

**Evaluating Ghana's Regulatory Readiness for Safe Nuclear Power Generation
Using International Law and Comparative Study Approaches**

THIS THESIS
IS SUBMITTED TO THE
UNIVERSITY OF GHANA, LEGON
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF A **PhD LAW DEGREE**.

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(10014704)



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PhD Thesis
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DECLARATION

I, Samuel Obeng Manteaw, do hereby declare that, except references made to the works of other writers which have been duly quoted and cited herein, this work is the product of my own research undertaken with the support of my supervisors and that this work has neither in whole or in part been presented for another degree elsewhere.

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I certify that I have read this thesis and that, in my opinion, it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Law.



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Approved for submission to the Univ. of Ghana School of Research & Graduate Studies

ABSTRACT

The National Nuclear Research Institute of the Ghana Atomic Energy Commission (GAEC) has over 16 years experience and *good safety record* in operating a 30kW Chinese-built tank-in-pool Miniature Neutron Source Reactor *for research* since 1995. Ghana however does not have a nuclear power plant. In 2007, Ghana officially expressed to the IAEA an interest in deploying a nuclear power plant to form part of the electricity grid to assist her achieve economic growth targets. Nuclear power requires effective regulatory regime that conforms to international nuclear laws on siting, design, construction, commissioning, operation (and decommissioning) of nuclear facilities to protect public health, safety, and the environment. This thesis reviews the sufficiency of Ghana's nuclear regulatory regime in dealing with these issues *vis-à-vis* international legal instruments and five (5) other countries' practices, and how any gaps in the legal system may be addressed. The research question is: to what extent is Ghana's nuclear power safety regulatory framework effective? It explores whether safety regulatory effectiveness is measurable, and if yes, what should be the main elements of such measurement in Ghana? The hypothesis tested by this question is that effectiveness of Ghana's nuclear energy safety regulatory framework is best measured by using a two-pronged nuclear regulation concept: (1) the "3S" concept (*i.e.*, safety, security, and safeguards) and (2) liability and compensation for nuclear and radiological damage.

It also examines: (a) whether risk-informed self-regulation is appropriate for Ghana; and (b) what regulatory option on liability and compensation for nuclear damage best suits Ghana? The hypotheses tested in relation to the subsidiary research questions respectively are that risk-informed self-regulation is utilized in Ghana's nuclear sector to effectively complement broad prescriptions; and the liability for nuclear damage in Ghana is best based on torts and insurance.

The main method used to address the research questions and test the hypotheses is a case study of the regulatory framework effectiveness of GAEC and Radiation Protection Board (RPB) using legislation study, questionnaires and in-depth interviews. GAEC and RPB were selected

for the case studies because of their respective legally mandated nuclear promotion and radiation protection functions. Scoping studies, case studies, literature reviews, analyses of international and comparative law, legislation, subsidiary legislation and common law, and a thematic analysis of the information assembled were also utilized in this study. The substantive content of nuclear norms, laws, principles, practices and performance indicators of nuclear energy regulation were identified, assessed, and synthesized in this thesis to provide an apt framework for conducting a composite evaluation of Ghana's readiness for effective nuclear power safety regulation.

Research findings include: (1) Ghana's few existing nuclear energy laws are deficient and none is on nuclear power; (2) efforts to develop a nuclear legal regime are ongoing; (3) GAEC has *good safety record* in using *research reactor* for extensive public services; (4) evaluating nuclear energy regulatory effectiveness, often conceptually focuses on the institutionalized regulatory body's operations; (5) such a conceptual approach is narrow and may omit other key actors and factors in nuclear energy regulation including the public, environment, operators, liability regimes; (6) a two-pronged "3S"+*liability* nuclear energy regulation gauge covering safety, security, safeguards and liability for nuclear damage offers a *safety-led* (concentric cycle, *not a Venn* linked) comprehensive basis for evaluation; (7) each of the four elements has well-tested conceptual and analytical framework norms for evaluating regulatory effectiveness; (8) for over six decades, international law and several States treat many of the four elements discretely; (9) Ghana's nuclear regulation does not tackle all the regulatory elements vital for nuclear power regulatory effectiveness; (10) Ghana's applicable legal rules on an act of God causing *nuclear damage* (e.g. *Rylands v. Fletcher* applicability) is unclear; (11) for effective regulation the regulator, operator, licensees, government, public, and relevant collaborators must all be seen to influence and contribute to a safety and security conscious nuclear industry; (12) regulatory effectiveness requires both direct and indirect normative and performance indicators; and (13) regulatory readiness is an endless continuum of a sufficient and effective safety culture regime.

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The thesis is dedicated to God for his providence, and also to:-

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List of Abbreviations and Acronyms

‘3S’	- Safety, Security, and Safeguards
“3S”+liability	- Safety, Security, Safeguards and Liability for Nuclear Damage
Aarhus Convention	- 1998 Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters,
AC	- Alternating Current
ADR	- Alternative Dispute Resolution Mechanism
AEC	- Atomic Energy Commission (USA)
AERB	- Atomic Energy Regulatory Board (India)
AFRA	- African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology
ALARA	- As low as reasonably achievable
ANLA	- African Nuclear Law Association
B.C.	- Before Christ
Bill	- The Nuclear Authority Bill 2012
BNARI	- Biotechnology and Nuclear Agriculture Research Institute
BSS	- Basic Safety Standards (IAEA)
CANDU	- Canada Deuterium Uranium reactors
CBD	- Convention on Biological Diversity
CEPMLP	- Centre for Energy, Petroleum & Mineral Law & Policy, University of Dundee
CNRC	- The Canadian Nuclear Regulatory Commission
CNS	- Convention on Nuclear Safety
CPPNM	- Convention on the Physical Protection of Nuclear Material
CSIR	- Council for Scientific and Industrial Research
DAE	- Department of Atomic Energy (India)
DC	- Direct Current
DOE	- Department of Energy (US)
EAC	- European Atomic Commission (EURATOM)
EAEC	- European Atomic Energy Community
EC	- Energy Commission
EIA	- Environmental Impact Assessment
ENATOM	- Emergency Notification and Assistance Technical Operations Manual
EPA	- Environmental Protection Agency

Espoo	- Espoo Convention on EIA in a Transboundary Context (1991)
EU	- European Union
EURATOM	- European Atomic Energy Community Treaty
FAO	- Food and Agriculture Organization
FPCC	- OECD/IEA Fusion Power Co-ordinating Committee
Fund	- Nuclear Authority Fund
GAEC	- Ghana Atomic Energy Commission
GC	- General Conference (IAEA)
GHARR-1	- Ghana Research Reactor One
GHG	- Greenhouse Gas emissions
GHS	- Ghana Health Service
GNRP	- Ghana Nuclear Reactor Project
GNRP	- Ghana Nuclear Reactor Project
GNS	- Ghana Nuclear Society
GPS	- Ghana Police Service
GSA	- Ghana Standards Authority
GTRI	- Global Threat Reduction Initiative (US)
GW(e)	- Giga Watt Energy
HSE	- Health and Safety Executive (UK)
IAEA	- International Atomic Energy Agency
IAEA/GOV	- IAEA Board of Governors
ICJ	- International Court of Justice
ICLSS	- International Consortium on Law and Strategic Security
ICRP	- International Commission on Radiological Protection
ICRU	- International Committee on Radiological Units and Measurements
IEA	- International Energy Agency
IEC	- Incident and Emergency Centre (IAEA)
IFC	- International Finance Corporation
ILC	- International Law Commission
ILO	- International Labour Organization
IMO	- International Maritime Organization
INES	- International Nuclear Event Scale
INFCIRC	- Information Circular (IAEA)

INLA	- International Nuclear Law Association
INPO	- Institute of Nuclear Power Operators (USA)
INSAG	- International Nuclear Safety Advisory Group
INSARR	- Integrated safety Assessment of Research Reactors Mission
	International Law Commission
IRRS	- Integrated Regulatory Review Service
IRSRR	- Incident Reporting System for Research Reactors
ISNL	- International School of Nuclear Law
ISSER	- Institute of Statistical, Social and Economic Research
ITER	- International Thermonuclear Experimental Reactor project
ITLOS	- International Tribunal for the Law of the Sea
ITPA	- The International Tokamaks Physics Activity
Joint Convention	- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997).
LECIAD	- Legon Centre for International Affairs & Diplomacy, UG
LI	- Legislative Instrument
McMahon Act	- The US Atomic Energy Act (1946)
MDAs	- Ministries, Departments, and Agencies
NADMO	- National Disaster Management Organization
NDC	- National Democratic Government
NEA	- Nuclear Energy Agency
NEA	- Nuclear Energy Agency (OECD)
NEI	- Nuclear Energy Institute
NES	- Natural and Environmental Sciences Department University of South Florida
NFC	- Nuclear Fuel Cycle
NFZ	- Nuclear Free Zone Treaties
NLI	- Nuclear Law Institute
NNRI	- National Nuclear Research Institute
NNWS	- Non-Nuclear Weapon States
NPCIL	- Nuclear Power Corporation of India Limited
NPP	- New Patriotic Party
NPP	- Nuclear Power Plant
NPPC	- Nuclear Power Planning Committee

NPT	- Nuclear Non-Proliferation Treaty
NRA	- Nuclear Regulatory Authority
NRC	- Nuclear Regulatory Commission (USA)
NRC	- National Redemption Council (NRC)
NRWMC	- National Radioactive Waste Management Committee
NSC	- National Security Council
NSG	- Nuclear Suppliers Group Guidelines (1975)
NUREG	- Nuclear Regulations (USA)
NWS	- Nuclear Weapon States
OECD	- Organization for Economic Co-operation and Development
OLA	- Office of Legal Affairs (IAEA)
ONR	- Office of Nuclear Regulation (UK)
OPEC	- Organization of Petroleum Exporting Countries
ORID	- Office of Research, Innovation and Development
OSART	- Operational Safety Assessment Review Team
P&I	- Agreement on the Privileges and Immunities of the IAEA
PAHO	- Pan-American Health Organization
Para.	- Paragraph
Pelindaba Treaty	- African Nuclear-Weapon-Free-Zone Treaty
PhD	- Doctor of Philosophy
PIPPA	- Pressurized Pile Producing Power and Plutonium
PNDC	- Provisional National Defence Council
RadSC	- Radiation Safety Committee
RES	- Resolution
RM	- Review Meetings
RPB	- Radiation Protection Board
RPI	- Radiation Protection Institute
RSA	- Revised Supplementary Agreement Concerning the Provision of Technical Assistance by IAEA
RSC	- Reactor Safety Committee
RW	- Radioactive Waste
RWM	- Radioactive Waste Management
SCRAM	- Safety Control Rod Axe Man (rapid (automatic) shutdown of a reactor)

