Technical Support Organizations: Other *Bricks* of the Defense in Depth Layers

Tips on how to produce, procure and assemble them

Accounts from Cuba throughout time

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Abstract. Following an objective approach, the interests of operators, regulatory authorities, and of the public, with regard to major hazard industries and practices would coincide in that all of them wish no undesirable outcomes from their applications. This paper conveys the will to share experiences gone through in Cuba that might be helpful to others, especially developing countries, in accommodating the interfaces of the above mentioned stakeholders, mainly in the area of attaining and managing technical support for reliability and availability; covering the lessons from two main stages; an initial one, having a nuclear power plant project under way, in addition to other projects involving the use of ionizing radiations in industry, research, medicine and radioisotope applications, as well as in education; and a second stage, up to present day, when there is no nuclear power plant project in construction, or operation, but the rest of the practices from stage one generally remain. In developing countries, where the availability of resources may be not enough or scarce, to have the capacity of identifying where the needs for technical support are the priorities, for implementation of a graded approach, is of paramount importance, so the efforts dedicated could, nevertheless, yield the greatest results in reliability and availability. Here are accounts mainly aimed at the attainment of safety objectives; which should be seen, and in fact is, in line, with the interests of regulators, licensees and of the public. The paper is prepared, mainly, pursuant to Topical Issues 2 and 4 of the Conference. ***Key, and related, terms:*** *Technical support, major hazard, safety, security, reliability, availability, nuclear power, ionizing radiations, irradiators, radioisotopes, assessments, research, training, interface, regulators, licensees, applicants, industry, graded approach, holistic approach, capacity building, event scenarios , accidents, risks, defense in depth.*

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1. Introduction

The intent for, planning, constructing and/or implementing; diverse nuclear technology applications, for peaceful uses, in Cuba may be divided into two, or even, three phases.

Although an ordered compilation of accounts was made consulting references, as well as recalling witnessed experiences; several judgments are the integrated appraisals of the author of this paper; are not explicitly from the references.

1.1 Phase I (1947 - 1958): *Non-Consistent Governmental Approaches. Mainly Limited Individual and Private Societies Endeavors.*

Phases in history should be viewed in the light of the surrounding circumstances, favorable or not; therefore, it must be said that the topics on nuclear applications were, somewhat, being launched in Cuba already by 1947, e.g. see Reference [1] from page 332 on. By that time, a ***National Commission for the Applications of Atomic Energy to Civil Uses*** (Comisión Nacional de Aplicaciones de la Energía Atómica a Usos Civiles) was established by presidential decree. Among the ***goals*** of that Commission were: ***to foster research on atomic energy and its applications to non-military uses***, mainly medical, and to other sectors of the

economy; to ***survey for the existence in Cuba of ¨natural sources of atomic energy¨***; to ***supply radioactive materials, substances or medications to public and private hospitals***; to ***grant scholarships and study travels to specialists for their upgrading***; to ***determine and prescribe the radiation protection requirements***; and to ***control and verify the effectiveness and efficiency of the means for detection of radiations and of any radioactive compound*** used in the country.

There where ***some eight X Ray therapy equipment in Cuba***, in addition to ***one device which employed Radon occurred from the disintegration of Radium***. ***This latter was decommissioned by the end of the decade due to the inherent overexposure hazards*** during its operation in connection with a low reliability in the control of the dose delivered. Between ***1947 and 1948 the first 'radium needles' were introduced*** in the country for the treatment of skin cancers. The ignorance, then, on the management of this technique and on the necessary protective measures during its application; caused that ***three of the operators lost several fingers due to overexposure***.

Radioisotopes for the treatment of cancer were used for the first time in 1950; those were acquired, by the time, through a foreign pharmaceutical supplier, and manipulated at a rudimentary laboratory installed at a hospital in Havana.

The first Cobalt irradiator for radiotherapy was introduced in the country by 1958, acquired by personal initiative of two Cuban physicians, for private as well as for public use.

