GNEII -- INSTILLING GLOBAL STANDARDS FOR NUCLEAR SAFETY, SECURITY, AND SAFEGUARDS IN DEVELOPING COUNTRIES

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ABSTRACT

Under US government sponsorship, Sandia National Laboratories (SNL) and the Nuclear Security Science and Policy Institute (NSSPI) at Texas A&M University are working with mid-east regional authorities to establish a nuclear power-related educational institute in the region. The Gulf Nuclear Energy Infrastructure Institute (GNEII) will seek to instill global standards for safety, security, and safeguards in regional personnel destined to work on the policy and technical aspects of nuclear power in middle-eastern countries. SNL and NSSPI, partnered with the Khalifa University of Science, Technology, and Research and the Emirates Nuclear Energy Corporation in Abu Dhabi, the United Arab Emirates, plan to jointly establish the institute. GNEII will initially focus on students from the six Gulf Cooperation Council countries, with a plan to expand its activities to include more countries throughout the region. The goal is to establish GNEII as a fully indigenous, university-associated, graduate credit-granting regional education program providing both classroom instruction and hands-on experience. Establishing GNEII on a firm foundation of regional "buy-in" will enable the institute to become a source of technical collaboration and scientific excellence between the Western and Muslim worlds. GNEII also promotes US, SNL, and NSSPI interests in developing a nuclear energy security and safety culture, increasing collaboration between the nuclear energy security and safety communities, and implementing global standards for nuclear energy expansion in the Middle East. The ultimate objective is for GNEII to be autonomous, regionally funded and staffed with personnel capable of teaching all GNEII courses, five years after its inauguration. The paper will discuss the institute's origin, management approach, implementation schedule, and planned curriculum.

INTRODUCTION

Over the past few years, a growing number of Middle Eastern states have expressed interest in nuclear energy for both electricity production and desalinization. Given the strong correlation across the globe between plentiful electricity and improved living standards, the desire to significantly increase electricity production in the region is certainly understandable. Moreover, the world-wide environmental emphasis on reducing the use of fossil fuels provides a clear motivation for considering nuclear power as a key source for the needed energy. Accordingly, a number of the Middle Eastern states have initiated studies and/or signed peaceful nuclear energy cooperation agreements with various nuclear supplier countries.[1] These studies and agreements illustrate that many of the 22 members of the League of Arab States (LAS) are seriously investigating the potential of peaceful nuclear power to secure their energy futures.

While nuclear power does offer countries in the Middle East the potential benefits described above, two important issues must be addressed before a peaceful nuclear energy program can successfully take root in the region. The first issue concerns the relative lack of indigenous human infrastructure

for assessing, building, operating, and regulating nuclear power plants. The term "human infrastructure" refers to adequate numbers of individuals who are available to work in nuclear-energy-related government and industry positions, and who possess the appropriate levels of education, training, experience, and knowledge. The International Atomic Energy Agency (IAEA) recently published a comprehensive analysis, *Milestones in the Development of a National Infrastructure for Nuclear Power,*[2] which describes in detail the nature and extent of the human and industrial infrastructure elements a country needs to safely and securely implement a nuclear energy program. This report, along with other IAEA studies and analyses, clearly establishes that countries wishing to implement new or expand existing nuclear energy programs must invest in a significant and long term educational/training effort in order to generate and maintain a full complement of indigenous, qualified human resources.

The second issue that must be addressed to enable a successful nuclear energy program in the region involves concerns over nuclear safety and proliferation. On a world-wide basis, nuclear energy has an excellent overall safety record. Nevertheless, nuclear power plants do possess a low probability potential for catastrophic accidents which may include wide-ranging consequences that cross national borders. In addition, technology, materials, and know-how associated with peaceful nuclear energy programs can contribute to proliferation and nuclear terrorism concerns. As a result, the international community understandably expects that any country planning to operate nuclear power plants will implement and maintain stringent, state-of-the-art global standards regarding nuclear safety, safeguards, and security.

The Gulf Nuclear Energy Infrastructure Institute (GNEII, "gee-nee") aims to help fill the human infrastructure gap and also address the nuclear safety/proliferation issues discussed above. GNEII will constitute a regionally based capability for educating an important segment of the indigenous human infrastructure needed to manage the assessment, regulation, and policy aspects of a national nuclear energy program in the Middle East. Graduates of the GNEII program will have learned about and internalized modern international standards for nuclear safety, security, and safeguards. In addition, they will have begun developing professional and personal relationships with their counterparts throughout the international nuclear community. In this way the Institute will continuously feed freshly graduated executives and managers into nuclear power decision-making positions throughout government and industry in the region. These GNEII graduates will bring with them, and thereby propagate, the global nuclear safety and security culture necessary to help ensure safe and responsible nuclear energy programs that are in compliance with all nonproliferation obligations and norms. The remainder of this paper describes the GNEII concept and its development status, educational curriculum, and future plans.