SEA	- Strategic Environmental Assessment
SF	- Spent Fuel
SNAS	- School of Nuclear and Allied Sciences
TMI	- Three Mile Island
TWh	- Terra Watt Hour
UG	- University of Ghana, Legon
UK	- United Kingdom
UN	- United Nations
UNAEC	- United Nations Atomic Energy Commission
UNCED	- The 1992 UN Rio Conference on Environment and Development;
UNCLOS	- United Nations Convention on the Law of the Sea
UNEP	- United Nations Environment Programme
UNFCCC	- United Nations Framework Agreement on Climate Change
UNGA	- United Nations General Assembly
UNSC	- United Nations Security Council
UNSCEAR	- United Nations Scientific Committee on the Effects of Atomic Radiation
US (or USA)	- United States of America
USF	- University of South Florida
USSR	- Union of Soviet Socialist Republic
Vienna Convention	- Vienna Convention on Liability for Nuclear Damage as amended
WANO	- World Association of Nuclear Operators
WHO	- World Health Organization
WNA	- World Nuclear Association
X-ray	- X radiation (Unknown ray)
ZCG	- Zangger Committee Guidelines

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Ruck v. Williams (1858) 157 E.R. 488

Rylands v. Fletcher (1868) L.R. 3 H.L. 330

Silkwood v. Kerr-McGee Corp. (1984)

Singapore Land Reclamation Case

St. Helen's Smelting Co. v. Tipping (1865) 11 H.L. 642

Sturges v. Bridgman (1879) 11 Ch. D. 852

Trail Smelter Arbitration (U.S. v. Canada) (1941)

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Vanderpuye v. Pioneer Shoe Factory [1981] G.L.R. 181

White & Others v. The Chief Constable of South Yorkshire Police

CHAPTER 1: INTRODUCTION AND CONCEPTUAL FRAMEWORK

“Regulation, of course, does not guarantee safety.”

✓ Donald N. Zillman, *The Role of Law in the Future of Nuclear Power* (2008:336)

1.1. Introduction: Regulation of Nuclear Power Plants

1.1.1 Background

At no time¹ has the demand for a reassessment of the regulatory regime for nuclear safety been so pressing as now (IAEA 2011). Credible high levels of nuclear safety regulatory effectiveness, which is so vital in improving public confidence and support for the introduction and expansion of nuclear power plants (Tromans 2010:2; Zillman 2008:324; Jackson 1997:104), continues to be seriously questioned by the public and governments (Jahn & Korolczuk 2012; Layne 2011; Lyman 2011; Reaney 2011). Increased safety expectations and concerns on nuclear power reactors in a post-Fukushima² world has resulted in stringent nuclear safety reviews, nuclear regulatory reassessment and nuclear plant stress tests in almost all countries that have nuclear power plants (EU 2012; ONR 2011; IAEA 2011(a)). Some countries including China, Germany, Japan and South Korea initiated policy justification reviews of their nuclear power programmes. Whilst Germany has taken steps toward phasing out nuclear power entirely, India, South Africa,

¹ At the time I embarked on this research project in 2009, most of my questionnaire respondents showed significant *disinterest* in nuclear energy. *Why nuclear?*, “*Why are you researching on nuclear energy law?*” were questions I was often condescendingly asked everywhere I went. Even at the Ghana Atomic Energy Commission, some respondents asked similar questions maybe to confirm the authenticity of my curiosity in this area of law. My greatest surprise was yet to come: In September 2009, whilst at University of Dundee to conduct research and interact with some experts in the field, an Asian PhD student asked of my research area. I told her. Her spontaneous response was “*That is horrible!*” She had no interest in having a discussion on it. After 11th March, 2011, Fukushima Dai-ichi has at least resuscitated animated discussions on nuclear energy issues. It has generated unprecedented concerns about nuclear safety and regulatory effectiveness globally; and that is the burden of this thesis.

² On 11 March 2011 Japan suffered its worst and largest recorded earthquake. It was a magnitude 9 earthquake. The epicentre was 110 miles east north east of the Fukushima Dai-ichi (Fukushima-1) nuclear power site which has 6 Boiling Water Reactors. Reactor Units 1, 2 and 3 on the site were operating at power before the event and on detection of the earthquake shut down safely. (Such automatic shutdown is at times referred to as *scram* or *trip*). 12 on-site back-up diesel generators started providing alternating (AC) electrical supplies to power essential post-trip cooling. About an hour later a very massive tsunami from the earthquake inundated the site. The peak water level of the ensuing tsunami was about 46 feet. The plant was not prepared to withstand a level greater than 33 feet high. It resulted in station blackout, *i.e.*, the loss of all but one diesel generator, some direct current (DC) supplies and essential instrumentation. It created damage around the site. Despite the efforts of the operators, back-up cooling was eventually lost. With the loss of cooling systems, Reactor Units 1, 2 and 3 overheated. This resulted in several explosions and what is predicted to be melting of the fuel in the reactors leading to major releases of radioactivity, initially into the air but later by leakage of contaminated water into the sea (IAEA 2011; Japan 2011; ONR 2011; Lyman 2011) (*For convenience, standard Social Science and the Harvard Blue Book footnoting styles are both used in this thesis deliberately*).

South Korea, Turkey, Abu Dhabi, Saudi Arabia, Vietnam, China, etc., have cautiously re-emphasized expansion plans. (Joskow and Parsons 2012:12; IAEA 2011(a)). The US Nuclear Regulatory Commission made history in February 2012 by approving a license for the first power reactor facility in 34 years, by a majority 4-1 vote. Prior to this, no new power reactor has been licensed in the US since the 1979 Three Mile Island accident. Paradoxically, of the five US Nuclear Regulatory Commissioners, only the Chairman Gregory Jaczko (as he then was) voted against the license approval. To him, lessons from the Fukushima accident are still evolving; and he “cannot support issuing this license as if Fukushima never happened” (Reuters 2012).

For 65 years, long before *Fukushima*, nuclear regulation has remained a global concern (UNGA 1946: Resolution 1; Eisenhower 1953; Szasz 1970; *Pacific Gas v. State Energy* 1983; *Silkwood v. Kerr-McGee Corp* 1984; Blix 1989; Fischer 1997). The IAEA Statute (dated October 23, 1956) came into force on 29th July 1957. It established IAEA as an international agency “to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world” (IAEA Statute 1956: II). Also, the UN and IAEA *1957 Agreement*, signed pursuant to Article XVI of the IAEA Statute, provides that “the [IAEA], which is established for the specific purpose of dealing with the peaceful purposes of atomic energy, will have the leading position in this field”.³ The IAEA Statute is a multilateral treaty under international law;⁴

³ See Protocol Concerning the Entry into Force of the Agreement Between the United Nations and the International Atomic Energy Agency, 1959 at page 9 (the Protocol provides information on the *travaux preparatoires* of the said Agreement. The Protocol particularly states that “[w]ith regard to paragraph 1 of Article I of the draft agreement, it is noted that the Agency, which is established for the specific purpose of dealing with the peaceful uses of atomic energy, will have the leading position in this field”) (emphasis mine). The Protocol further recalls the approval of the Agreement by the IAEA’s General Conference, during its 1st special session on 23 October 1957, and by the UN General Assembly during its 12th session on 14 November 1957 and the Agreement’s entry into force on 14 November 1957 as provided in the Agreement’s Article XXIV *i.e.*, “this Agreement shall enter into force on its approval by the General Assembly of the United Nations and the General Conference of the Agency”. INFORCIRC/11, 1959:8-9, available at <http://www.iaea.org/Publications/Documents/Infcircs/Others/infcirc11.pdf>

⁴ See Articles XXI and XXII of the IAEA Statute, 1956. For instance, Article XXI of the IAEA Statute is titled “Signature, acceptance, and entry into force” and provides as follows:

“A. This Statute shall be open for signature on 26 October 1956 by all States Members of the United Nations or of any of the specialized agencies and shall remain open for signature by those States for a period of ninety days.
B. The signatory States shall become parties to this Statute by deposit of an instrument of ratification.

and it gives the IAEA a definitive mandate, *inter alia*, to establish or adopt standards in the field “safety”. The IAEA Statute authorizes it,

“to establish or adopt, in consultation and, where appropriate, in collaboration with the competent organs of the United Nations and with the specialized agencies concerned, standards of safety for protection of health and minimization of danger to life and property (including such standards for labour conditions), and to provide for the application of these standards to its own operations as well as to the operations making use of materials, services, equipment, facilities, and information made available by the Agency or at its request or under its control or supervision; and to provide for the application of these standards, at the request of the parties, to operations under any bilateral or multilateral arrangements, or, at the request of a State, to any of that State’s activities in the field of atomic energy.”⁵ (Article III.A.6)

Thus, the adoption of *standards* and *their application* are key aspects of the Agency’s normative work. The IAEA has since 1958, in consultation with the competent organs of the UN and with the specialized agencies concerned, established a number of *safety standards*.⁶ The IAEA has also accelerated the creation of several international norms pursuant to its mandate.⁷ Although the *standards* are *non-binding* on States,⁸ many States have adopted them for use in their national domestic laws and regulations, and some have been incorporated into bilateral and multilateral agreements of States, and those sovereign acts of States add weight to such adopted *standards*. It

C. Instruments of ratification by signatory States and instruments of acceptance by States whose membership has been approved under paragraph B of article IV of this Statute shall be deposited with the Government of the [US] ...

D. Ratification or acceptance of this Statute shall be effected by States [via] their respective constitutional processes.

E. This Statute, [...], shall come into force when eighteen States have deposited instruments of ratification in accordance with paragraph B of this article, provided that such eighteen States shall include at least three of the following States: Canada, France, the Union of Soviet Socialist Republics, the United Kingdom of Great Britain and Northern Ireland, and the United States of America. Instruments of ratification ... deposited ... shall take effect on the date of their receipt.”