By the end of the 1950s, the governmental institutions had still no achievements towards systematic radiation protection/safety/security. In theory, personnel occupationally exposed were allowed more vacations per year, by a law passed in 1948; but without sufficient knowledge on the effects of ionizing radiations on the human organism. ***The use of radiation sources was not under control, neither the personnel occupationally exposed. The only measures implemented in practice, in many cases without comprehension of cause, were those recommended by the manufacturer***.

The support for scholarships, and travels of study, stated in the decree was not effectively realized, since there were few physicians interested in the application of ionizing radiations in therapy that could be afforded attendance to relevant international events, or that could achieve some upgrading at institutions overseas; and when did was as a result of personal efforts or due to the support of private societies, such as the League Against Cancer.

Applications of radioisotopes in economy were not experiencing development either. Limited research was conducted mainly at the Instituto Nacional de Hidrología y Climatología, whose ***scarce results would not reach beyond publication in scientific reports due to a lack of resources and support.***

It was in medicine, in which the country had a certain development, where modest achievements were attained with the use of radioisotopes for the treatment of cancer. These, however, were ***the result of individual actions by a limited number of physicians***.

In ***June 1955***, the then president decreed the ***dissolution of the then National Commission for the Applications of Atomic Energy to Civil Uses***, and the ***institution of another so called Comisión de Energía Nuclear de Cuba (CENC)***.

This CENC was ascribed the Consejo Nacional de Economía (National Council of Economy), ***had a short life and lacked a real budget***. CENC, in addition to the ***goals*** of its predecessor, stated those with regard to the conduction of ***feasibility studies for the installation of power reactors*** in the country, and for the ***regulation and control of all related activities***. However, as opposed to that, ***the country lacked an economic and scientific and technical***

infrastructure capable of supporting and accommodating the development of a nuclear power program: **There was not a unified national electric supply system – grid-, provided with high capacity lines; neither local developed industrial support, nor availability of related local scientific institutions and manpower.**

2. Phase II (1959 - 1992): *Re-Birth – Growth – Stagnation – Shutdown - Hardships*.

2.1 Infrastructure: From 1959 on, a new governmental concept, with a new governmental approach gained power, and has prevailed. New politics and policies started being implemented, and also developed, in most significant aspects of society and economy, including reorientation in the foreign relations. ***In order to obtain social achievements and related science and industry development in whichever branch or field; it was obvious that one of the starting points in those directions had to be to foster the education of the population***, which had a significant portion of illiterates; through the implementation of an **effective educational system**. This **included also the higher education**; throughout time, **a network was created and developed, involving more than 31 superior institutes, universities, and their regional subsidiaries**. It must be said also that the notable accomplishments, as there were in other fields, that were remarkable from 1971 to 1985, following five-year period plans, had a support by the national policies, plans and actions, and were, also, under the umbrella of general significant ***feasibility conditions fostered in the environment of the international agreement so called Consejo de Ayuda Mutua Económica (Council for Economic Mutual Assistance –CEMA-, no longer existing)***, which was integrated by a set of, then, socialist countries; ***the International Atomic Energy Agency (IAEA)***; and the ***United Nations Development Fund (UNDF)***.

In this Phase II, new conventional power plants were built and put in operation; upgrading of the then existent took place; thousands of kilometers of electric lines, as well as hundreds of electric substations were installed; **the unification of the electric systems in only one grid was realized**, interconnected at 110 kV and 220 kV, conforming the **Sistema Electroenergético Nacional** (National Electro-Power System).

The creation of ***Academia de Ciencias de Cuba (Academy of Science of Cuba) in 1961 encouraged*** the ***establishment of multiple research institutes to approach scientific disciplines*** of diverse nature, mainly those aimed at the social-economic development, and the **formation of scientific manpower**; both for the solution of problems already existing and for more prospective topics as well. Examples of those institutes are: the Cuban Institute of Derivatives of the Sugar Cane; the Cuban Institute of Mineral Resources; the Cuban Institute for Mineral -Metallurgic Research; and the Center for Chemical Research, among others.

