Vision and Framework for Technical and Management Support to Facilitate Foreign Spent Fuel Storage and Geologic Disposal in Russia

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July 1, 1999

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Fission Energy and System Safety Program
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Introduction

This 'Technical and Management Support' program would facilitate the transfer of spent fuel from commercial power plants in Taiwan to a storage and geologic repository site near Krasnoyarsk, Russia. This program resolves issues of disposition of Taiwan spent fuel (including U.S. origin fuel) and provides revenue for Russia to develop an integrated spent fuel storage and radioactive waste management system including a geologic repository. LLNL has ongoing contracts and collaborations with all the principal parties and is uniquely positioned to facilitate the development of such a program. A three-phase approach over 20 years is proposed: namely, an initial feasibility investigation followed by an engineering development phase, and then implementation.

Statement of Objective and U.S. Interest

The objective of the proposed effort is to facilitate, organize, integrate, lead and manage the technical program required for the timely implementation of an integrated spent fuel storage, transportation and geologic disposal system in Russia capable of receiving, storing and disposing of Taiwan spent fuel with initial shipments by 2007 and a capacity of at least 6,000MT by the year 2020.

The U.S. has several vested interests in this program, including:

- Final disposition of spent U.S. origin fuel
- Future energy security for Taiwan
- Development of Russian spent fuel storage and radioactive waste geologic disposal capabilities
- Funding beneficial activities utilizing Russian nuclear production complex staff and resources
- Demonstration of international repository technology leadership

Approach

The general approach to this tri-party program relies on Russian and Taiwan internal capabilities to the maximum extent possible for activities in Russia and Taiwan, respectively, and on commercially available services wherever available. Existing Russian technologies would be used to the maximum extent possible for transporting, receiving and storing spent fuel within Russia. A formal Russian geologic repository program would be initially focused on the geologic disposal of BWR and PWR spent fuel from Taiwan. The primary funding for the program would be from resources set aside for spent fuel disposition in Taiwan.

This approach utilizes the maximum amount of existing Russian technologies and resources, and will further support the redirection of former weapons complex engineers and scientists in a series of non-defense projects with both a long-term schedule and foreign income. The development of an integrated spent fuel transportation, storage and geologic disposal system in Russia for the spent fuel from Taiwan would provide the foundation for future management and disposition of Russian radioactive materials generated during the Cold War by making incremental additions to this same system. Russian sources of high-level radioactive materials such as RBMK spent fuel; Russian vitrified HLW from Mayak and K-26; and other sources, including future spent MOX fuel can be similarly transported, stored and geologically disposed. This has major nonproliferation and environmental benefits to Russia, the U.S. and the world.

The program would be conducted in three phases, with tri-party decision points on whether to proceed further at the end of each of the first two phases. The first phase is a preliminary feasibility investigation to validate the potential, identify problems and provide all necessary information to the U.S., Russia and Taiwan for a decision on whether to initiate the second phase. The second phase includes design and development of the storage and transportation systems needed for receipt of spent fuel and conduct of geologic repository site selection studies. Implementation and actual operations would be the third phase, concurrent with completion and start-up of the geologic repository.

Elements of the Program

Spent Fuel Storage:

Russia has reasonably well-developed technologies for spent fuel storage, namely wet spent fuel storage at both Mayak and Krasnoyarsk for many non-defense related spent fuel types. Dry spent fuel storage technologies have been recently developed and continue to evolve for nuclear navy spent fuels and for RBMK spent fuels. These technologies are now being deployed in Russia. Thus, minimal technical assistance is needed on spent fuel storage technology. The engineering, siting and licensing of spent fuel storage are basically ready for implementation in Russia.

Krasnoyarsk-26 (K-26) was named by Minatom in 1999 as a future dry spent fuel storage facility site. Facility start-up is planned for 2006. The investment justification phase has already been completed (Phase 3 of the Russian development cycle).¹ The next phase of generating working designs, making site preparations, initiating construction and fabricating equipment is now ready to be started once funding is available. The lead Russian design institute and lead scientific institute for dry spent fuel storage have been selected by Minatom. LLNL works with both institutes as well as the K-26 site operating company in current contracts, using DOE-MD and DOE-NN funds.