⁵ Article III.A.6 of the IAEA Statute, 1956 (emphasis mine), available at http://www.iaea.org/About/statute_text.html#A1.21

⁶ For a list of about 70 IAEA Safety Standards applicable to Nuclear Power Plants, see IAEA, Nuclear Power Plants: Applicable Safety Standards (available at <http://www-ns.iaea.org/standards/documents/default.asp?s=11&l=90&sub=10&vw=9#sf>)

⁷ It facilitated the *establishment of Conventions under its auspices*, and concluded *agreements with Specialized Agencies of the UN System, other Intergovernmental Organizations* such as the OECD’s NEA and EURATOM and *States* including the *Safeguards Agreements with Non-Nuclear Weapon States* pursuant to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). See Articles III.D, XII, and XVI of the IAEA Statute, 1956 (providing respectively for IAEA’s general mandate to conclude agreements, IAEA’s pre-NPT Safeguards arrangements, and relationship with other organizations.). The NPT Safeguards Agreements are however concluded under Article III of the NPT which sets out a “*trilateral legal construct*” mandating its Non-Nuclear Weapon State parties (NNWS), as binding obligation, to conclude bilateral Safeguards Agreements with the IAEA. See also Odette Jankowitsch, *The Normative Role of the International Atomic Energy Agency, Legal Basis and Legal Sources*, 13, 16-21 (in *International Nuclear Law: History, Evolution and Outlook*, OECD, NEA, France 2010)

⁸ Article III.D of the IAEA Statute, 1956 (Providing that “Subject to the provisions of this Statute and to the terms of agreements concluded between a State or a group of States and the Agency which shall be in accordance with the provisions of the Statute, *the activities of the Agency shall be carried out with due observance of the sovereign rights of States*” (emphasis mine). So, State sovereignty as understood in international law has been preserved, and consequently, the IAEA does not have any supranational role even as regards it members in the carrying out of its activities and functions or duties.) See Harris 1998:6; Morgenthau 1985.

has further been argued that “some binding nature, usually of a technical rather than legal nature, attaches to the standards by way of their application by the Agency to its own operations conducted in member states ... [*i.e.*,] as *ius definitivum* as opposed to *ius cogens* ...”⁹

The safety standards are generally accepted as examples of the new sources of international law (international soft law)¹⁰ which emerged mainly during mid 20th century.¹¹ States are expected to conduct their affairs in compliance with international soft law (Schachter 1977; Bothe 1980; Van Hoof 1983; Jennings 1958; Gruchalla-Wesierski 1984; Riphagen 1987; Dupuy 1991). In the *ICJ's Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons*, two soft law instruments were cited as obligating States “to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction” and that the principle had become “*part of the corpus of international law relating to the environment.*”¹² International soft law may add to generally accepted sources of international laws prescribed in Article 38(1) of the Statute of the ICJ, by practice and conduct of States.¹³ Cases like *Trail Smelter Arbitration, the 1973, 1974 and 1995 Nuclear Tests Cases*,

⁹ Jankowitsch, *The Normative Role of the International Atomic Energy Agency*, *supra* note 7, at 22. *Ius cogens* refers to peremptory norms or higher laws that nations must follow; *ius definitivum* refers to applicable definite law for defined issues.

¹⁰ *International soft law* include Declarations and resolutions adopted by the UN organs or other international organizations (as defined in Article 2(i) of the Vienna Convention on the Law of Treaties, 1969), as well as guidelines, principles and recommendations produced by multilateral conferences such as the 1972 UN Stockholm Conference on the Human Environment and the 1992 UN Rio Conference on Environment and Development; and may include IAEA regulations and requirements.

¹¹ Vep P. Nanda, *International Environmental Norms Applicable to Nuclear Activities*, 195 (in *Updating International Nuclear Law*, 2005, Heinz Stockinger *et al.* (eds))

¹² 1996 I.C.J. 226, 240-243 para. 28-30 (citing *inter alia*, Principle 21 of the 1972 Declaration of the UN Stockholm Conference on the Human Environment (U.N. Doc. A/CONF.48/14 and Corr. 1 (1972); and Principles 2 and 24 of the 1992 Declaration of the UN Rio Conference on Environment and Development (U.N. Doc. A/CONF.151/26, vol. I-IV (1992)) (emphasis mine)

¹³ Article 38(1) of the ICJ Statute provides that:

- “1. The Court, whose function is to decide in accordance with international law such disputes as are submitted to it, shall apply:
- a. international conventions, whether general or particular, establishing rules expressly recognized by the contesting states;
 - b. international custom, as evidence of a general practice accepted as law;
 - c. the general principles of law recognized by civilized nations;
 - d. subject to the provisions of Article 59, judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law.”

Gabcikovo v. Nagymaros Dam Dispute, *Mox Plant Case* and *Singapore Land Reclamation Case*, etc., have emphasized the relevance of international soft law. Arguably, some IAEA standards, e.g., those on transport, may even be deemed *binding* international norms. As Jankowitsch notes,

“it would ... be legally more correct to view certain [IAEA] standards, notably those qualified as “requirements” ... as having different legal implications from other types of “soft law” documents. The very purpose of those standards is to “regulate” and to be applied more or less *in integrum* as binding, sole technical norm by way of their incorporation into domestic or international law.”¹⁴

Moreover, radiation protection, which at the beginning of the 1900s was focused mainly on the health effects, hazards, risks, unit of measurement, metrology, etc., of radiation as applied to medicine, has since 1928, and mainly in 1950, widened its focus beyond the medical profession and other radiation researchers and workers to address public and environmental protection issues (Lazo 2010:109). The general principles of radiological protection are a “chapeau” or envelope for all nuclear legislation (Stoiber *et al.* 2003:47); because they are broadly applicable to all nuclear related activities and to all facilities at which ionizing radiation is produced (Lazo 2010:106). The whole nuclear process from initial mining of uranium to the final disposal of spent nuclear fuel poses risk of excessive radiation exposure to people and the environment. The IAEA in collaboration with several institutions and stakeholders like ICRP, UNSCEAR, ICRU, ILO, WHO have developed international non-binding standards on radiation (and other areas of nuclear energy) that may be adopted by its member states. These standards may be applied to IAEA’s operations (e.g., services, materials, equipment, information) made available on bilateral or multilateral terms; or to a country’s atomic energy activities at the request of that country.

¹⁴ Odette Jankowitsch, *The Normative Role of the International Atomic Energy Agency*, *supra* note 7, at 22 (citing the IAEA *Regulation for the Safe Transport of Nuclear Material* as an example of such legal norms having higher implications than the other soft law documents like Codes and Guides). See also Odette Jankowitsch, *The International Law of Transport of Nuclear and radioactive Material* 185- 218 (in *International Nuclear Law: History, Evolution and Outlook*, OECD, NEA, France 2010). The IAEA published its first regulations for the safe transport of radioactive material in 1961. It forms the basis of all the international modal regulations on the transport of radioactive material whether by land (road and rail), water, air, post, etc. These regulations have been reviewed and updated regularly over the last 50 years. *The most recent revision is the 2009 (now 2012) edition*. They have also been adopted by national regulatory authorities creating a strong global regulatory framework. See IAEA, *Safe Transport* (Updated Feb. 22, 2012) at <http://www-ns.iaea.org/tech-areas/radiation-safety/transport.asp> (accessed June 2012)

Over sixty years of nuclear law (statutory, regulatory, and international) has provided a strict framework to address issues facing nuclear power in the 21st century.¹⁵ As Zillman notes, “[i]t is probably accurate to call nuclear energy the most legally controlled energy source ... No other energy source has been subject to the comprehensive legal regulation that nuclear power has.”¹⁶ Consequently before a country can legitimately initiate a nuclear power programme, it is bound to comply with the international legal framework governing nuclear energy and the processes thereunder. Any country considering establishing a nuclear power plant (be it to satisfy growing energy needs and requirements, and/or to diversify their energy mix, achieve greater autonomy and security of energy supply or reduce carbon emissions), must address a variety of legal, social, technical, environmental, economic, human resource and financial issues (IAEA 2011(b); HSE 1992). An issue that is generally regarded as of paramount importance in this process is the adequacy of the domestic regulatory framework or the institutional and legislative infrastructure. (Reyners & Jankowisch 2007:22): Nuclear energy’s special risks and benefits require regulation.

Being a very strict and intensely regulated industry, nuclear power plants operate within a robust, highly specialized, highly technical field full of a “... wide range of national and international legal instruments that comprise that regulatory framework” (Echavarri & Auge 2010:3). Also, lessons learnt¹⁷ so far from accidents such as *Windscale*, *Kyshtym*, *Three Mile Island*, *Chernobyl*, and *Fukushima* – rated as Level 7 major accident (the highest level) on the International Nuclear Event Scale (INES), like Chernobyl – are adding many useful layers of nuclear safety regulation requirements. (IAEA 2011; Japan 2011; Tromans 2010:31-36; WANO 2012).

¹⁵ Donald N. Zillman, *The Role of Law in the Future of Nuclear Power* 319, 326 (in *Beyond the Carbon Economy: Energy Law in Transition*, Donald N. Zillman *et al.*, (eds), Oxford: Oxford University Press, 2008)

¹⁶ *Id.*, at 327

¹⁷ See Japan Country Report to the IAEA (2011); IAEA 2011; Government of Japan 2011; Tromans 2010:31-36; WANO 2012

The Fukushima accident was a tragedy for the people affected and has badly undermined public confidence in the safety of nuclear power. There is no direct fatality from the accident a year on, but that is muted by the huge financial costs,¹⁸ evacuation depression,¹⁹ trauma,²⁰ environmental damage,²¹ and public outcry against nuclear energy in the wake of the accident. While some argue that Japan has an effective nuclear regulatory regime which helped to ameliorate an otherwise more devastating impact of the accident, others posit that Japan's nuclear power regulation had some gaps, including human error, which were exposed by the earthquake and tsunami.²² In the din of the current cacophony of reviews and critique, one issue remains clear: nuclear safety regulatory effectiveness is a core pre-requisite of nuclear power generation and other peaceful application of nuclear energy; and it must be *improved continuously* (IAEA 2011).

1.1.2. The Necessity for Nuclear Power Regulation in Ghana

Ghana does not have a nuclear power plant. But in line with its energy policy,²³ the country took a Cabinet decision in 2008 to establish a nuclear power plant by the year 2018. This decision was based on recommendations of a 7-member Committee set up by the government in May 2007 to look into the advisability or otherwise of introducing nuclear power in Ghana.²⁴ The Committee *inter alia* advised the government to develop a legal framework for the operation of nuclear

¹⁸WANO 2012

¹⁹ Tens of thousands of people (over 80,000) were evacuated from a zone extending 20km from the site and remain so today.

