July 11, 2000

MEMORANDUM TO: Elizabeth L. Doroshuk, Team Leader
Team A
Office of International Programs

FROM: John E. Ramsey, Senior Program Manager ***/RA/***
Team A
Office of International Programs

SUBJECT: TRIP REPORT - JUNE 2000 TRAVEL TO ARMENIA

From June 18 to 25, 2000, I was on official travel to Armenia. The principal goals and objectives of my trip were to meet with officials from the Armenian Nuclear Regulatory Authority (ANRA) to discuss ongoing or planned NRC assistance activities, perform site acceptance testing and inspection for NRC-supplied USAID-funded equipment and participate in a joint U.S./U.K. ceremony dedicating the new ANRA emergency response center. I also had several meetings with both U.S. Embassy and Armenian officials on other nuclear safety-related issues.

A summary writeup of the activities conducted and the discussions held is provided as Attachment 1. A more detailed description of ongoing or planned NRC/ANRA assistance activities (including results achieved) is provided as Attachment 2.

Of particular note was the success of the joint U.S./U.K. ceremony dedicating the new ANRA emergency response center. During the dedication ceremony, the U.K. Ambassador highlighted the close cooperation and coordination that occurred between the U.S. (NRC) and the U.K. (British firm WS Atkins, contractor to the U.K.'s Department of Trade and Industry) in establishing the ANRA emergency center. Significant cost savings were achieved and timeliness of implementation was greatly enhanced as a result of the close U.S./U.K. collaboration.

This trip also coincided with the 5th anniversary (May 1995 to May 2000) of NRC/ANRA assistance activities. ANRA has made significant progress in developing as an independent regulatory authority since its inception in 1993. Examples of significant advancements achieved by ANRA include enactment of Armenia's basic nuclear law, mastering of analytical analysis tools for performing safety assessments, establishment of an emergency response center and an emergency response and assessment capability, licensing of a dry cask storage facility in accordance with international standards and a significant increase in ANRA staffing (from 7 personnel in 1993 to 30 in 2000).

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Attachment 1

TRIP REPORT
TRAVEL TO ARMENIA
JUNE 2000

Emergency Response Center

Since July 1997 NRC has been providing basic office equipment (including computer equipment) to the Armenian Nuclear Regulatory Authority (ANRA). In the late summer of 1999, the U.K. government announced a new project to assist ANRA in developing an emergency response center. Shortly after announcement of the U.K. effort, representatives from NRC and WS Atkins (contractor to the U.K.'s Department of Trade and Industry) met and agreed to cooperate in developing this emergency response center. Of principal concern was ensuring that any equipment provided by the U.K. would be compatible with equipment already provided to ANRA by NRC. During this meeting, the NRC and WS Atkins representatives agreed that actual installation of equipment provided by the U.K. would be done by NRC (work actually performed by Mega-Tech, Inc. under contract to NRC) at NRC expense (using USAID-funds). Mega-Tech would also be responsible for ensuring compatibility between U.K.-provided and NRC-provided equipment.

This cooperative effort was a great success. The ANRA emergency response center was completed in early June 2000.

A joint U.S./U.K. ceremony dedicating the new ANRA emergency response center was held on June 22, 2000. The dedication ceremony was attended by representatives of NRC, WS Atkins, ANRA, the Armenian Emergency Management Agency, the Armenian Nuclear Power Plant, the Armenian Prime Minister's office, the U.K. Embassy (including the U.K. Ambassador) and the U.S. Embassy. There was also extensive media coverage of the event (4 Armenian television stations and 3 Armenian newspapers sent correspondents).

During the dedication ceremony, the U.K. Ambassador highlighted the close cooperation and coordination that occurred between the U.S. (NRC) and the U.K. (British firm WS Atkins, contractor to the U.K.'s Department of Trade and Industry) in establishing the ANRA emergency center. The U.K. Ambassador indicated that significant cost savings were achieved and timeliness of implementation was greatly enhanced as a result of the close U.S./U.K. collaboration.