Transportation:

There are several technical issues requiring assessments related to transportation of spent fuel from a Russian seaport (such as Vladivostok or Vanino) by railroad to Krasnoyarsk. These include identifying an approved rail transportation cask for Russian railroads and determining its compatibility both as an ocean ship transport cask and as a Krasnoyarsk spent fuel dry storage cask. The compatibilities and interfaces must be assessed early and managed carefully so as to minimize secondary cask transfer and unloading operations at either the Russian sea port before rail transport in Russia or after receipt at Krasnoyarsk for extended dry storage prior to geologic disposal. This is a critical area to be assessed early, together with the selection of the proper Russian seaport, identification of seaport docking modifications and the specific Russian rail route. LLNL works with a Russian design institute capable of such rail transport studies in a current DOE-MD contract. The existing rail routes and two possible seaports in Russia accessible from Taiwan are shown in the attachments to this document.

The issues related to loading the Taiwan spent fuel into casks and transporting these casks to Russia are best managed and handled by Taiwan. Commercial ocean transport services are available (e.g., PNTL, BNFL, COGEMA) for loading and international ocean shipping of spent fuel. Such shipping is routinely carried out between European ports and between Japan and

¹ Note: there is a formal Russian governmental approval process equivalent to the U.S. NEPA/ROD process that must be followed.

Europe. The Russian interface specifications for the transportation casks will be the major interface to be coordinated between Russia and Taiwan to ensure success.

Geologic Repository:

Due to lack of funding, there is no significant active geologic disposal program in Russia, although expert staff is available for such work. An active Russian program existed in the 1980's and work was done to select specific sites near both the industrial sites of Mayak and Krasnoyarsk-26. A single integrated Russian repository for all the Cold War high-level wastes was even assessed and a site located in the early 1980's, but was then put on indefinite hold. Plans and proposals exist to develop the two geologic repository sites, and with funding, completion of the specific site selections, site characterizations, underground laboratories, and design at both the Mayak and Krasnoyarsk sites can be restarted rapidly. LLNL has summaries of these initial Russian geologic repository proposals. LLNL has served as the U.S. co-chair of geologic disposal for the joint US-Russian plutonium disposition programs since 1995. LLNL has contracts with a Russian design organization and with the two lead scientific institutes for these two sites with DOE-MD funds. A preconceptual design for a repository in a granite massif near Krasnoyarsk-26 was developed in one contract. The Mayak site preconceptual repository design is planned for another contract currently under final negotiation.

A Russian geologic repository program will have to assess the issues of selecting one or two geologic repositories at Mayak and Krasnoyarsk. Technical issues of site selection criteria and methodologies, site characterizations, reliance on the natural and engineered barriers, and allowing import of either foreign or other Russian radioactive waste all require resolution and technical assistance.

Roles and Responsibilities

Development of a tri-party (Taiwan, U.S., Russia) program must recognize the interests and responsibilities of each involved party.

United States

The U.S. interest in energy security for Taiwan, final disposition of spent U.S.-origin fuel and the special relationship between U.S. and Taiwan allows the U.S. to serve the role of facilitator and technical monitor for this program. The U.S. would have to enter into agreements with Taiwan and Russia that provide for successful implementation of the program. This will involve many complex issues and interested government agencies as well as non-governmental organizations. Due to the unique aspects of the relationship between Taiwan and the U.S., the coordination of technical activities in this program requires careful management.²

² Shortly after the United States Government changed its diplomatic recognition from Taipei to Beijing on January 1, 1979, the American Institute in Taiwan (AIT) was established as a non-profit, private corporation. The Taiwan Relations Act (PL 96-8) of April 10, 1979, authorized the continuation of "commercial, cultural and other relations between the people of the United States and the people on Taiwan." It also provided that "any programs, transactions, or other relations conducted or carried out by the President or any Agency of the United States Government with respect to Taiwan shall, in the manner and to the extent directed by the President, be conducted and carried out by or through the American Institute in Taiwan." The Department of State, through a contract with the Institute, provides a large part of AIT's funding and guidance in its operations. Congress, in passing the Taiwan Relations Act, also assumed an oversight role with respect to the Institute's operations.

Since Taiwan has no diplomatic representation in the US, commercial and cultural relations with the people of the US are maintained through a private instrumentality, the Taipei Economic and Cultural Representative Office (TECRO) with headquarters in Taipei and field offices in Washington and 12 other US cities.