²⁰ WANO 2012

²¹ WANO 2012

²² See Japan Country Report to the IAEA; see also Amir Shahkarami, *Fukushima Dai-ichi Global Learning* (in Nuclear Energy Safety: Improving Safety in the Aftermath of the Fukushima Crisis, International Workshop Final Report, Beijing, June 2011) (Arguing that the accident in Fukushima was due to human error, ranging from seismologists who claimed the fault was inactive to the placement of backup power generators in the lower levels of the plant). Workshop materials and videos are available online at: http://www.nrdc.cn/english/E_news_center_flag.php?id=1429&cid=208 (accessed June 2012)

²³ See *National Energy Policy* (February 2010 revised edition). In *Clause 1.6.*, the Policy objectives includes “to diversify the national energy mix by promoting renewable energy sources, *nuclear* and coal.” (Emphasis added). *Clause 2.5* of the Policy lists policy actions that will be pursued to secure future fuel supplies, to include the development of “nuclear power as an option for electricity generation in the long term”.

²⁴ See IAEA, Country Nuclear Power Profile: *Ghana Country Profile* (2012)

power facilities in the country and a regulatory body for the regulation and enforcement of technical standards for nuclear safety and radiological protection.²⁵ It also recommended that the government accedes to all international agreements and protocols related to non-proliferation, physical protection, nuclear safety and security as well as civil liability.²⁶ Ghana then officially expressed to the IAEA its intention to introduce a nuclear power plant to augment its electricity generation capacity.²⁷ This has been re-affirmed at several fora by government officials.²⁸

Ghana's expression of intention to go nuclear raises many issues. Public statements of intentions or unilateral declarations by government officials can create commitments in international law, given the context, and may legally bind a state.²⁹ In the 1973, 1974, and 1995 Nuclear Tests Cases (*New Zealand v. France*), the ICJ stated that France's statement of intention to cease atmospheric testing (made by its public officials) "may create commitments in international law." The ICJ was however quick to add that, not all statements by officials of a State may create commitments. Elias notes "pronouncements on the binding character of unilateral declarations by

²⁵ *Id.*

²⁶ *Id.*

²⁷ Ghana applied to the IAEA in 2004 for assistance in undertaking energy and nuclear power planning studies; and made a firm commitment to add nuclear to her energy mix in 2007. See IAEA, *Ghana Country Profile* (2012); See also, World Nuclear News, *Ghana Coordinates Nuclear Planning Activities* (Nuclear Power News, May 17, 2012)

²⁸ See for e.g., *Statement by Hon. Ms. Elizabeth A. Ohene, Minister for Tertiary Education, Science and Sports of the Republic of Ghana at the 52nd Regular Session of the General Conference of the IAEA*, at p. 8 (Vienna: IAEA, 29th September 2008 – 4th October 2008) (noting that "[t]he Government of Ghana has decided to generate electricity using nuclear power plants in the long term. We are pleasantly informed by the [IAEA] of its willingness to work very closely with the national stakeholder institutions to establish the first nuclear power plant."). See also, *Statement Read on Behalf of the Hon. Ms. Sherry Ayitey, Ghana's Minister of Environment, Science and Technology, By the Deputy Permanent Representative at the 55th Regular Session of the IAEA General Conference*, p. 3 (Vienna: IAEA, 19-23 September 2011); See also, World Nuclear News, *Ghana Coordinates Nuclear Planning Activities* (Nuclear Power News, May 17, 2012) (reporting that Hon. Alhaji Fuseini, the Deputy Minister for Energy in Ghana has stated at a stakeholders conference in Accra that "nuclear power is one of the options being considered to play a significant role in Ghana's energy sector ... It is expected that in the foreseeable future this energy option will be introduced into our energy mix to make effective contributions to our development efforts towards the achievement of sustainable energy ...")

²⁹ See *The 1973, 1974, and 1995 Nuclear Tests Cases* (*New Zealand v. France*), Judgment, 1974 I.C.J. 4, para. 48; See also, the ICJ's 1961 *Judgment in the Temple of Preah Vihear*, 1961 I.C.J. Rep. pp. 31, 32 (where the I.C.J. stated that "[w]here as is generally the case in international law, which places the principal emphasis on the intention of the parties, the law prescribes no particular form, parties are free to choose what form they please provided their intention clearly results from it ... [T]he sole relevant question is whether the language employed in any given declaration does reveal a clear intention...") (Emphasis added). (On July 18, 2011, the ICJ indicated *Provisional Measures* in its 1961 *Judgment in the Temple of Preah Vihear* upon Cambodia's request for interpretation of the judgement, since Thailand was preventing access to the Temple.)

France would seem to be highly questionable and in any case, not supported either by principle or by authority” (Elias 1983:118) (ICJ *Burkina v. Mali* 1986:36; *Nicaragua v. USA* 1986:261). In Ghana’s case, a request for assistance preceded and followed the declarations: IAEA support to Ghana pursuant to requests to plan and implement its statement of intent from the highest level of government (the Cabinet) is ongoing. Ghana may thus be expected under international law to establish the necessary legal and regulatory framework to govern nuclear power and nuclear energy activities.³⁰ Second, Ghana keeps assuring the international community that it “is fully committed to nuclear safeguard, safety and security and will continue to ensure that all practices of nuclear technology are conducted in a safe, secure and environmentally friendly manner.”³¹

Third, Ghana has serious gaps in its nuclear regulatory framework and is putting necessary structures in place to address some of the gaps. The existing laws do not deal with nuclear power, but a draft bill is being finalized. Also, it is the sole mandate of the Radiation Protection Board (RPB) under the Legislative Instrument LI 1559 of 1993, to authorize, license, inspect and control all activities and practices involving radiation sources, radioactive materials and related matters.³² RPB is thus the *de jure and de facto* regulatory body on such matters. Yet, GAEC, the promotional body for nuclear operations in Ghana³³ is almost a *de jure and de facto* regulator under the current regulatory scheme. Under the constitutive legislative instrument of RPB, five of RPB’s eleven members work under the auspices of and are directly appointed by GAEC.³⁴

³⁰ See, *Statement by Hon. Ms. Elizabeth A. Ohene, Minister for Tertiary Education, supra* note 28, at pp. 8-9 (noting that “[i]n Ghana, a draft legislation to establish an independent regulatory body, which has taken on board relevant international instruments has been prepared and awaiting parliamentary approval...”)

³¹ *Id.*, at p. 8.; See also, *Statement Read on Behalf of the Hon. Ms. Sherry Ayitey, Ghana’s Minister of Environment, Science and Technology, at the 55th Regular Session of the IAEA General Conference*, p. 7 (Vienna: IAEA, 19-23 September 2011)

³² See Regulation 2 of the *Radiation Protection Board Legislative Instrument*, 1993 (LI 1559)

³³ See *Ghana Atomic Energy Commission Act*, 2000 (Act 588)

³⁴ *Id.*, Regulations 1, 2, 12, 13, 14, etc (Providing functions and membership of RPB; and appointment by GAEC of key officials including the Chief Radiation Protection Officer of GAEC who automatically becomes a member of the RPB).

Appeals from the decisions and actions of RPB regarding cancellation, suspension, refusal to grant or renew a licence, goes to GAEC; and GAEC has the authority to consider the appeal and make such order as it deems proper and any such order of GAEC shall be final.³⁵ GAEC thus has power to bind licensee(s) and RPB. It is also unclear what the term *final* means in the context. Is it finality with regards to administrative appeals? Or is the statute clothing GAEC with final judicial authority and power contrary to Article 125(3) of the 1992 Constitution of Ghana?³⁶ Any such final judicial power may be void under Article 1(2) of the Constitution.³⁷

Intricately, RPB appears to be eclipsed by GAEC legally (*See* Figure 1.1). It is not a “regulatory capture” of RPB by GAEC (Faanu et al. 2010:91; Amuasi 2001:1-3). RPB and GAEC work together with shared mutual respect and skill in their operations. It is a family with assigned roles and responsibilities in a structured collegial environment. To make Ghana’s system conform to international norms on clear regulatory independence in nuclear energy regulation, and avoid any semblance of RPB’s dependence on GAEC, RPB as constituted under LI 1559 must be reformed to address the independence issue.³⁸ As noted at the IAEA General Conference (2010):

“Ghana remains committed to the implementation of the relevant international instruments of nuclear safeguards, safety and security and in that regard, is making efforts to ratify relevant international nuclear legal instruments. In pursuance of this, a Bill to establish an *Independent Nuclear Regulatory Authority* will soon be placed before Parliament for approval to pave the way for the establishment of an effective institutional and human capacity to address proposals for the utilization of nuclear energy as an additional source of energy for the country.”³⁹

³⁵ *Id.*, at Regulation 14

³⁶ See Article 125(3) of the Fourth Republican Constitution of Ghana (1992) (emphasizing that “the judicial power of Ghana shall be vested in the Judiciary; accordingly, neither the President nor Parliament nor any organ or agency of the President or Parliament shall have or be given *final judicial power*”). (Emphasis mine)

³⁷ See Article 1(2) of Ghana’s 1992 Constitution *supra* note 36 (“[t]his Constitution shall be the supreme law of Ghana and any other law found to be inconsistent with any provision of this Constitution shall, to the extent of the inconsistency, be void”).

³⁸ See IAEA, *Fundamental Safety Principles*, Principle 2, para. 3.8 – 3.11 (SF-1, Vienna: IAEA, 2006); See also Carlton Stoiber, et al., *Handbook on Nuclear Law* (Vienna: IAEA, 2003)

³⁹ See, *Statement by Ghana at the 54th Regular Session of the IAEA General Conference*, p.4 (Vienna: IAEA 20-24 Sept. 2010) (Italics mine)

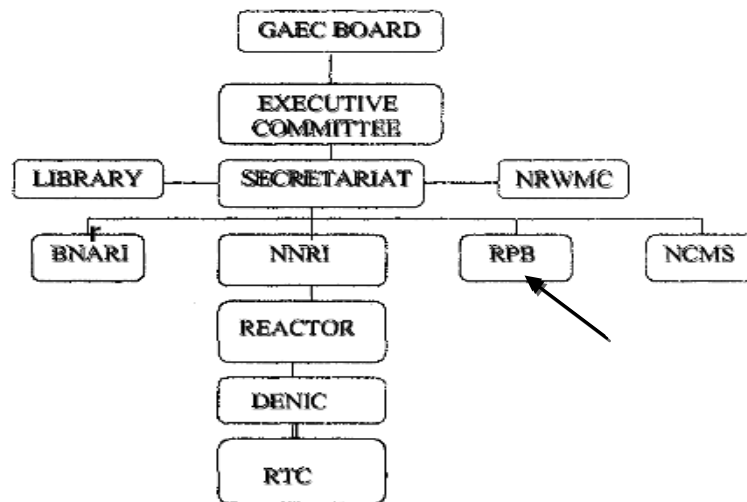


FIGURE 1.1: Organogram of GAEC

Source: GAEC, *At A Glance* (1998) (Arrow inserted)

It may further be argued that, RPB's structure and relationship with GAEC effectively utilizes the few technically trained nuclear personnel, aids the seamless exchange of knowledge and information, and enhances transparency. Like the concept of family, RPB and GAEC work together, but each knows its roles and responsibilities. It is a structure with shared mutual respect, trust and skill in their operations: and this collegial bonding cannot be a "regulatory capture". It seems to rather enhance regulatory practice: it encourages regulators, operators, and promoters to sit down together across the table to decide what should be done. It has enabled Ghana implement a non-prescriptive performance-based self-regulation in its nuclear regulation and practice for decades. However, a core danger inherent in this approach is the strong reliance on practices or traditions. It may even result in lack of clearly written rules on requirements. RPB has addressed this and produced several Guides and other documents to provide information on minimum requirements. Introducing nuclear power will require additional Guidelines and laws.