Site Acceptance Testing and Inspection

Mega-Tech of Falls Church is under contract to NRC to provide basic office equipment (computers, fax machines, etc.) to ANRA. All equipment that Mega-Tech is required under the terms of the contract to provide to ANRA was verified to be installed and working at ANRA headquarters.

Other Nuclear Safety-Related Discussions

Since 1996, DOE has had a number of safety significant improvement projects underway with the ANPP. These include fire protection improvements, construction of a redundant service water system, installation of main steam isolation valves and installation of a safety parameter

display system. Installation and completion of these urgently needed safety improvements had been scheduled for the ANPP's planned fall 1999 outage.

DOE-sponsored nuclear safety assistance activities always require that the recipient country provide some support (funding, manpower, engineering, in-kind contribution, etc.) for ongoing or planned projects. In early 1999, it became apparent that the ANPP was experiencing difficulties in obtaining funding needed to support installation and completion of the DOE-sponsored projects. Discussions were held between senior U.S. and Armenian officials in both March and May 1999 to convey the importance of ensuring that the ANPP was provided with the financial resources needed to support the DOE-sponsored projects. The Armenian authorities indicated that they understood the significance of this concern and would work to remedy the problem.

In September 1999 the ANPP shut down for an approximate 2 month refueling and maintenance outage. All of the DOE-supplied equipment was onsite and available for installation. However, the ANPP was not able to perform the engineering work needed to support installation of the equipment, nor did they have funding needed to actually install the equipment. Thus, the equipment was not installed during the fall 1999 outage.

In March 2000 the President of Armenia established a special task force to address funding issues at the ANPP. Establishment of this task force was in direct response to U.S. and EU concerns, as well as in response to concerns voiced by the President's own independent Nuclear Safety Council. The task force has met at least monthly since its inception. However, finding funding needed to support safety upgrades at the ANPP continues to be problematic. Thus, it is unclear as to whether the DOE-sponsored safety upgrades will be implemented at the ANPP during the fall 2000 outage (currently scheduled to start in late August 2000 and conclude in November 2000). The U.S. Embassy will continue to follow this situation and report upon significant developments.

Meeting Summary
Between the
Armenian Nuclear Regulatory Authority
And the
United States Nuclear Regulatory Commission
June 23, 2000

Representatives of the Armenian Nuclear Regulatory Authority (ANRA) and the United States Nuclear Regulatory Commission (USNRC) met in Yerevan, Armenia from June 20 to 23, 2000.

The ANRA and USNRC representatives recalled that the primary focus of USNRC/ANRA nuclear safety assistance activities is to strengthen the scope and depth of ANRA's technical capabilities, including ANRA's ability to independently analyze safety issues at the Armenian Nuclear Power Plant (ANPP). These activities have involved training on USNRC methodology and practices for analyzing safety issues, training on analytical tools (such as computer codes) used for performing safety analyses and provision of needed equipment (computers, computer codes, etc.). Since this direction was established in early 1997, it has remained largely unchanged. The ANRA and USNRC representatives agreed to continue proceeding in this direction.

The ANRA and USNRC representatives reviewed the progress that has been made in their joint activities. It was noted that significant progress continues to be made in strengthening ANRA's technical capabilities. The ANRA and USNRC representatives jointly developed an overview of ongoing or planned USNRC/ANRA assistance activities, a copy of which is attached to this meeting summary. The ANRA and USNRC representatives agreed to continue to work together to accomplish the activities described in this overview.

The ANRA and USNRC representatives also reiterated the importance of coordination. Ongoing or planned USNRC/ANRA activities have been closely coordinated with and are complimentary to assistance provided to ANRA by others. For example, assistance to ANRA is being provided by the IAEA and through the European Union's TACIS program in such areas as development of nuclear legislation and regulations and development of an inspection program.