Through AIT and TECRO, the United States and Taiwan have 21 bilateral agreements on science and technology issues. These include scientific and scholarly cooperation, exchange of technical information,

LLNL's proposed role is to assist, integrate and coordinate the Russian and Taiwan activities to develop the spent fuel storage, transportation and geologic disposal systems by acting as the technical and scientific manager for all participants. LLNL activities include integrating and coordinating necessary project elements among Russian scientific, design and construction institutes and organizations, coordinating with similar organizations in Taiwan, identifying project management, institutional and technical needs required for implementation, facilitating and obtaining U.S. or other technical assistance when needed and requested by organizations in Russia and Taiwan. Technical assistance to Russia or Taiwan would be provided by the best organization for the specific need, as identified jointly by organizations in Russia, Taiwan and LLNL. Assistance could include nuclear industry vendors for casks; BWR and PWR spent fuels; nuclear utilities for current dry spent fuel storage operations; and national laboratories for transportation, dry storage and spent fuel geologic repository technical issues. Assistance from U.S. regulatory and environmental agencies in the form of lessons learned and licensing, or permitting, are other possible examples. LLNL would also assure compliance with national and international expectations for nuclear safety, MPC&A and transparency. LLNL is the lead laboratory for the DOE-NN nuclear materials safety program and would monitor that international and Russian nuclear safety standards are achieved in all program elements.

Taiwan

The need for Taiwan to dispose of spent fuel provides the primary motivation for implementation, and the resources set aside in a trust fund for that purpose financially enable the program. Representatives from Taiwan would have to enter into agreements to fund the implementation of this program. Taiwan would need assurance that they would achieve an acceptable final disposition of the spent fuel for their investment. Taiwan would be responsible for contracting shipping and handling of the fuel from the reactor sites, onto suitable ocean transport ships, and delivery to the selected Russian port. Taiwan has in operation the systems and permitting processes for shipment of LLW by ocean ship to a storage site. That experience can be extended to shipments of the spent fuel through international waters, drawing on the commercial experience of the British and French (including the use of existing ships).

Russian Federation

Russia's potential interest to accept foreign development funds and host an integrated system for the handling, transporting, storage and eventual geologic disposal of radioactive waste and spent fuel provides the opportunity for this program to go forward. The Russian government would have to enter into agreements with the U.S. government to assure implementation of acceptable final disposal of the Taiwan spent fuel in a geologic repository without reprocessing. The U.S. would enter into agreements with Taiwan (probably through the AIT/TECRO mechanism) to assure implementation of receipt, transportation, storage and geologic disposal. Appropriate Russian institutes and organizations would be responsible for planning, implementing, permitting, constructing and operating the integrated spent fuel and radioactive waste management (storage, transportation and geologic disposal) system. The U.S. role should be to facilitate and monitor these activities and supply technical assistance when needed and requested. LLNL has current contracts and working relationships with most of the Russian organizations likely to be involved.

Path Forward

Phase-I Preliminary Feasibility Investigation

Prior to commitments to large-scale development of this program, preliminary scoping and feasibility studies would be conducted including interactions with all interested parties. Initial funding would be from U.S. DOE, with the potential for further support from Taiwan. The goal of this preliminary feasibility investigation would be to further define the issues, opportunities and activities needed to implement this program. Program activities and schedules, the state of development of process descriptions and facility concepts would be documented. National and international concerns, interests and institutional requirements requiring resolution would be explored and documented. This would provide in an integrated plan the information needed for tri-party policy-makers to decide whether to pursue further development.

Phase-I would include both formal and informal interactions with Taiwan and Russian representatives. Formal negotiations regarding potential terms for implementation would involve Russia, Taiwan (AIT), DOE and other U.S. agencies. Technical topics would be addressed by lab-to-institute methods. LLNL would be responsible for coordinating and delivering the final integrated plan. Participation in preliminary investigations by Russian organizations would be funded initially by the U.S. DOE through lab-to-institute contracts. Taiwan participation would be funded by Taiwan sources. Taiwan funding of U.S. and Russian activities (via the U.S.) would be developed when appropriate.

To achieve the goal of providing initial storage capacity for Taiwan by 2007, an opportunity for an early decision is provided. By beginning this preliminary investigation in FY-00, a decision to proceed to Phase-II could be made in FY-01. If required, a mid-phase evaluation of preliminary feasibility potential could be scheduled for late FY-00.