Fourth, Ghana has assumed legal obligations under the IAEA Statute and other Conventions to regulate the peaceful and safe use of nuclear energy in Ghana. Ghana acceded to the *IAEA Statute* on 28 September 1960; and accepted the Agreement on the Privileges and Immunities of

the IAEA in 1963. Ghana ratified the Nuclear Non-Proliferation Treaty in 1970; and also signed the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (with Protocol); African Nuclear-Weapon-Free-Zone Treaty (Pelindaba Treaty); and the Revised Supplementary Agreement Concerning the Provision of Technical Assistance by IAEA (RSA); acceded to the Convention on the Physical Protection of Nuclear Material; ratified the Convention on Nuclear Safety; acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; and accepted the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) - Fourth Extension.⁴⁰ These laws, mainly, the Convention on Nuclear Safety, require signatories to establish a *regulatory* regime for nuclear power.

Fifth, in addition to international legal requirements for the adoption of a comprehensive nuclear energy regulatory framework, receipt of IAEA assistance – technical, financial, etc – creates an obligation to abide by established safety and other standards.⁴¹ From 1968 to March 1995, Ghana had received IAEA support amounting to US\$8 million for nuclear development in Ghana: “of this about 36% [went into] nuclear techniques in agriculture, 16% in medicine, 14% in industry and hydrology and 9% in nuclear engineering and technology.”⁴² The IAEA support for peaceful

⁴⁰ After acceding to the IAEA Statute on 28 September 1960, Ghana accepted the Agreement on the Privileges and Immunities of the IAEA on 16 December 1963; signed the NPT in 1968 and ratified it in 1970; signed the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (with Protocol) on 6 July 1973 and it entered into force in Ghana on 17 February 1975. Ghana signed the Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA) on 30 January 1989; and the African Nuclear-Weapon-Free-Zone Treaty (Pelindaba Treaty) on 11 April 1996. It took 13 years to enter into force on 15 July 2009. Ghana acceded to the Convention on the Physical Protection of Nuclear Material on 16 October 2002 and it entered into force in Ghana on 15 November 2002. Having signed the Convention on Nuclear Safety on 6 July 1995 it recently ratified it on 1 June 2011 and it entered into force in Ghana on 30 August 2011. Ghana also acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management on 1 June 2011 and it entered into force in Ghana on 30 August 2011. It accepted the African Regional Co-operative Agreement for Research, Development and Training Related to Nuclear Science and Technology (AFRA) - Fourth Extension on 21 June 2011.

⁴¹ Article III.A.6 of the IAEA Statute, 1956 *supra* note 3

⁴² IAEA, *Inauguration of Ghana Research Reactor 1*, Statement by the Director General of the IAEA, Dr. Hans Blix, [as he then was], Inauguration of Ghana Research Reactor 1 at Accra, Ghana, 8 March 1995 (in Statements of the Director General: IAEA).

uses and applications of nuclear energy in Ghana is on-going, with the collaboration of other development partners and agencies.⁴³ The IAEA is helping Ghana build human resource capacity by assisting University of Ghana and GAEC establish the Graduate School of Nuclear and Allied Sciences (now, an IAEA designated Centre for Nuclear Knowledge Management and Human Resource Development in Africa). Ghana enjoys several IAEA Technical Cooperation Projects (*viz.*, Planning for Sustainable Energy Development GHA0008 and RAF016; Human Resource Development GHA0010; Evaluating the Role of Nuclear Power in Future Options for Electricity Generation GHA0011, etc) as well as fellowships, participation in IAEA sponsored visits, workshops and training courses on nuclear power regulatory framework, etc.

Sixth, though regulation does not guarantee safety, there is nevertheless the need for Ghana to establish a regulatory regime that will be implemented, well monitored and enforced to provide sufficient guidelines on nuclear safety and security for the protection of people, property and the environment; and the promotion of public confidence and tolerance for, or acceptance of nuclear power generation. Seventh, concerns on safeguards to maintain peaceful uses of nuclear energy, or to meet strict requirements on acquisition of nuclear related equipment and materials, obtain international aid and cooperation, and several other factors, including the need for a legally binding regime on nuclear power safety and non-proliferation in Ghana, require Ghana to have an appropriate legal and institutional framework to regulate nuclear power generation activities.

⁴³ On Ghana's nuclear research activities and IAEA support, see B. J. B. Nyarko, *et al.*, *Evaluation of the Role of Nuclear Power in Ghana's Future Electricity Generation*, Presentation, GHA/0/011 (2011); E. H. K. Akaho, *Status of Implementation of a Road Map and Overview of Building Infrastructure for the Nuclear Power Programme in Ghana*, Presentation, GNEP (2009); J.H. Amuasi, *Nuclear Education in Ghana, Global Nuclear Energy Partnership Pre-Assessment Study for the Introduction of Nuclear Power in Ghana*, SNAS/GAEC, Accra (2009); M. K. Dzobo, *Ghana's Experience in Long-Term Energy Planning and the Use of IAEA's Energy Planning Tools*, INT4142 9002 Workshop Presentation, IAEA (2009); E. H. K. Akaho, *Nuclear Power for Generating Electricity in Ghana: The Issues and Challenges*, GAAS, (2008); B.J.B. Nyarko, *Nuclear Energy for Sustainable Development of Ghana: The Issues and Challenges*, Presentation, p. 21 (2008); B.J.B. Nyarko *et al.*, *The 30 kW Research Reactor Facility in Ghana: Past, Present and Future Programmes* (GAEC, IAEA-AFRA, 2008); E. H. K. Akaho *et al.*, *Safety Analysis Report for Ghana Research Reactor-1*, GAEC-NNRI-RT-26 (1995); E.H.K. Akaho *et al.*, *Final Safety Analysis Report for Ghana Research Reactor-1*, GAEC-NNRI-RT-90 (2000)

There are a lot of standards, principles, requirements and literature *on nuclear power generation and its regulation*; but they do not focus on Ghana specifically.⁴⁴ Recognition or acceptance, of a country's policy decision to establish or utilize nuclear power is very international in scope. Markets for nuclear equipment, radiation sources, technological components, their production, imports, exports, etc., are all increasingly subject to strict well enforced international regimes. However, "licensing processes and regulations are still highly influenced by national legislation and legal cultures."⁴⁵ So, though international nuclear energy standards, principles or norms may be generally applicable and can be adopted by Ghana *mutatis mutandis* into its national legal system, it is important that such adoption and application of principles take into account local nuances or context. This thesis provides a textured context on Ghana's legal and regulatory regime relevant to nuclear energy, public health, environmental protection, grid electricity transmission, distribution and usage, and other related matters that may impact nuclear power.

Moreover, most of the available literature, and even model laws, on nuclear power regulation have often evolved in compartmentalized segments with little cross-fertilization of synergies. Wolfram Tonhauser, the Head of the IAEA's Nuclear and Treaty Law Section in the Office of Legal Affairs (OLA), recently commented on this lacuna and the efforts of the IAEA to fill that gap. As he puts it, the IAEA's legislative assistance programme has "recognized that a new

⁴⁴ For *e.g.* see IAEA, *Scientific and Technical Publications*, available at website <http://www-pub.iaea.org/books/>; (providing access to hundreds of materials on various aspects of nuclear energy); see also IAEA, *Nuclear Energy Series Catalogue*, at http://www-pub.iaea.org/books/IAEABooks/Series/134/Nuclear_Energy_Series (providing access to over 80 PDF books and publications on nuclear power); see also, <http://www-pub.iaea.org/books/IAEABooks/Series/33/Safety-Standards-Series>; <http://www-ns.iaea.org/standards/>; <http://www-pub.iaea.org/books/IAEABooks/Series/73/Safety-Reports-Series>; and <http://www-ns.iaea.org/standards/documents/default.asp?s=11&l=90&sub=10&vw=9#sf> (each site provides access to hundreds of materials); But see B.J.B. Nyarko *et al.*, *Resource Needs for Nuclear Power Generation in Ghana*, EREM No. 2(56), 57 (2011) at 62–68 (providing a synopsis of some international nuclear conventions and requirements and the status of Ghana on some of them). See also S.A. Birikorang, *et al.*, *Prospects of Nuclear Power Today as Part of Ghana Energy Mix and Socio-Economic Development*, EREM, No. 2(60), p.67-76 (2012); E. Ampomah-Amoako, *et al.*, *Environmental and Safety Concerns for Nuclear Power Generation in Ghana*, EREM, No. 1(55), pp. 49-65 (2011)

⁴⁵ Gabriel Michanek and Patrik Soderholm, *Licensing of Nuclear Power Plants: The case of Sweden in an International Comparison*, Energy Policy 37 (2009) 4086–4097, at p. 4086; See also Stoiber, *et al.*, *Handbook on Nuclear Law* *supra* note 38, at p.6.

comprehensive approach was required which emphasized the inter-relationships between safety, security, safeguards as well as nuclear liability ... This approach not only recognizes the complex technical and legal inter-relationships as well as the areas of co-existence and diversity of ... international legal instruments but also provides for their practical implementation – so that they may be given effect in a national legislative framework”.⁴⁶

This is what this research study seeks to do. It makes an empirical and academic research inquiry on Ghana’s legal framework, which has a bearing on nuclear energy. It examines:

- (i) the international legal instruments on nuclear power vis-à-vis the Ghanaian situation;
- (ii) the constitutional, institutional and legislative frameworks for nuclear power plants; and
- (iii) useful comparative examples of nuclear energy regulation in other countries.

This thesis and similar studies are currently crucially needed to generate new academically sound and practicable substantiated information; and provide direction to informed decision making between available nuclear regulatory options in Ghana.