In the mid 1960s, the first institutions for medical research were created, which would later provide the scientific support to an intense transfer and assimilation of knowledge and specialized technologies with regard to ambitious health care plans. In 1966, for example, the following research institutes were established: Endocrinology and Metabolic Diseases; Cardiology and Cardiovascular Surgery; Neurology and Neuro-Surgery; ***Oncology and Radiotherapy***; Gastroenterology; Angiology; Hematology; and Nephrology.

2.2 Nuclear Energy: Nuclear techniques were being introduced in the country, in several sectors of the economy, in **medicine**, in **research** and in **scientific and technical services**, as a part of a **wide nuclear program**, which contemplated also; the construction of ***nuclear***

power plants; research centers; and ***centers for specialized productions***, and, last in this paragraph, but not least; the ***establishment of a national regulatory system on nuclear and radiation safety and security***.

Significant achievements were attained by the last decade of this phase, but ***because comprehensive supporting and development programs were being implemented previously***, and starting, almost from zero, around 30 years before, in line with early defined governmental views and policies.

Since the early **1960s**, together with the efforts for the creation of the scientific and technical infrastructure, the ***first steps towards the assimilation of nuclear science and technology*** were taken, especially with the establishment of the **Institute of Oncology and Radiobiology**; and of the **National Center for Scientific Research**.

By those years, the ***Institute of Nuclear Physics of the Academy of Science***, was also created, ***in cooperation with the former Soviet Union***, and its activity was mainly oriented to the ***formation of the first specialists***, this Center was provided with a natural uranium-light-water sub-critical assembly; and its auxiliary facilities; equipment for tasks with radioisotopes, and the corresponding instrumentation.

During the ***1970s***, the use of radioisotope techniques, and radiation sources was extended to new branches of medicine and economy. ***A department of Nuclear Physics, and one of Nuclear Power***; were created at the ***School of Physics*** and the ***School of Electric Engineering*** of the ***University of Havana***, respectively. ***Cuba started receiving international cooperation in the nuclear field by means of the International Atomic Energy Agency (IAEA)***, ***CEMA***, and ***UNDF***. In April, **1976**, in the context of an **intergovernmental agreement** subscribed with the Soviet Union, the **construction of a first Nuclear Power Plant was included**.

Nonetheless, those were still years when limitations of varied order, the absence of a clear perspective of goals and priorities, and the existent dispersion of human and material resources would not allow integration of a national nuclear program.

Later on, it was the clear understanding of the need for creation of a solid infrastructure for the assimilation of nuclear energy, and for the introduction of nuclear science and techniques in the nation's economy, encompassing investments, personnel formation, research, cooperation, and other topics, what led to significant politics, policy, and organizational; decision making. By the beginning of **1980**, the nuclear field was restructured, starting with the ***constitution of the Comisión de Energía Atómica de Cuba – CEAC- (Commission of Atomic Energy of Cuba)***.

This **Commission** would ***coordinate and control the national efforts*** **of the main nuclear field stakeholders**, and would ***advice the government on the policy to adopt in these matters***. This inter-ministerial Commission was to be headed by a **Vice-president of he Council of Ministers**, and integrated by the **ministers of; Basic Industry; Higher Education; the President of the Academy of Science of Cuba**; and by the **Executive Secretary of the Commission**, at the same time, head of **Secretaría Ejecutiva para Asuntos Nucleares** (**SEAN**) (Executive Secretariat for Nuclear Affairs), ***agency in charge with the professional and systematic application of the defined policy***.