Phase-I Activities, Schedule and Budget (k\$)

Activity	FY00	FY01	Total
Russian Handling and Storage Facility Concept	800	800	1600
Feasibility Study of Russian Rail Transport	300	300	600
Technical Survey of Krasnoyarsk Repository Site	600	800	1400
Feasibility Study of Taiwan Shipping, Handling and Ocean Transport	200	100	300
Review of National and International Regulations and Requirements	500	500	1000
Phase-II Program Plan Development, Schedule and Documentation	800	800	1600
Total	US 1900 Russia 1300 Total 3200	US 2100 Russia 1200 Total 3300	US 4000 Russia 2500 Total 6500

Phase-I Activity Descriptions

Russian Handling and Storage Facility Concept: Technical evaluation of the requirements and design concepts for receiving and storing Taiwan spent fuel for up to 40 years at Krasnoyarsk. Maximize use of existing Russian expertise, staff and facilities. Issue Russian contracts for technical studies and planning. Prepare schedule and budget estimate for development program.

Feasibility Study of Russian Rail Transport: Assess options for transport of spent fuel shipping casks from a Russian port to Krasnoyarsk. This includes interface with the ocean transport system, rail transport and handling. Issue Russian contracts for technical studies and planning. Provide schedule and budget estimate for development.

Technical Survey of Krasnoyarsk Repository Site: Prepare a preliminary evaluation of the technical approach to development of a Russian geologic repository. Contract with Russian organizations responsible for geologic repositories to obtain technical studies, schedules and plans. Assemble the Russian documentation on the potential repository site. Outline a site characterization program, a conceptual design and an institutional plan. This information will provide the basis for a realistic schedule and budget for Russian repository development.

Feasibility Study of Taiwan Shipping, Handling and Ocean Transport: Work with organizations in Taiwan to assess technical and institutional requirements for loading spent fuel into transport casks and transfer to ocean transport system. Consider commercially available services. Prepare schedule and cost estimate for development.

Review of National and International Regulations and Requirements: Review laws, regulations, requirements, policies and other institutional issues to understand the implications for going forward with this tri-national program. U.S., Taiwan, Russian and International issues must be considered. Contract for Russian regulatory studies. Prepare a roadmap for regulatory path forward.

Phase-II Program Plan Development, Schedule and Documentation: Prepare Phase-II plan documentation. Manage the activities including schedule, budget and plans. Provide regular status reports and final documentation from Phase-I.

Phase-II Engineering Development

Engineering development in Phase-II would proceed after a favorable decision based on the information developed in Phase-I. Phase-II could begin as early as late FY-01 and would last approximately 5 years. Funding would be primarily from Taiwan resources. The detailed activities for Phase-II will be developed during Phase-I. The goals include design and construction of spent fuel handling and storage facilities, site characterization and preliminary design of a geologic repository and documenting the interfaces needed to provide confidence that the program will be successful in disposition of Taiwan spent fuel. Activities would include regulatory development in Taiwan and Russia; demonstration of shipping and handling capability in Taiwan; development, permitting and fabrication of rail cask transport system in Russia, including port facilities; and design, siting, permitting and construction of handling and storage facilities at the site selected in Russia. To meet the working goal for initial shipments by 2007, the transportation and storage capabilities must be sufficiently developed to provide confidence that shipments could commence in a timely manner following a decision to proceed with implementation. To provide confidence that final geologic disposition will be achieved, the repository program in Russia should achieve a site recommendation decision that documents expectation that a viable repository

can be developed and operated in Phase-III. It is estimated that Phase-II costs would be in the 250-500M\$ range.

Phase-III Implementation

Implementation of shipping, storage and disposal would follow favorable decisions at the end of Phase-II. The activities cost and schedule for Phase III implementation will be preliminary in Phase-I and fully developed in Phase-II. The goal for initial receipt of Taiwan spent fuel for interim storage is 2007. Further storage capacity will be needed until operation of the geologic repository begins. The schedule for repository operation cannot be accurately known until appropriate regulations are developed and site investigations have been carried out. A preliminary goal is to have the geologic repository operational prior to 2020, but this schedule will be determined in Phase-II. It is estimated that full implementation costs would be in the several B\$ range, probably dominated by the fee charged by Russia (cost/ton) for storage and final disposal of the Taiwan spent fuel.

Summary and Conclusion

This proposed program represents a unique opportunity to develop, under the control of the U.S.DOE, the concept of Russian disposition of foreign spent fuel and development of an integrated spent fuel and radioactive waste management system in Russia, including a geologic repository. This program would resolve the Taiwan spent fuel disposition issue and utilize Taiwan funds to achieve this and other goals. Russia would develop the facilities and capabilities for geologic disposal of spent fuel and radioactive materials from the Cold War, while providing jobs and new direction for former Russian nuclear weapons scientists and engineers.