Lastly, the ANRA and USNRC representatives marked the 5th anniversary of USNRC/ANRA assistance activities (May 1995 to May 2000). Significant achievements made by ANRA over the past 5 years (such as enactment of Armenia's basic nuclear law, mastering of modern tools for analysis of different safety aspects, establishment of an emergency response center, licensing of a dry cask storage facility for spent fuel in accordance with international standards, increase in staffing from 16 to 30 people, etc.) were noted.

Ashot Martirosyan
Chairman
Armenian Nuclear Regulatory Authority

John E. Ramsey
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United States Nuclear Regulatory

Commission

USNRC/ANRA NUCLEAR SAFETY ASSISTANCE ACTIVITIES
OVERVIEW OF CURRENT AND FUTURE ACTIVITIES
JUNE 2000

USNRC/ANRA Cooperative Arrangement

Both USNRC and ANRA recognized that strengthening the scope and depth of ANRA's technical capabilities would necessitate providing ANRA with access to certain USNRC-developed computer codes. Accordingly, in September 1997 USNRC and ANRA entered into a cooperative arrangement that (amongst other things) contains provisions by which ANRA can be provided access to needed computer codes.

Development of Transient and Accident Analysis Capabilities

Armenia has largely been dependent on Russian institutes to perform transient and accident analyses of the ANPP. The Armenian authorities desire to develop such a capability within Armenia.

Efforts to strengthen ANRA's ability to independently perform transient and accident analyses of the ANPP using the RELAP code began in early 1998. This training program (which was to be conducted at Brookhaven National Lab) was envisioned to last approximately 3 years. 5 Armenian specialists were selected to participate in this training program. The fundamental goal of this effort was to 1) develop an accurate model of the ANPP and 2) ensure that the Armenian specialists could effectively use RELAP to perform a broad range of transient and accident analyses.

During 1998 and 1999, the Armenian specialists traveled to BNL 3 times (January 1998, November 1998 and April 1999), spending a total of 15 man-months at BNL. BNL specialists traveled to Armenia 2 times, spending a total of 1 man-month in Armenia. In addition, while in Armenia the Armenian specialists devoted a large percentage of their time to this project (obtaining plant specific data, refining the ANPP computer model, performing initial transient and accident analyses, etc.). BNL and Armenian specialists were also in frequent contact (e-mail, phone, etc.) during this time.

By late 1999, the Armenian specialists had developed a working model of the ANPP and were able to effectively use RELAP to perform transient and accident analyses. A Sun Workstation has been provided to ANRA and the RELAP code has been installed on that computer. Armenian specialists are currently using this training for assessment of safety analysis submitted by the ANPP for licensing of safety improvements (including replacement of pressurizer and steam generator safety valves and installation of main steam isolation valves).

During 2000, this project is being expanded to couple a reactor kinetics modeling capability (using the PARCS code) into the RELAP code. An initial workshop was conducted at BNL in January/February 2000. Developing this capability necessitates that extensive modifications be made to the PARCS code to account for differences between VVER fuel (hexagonal geometry) and U.S. light water reactor fuel. BNL and Armenian experts are working together to make these modifications. Once complete, addition of the reactor kinetics modeling capability will be installed on the ANRA Sun Workstation and will be used by ANRA for review of reactivity-induced transients/accidents and for some aspects of core calculations that should be reviewed by ANRA before annual refuelings.

It is expected that this effort will be complete by the end of 2000.

Assessment of ANPP Confinement Integrity

ANRA desires to develop the capability to independently assess the leaktightness/integrity of the ANPP confinement system. This is part of the effort to increase the maximum design basis LOCA at the ANPP from a 50mm break to a 200mm break. This effort is modeled after a similar effort taken at Bohunice; however, it is recognized that at Bohunice credit was taken for leak before break.