Whilst the topics of **nuclear and radiation Research and Development, as well as of Protection and Safety were conducted by institutions of SEAN**; the duties for **construction and operation of nuclear power plants (NPPs) would relay on the Ministry of Basic Industry**, through its division for NPPs, with the involvement of its **Design Office**

(EIPIB), its **Investment Unit**, and its **Main Contractor** and **subcontractors** (ECOI-6; ECOI-2; etc). Construction of the first reactor started in 1983, and of a second in 1985, at the same site. Operation was supposed to start by the beginnings of the 1990s. The reactors were Soviet designed (PWRs) WWER-440 type, V-318, 417 MW. The surroundings of the NPP under construction, the Juraguá region, became sites for training centers on related technical crafts.

In 1987, the **Instituto Superior de Ciencia y Tecnología Nucleares –ISCTN-** (Higher Institute of Nuclear Science and Technology) was established, wherein students in increasing numbers went and graduated; from Nuclear Physics, Radiochemistry, and Nuclear Engineering. Post-graduate studies were also available there.

Among other centers, lots of medium-level technicians and qualified workers were formed at Centro Politécnico Electronuclear de Juraguá, since its establishment in 1981, feeding in the main Contractor and Subcontractors in the construction of the NPP with skillful manpower.

On the other hand, the **Institutos Preuniversitarios Especializados en Ciencias Exactas – IPECE-** (Senior High Schools Specialized in Exact Science), which operate in different provinces of the country, became a significant source of very suitable students for every profession in the economy, and in special, for the nuclear field, which was the initial fosterer of this kind of institutes.

In 1987, the **Centro de Estudios Aplicados al Desarrollo Nuclear –CEADEN-** (Center of Applied Studies for Nuclear Development) is established. Dedicated to; applied research; assimilation and development of new technologies, supply scientific-technical services to multiple national institutions. Its main activities were, or are, in connection with; the Physics of condensed media, Analytical Chemistry; Radiochemistry; Radiobiology; Nuclear Electronics; metallographic and corrosion studies; non-destructive examinations; sterilization of materials; production of new crop varieties; development of methods for treatment and immobilization of low level radioactive wastes; the design of technological schemes for production of different materials by chemical and chemical-physical processes; among others.

In connection with the whole nuclear programme, with all the projects and activities mentioned, from the construction of NPPs, to the different sectors using ionizing radiations; the factor of nuclear and radiation safety and security, was given top priority. The approval of the **Decree-Laws 56/82**, **98/87** (for the ***Regulation of the Peaceful Uses of Nuclear Energy***; and ***On the State Supervision of the Safety at Nuclear Facilities***; respectively), and other rules; meant a significant step towards the creation of an integrated system of regulations and measures, as a framework for the establishment of an effective regulatory regime. Aimed at providing essential support to the whole program, including to the regulatory system; the **Centro para la Protección e Higiene de las Radiaciones –CPHR-** (Center for Protection and Hygiene from Radiations) was created; the leading and coordinating technical institution on radiological surveillance in the country, linked to a network of nation-wide environmental monitoring, and providing individual dosimetric control, to all workers occupationally exposed.

Another step towards strengthening the regulatory regime was the subscription of an intergovernmental agreement Cuba – Soviet Union, by the beginning of 1989, regulating the Technical Support to the Cuban Regulatory Authorities.

The **Centro Nacional de Seguridad Nuclear – CNSN -** (National Center for Nuclear Safety; leading nuclear and radiation safety regulatory authority) was established on November 30, 1990, by Resolution of the SEAN, and officially inaugurated on March 17, 1991.

An element worth to underline, is the assistance and technical cooperation received from the IAEA, practically in every sector of the Cuban Nuclear Program, through the execution of multiple projects and participation in training courses. The assistance provided by the UNDF has also been significant.