CONCEPT

GNEII will be an educational institute serving a select, multinational student body. Initially GNEII students will come from the six Gulf Cooperation Council (GCC) countries.[3] Once the institute is fully operational, it will be open to students from nations throughout the Middle East region which are in good standing with regard to their nonproliferation obligations (e.g., Jordan, Egypt, et al). At steady state we currently estimate the institute will enroll between 15 and 25 students each academic year. The curriculum (further described in a later section of this paper) will focus on nuclear safety, security, and safeguards, with an emphasis on the understanding and application of

global standards in these three critical subject areas. The academic program comprises two 12-week semesters. The first semester will stress technology and policy fundamentals. The second semester will constitute a "capstone" module in which the students will apply the knowledge gained during their fundamentals semester to real-world issues.

GNEII is a strategic effort designed to inculcate a modern safety and security culture in future nuclear energy program decision-makers throughout the Middle East region. Accordingly, during the early stages of establishing the institute, the project's US sponsors and stakeholders agreed on three fundamental criteria that had to be satisfied before they would commit to formally establishing GNEII. First, the institute was required to be physically located in the Middle East region. This requirement meant that some country from the region would have to commit to providing an appropriate facility along with the funding to cover the administrative and operational costs of housing GNEII. Second, GNEII had to be "demand driven." In other words, the regional participants had to want it. They had to agree to provide a significant portion of the initial funding for GNEII and commit to taking on essentially full financial support of the institute after a nominal 5-year start-up phase. The third and final requirement concerns the content of the GNEII academic curriculum. Simply put, the curriculum must be designed to help the region build its human infrastructure for nuclear energy with a specific emphasis on nuclear safety, safeguards, and security.

PARTNERSHIP

GNEII is being set up by a broadly based partnership involving academic and governmental organizations in both the United Arab Emirates (UAE) and the United States. The UAE's lead participant in the GNEII partnership is the Nuclear Engineering Program at the Khalifa University of Science, Technology, and Research (KUSTAR) in Abu Dhabi. KUSTAR is directly supported in this partnership by two important UAE government organizations, ENEC and FANR. The Emirates Nuclear Energy Corporation (ENEC) is responsible for the deployment, ownership, and operation of nuclear power plants in Abu Dhabi, and it is currently involved in an aggressive effort to install a major nuclear power program in the UAE. The Federal Authority for Nuclear Regulation (FANR) is the recently established nuclear regulatory body for the UAE. Its functions and responsibilities essentially mirror those of the Nuclear Regulatory Commission in the US. Both ENEC and FANR have an evident interest in the quality of GNEII graduates.

Two participants make up the US side of the GNEII partnership: (1) the International Safeguards and Global Engagement Department at Sandia National Laboratories (SNL) and (2) the Nuclear Security Science and Policy Institute (NSSPI) at Texas A&M University. SNL originally conceived the GNEII concept and brings to the partnership significant technical and policy expertise in the areas of nuclear safety and security. NSSPI has considerable research and educational expertise in the technical and policy aspects of nuclear security, including reactors, safeguards, and nonproliferation. SNL and NSSPI jointly share the responsibility for developing the courses and providing the instructors for GNEII during its initial operational phase. Financial support for SNL and NSSPI during this initial period of GNEII's start up activities has been provided by two US Government offices concerned with combating proliferation, one in the Department of Energy[4] and one in the Department of State.[5]

On March 16, 2010, in Abu Dhabi, UAE, representatives from the five partnering organizations (KUSTAR, ENEC, FANR, SNL, and NSSPI) met to formally sign a Letter of Intent publicly announcing their agreement to establish GNEII in Abu Dhabi as "an educational institution that will provide classroom instruction and hands-on experience in nuclear energy safety, security, safeguards and non-proliferation for the UAE's civil nuclear energy program."[6] We are currently negotiating a Business Operating Plan amongst the GNEII partners which will specify the administrative, financial, and operational procedures that will govern the institute. GNEII is scheduled to be inaugurated as an official institute in Abu Dhabi in September, 2010.