In September 1999 in Moscow, the IAEA sponsored a topical meeting on VVER confinement issues. This topical meeting provided an opportunity for countries that operate VVER-type reactors to share their experiences. ANRA and BNL representatives participated in this topical meeting.

USNRC has agreed to further assist ANRA in developing this confinement assessment capability. This effort (in which BNL will also participate) should start upon completion of the RELAP/PARCS-related activities.

Spent Fuel Storage

Storage of spent fuel is a significant issue at the ANPP because the ANPP spent fuel pool is essentially full. In response, the Armenian authorities undertook to develop a dry cask storage facility (based upon the NUHOMS system, but modified to accommodate VVER fuel) adjacent to the ANPP. ANRA is responsible for licensing this dry cask storage facility.

ANRA's review of the proposed NUHOMS system for the ANPP identified two significant safety issues, criticality and acceptable peak cladding temperature.

The design basis of the ANPP spent fuel pool assumes the pool is filled with non-borated water; however, in practice borated water is used. The spent fuel pool boration system at the ANPP is not a safety system, so boron dilution events are considered credible. Initial safety analyses performed for the dry cask storage system did not include assessment of the effects of a boron dilution event while the storage casks were in the spent fuel pool, an assessment that ANRA desired be performed. The results of this assessment indicated that sub-criticality within the storage casks could not be assured.

The peak cladding temperature acceptance criteria initially proposed by the spent fuel storage cask vendor were 380 degrees Centigrade for normal conditions and 570 degrees Centigrade during transient/accident conditions for fuel that had been stored in the spent fuel pool for at least 5 years. It was discovered that these criteria were developed for U.S. light water reactor fuel, an assessment of applicability of these criteria to VVER reactor fuel had not been performed. It was also discovered that the original storage cask design did not account for the high level of dust present in the area around the ANPP (i.e., the settling of the dust on the casks can significantly affect the heat transfer characteristics of the casks).

In June 1999, the IAEA sponsored a one-week mission to Armenia. The principal objective of this mission was to review the ANPP NUHOMS Spent Fuel Storage Facility safety analysis report and provide comments concerning the completeness and adequacy of the report. This IAEA mission was closely followed (July 1999) by an NRC-sponsored workshop. This USNRC-

sponsored two-week workshop at BNL provided the Armenian specialists with additional details regarding USNRC's regulatory requirements for dry cask storage facilities. This effort included providing ANRA specialists with training on analytical tools used to perform safety analyses of dry cask storage systems (such as the MCNP code for analyzing

criticality issues). Plant-specific issues associated with the proposed NUHOMS facility at the ANPP were also discussed. Since that time, BNL experts have received and responded to specific questions from their Armenian counterparts.

ANRA now expects that the two main safety concerns will be resolved shortly. A license to begin storing spent fuel in the dry cask storage facility will then be granted. Resolution of the criticality concern during a boron dilution event involves modifying the design of the spent fuel storage casks to include the use of boron-impregnated stainless steel (i.e., the original cask design utilizes stainless steel without boron). Resolution of the peak cladding temperature concerns involves adding temperature sensors (thermocouples) to monitor cask temperature as an indicator of significant dust buildup. In addition, a comparison of U.S. light water reactor fuel and VVER reactor fuel was performed. This comparison showed close similarity between the relevent properties of U.S. light water reactor fuel cladding and VVER reactor fuel cladding.

This effort is expected to be essentially complete by the end of 2000.

Seismic Issues

The original design of the ANPP included some modifications (as compared to similar VVER-440/230 reactors) to account for seismic hazards. Certain key structures and systems were modified to withstand a peak ground acceleration of 0.20g. The Armenian authorities have now established a new review level earthquake, necessitating that the ANPP be upgraded to withstand a peak ground acceleration of 0.35g. ANRA is responsible for safety and regulatory oversight of this upgrading process.