By initiating the early start of the preliminary studies discussed above, the information basis would be developed to allow U.S., Taiwan and Russian policy makers to make a future decision on implementation in a timely manner.

Attachments

Additional reference information can be found in the following attachments to this proposal:

1. Overview and Background Information
1. Ocean Shipping Considerations
1. Maps and Routes

Attachment 1

Background for the LLNL Framework to Facilitate Foreign Spent Fuel Disposition in Russia

Background

The need by Taiwan to secure disposition of its spent fuel combined with the potential willingness of Russia to develop a repository and to dispose of the Taiwan spent fuel creates a unique opportunity that will benefit not only Taiwan and Russia, but also the U.S. The purpose of this proposal is to recommend an approach to successfully exploiting this opportunity.

Situation in Taiwan

Taiwan is the rapidly exhausting its capacity to store spent fuel at existing reactor sites. Taiwan will have to begin to curtail nuclear generation of electricity in 2007 if no disposition is found for their spent fuel. Very significant financial resources accumulated in their nuclear waste fund will allow Taiwan to finance an international disposition effort.

Table 1 provides a summary of the current and projected power reactors in Taiwan. The total reactor operating experience in Taiwan is approximately 100 reactor years as of early 1999. The fraction of electric power from nuclear reactors is approximately 25-30%. Table 2 provides some estimates of spent fuel inventories by reactor type.

Table 1: Current and Projected Power Reactors in Taiwan

Reactor	Type	Net MWe	Operational Date
Currently Operating			
Chinshan 1	GE BWR-4	604	12/78
Chinshan 2	GE BWR-4	604	7/79
Kuosheng 1	GE BWR-6	948	12/81
Kuosheng 2	GE BWR-6	948	3/83
Maanshan 1	W PWR	890	7/84
Maanshan 2	W PWR	890	5/85
Under Construction			
Lungmen 1	GE ABWR	1300	Est. 2004
Lungmen 2	GE ABWR	1300	Est. 2005

Table 2: Estimated current spent fuel inventories

	Reactor years	SF (t)	SF (assemblies)
BWR-4	40	800	3500
BWR-6	31	700	3000
PWR	29	600	1100
Total	100	2100	7600

The spent fuel generation rate in Taiwan can be estimated to be approximately 120-150 t/year. This generation rate will increase to about 175-200 t/year when the new ABWRs come on line. The total spent fuel from 8 plants running to end of license is estimated in the range of 7500 t.

Currently, Taiwan spent fuel is stored in pool storage at each reactor, with little flexibility to transfer spent fuel from one site to another. The Maanshan PWRs have expanded and re-racked

their pools to accommodate 2160 assemblies each, which gives them capacity to store fuel from their entire 40 years of operation.

Situation in Russia

Russia has previously considered the establishment of a geologic repository at several sites. An active program existed in the 1980's and work was done to select specific sites near the industrial sites of Mayak and Krasnoyarsk-26. A single integrated Russian repository for all the Cold War high-level wastes was assessed and a site located in the early 1980's. Although, due to lack of funding, there is at present no significant active geologic disposal program in Russia, plans and proposals exist to develop the two repository sites at Mayak and Krasnoyarsk-26. With appropriate funding support, the specific site selections, site characterizations, underground laboratories, and design at both the Mayak and Krasnoyarsk sites can be restarted rapidly.

LLNL Experience and Background in Russia and Taiwan

The proposed program to facilitate foreign spent fuel disposition in Russia entails a number of complex issues requiring broad experience in dealing with key participants from both Russia and Taiwan. LLNL is uniquely qualified to manage this program by virtue of our ongoing contacts and collaborations with participants from both places.

LLNL has substantial and unique experience and contacts in each of the major program elements that must be brought together to address the issues associated with foreign spent fuel disposition in Russia. LLNL has served as co-chair of geologic disposal for the joint US-Russian plutonium disposition programs since 1995, and has ongoing contracts with the required Russian Minatom organizations under the Material Disposition program. For example, LLNL has a contract with a Russian design organization and three lead scientific institutes for the spent fuel storage site and the two repository sites under DOE-MD funding.