1.1.3. Scope and Focus

Considering the breadth of the issues that this inquiry seeks to deal with, defining the scope and focus of the study is critical. Nuclear power regulation is a slippery term. It can indicate form, such as broad legal (common law) or legislative regimes that govern nuclear power. It can also refer to detailed technical rules, operational requirements or even administrative processes. On the issue of substance, it can deal with the facilities associated with the nuclear fuel cycle (i.e. the whole gamut of facilities and activities associated with the production of nuclear power). These include nuclear fuel fabrication plants, research and test reactors, power reactors, spent fuel

⁴⁶ See, Wolfram Tonhauser and Anthony Wetherall, *The International Legal Framework on Nuclear Safety: Developments, Challenges and Opportunities* 157, at 168-9 (in *International Nuclear Law: History, Evolution and Outlook*, OECD, NEA, France 2010) (Noting IAEA’s OLA has “developed the so called “3S” approach to nuclear law.”)

storage facilities, enrichment plants, reprocessing facilities, radioactive waste management facilities and radioactive ore mines and milling plants. Or it may only deal with a facility within the fuel cycle, *e.g.* nuclear power reactors, as in this thesis. It can also denote substantive rules on radiation protection, environmental protection, safety of radioactive materials or sources, nuclear security, safeguards, liability, penal measures, etc. When a specific area is indicated as the focus of regulations, say *safety*, there is the need to clarify whether it is radiation safety, nuclear plant, equipment and operations safety, nuclear transport safety, or radioactive waste safety. And still, does it refer to detailed technical and operational rules or general broad legislative prescriptions on for example, radioactive waste *safety*, or plant, equipment and operations *safety*, etc. Setting thematic and geographic boundaries is thus important in sharpening the focus of this study.

1.1.3.1. Thematic Scope and Focus

Regulation of safety in nuclear power *generation* is the theme. The term *regulation* or *regulatory regime* and similar expressions herein *do not* refer to *detailed* technical and operational rules or requirements for nuclear power generation. They rather refer to the legal framework: legislation, institutions and the *fundamental* measures or *general* rules and principles that are necessary for minimizing the risks posed by nuclear power plants. The CNS Preamble 8 similarly distinguishes fundamental safety principles from detailed safety standards. What constitutes detailed technical rules; fundamental or general rules and principles; and how may they be distinguished? *Detailed* technical requirements are reflected in rules, regulatory documents, standards or guidance that are promulgated by the regulatory body (Figure 1.2). Levels 1 to 3 in Figure 1.2 usually comprise detailed technical rules. Level one often provides non-mandatory guidance on how to satisfy requirements of both the detailed technical rules and main general legislation or regulations. At times, level four may contain very detailed technical rules as well.

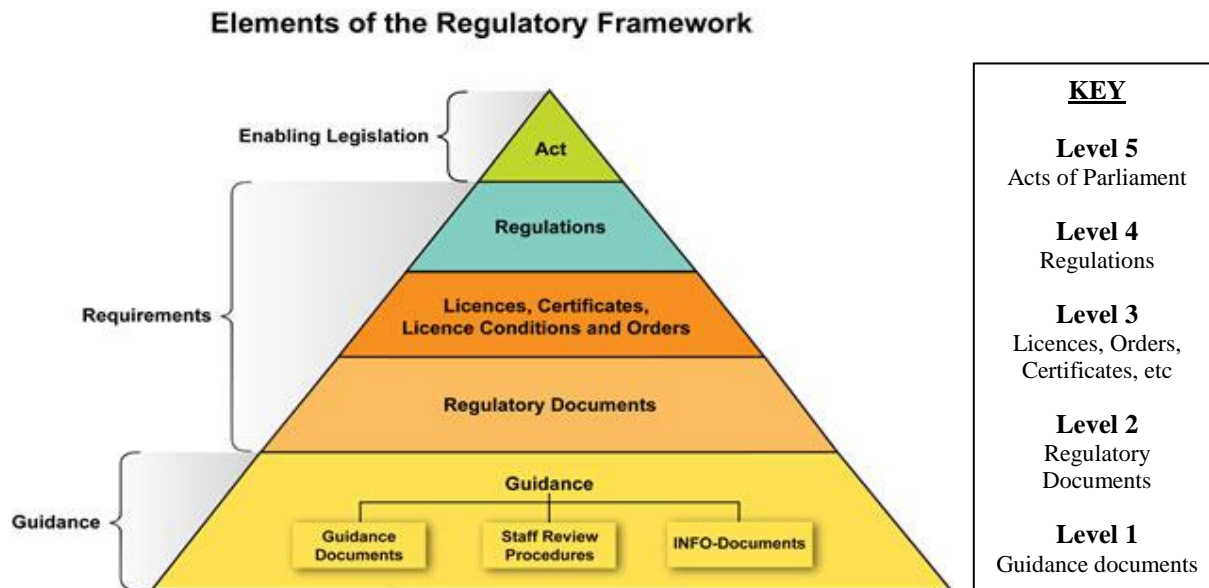


Figure 1.2: REGULATORY FRAMEWORK

Source: The Canadian Nuclear Regulatory Commission (Jan., 2011) (Key insert mine)

This thesis deals with matters relating to Figure 1.2's levels 4 and 5, but it nevertheless provides examples of detailed rules in levels 1 to 3 where necessary for illustration purposes. This is a best practice reflected in *IRRS* and *OSART* missions, CNS, etc. Detailed technical safety regulations for nuclear power plants cover many issues: e.g., regulatory rules on *bolts*. *Door locks* rules in US nuclear power plants require an ability to manually override electric locks during power failure.⁴⁷ It is not practicable to provide for even a small fraction of crucial detailed measures in nuclear legislation. Also, technical progress might be stalled if current state of the art rules were ossified into law. Nuclear power reactors complicate this matter by requiring numerous complex technical and administrative measures than any other facility in the nuclear fuel cycle (NEA 1985). Such detailed technical rules must thus be allowed to evolve on a rolling basis; and they often work best in a *risk-informed performance-based regulatory regime* (Wilpert 2008).

⁴⁷ See Regulatory Guide 5.65, "Vital Area Access Controls, Protection of Physical Security Equipment, and Key and Lock Controls," U.S. Nuclear Regulatory Commission, September 1986. [8610030129]; See also NRC, Resolution of Generic Safety Issues: Issue 81: *Impact of Locked Doors and Barriers on Plant and Personnel Safety* (Rev. 5) (NUREG-0933, Main Report with Supplements 1–34), available at <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0933/sec3/081r5.html>

Three objectives are usually implicated in a *safety* regulatory framework: (1) the general nuclear safety objective; (2) radiation protection objective and; (3) technical safety objective (Stoiber *et al.* 2003:64). The general safety objective seeks to prevent accidents. It provides for the setting up of effective defences against radiological hazards, and for monitoring. The aim is protection from harm. It often includes safety in relation to sources, equipment or facilities, transport, and radioactive waste. Straddling this objective is the radiation protection objective which aims at ensuring that during normal operation of the facility, radiation exposure is kept below prescribed limits, and as low as reasonably achievable (ALARA), and the consequences of any accidents is mitigated. The technical safety objective puts a premium on the reasonably practical measures to prevent accidents with radiological consequences, mitigate such consequences should they occur, and make the likelihood of serious accidents very low. It provides rules on mitigating the impact of accidents if the two safety requirements of nuclear and radiation safety are not fully met.

1.1.3.2. Route to the Thematic Scope and Focus

The route to the theme, *regulation of safety* in nuclear power generation, is a dual circuit which comprises the most quotidian and popular trio in nuclear law (safety, security, and safeguards *i.e.* the ‘3S’) on the one hand, and liability on the other hand. Using a two pronged ‘3S’+liability concept, it seeks to bring together these four elements, namely safety, security, safeguards and liability, in an attempt to show their inter-relationship, common origins, and relevance of each element on the other, *especially safety*. The point is not that the challenges and issues faced by one element could be read off the other. Rather the focus is to distil enduring eclectic and serious questions that they raise relative to safety, investigate the legal principles, concerns, background of ideas or forces that have shaped responses to those questions, and how nations have attempted or managed to construct those responses into a nuclear power safety regulatory regime.

After this journey into the historical and international vicissitudes of nuclear energy, the thesis cuts through the swathe of Ghana's laws, regulations and cases relevant to the inquiry to seek analogous correlations, gaps and best practices. It then becomes increasingly clear that, globally, safety is often identified as an all-encompassing integrating principle having *both* profound specificity and an abiding intrinsic capacity to adopt the '3S'+liability quartet precociously into the regulatory category of *nuclear safety regulation* (in a concentric cycle swirl and ripple, rather than by Venn linkages). Hence, this inquiry into the sufficiency of Ghana's regulatory regime for nuclear power generation uses safety as an interpretative key for discerning the '3S'+liability nuclear regulatory requirements that has at times engaged the attention of thoughtful people.

1.1.3.3. Geographic Scope and Focus

The study focuses on Ghana and its laws and cases. It draws on international law and best practices in a comparative case study approach. Relevant legal materials and regulatory systems of several geographical areas are discussed with a comparative perspective. Without any claims of representativeness, regulatory lessons and best practices of the USA and United Kingdom are discussed *at various stages* of the study. Examples from Switzerland, Sweden, South Korea, South Africa, Japan, India, Germany, France, Finland, and Canada are also used to illustrate widespread persistent similarities and consistency of practices in the very strictly regulated nuclear industry; as well as highlight policy frameworks and their effects on regulatory regimes.