In addition to the specific partnering entities working to formally establish the institute, a number of important "collaborative" organizations are also contributing, as they are able, to the formation, development, and long term operation of GNEII. Various regional and international entities offered to support the institute to help ensure GNEII always imparts an educational experience and a safety and security culture that is fully consistent with current global norms. These collaborating organizations may contribute academic and planning assistance, practitioner experience, hands-on training, and research expertise that will substantially enhance the educational value of the GNEII experience. To date, GNEII's collaborating organizations include:

- International Atomic Energy Agency
- World Institute for Nuclear Security
- Landau Network Centro Volta
- UAE Ministry of Foreign Affairs
- US Nuclear Regulatory Commission
- US Department of Energy-Office of Nuclear Energy
- Texas A&M University-Qatar
- Regional Representation – Egypt, Qatar
- League of Arab States/Arab Atomic Energy Agency

STUDENTS AND EDUCATION PROGRAM

GNEII will primarily recruit students, with policy and/or technical backgrounds, who are working as entry to mid-career level Middle Eastern government and government-affiliated corporate officials. Upon completion of the program, these individuals should be in a position to return to their home countries to apply their newly gained knowledge in the context of their domestic laws, regulations, and politics. GNEII course material will be taught at the graduate level of instruction. Accordingly, incoming students must have at least a bachelor's level of education or equivalent work experience. Incoming GNEII students must also hold a governmental/corporate commitment to be employed in their home state's nuclear energy infrastructure upon completing the program.

GNEII's curriculum will emphasize a systems approach to problem-solving and incorporate regional issues in order to address Middle Eastern perspectives about a responsible nuclear energy culture. The first semester *fundamentals module* will consist of three nominally month-long units that cover nuclear energy prerequisites and fundamentals, nuclear energy management and safety, and nuclear energy safeguards and security. Each month's topics of instruction will build upon previously gained information, with the focus being on emphasizing the interconnectivity between nuclear energy safety, safeguards, and security.

Unit 1, *Nuclear Energy Prerequisites and Fundamentals*, will be designed to develop a common understanding of basic principles that effect nuclear safety and security – to include courses on geopolitical and historical issues; the NPT; basic nuclear reactor physics; the nuclear fuel cycle; laws, norms and regulations; systems thinking; and technical tools and approaches to nuclear non-proliferation.

Unit 2, *Nuclear Energy Management and Safety*, will be designed to develop an intellectual and technical understanding of nuclear power plant operations and safety – to include courses on nuclear power plant management and operations; nuclear reactor safety systems; probabilistic risk assessment; human performance factors; radiological materials management, safety and health physics; nuclear reactor accident modeling; and emergency preparedness and response.

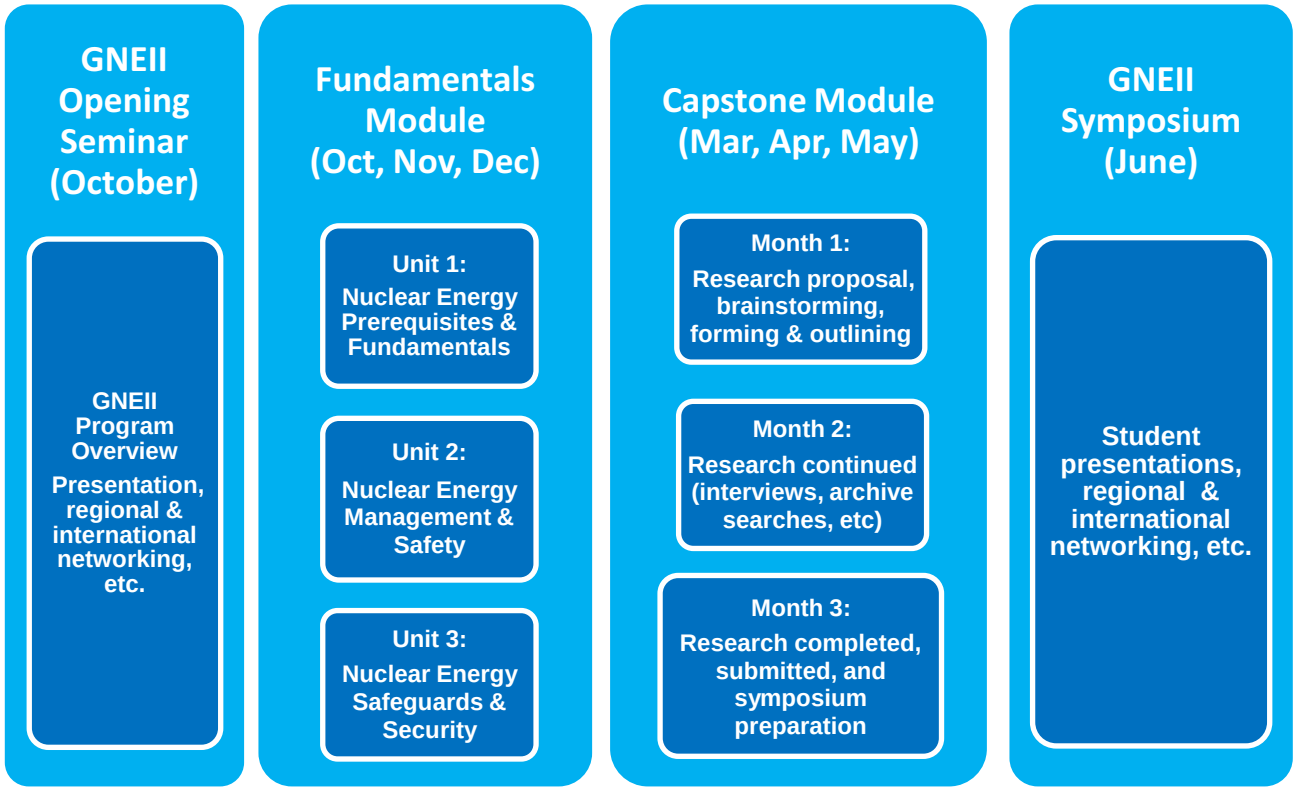
Unit 3, *Nuclear Energy Safeguards and Security*, will be designed to develop intellectual and technical capabilities in nuclear safeguards, material control and physical security – to include courses on nuclear facility vulnerability assessment; nuclear export control; safeguards; inspection and monitoring regimes; sub-state nuclear threats; physical protection system design and implementation; material control and accountability; and export control laws and norms.

