designing and developing a geological disposal facility for higher activity wastes rests with the Nuclear Decommissioning Authority (NDA). The NDA has a baseline disposal plan that envisions first emplacement of legacy intermediate level waste in 2040, emplacement of legacy high level waste and spent fuels in 2075, emplacement of spent fuel from new reactors in 2130, and commencement of facility closure in 2175.

The UK has accumulated a substantial legacy of radioactive waste from a variety of different nuclear programs, both civil and defense-related. For decades, the UK struggled to find a solution to the problem of long-term radioactive waste management. The nearest the UK came was a planning application for a "Rock Characterisation Facility" as the first step towards geological disposal in Cumbria in 1994. The application went to a public inquiry and was rejected in 1997, largely on the basis of the site selection process used and scientific and technical uncertainties at the time.

Recognizing that the existing approach was unworkable, the government undertook a more fundamental review of options for managing radioactive wastes in the long term. In 2001, the UK government initiated the "Managing Radioactive Waste Safely" (MRWS) program, which provided for public consultation on the waste management issue with the goal of finding a practicable solution for the UK's higher activity wastes. The process was designed to work in an open and transparent way that inspired public confidence, was based on sound science, and ensured the effective use of public monies. Having collected feedback from a public consultation process, an independent body, the Committee on Radioactive Waste Management (CoRWM) was set up to recommend specific program options. In July 2006, CoRWM announced an integrated package of recommendations for pursuing geological disposal, coupled with safe and secure interim storage and a program of ongoing research and development. Following publication of a white paper in 2008, the UK government launched a search for an engineered, underground site to serve as a permanent disposal facility for high-level radioactive wastes. The government invited communities across the country to learn more about what it would mean to potentially host this facility. To date, only a group of communities in West Cumbria, near the Sellafield nuclear site in northwest England, have sought to examine the possibility further. They formed a West Cumbria MRWS Partnership, including a range of local stakeholders, to examine the proposal and make recommendations to the local decision-making bodies on whether to proceed further. A comprehensive local consultation is currently underway to gauge public view prior to submission of the final recommendation whether to proceed or not.

The U.K. has taken a noteworthy approach to providing benefits to potential host communities. One element is an "Engagement Package" which Government agrees upon each year to support the running costs of the MWRS partnership,

including all the research, project management, consultants, travel expenses, staff time and public engagement work. In 2011 the support costs were approximately 1.2 million pounds. This kind of Engagement Package is anticipated to continue throughout the whole siting process, and be extended to individual host communities as they enter the process actively, to cover their own costs. Note, however, that the definition of Engagement Package does not cover any 'incentive' type payments - only reimbursing actual costs incurred.

A "Community Benefits Package" will only be paid when a host community has passed the time at which it can withdraw from the process (i.e. when a final planning application is submitted for the actual facility to be built). The Community Benefits Package would, however, be agreed upon well before that point.

A site has not yet been selected so there are no specific agreements to date regarding what amount of money or investment any community would receive for hosting the facility, only a promise in the Government's policy that these kinds of benefits be available to the community that finally agrees to host a repository. Recognizing this, but wanting reassurance at the same time, the current partnership has developed a number of principles for community benefit that have been agreed to by the Government, so that the community's understanding of the type and scale of benefits meets their expectation. These principles will form the basis for any future negotiation.