1.1.4. Characterizing Issues: '3S'+Liability & Regulating Radioactivity Risk/Benefit

Nuclear energy poses special risks of ionizing radiation. Radioactivity has potential deleterious effects on health and safety of persons and the environment, yet, it has major benefits in various fields like medicine, agriculture, industry, and electricity. Risks and benefits of nuclear energy must be managed carefully, especially the generation of nuclear power (including nuclear fuel

cycle activities) which could involve excessive exposure to radiation or radiation substances. Ghana's policy decision to utilize nuclear power requires *regulations* that set the key terms under which the nuclear power programme will operate. There is the need for effective regulations that are well designed – and enforced. Such a regulatory regime must adopt a “cradle to grave” approach to provide for *planning, siting, design, manufacturing, construction, commissioning, safe operation* and *decommissioning* of Ghana's proposed nuclear power plant in a manner that protects public health and safety, and the environment against radiation and non-radiation issues. **But, how should it be done?** As Prof. Michael Reagan notes, “[t]he real questions for the future, ... are not whether to regulate for health, safety and the environmental protection, but how to do so – most effectively, least expensively, and with a minimum of adversarial squabbling.”⁴⁸

Nuclear power regulation, like a Gordian knot, is a complex matter. To cut such a Gordian knot⁴⁹ requires *a full review of the sufficiency of existing and proposed nuclear regulatory regimes*. The “3S”+liability guide (*i.e.*, safety, security, safeguards + liability) provides broad headings for categorizing several *issues* that should be raised during such review. An analysis of issues using the substantive content of the legal norms they embody or relate to, must go in tandem with the legal nature and origin of those norms as well as the local contextual requirements, needs or gaps they are meant to deal with. *Appendix C* provides details of this approach.⁵⁰ The “3S”+liability concept is a major topic. Chapter 2 discusses and critiques the safety prong of the concept as part of an extensive literature review. What is presented hereunder is a brief skim of some issues to

⁴⁸ Michael D. Reagan, *Regulation: The Politics of Policy*, 111 (Boston: Little, Brown & Co, 1987)

⁴⁹ The Gordian knot is based on a Phrygian legend, about Alexander the Great, from which developed the proverbial expression “*to cut the Gordian Knot*”, meaning to cut right to the heart of a matter without wasting time on external details. See B. W. Burke “Anatolian Origins of the Gordian Knot Legend,” *Greek, Roman and Byzantine Studies* 42, 255-261 (2002); See also, L. E. Roller, “Midas and the Gordian Knot,” *Classical Antiquity* 3, 258-271 (1984). See also, The Gordion Archaeological Project, *The Gordian Knot* (Univ. of Pennsylvania, Digital Gordion) available at <http://sites.museum.upenn.edu/gordion/articles/myth/38-gordianknot> (last visited on 16 June 2012)

⁵⁰ See APPENDIX C (extracts from Stoiber *et al.*, Handbook on Nuclear Law: Implementing Legislation (Vienna: IAEA 2010))

be considered under a “3S”+liability focused inquiry into the sufficiency of Ghana’s regulatory regime to compel *safe* nuclear power generation. This study however focuses on safety. It uses safety as an integrating principle or interpretative key for discerning the ‘3S’+liability nuclear regulatory requirements as concentric cycles, rather than Venn linkages [See Section 2.4. *infra*]

1.1.4.1. Safety

Safety, here, deals with *unintended conditions or events* that may lead to *radiological releases from authorized activities*.⁵¹ It relates to intrinsic hazards. How does a regulatory regime ensure nuclear safety? Should the regulatory regime proscribe and totally forbid nuclear power? Should it permit it through a referendum? Should regulations provide for nuclear safety beyond the confines of the four main areas of nuclear safety as defined in international law and state practice, *i.e.*, radiation, nuclear, transport, and radioactive waste?⁵² Bearing in mind, also, that safety usually relates to *radiation protection* and *safety of radiation sources* (safety of sources). *Sources* come in different types, so *safety* is termed *nuclear safety*, *radiation safety*, *radioactive waste safety* or *transport safety*, depending on the source in question. *Protection* in nuclear law primarily deals with protecting humans against *exposure to radiation* whatever the *source*, so it is always *radiation protection*.⁵³ How should regulations take care of the means for achieving such protection of people and safety of sources? What regulatory functions must be prescribed?

Should the law insulate the regulatory body from the promotional and industry bodies and clothe it with independence? If so, how must it be done? And is independence of the regulatory body a

⁵¹ See Carlton Stoiber, *Nuclear Law Handbook*, *supra* note 38, at page 69

⁵² See IAEA, *Fundamental Safety Principles*, Scope, p.3, para. 1.9 (SF-1, Vienna: IAEA, 2006) See also, IAEA, *IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection* (2007 Edition)

⁵³ See, IAEA, *IAEA Safety Glossary: Terminology Used in Nuclear Safety and Radiation Protection* (2007 Edition). Also, *non-radiation issues* such as avoiding environmental deterioration, thermal pollution, improper land usage, grid zoning and load, maintaining quality electricity service at reasonable rates, etc., require regulatory intervention and are analyzed in this thesis.

sine qua non for its effectiveness and efficiency? Is the current structure of Ghana's Radiation Protection Board (RPB) inimical to independence of RPB from GAEC?⁵⁴ Should a regulatory law adopt a prescriptive approach or performance-based risk-informed self-regulation approach? Should regulations prescribe regulator reactivity or a proactive attitude rather? What about management of safety by operators and verification of operational safety culture? What principles of nuclear safety should be contained in regulations? How effectively may regulations seek to prevent *accidents* and mitigate consequences of *accidents* should they occur?

What about effective emergency preparedness and its coordination? What (additional) role(s) should be prescribed for existing institutions such as the National Disaster Management Organization (NADMO)? Which institution should lead in nuclear emergencies? Should regulations prescribe capacity building for the regulator, operators, industry, disaster responders, health workers, etc? Should engineering, technical design and operational protections be prescribed in a regulatory law? Should the law be technology specific? Or it should be flexible to allow operators to adapt practices and designs to new technologies without requiring any significant changes in the law? Are the processes required to protect the environment under the Environmental Assessment Regulations, Environmental Protection Agency Act and related laws in Ghana sufficient for nuclear power's environmental issues?⁵⁵ Where should a plant be sited and under what legal arrangements on zoning, land planning, grid size, and seismic dangers?⁵⁶

⁵⁴ *Supra*, notes 32-39 and accompanying text including Figure 1.1.

⁵⁵ Environmental Assessment Regulations 1999, LI 1652, Regulation 30 (1) – requires all undertakings including plans and programmes, which are likely to have significant environmental impacts to be subjected to environmental assessment in their planning (Strategic Environmental Assessment) and execution (Environmental Impact Assessment). This is to ensure that environmental issues are considered with socioeconomic issues at the early stages of plan preparation and implementation. Several gaps in the law are discussed in Chapter 2 below. Moreover, in addition to *radiological issues*, there are *non-radiation issues* such as avoiding environmental deterioration, thermal pollution, improper land usage, grid zoning and load, maintaining quality electricity service at reasonable rates, etc., that require regulatory intervention.

⁵⁶ Ghana recorded severe magnitude 6.5 earthquakes in 1862 and 1939. See, Junner, *et al.*, *The Accra Earthquake*, *infra* note 58

Should private commercial entities be permitted to establish nuclear power plants or it should be a field fully occupied by the government given the risks involved? Are existing laws sufficient? Given the long lead time to establish a nuclear plant, how can the regulatory regime insulate a nuclear power project from lethargic political will especially in cases of change of government or party in power, considering Ghana's experiences? Should regulatory laws be scattered in various legislations covering different areas of nuclear energy governance? Is a very comprehensive regulatory law that synergistically cover various areas of nuclear power preferable? The issues on safety are endless and cross-cutting and some are closely linked to security and safeguards. In the nuclear sector one can "never say the task is done. It is an inherent responsibility to explore, examine and assess ... significance of nuclear safety and security vulnerabilities continuously."⁵⁷

1.1.4.2. Security

Security, the second component in the "3S" concept, usually addresses the *intentional misuse* of nuclear or other radioactive materials *by non-state elements* to cause harm (Stoiber 2012:219). It also relates to external threats to facilities and materials (Gehr 2007:1; Jankowitsch 2008:883). How may physical protection, intelligence gathering, law enforcement be coordinated, regulated or enforced to implement substantive norms and principles of physical security? (Dupuy & Hoss 2005:225). Are Ghana's laws on terrorism, crime, extradition, punishment, etc, sufficient?

1.1.4.3. Safeguards

Safeguards (i.e., *non-proliferation*) restrain *States activities* that could lead to *the acquisition of nuclear weapons or other nuclear explosive devices*. It ensures peaceful purposes only in nuclear energy uses. It binds States to their international legal commitments on *non-proliferation*, if any.

⁵⁷ See IAEA, *IAEA International Expert Meeting on Fukushima Accident Proposes Safety Improvements* (13 March 2012) (quoting a statement by the meeting's Chairman Richard Meserve) available at <http://www.iaea.org/newscenter/news/2012/fukushimasafety.html>

Are strict controls on import and export of nuclear technology transfer in place? The key issue here is whether the regulatory framework provides for true accountancy, containment, surveillance and inspections by IAEA as required by Ghana and IAEA's Safeguards Agreement? Are existing border control measures effective? Should regulations prescribe additional rules on import and export of nuclear or radiation sources and their related equipment and materials?

1.1.4.4. Liability

Liability deals with the *legal regime* to compensate for nuclear damage (Pelzer 2012:355). What liability regime is best suited for nuclear activities in Ghana? Should it be based on torts; or insurance only as pertains in international conventions and in many countries? If insurance, which of the existing international schemes might better fit Ghana's circumstances? Must it be absolute strict liability without exceptions for some *force majeure* incidents like extraordinary acts of God as pertains in UK? Or should it rather be strict liability as in *Rylands v. Fletcher*, with exceptions for extreme natural disasters as in Japan? Although, seismically, Ghana is in a relatively stable region that rarely experiences earthquakes, it has a record of severe infrequent seismic activity with two of them reaching magnitude 6.5 on the seismic scale in 1862 and 1939, and 4.7 thirty years later in 1969.⁵⁸ Should international trans-boundary radiation harm of large scale proportions be dealt with differently from common and quotidian gradual emissions of pollutants that may cumulatively have potentially devastating consequences? Also, how may the precautionary principle, which holds that action to prevent serious environmental harm should be taken even in absence of clear scientific evidence of a causal link, be balanced with the *clear and convincing evidence* standard of *Trail Smelter Arbitration*? (Craik 2005:112; Handl 2005:125; McCaffrey 2005:39; Miller 2005:174; Nanda 2005:191; Okowa 2005:201; Van Dyke 2005: 207)

⁵⁸ See, N. R., Junner, *et al.*, *The Accra Earthquake of 22nd June 1939*. Gold Coast Geological Survey (Bulletin No.13, 1940); See also, Thomas Akiti, *Seismic History and Social Concerns in the Selection of Site for a Nuclear Power Plant for Ghana* (Vienna: Presentation, 2011) (listing other earthquakes from the 1600s to date, including 1906 (5.0), 1964 (4.5), 1969 (4.7), etc)

1.2. Statement of Research Problem

In 2007, Ghana officially expressed to the IAEA an interest in deploying a nuclear power plant to form part of the electricity grid to assist her achieve economic growth targets. Nuclear power requires effective regulatory regime that conforms to international nuclear laws on siting, design, construction, commissioning, operation (and decommissioning) of nuclear facilities. The primary rationale for strict regulation of nuclear power plants is protection of the public and environment against the risks and consequences of exposure to radiation; be it from unintended accidents or intentional malicious acts and malevolent sabotage by non-state criminal or terrorist elements. Ghana's laws on nuclear energy are deficient and they do not provide a regulatory framework for nuclear power. There is the need for Ghana to enact relevant national legislation to domesticate ratified international instruments and provide for effective regulation of nuclear power in Ghana.