The second semester *capstone module* will give GNEII students an opportunity to apply the knowledge they gained during the *fundamentals module* to real-world, regionally-focused research projects. GNEII students will work with their employers and institute faculty to identify potential research issues in the Middle East pertaining to nuclear energy development, management, safety, safeguards, or security. During the *capstone module,* students will work in groups or individually to conduct the analysis and address both policy and technical questions associated with each research topic. As an added benefit from this process, students from different regional states will gain familiarity with, and sensitivity to, multi-lateral collaboration on issues related to nuclear energy. Each student capstone project will result in a report or paper to be presented at an annual GNEII Symposium. As an example of a capstone project, GNEII students could address many of the technical and/or policy issues involved with developing a regional monitoring system for radiological materials. The students would not be expected to design the system, but rather to analyze difficulties and solutions associated with intra-regional technology transfer, non-uniform capabilities between regional states, and interstate policy coordination.

We plan to test run a first semester GNEII pilot course in February, March, and April, 2011, with a reduced-size initial class. Feedback from this experience will be applied to optimize course content and teaching approaches for the full-up program. The first semester of the full-up program will start in the fall of 2011, consistent with the KUSTAR academic calendar. The planned GNEII academic schedule is shown in the following figure. We envision a 2-3-day opening seminar to be attended by the incoming students along with their supervisors and other high-level executives from the regional government and corporate entities supplying the students. This opening seminar will provide the high-level attendees with an overview of the student education program to follow, introducing the specific topics that will be taught in more detail to their employees/students. In addition, the opening seminar will give students an opportunity to network with decision makers from throughout the regional nuclear energy industry. After an approximately two-month mid-course break, the *capstone module* will commence. We plan to implement a flexible arrangement so that, when possible, a significant portion of the research and analysis conducted during the

capstone semester can be accomplished at the student's place of employment. The conclusion of the full-up academic program will be a GNEII symposium at which the GNEII graduates present their research results to their peers, high-level government officials from the region, and representatives from GNEII's partner and collaborating organizations.

GNEII Academic Schedule



The GNEII educational program faces a number of challenges mostly associated with the characteristics and qualifications of the incoming students. For example, GNEII students can come from any of 22 countries in the Middle East region, suggesting a potential language-of-instruction problem. However, during the extensive GNEII development and planning activities we accomplished throughout the region over the past 18 months, we observed that nearly all indigenous persons working in nuclear related government and industry positions spoke fluent English. It is also the case that the official language of the key international nuclear organizations, such as the IAEA, is English. As a result, teaching all the GNEII courses in English provides a double benefit. It substantially reduces the language barrier for the multiple nationalities in the classroom, most of whom speak English as a second language, and it simultaneously improves the communication skills of these students in English, the international language of nuclear intercourse.

Another challenge arises from our desire that GNEII students be up-and-coming future leaders from the organizations in which they work. It is understandably difficult for any organization to decide to part with a productive, promising employee for 13 weeks. A natural tendency might be for some organizations to put forward a less capable employee for the GNEII student position. In response, we must be able to persuade the leadership of the target organizations to recognize the strategic value of sending their top performer(s) to GNEII for a semester or two. The education and broadening experience their best employees gain over a few months at GNEII should pay substantial organizational and mission dividends many years over.