Although from around 1990 major nuclear power program projects were in, supposedly temporary, shutdown stage in their construction processes or even at earlier stages in their creation (for instance a sub-critical assembly, or a research reactor project), the, then *probable*, definitive shutdown of the construction of the Juraguá NPP project was declared in 1992. Deficiencies worth to mention during the process include: **I. Delays in the execution of multiple phases**, due, in turn, to chain-delays in multiple supplies of goods and services; **production effectiveness and efficiency issues** needed significant improvement in multiple corporate and non-corporate areas. **II. Vulnerability of feasibility**; the acquisition of goods and services were not based on, not afforded by, plane traditional monetary mercantile exchange, but on exchange conditions circumstantially mutually accepted with the Soviet Union and in the environment of the CEMA (which were the only viable choices), when these entities ceased to exist as such, the construction of the NPPs and other projects foreseen, or somewhat started, were no longer feasible.

In general, since around 1990, and as a result of multi-cause phenomena, external and internal causes (of varied nature); the social economic conditions in Cuba have been of hardships, including dire straits recurrent periods; insufficient power generation capacity – reliability and availability -; a sui generis economy of survival.

3. Phase III (1992- 2014): *Striving out of Hardships – Attaining Safety with Fewer Resources – Re-Fostering Prospects. Further* development and strengthening of the Regulatory Authority.

By **Decree-Law 147, of April 1994, On the Reorganization of the Organisms of the State Central Administration**; the **Ministry of Science, Technology and Environment (CITMA)**, was created. The CEAC and the SEAN, CEADEN, CPHR, CNSN, and others; were thereby ascribed to it. In **February, 2000, the Decree-Law 207 On the Use of Nuclear Energy**, was approved; among other topics, it covers; nuclear scientific research and technology development; any safety related service supply. States also; that safety shall have overriding priority; that for the use of nuclear energy, authorizations are required; that the use of nuclear energy shall comply with the basic principles of radiation protection; must be accompanied by necessary information to the public on its benefits, risks, safety measures, by the inclusion of its theoretical and practical bases into the programs of the National Education System; the Ministry of Public Health (MINSAP) is in charge with regulating, in coordination with CITMA (CNSN); on the safety of medical and stomatology diagnostic X Rays; and of performing the medical surveillance of the exposed personnel; CITMA (CNSN) shall supervise the regulation and control performed by MINSAP. Authorizations are granted, modified, renewed, suspended, or revoked; based on judgments issued by CNSN on the fulfillment by the authorization holder, or applicant, of the safety regulations. The holders or applicants of authorizations are obliged to ensure safety and security; including fire protection. They are also responsible for the preparation and readiness of contingency plans; for radioactive waste and spent fuel management, for decommissioning (this duty may be

contracted from a specialized entity). DL-207 superseded multiple previous legislation, including Decree-Laws 56/82, and 98/87**.**

The, national, ***Basic Safety Standards*** were approved by Joined Resolution CITMA-MINSAP on November 30, 2001. Its article 86 requires that any institution planning; to establish its own services on individual radiation monitoring; or to provide services to others; shall require authorization from the relevant Regulatory Authority; under the terms and conditions determined by it.

The ***Rules for Endorsement of the Competence of Services*** were approved by ***CITMA's Resolution No. 6, on January 2005***. At present, there is also awareness and consideration of IAEA's GSG-4 *Use of External Experts by the Regulatory Body*, issued on 2013. This topic was also dealt with in the rules for ***Authorization of Practices Associated to the Use of Ionizing Radiations*** (CITMA's Resolution 25/98).

At present, CNSN is involved, together with CPHR, in a research project; lead by CPHR, aimed at improving the National Dosimetric Bank, a tool that would facilitate effective maintenance and control of the dosimetric records of the country's workers occupationally exposed.

Management of radioactive wastes, and of disused sealed radioactive sources; is conducted in Cuba pursuant to ***CITMA's Resolution No. 35/2003; Rules for the Safe Management of Radioactive Wastes.*** This is preformed, by CPHR, in a centralized manner, and having authorization granted by CNSN for the management and transport of radioactive wastes and disused sealed sources.