Several years ago, the IAEA established a project (TC Project ARM/9/002) to assist the Armenia authorities in establishing a process for assessing seismic vulnerabilities at the ANPP and for identifying key seismic upgrades that should be considered. As part of this project, the IAEA is providing ANRA experts with training on the use of the STARDYNE and SuperSASSI codes for seismic analysis.

USNRC and ANRA representatives participated in an IAEA-sponsored meeting in February 1999 to coordinate international efforts to address seismic issues in Armenia. At this meeting, USNRC committed to assist in strengthening ANRA's technical capabilities in this area. Since this time, seismic experts at BNL have been in close contact with their ANRA counterparts, providing assistance on the use of the STARDYNE code and other seismic-related issues.

For example, ANRA is currently experiencing difficulties developing an appropriate model of the ANPP reactor building. Current efforts are focused on using the STARDYNE code. ANRA has indicated that they want to use STARDYNE to model detailed structural interactions because their reactor building is actually two buildings and because the Russian design firm that is supporting the ANPP is also using STARDYNE.

USNRC has committed to identify a STARDYNE user that can assist and/or train ANRA on applying STARDYNE to very complex systems, and to continue to assist ANRA in resolving their modeling difficulties. For example, ANRA could try using STARDYNE only with simple driving forces (e.g., equivalent peak acceleration) instead of their current practice of using STARDYNE with very complex time histories of seismic loads. Another option could include

use of the SASSI computer code (which uses simplified “stick” models of structures to model complex structure/structure soil/structure interactions for seismic) to resolve complex loading histories and provide a simplified driving force for STARDYNE.

In July 2000, ANRA and BNL experts will participate in a seismic analysis workshop sponsored by the IAEA at Siemens in Germany. In addition, an approximate two-week seismic walk down of the ANPP will be conducted in early September 2000. Experts from the IAEA and the DOE will assist the ANPP in performing this walk down. NRC will provide support to ANRA for regulatory issues associated with this walk down.

It is expected that ANRA will need continued support in this area. USNRC agreed to provide support to ANRA, in coordination with the efforts of the IAEA and others.

Emergency Planning/Emergency Preparedness

The first nuclear power plant-related emergency exercise since the 1995 restart of the ANPP was conducted in Armenia on September 5, 6, and 7, 1999. The principal goals and objectives of this exercise were 1) to determine whether the Armenian authorities could appropriately gauge the severity of and classify a postulated accident, 2) notify other relevant authorities (including potentially affected neighboring countries) that an accident was occurring, 3) determine actions needed to protect the local population and 4) identify steps that would be taken to implement the protective actions identified (i.e., not actually implement the protective actions). Representatives from France, Russia, U.K., IAEA and the U.S. were invited to participate in the conduct of this exercise.

Overall, the exercise was very successful. The Armenian authorities successfully demonstrated their ability to gauge the severity of and classify the accident, to make initial notifications that an accident was occurring and to determine actions needed to protect the local population.

Recommendations were made to the Armenian authorities to develop a significantly more detailed plan describing the division of responsibilities and authorities between the various Armenian organizations to avoid confusion and duplication of effort. The Armenian authorities agreed with this recommendation. In addition, the Armenian authorities announced their intention to conduct a similar exercise sometime in 2001.

In August 1999 (prior to the conduct of the September 1999 exercise), NRC sponsored a two-week workshop on emergency planning/emergency preparedness at BNL. This workshop provided the participants with an introduction to USNRC's emergency planning and emergency preparedness requirements for nuclear power plants. USNRC and BNL representatives also participated in the September 1999 emergency exercise. In addition, starting in March 1999 the U.K. initiated a project to provide ANRA with equipment for an emergency response center. USNRC coordinated with the U.K. on provision of equipment for ANRA to ensure that USNRC-provided equipment would be compatible with U.K.-provided equipment.

As needed, NRC will continue to provide support to ANRA in this area.