LLNL's leadership role in the HEU Transparency and the MPC&A programs provide additional expertise in working with Russian Minatom organizations. LLNL also actively participates in working collaborations in Russia through the Initiatives for Proliferation prevention (IPP) Program and as a Partner with the International Science and Technology Center in Moscow.

With regard to Taiwan, we have maintained active interactions with the Institute of Nuclear Energy Research (INER), Taipower and the Taiwan Atomic Energy Commission in a broad range of technical areas, including those related to storage and disposition of spent fuel. LLNL Staff interact regularly with representatives from the American Institute in Taiwan (AIT) and the Taipei Economic And Cultural Representative Office (TECRO). We are well acquainted with the key decision-makers from Taiwan. We are well positioned to facilitate the interactions necessary for successful completion of this venture in both Russia and Taiwan.

Over the past two years LLNL has sponsored a series of workshops on East Asian regional cooperation in nuclear energy with representatives from Japan, Korea and China; the workshop scheduled for this September 1999 will be held in Las Vegas and will address the back end of the fuel cycle. This workshop includes Russian representatives, and a separate meeting is organized with representatives from Taiwan to present and discuss options for spent fuel disposition including the Russian repository concept and the proposal of the Non-Proliferation Trust.

Attachment 2

Ocean Shipping Considerations

The shipment of spent fuel by ocean transport is well understood and in commercial practice. Companies such as COGEMA and BNFL depend on ocean transport services as part of their overall nuclear fuel cycle business. Issues that must be considered include ocean transport, marine port facilities, licensing, monitoring and logistics (i.e., planning and coordination of shipments).

Ocean Transport Services

The shipment of spent fuel is practiced commercially, and commercial companies involved in fuel services maintain fleets of ships to accommodate international transfers of spent fuel. Pacific Nuclear Transport Limited (PNTL), for example, operates a fleet of six special-purpose ships to transport spent fuel from Japan to the UK and France.

The operating experience of spent fuel shipping has been excellent; international irradiated fuel has been shipped commercially for over 20 years, with several millions of miles of accumulated transit distance. The shipment of spent fuel from Taiwan to Russia should be readily accommodated by commercial shipping interests such as PNTL.

To begin the planning process for transfer of spent fuel from Taiwan to Russia, an ocean transport feasibility study should be conducted to verify the availability of suitable shipping capacity. This study should be carried out under Phase I of the proposed program.

Marine Port Facilities

The shipping of spent fuel by ocean vessel requires specialized marine port facilities. In Taiwan, local restrictions on land transport may require the establishment of port facilities at multiple ports. Facilities in Russia must be established to receive spent fuel from the ocean vessel and transfer it to appropriate rail facilities for rail transport to Krasnoyarsk.

The shipping system compatibilities and interfaces must be assessed early and carefully managed so as to minimize secondary cask transfer and unloading operations at either the Russian sea port before rail transport and in Russia or after receipt at Krasnoyarsk for extended storage prior to geologic disposal. This is a critical area to be assessed early, together with the selection of the proper Russian seaport and the specific rail route.

Initial studies need to focus on the identification of required facilities and interfaces to cost effectively handle spent fuel at marine terminals and to assure compatibility with land transportation and storage operations..

Licensing, Monitoring and Logistics

Shipment of spent fuel from Taiwan to Russia requires accommodation of regulatory requirements from both Taiwan and Russia. In addition, compliance with the requirements of the International Atomic Energy Agency (IAEA) must be achieved. As part of the initial studies under this program, an effective plan for regulatory compliance must be completed.

In addition, for reasons of regulatory compliance, safeguards, and good business practice, shipment monitoring must be addressed. Monitoring and the planning and coordination of shipments (i.e., transportation logistics) should be considered together in developing a monitoring and planning strategy for spent fuel shipments from Taiwan to Russia.

Attachment 3 Maps and Routes

In this attachment, maps are provided as references to the geographic issues associated with the proposal to dispose of spent fuel from Taiwan in Russia.

Map 1:

Map of Taiwan showing position in the East China Sea and locations of existing Reactor sites

Map 2:
General map of Russia showing southeastern seaports (e.g., Vanino and Vladivostok) and the location of Krasnoyarsk in central Russia

Map 3:
Map of Russia showing current Russian contacts for Pu disposition projects

Current Russian contacts for Pu disposition projects

Map 4:
Map of Asia showing rail route in Russia and geographic relation to Taiwan