During these years, CNSN has conducted a set of actions aimed at fostering development of a **Safety Culture**, in accordance with the evolution of the safety approaches and concepts in the last decades, which recognize the high contribution of human and organizational factors for the prevention of accidents. Examples of these initiatives are; **Annual Regulatory Conferences**, since the year 2000; creation of a **System for Analysis, Dissemination of, and Learning from; Events (ADASIR)**; around the year 2009; a proposal for Safety Culture Indicators at the Regulatory Authority; and, in the same year; a definition of safety culture aspects to be included in inspections check lists.

3.1 Emergency Preparedness and Response: In case of a radiological emergency, CNSN is the organization to support Estado Mayor Nacional de la Defensa Civil –EMNDC- (National Chief of Staff of the Civil Defense), with regard to the assessment of radiological topics and the proposal of protective and mitigative measures to take or activate.

3.2 Research and Development: CNSN fosters safety assessments and research, and in that sense; has participated in multiple research and development projects, in the context of different programs since its establishment, in topics such as; **Compilation of Safety improvements incorporated into the reactor WWER-440/V-318; as opposed to reactor WWER-440/V-213** (around 1994)**; Application of PSA techniques to sources of ionizing radiations**; **PSA to the treatment process by Cobalt-therapy** (2001- 2003); **PSA to the treatment process by Radiotherapy with a Linear Electron Accelerator for medical uses (LINAC)**, 2005 – 2008; **Safety assessment of Telecobalto-therapy treatment using the method of Risk Matrices**, around 2011; and many others.

3.3 Information to the public: For years, CNSN has taken actions towards fostering and developing ways and mechanisms for social communication, which would help dissemination, education, learning; cultivation of the public, on the advantages of the use of ionizing radiations, as well as on the associated risks, considering it as an integral part of the

safety of the practices **'… safety in the use of nuclear energy is assured with an effective regulatory authority; together with a responsible user, and an educated public...'** Recently, the nuclear accident occurred at Fukushima, Japan, demanded involvement of CNSN in Radio and TV broadcasts, for the purpose of clarifying the Cuban public on the subject. Today, it still is a challenge to accomplish more awareness and culture of the public on the benefits and risks of ionizing radiations.

3.4 Institutional relations: These relations are aimed mainly at cooperation with national regulatory authorities that, for their field of competence, interface with the use sources of ionizing radiations in the country. Among these organs is the **Ministry of the Interior – MININT-** with regard to **security and fire safety**; the Chief of Staff of the Civil Defense; with regard to Emergency Preparedness and Response; the Ministry of Heath; with regard to the regulation and control of the use of X Rays for medical and stomatology diagnosis.

CNSN also maintains relations with the **National Customs**, and with the **Ministry of Foreign Trade and Foreign Investments**, for strengthening the control mechanisms at borders during imports and exports of radioactive sources and nuclear materials, as well as with national groups, scientific societies, professional organizations - mainly in the medical field-; and with the Nuclear Energy and Advanced Technologies Agency (AENTA), with regard to promotion and application of the nuclear techniques (not by the regulatory authority). Since 2009, CNSN has participated, together with MININT, in multiple activities within the Integrated Nuclear Security Support Plan. Cuba has received related IAEA expert missions.

CNSN annually submits a report to the head of CITMA, on the tasks realized, with the purpose of showing the status of nuclear and radiation safety in the county, in connection with CNSN performance of its own duties. Likewise, prepares information for the government; on the status of Radiation Safety at Users' facilities. More than once, the Director General of **ORASEN (Office for Environmental and Nuclear Safety Regulations)**, to which CNSN ascribes; has rendered reports at the Permanent Commission on Energy and Environment of the Parliament.