Development of a Safety Analysis Report for the ANPP

ANRA wants ANPP to develop a Safety Analysis Report (SAR), consistent with international practice. ANRA would like to use the SAR development process to both identify the current ANPP design basis and to identify, assess and prioritize possible design basis upgrades (increase design basis LOCA, etc.).

In August 1999, the IAEA sponsored a one-week mission for two experts to travel to

Armenia. The principal objective of this mission was to share with ANRA experts the regulatory experience of the USNRC and UJD (Slovakia) in the areas of requirements for the contents and layout of the SAR and the regulatory review and assessment process for the SAR.

As follow-up to the IAEA mission, ANRA expressed an interest in learning additional details about UJD practice and experience in this area, using the SAR that was developed for Bohunice V-1 as a reference model. Examples of the kinds of issues that ANRA experts were interested in discussing with Slovak experts include:

- How to interpret/supplement Russian codes and standards;
- How to select appropriate acceptance criteria for safety analysis;
- How analysis and assessments made earlier should be considered in the new SAR;
- Safety classification of elements and systems;
- Selection of appropriate initiating events to be analyzed;
- Selection of appropriate beyond design accidents to be included in the SAR;
- Selection of the methods and codes for performing analyses;
- Inclusion of PSA results in the SAR; and
- Organization of the SAR development (roles and responsibilities of utility, regulator, technical support organizations, etc.).

USNRC sponsored an initial workshop in Slovakia in April 2000 to address these questions. Experts from UJD, VUJE, BNL, ANRA and the ANPP participated in the workshop.

Last year ANRA produced a draft document outlining the desired content and format of an SAR. After discussions with the ANPP, it was concluded that the amount of effort involved was so extensive as to make the project not practical. Based upon the information gained from discussions with the Slovak experts during the April 2000 workshop, ANRA has revised its guidelines concerning the technical content and the degree of detail needed for the ANPP SAR. The ANRA guidelines are now more focused; they reflect the operational status and expected lifetime of the ANPP. It is expected that the ANRA guidelines for development of the ANPP SAR will be issued as a regulatory requirement around August 2000.

As needed, NRC will continue to provide support to ANRA in this area.

Pressurized Thermal Shock

Unit 2 of the ANPP began operation in 1980. The unit was shut down in 1989 following the Spitak earthquake. Thus, the unit had operated for approximately 8 to 9 years before its 1989 closure.

Before the November 1995 restart of Unit 2, an analysis of susceptibility of the Unit 2 reactor to pressurized thermal shock (PTS) concerns was conducted. At that time, it was concluded that PTS would not be a significant concern for the first few cycles of operation after restart. However, it was recommended that within 2 to 3 years after restart a more detailed assessment be conducted to assess potential longer-term PTS concerns.

This detailed assessment is underway. ANRA is responsible for safety and regulatory oversight of this effort. ANRA expects that they may need support in this area as this

detailed assessment progresses. USNRC agreed to provide such support to ANRA.

Provision of Basic Office Equipment

ANRA was created in 1993. At this time, ANRA had 7 employees. Unfortunately, budget restrictions precluded the Armenian government from providing ANRA with basic office equipment. At present, ANRA has 30 employees. This increase in staffing has generated additional basic office equipment needs.

In July 1997, NRC began an effort (utilizing Mega-Tech, Inc.) to provide ANRA with needed office equipment. Since that time, ANRA has been provided with 17 personal computers, a Sun Workstation and 11 printers. All of this equipment has been configured into a local area network (LAN). ANRA has also been provided with a telephone system, a security system, an emergency generator, fax machines, copy machines, etc. Modifications have also been made to ANRA headquarters (upgrading electrical system, phone system, heating, ventilation and air conditioning system, etc.) as needed to support installation and use of this equipment. In addition, a microwave radio system (voice and data) was established between ANRA and the ANPP. In conducting this work, Mega-Tech specialists spent a total of 12 man-months working in Armenia installing this equipment.

USNRC agreed to continue to provide support to ANRA in this area.