The most significant pedagogic challenge for this program will likely be the widely varying educational backgrounds we expect to see in the incoming student body. All incoming students will have bachelor degrees, and we expect very few will have any nuclear engineering courses in their portfolio. From that perspective all the incoming students will be equally in need of the GNEII course content. However, we anticipate the bachelor degrees these students possess will be in many different fields, from history, business, and psychology to science, engineering, and mathematics. As a result, the challenge will be to teach the necessary physics and science fundamentals without boring the engineers and while not "losing" the liberal arts majors. NSSPI has recent experience dealing with a similar situation from teaching short courses in the US to graduate students with equally disparate educational backgrounds. In response we developed a variety of classroom and web-based approaches that have been reasonably successful at compensating for these disparities, and we plan to apply some of the same techniques to the GNEII program.

INDIGENIZATION PLANS AND FUTURE EXPANSION

At the beginning of GNEII operations, SNL and NSSPI will provide the academic content (e.g., course materials, classroom instructors, and capstone mentors) for the program. The non-academic remainder of GNEII's responsibilities (e.g., administrative support, physical plant, instructor housing) will be met by KUSTAR and its UAE support team. Within five years of GNEII's inaugural class, the academic responsibility for preparing and teaching the institute's courses will begin devolving to KUSTAR. This transition to indigenous academic leadership of GNEII will be accomplished through a combination of steps, such as the training of a subset of KUSTAR faculty members, leveraging the capabilities of the UAE's professional nuclear power community, and preparing select institute graduates for instructor duty. Moreover, as the institute matures, it can begin to employ as instructors knowledgeable expatriates associated with the UAE's nuclear energy program or other nuclear power-related expertise from within the region, all of which will serve to further GNEII's progress toward indigenization.

As demand increases for nuclear energy infrastructure education in the Middle East and GNEII matures into a self-sustaining entity, the institute will have the opportunity to expand its activities and capabilities. Potential expansion could include making additions to both the core and the elective curricula; sponsoring periodic regional workshops on nuclear safety, safeguards, and/or security-related topics; providing video-teleconferencing services; or developing applied research programs. In the research arena, GNEII could become a source of technical collaboration and shared scientific excellence between the Western and Muslim worlds. Any such evolution of GNEII will be determined by the needs of the region, will aim to leverage the capabilities of each

partner organization, and, by involving indigenous talent, will tend to further instil global nuclear safety, safeguards, and security standards throughout the Middle East.

CONCLUSION

GNEII is only a small piece of a much larger, multi-faceted, multi-national and loosely coordinated effort to develop the needed human infrastructure for nascent nuclear energy programs throughout the world. Nevertheless, the GNEII concept does offer significant local, regional, and global benefits. Locally, in addition to individual personal reward for the students, GNEII will further the host country's quest to become an intellectual and academic hub in the Gulf area. Regionally, the institute will provide the various national energy programs with an enhanced understanding of the safety, security, and safeguards aspects of nuclear energy, thus improving these nations' energy-related decision-making processes. Globally, GNEII will give the world community a model for an educational institute that addresses the policy/technology attributes of nuclear energy safety, security, and safeguards. This model is transportable to other fast-developing regions with nuclear energy aspirations, such as Southeast Asia and South America. Finally, GNEII also promotes SNL, NSSPI, KUSTAR, ENEC, and FANR interests in developing an internationally shared nuclear energy security and safety culture, increasing collaboration between the nuclear energy security and safety communities, and implementing current global standards for nuclear energy expansion.

REFERENCES AND END-NOTES

[1] E.g., UAE: early 2009 US/UAE 123 Agreement; Jordan: agreements for nuclear power plant (NPP) in 2012; Egypt: chose Australian firm to design NPP in 2009; Qatar: 2008 MOU with France on nuclear cooperation.

[2] For details, please see http://www-pub.iaea.org/MTCD/ publications/PDF/Pub1305_web.pdf

[3] GCC countries: Bahrain, Kuwait, Oman, Saudi Arabia, Qatar, and United Arab Emirates

[4] US Department of Energy -- National Nuclear Security Administration/Nonproliferation & International Security/Office of Global Security Engagement & Cooperation (DOE/NA242)

[5] US Department of State-Office of International Security & Nonproliferation/Cooperative Threat Reduction/Partnership for Nuclear Security (DOS/ISN/CTR/PNS)

[6] Press Release, AMEinfo.com, http://www.ameinfo.com/227049.html , 17 March 2010