3.5 International relations: CNSN maintains a wide activity expressed in the assistance to CITMA with regard to Conventions, International Agreements and Treaties, as well as actions derived from commitments contracted by the Cuban State in the nuclear field. Through the years, CNSN has maintained an ample and important relation with the IAEA, and, later on; with the Latin-American Region eventually including subscription of Cooperation Agreements, like one with the Regulatory Authority of Mexico in 1996; and another with the Regulatory Authority of Spain in 1999; which allowed training of a significant number of CNSN specialists along several years.

The establishment of the Foro Iberoamericano de Organismos Reguladores Radiológicos y Nucleares – FORO- (Iberoamerican Forum of Radiological and Nuclear Regulatory Authorities) in 1997, as a result of a decision made by the regulators from Argentina, Brazil, Cuba, Spain, and Mexico, for cooperation in topics of common interest; has generated a significant and sustained participation of CNSN within the ambit of this association, in topics such as; ***the safety of facilities and risk assessment methodologies***; ***radiological control of scrap material***; ***integrated management of information***; ***the Network of the FORO***; ***ageing and useful life extension of NPPs***; and; ***medical exposures.*** Other countries continue to join the FORO; a practical Agreement was subscribed with the IAEA, which develops a technical program in multiple areas of regulatory interest in the region. The outcomes of the projects are disseminated in the region, and their publication by the IAEA is foreseen.

3.6 Education and Training: For more than 10 years now, CNSN gets involved, together with CPHR, in the delivery of the course ***Bases of Radiation Protection***, which is mainly oriented to users of radiation sources; radiation safety officers in particular. CNSN has contributed, throughout the years, to the formation of national and foreign specialists, by means of the participation of its experts in different courses, workshops and seminars.

3.7 Scientific and technical development and support: CNSN, since its creation, fostered development of national capacities for the conduction of independent safety assessments to the national NPP projects underway, as well as for the research reactors foreseen in the Cuban Nuclear Energy Program. To that purpose created groups for Probabilistic Safety Analyses, and for Thermo-hydraulic modelling; of NPPs, trained staff, and acquired software, and related support documentary information. All these levelled with the state of the art at the time (the 1990s). In spite of the decision for definitive shutdown of the construction of the foreseen nuclear facilities in the country, these staffs were maintained at CNSN, with the purpose of extending and applying the experience and skills gained to other branches of national major hazard industries; as well as supporting the regulatory control in safety assessments of the radioactive facilities and practices. Since 1999, in addition to multiple safety assessments conducted in support to the Regulatory duties of CNSN; multiple safety studies have been realized to major hazard industries; knowledge on safety assessments has been disseminated; and support is also provided to other Regulatory Authorities ascribed also to ORASEN. During this period, CNSN experts have participated in dozens of safety studies nation wide and overseas, including preparation of Contingency Plans, and delivery of training courses in safety related topics, having a significant impact upon the industrial sector.

4. Conclusions.

Although the introduction of nuclear energy techniques would require previous creation of sufficient legislative, educational, organizational, industrial and other infrastructural bases; along with manpower availability; in view of its multidisciplinary features it may also be a driving force compelling development, in a faster and more integrated fashion; of the relevant society infrastructures. Special attention should be paid to the assurance of project feasibility and sustainability issues.

5. Recommendations.

Special consideration should be given to early support in the formation of local regulatory personnel and to its relevant units; and/or to non-regulatory governmental agencies; that would be dedicated to technical support in safety assessment and/or to preparation of Safety Cases. These Safety Analyses / Safety Cases / Risk Assessments Reports, including application of relevant qualitative and quantitative techniques, and their graphic representations of defense in depth of a facility or practice would show projects' multiple required, and available (or not), layers of defense (*barrier elements*); passive, active, organizational, whether preventive or mitigative; for several, event scenarios to be taken into consideration. The related technical topics, disciplines, and the scopes or extent of the technical support needed; would then be dependent on the strengths and weaknesses of an organization, or country, for ensuring, and for evaluating; availability and reliability of the varied and required (multidisciplinary) layers of defense, and of their related in depth assurance measures. The approach should be holistic, and the priorities should be risk based.

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