Perceived nuclear regulatory deficiencies in Ghana have often been critiqued. Perhaps the utmost criticism of nuclear energy regulation in Ghana is that safety and radiological protection for people and the environment are statutorily entrusted to the Radiation Protection Board (RPB) in a statutory scheme that places RPB *under* GAEC, the agency primarily devoted to the promotion of nuclear energy. RPB has the sole mandate under LI 1559, to authorize, license, inspect and control all activities and practices involving radiation sources, radioactive materials and related matters. It is the *de jure* and *de facto* regulatory body on such matters (and does so through the Radiation Protection Institute).⁵⁹ Yet, GAEC, the promotional body for nuclear operations in Ghana, is also a *de jure* and *de facto* regulator under the current regulatory scheme. (*See supra* notes 32-39 & Figure 1.1. and accompanying text for a synopsis on this and other related issues).

⁵⁹ See Regulation 2 of the *Radiation Protection Board Legislative Instrument*, 1993 (LI 1559) for the licensing duties of the RPB. The Radiation Protection Institute (RPI) is one of the Institutes of GAEC and created by GAEC in February 2002, in pursuance of Section 3(1)(c) of the Ghana Atomic Energy Act, 2000 (Act 588) which authorises GAEC to establish Institutes.

Moreover, the Radiation Protection Institute (RPI) is one of the Institutes of GAEC. RPI was created by GAEC in February 2002, in pursuance of Section 3(1)(c) of the Ghana Atomic Energy Act, 2000 (Act 588), which authorises GAEC to establish Institutes. The RPB continues its role as the regulatory authority and *serves as the Managing Board* of RPI. But Section 3(1)(c) of Act 588 provides that *GAEC shall exercise control over the Boards of Management of the Institutes established by GAEC.*⁶⁰ Whether the Nuclear Regulatory Authority, the proposed successor to the regulatory functions of the RPB, can satisfy critics who feel the RPB and GAEC regulatory family unity unduly favours GAEC's promotional responsibilities remains to be seen. But it will mainly depend on the effectiveness of the proposed Nuclear Regulatory Authority Bill which has been drafted, and is to be submitted to Parliament for enactment. (It is analyzed in Chapter 6).

Therefore in sum, the first part of the problem is that Ghana has a deficient regulatory framework for nuclear energy with no enactment on nuclear power, and so it must be developed. The second part of the problem is that there is no comprehensive framework for evaluating regulatory effectiveness in Ghana and, thus, it must be constructed, so that based on it, a suitable regulatory regime can be crafted. Third, a body of *legal* literature on nuclear energy regulation in Ghana that would inform discussions and assist public education on the subject does not exist and, therefore it must be developed. Fourth, radioactivity is one of the few subjects in the field of environmental pollution to which people react so emotionally with real deep fears, very strong objections, and at times, gravely wild and lurid imaginations. It is thus vital to have in place legal and regulatory controls, in which the public can have full confidence, to protect or 'safeguard'

⁶⁰ Section 3(1) of the Ghana Atomic Energy Act, 2000 (Act 588) provides for the functions of GAEC. Section 3(1)(c) states that "[t]he functions of the Commission are ... to establish, for the purposes of research and in furtherance of its functions, Institutes of the Commission and to exercise control over the boards of management of the Institutes".

them against the risks which they fear, prevent radiation exposure, and ultimately avoid any long term or irreversible damage to people, property and the environment.

1.3. Research Questions

1. Whether Ghana's nuclear power regulatory regime is sufficiently effective to deal with the stern questions on the dangers of nuclear power; and, what key issues are relevant in assessing and developing an optimally effective nuclear regulatory regime in Ghana?
2. Whether it is necessary, and if so, how to involve lay public in all aspects of nuclear energy with candour and transparency despite the technical nature of the field?

1.4. Hypotheses

Four (4) hypotheses are encapsulated in the *first* research question's multilateral test; and a fifth hypothesis is tested by the *second* research question which seeks to provide a socio-legal context for the incorporation of public involvement and public acceptance processes into nuclear power regulation in Ghana. The five (5) hypotheses tested by the research questions are as follows:

1. Effectiveness of Ghana's nuclear safety regulatory framework is best measured by using the two-pronged "3S"+liability concept (*i.e.*, safety, security, safeguards + liability).
2. The proposed Nuclear Bill, 2012 is a sufficiently effective regime but it can be improved.
3. Using risk-informed performance-based self-regulation to complement broad prescriptive regulatory rules has contributed to the nuclear research reactor safety record in Ghana.
4. Liability for nuclear damage is best based on torts and insurance pools in Ghana.
5. Technical experts' open attitude to inform and involve people lacking technical expertise, as necessary interested parties, results in acceptable decisions that respond to areas of public concern (areas learnt about in the interaction), and enhances public confidence.

1.5. Objectives of the Research Study

This research study sought to meet the following objectives:

1. To produce a framework for evaluating Ghana's nuclear regulatory regime by identifying or characterizing elements or issues to be analyzed and the applicable "3S"+liability tools for analysis; and show how all these fit together in the overall evaluation approach.
2. To evaluate Ghana's nuclear regulatory readiness (*i.e.*, sufficiency and effectiveness of the regulatory regime to govern Ghana's nuclear power generation) against the evaluation framework, so as to determine Ghana's regulatory readiness status and cautiously identify optimally effective nuclear regulatory regime approaches for Ghana.
3. To analyze and identify synergies in risk-informed performance-based self-regulation and prescriptive regulations and show how they complement each other to improve safety.
4. To identify the best nuclear liability regime for Ghana in case of nuclear damage.
5. To identify key public-industry-relations questions nuclear operators and regulators can ask introspectively, and act thereon, to inform, involve and engage the public to improve public confidence and trust on all issues; and better respond to areas of public concern.⁶¹

1.6. Methodology of the Research Study (Discussed in Chapter 3 in more detail)

The study combines doctrinal normative and comparative legal analysis with empirical studies and socio-legal approaches. The legal analysis constitutes the core of the study. The first research question (section 1.3 *above*) could be tackled effectively through legal analysis. The socio-legal approach then goes beyond the text of law to consider context and, often, subtext:⁶² in an interdisciplinary approach to analyse law, legal phenomena, and the relationships between these

⁶¹ A question that captures aspects of respondents' expectations might be framed as follows: What should we do on this issue to reach out to, inform, and involve the public in what is being planned, before the fact, not after the fact, with sufficient notice and explain actions in language the public can understand, with full confidence in the public's ability to make intelligent judgments and provide feedback to guide decisions that respond to areas of public concern identified in the interaction?

⁶² See Brian Tamanaha, *Realistic Socio-Legal Theory: Pragmatism and a Social Theory of Law* (Oxford: Clarendon Press, 1997)

and wider society. The socio-legal approach supplements the legal analysis with relevant context by relating it to an examination of law and society relations in regulatory regimes.⁶³ Empirical studies, public views on nuclear power and its regulation, and the ‘3S’+liability concept also shaped this study’s evaluation framework. Ghana’s legislation, regulatory laws and regulatory options on nuclear power were analysed using assessment criteria comprised in the ‘3S’+liability evaluation framework as terms of reference to identify an optimal nuclear regulatory regime. (Chapter 3 *below* provides very detailed information on the methodology used for this research).

1.6.1. Data Collection Methods and Strategies

The input to this study comprised *qualitative* data collection methods and strategies, including an extensive literature review of nuclear energy, regulation, and nuclear power regulatory regime options. It covered pertinent international nuclear law, national legislation on nuclear energy, environment, land use planning, and liability for harm; statutory and common law. A *case study* was conducted on both RPB and GAEC as the regulatory and promotional-cum-quasi-regulatory bodies for nuclear energy in Ghana respectively. *Quantitative* official data were also utilized.

Empirical studies, non-controlled semi-structured and unstructured *observation* and *participatory* methods were used to obtain qualitative primary data from RPB and GAEC on what is currently happening on the nuclear power project. Focussed *interviews* were also conducted using supplementary questions that aim at specific mop up clarifications to information gathered during the observation and participation phase. *Questionnaire-based survey* of public perceptions on nuclear power was also extensively administered to obtain primary data.

⁶³ See Amanda Perry-Kessaris, *What Does it Mean to Take a Socio-Legal Approach to International Economic Law?* (In SOCIO-LEGAL APPROACHES TO INTERNATIONAL ECONOMIC LAW: TEXT, CONTEXT, SUBTEXT, A. Perry-Kessaris, ed., Routledge, 2012) (Abstract available at SSRN: <http://ssrn.com/abstract=2085007>)

1.6.2. Conceptual Framework for the Research Methodology

The conceptual framework for this research comprised the use of the ‘3S’+liability concept as a tool to produce an evaluation framework to gauge Ghana’s regulatory readiness and identify an optimally effective nuclear regulatory regime for Ghana. It followed five interrelated steps: (1) *formulation*, (2) *verification*, (3) *validation*, (4) *assessment*, (5) *identification, development and proposal*. The first step in the process was to *formulate* a framework for evaluating or assessing a nuclear power regulatory regime to test its effectiveness using literature review data as input. The second step in the process was to *verify* the framework conceptually not with the literature review data only, but also by a case study of nuclear energy experts in Ghana and elsewhere.⁶⁴

The experts comprised scientists, lawyers, and regulators at GAEC, Radiation Protection Board, Radiation Protection Institute, and the National Nuclear Research Institute (operators of GAEC’s 30kW Chinese-built tank-in-pool Miniature Neutron Source Research Reactor *viz.*, GHARR-1). Relevant documents on Ghana’s nuclear power program, including key plans, procedures and the proposed Nuclear Authority Bill were also used as input for the case study. A protocol was developed as a guide for the case study to control my objectivity in the observation and participation method utilized for some aspects of the case study. The framework verification was further enhanced by views of seasoned international nuclear law experts at the IAEA, OECD’s Nuclear Energy Agency, International Nuclear Law Association and *many* others.⁶⁵

⁶⁴ The International Atomic Energy Agency (IAEA), Nuclear Energy Agency (NEA) of the OECD, University of Ghana, North West University of South Africa, University of Giessen in Germany, the Ghana Atomic Energy Commission, International School of Nuclear Law in Montpellier, France, Nuclear Law Institute of the IAEA in Vienna, Austria, the University of Dundee’s Centre for Energy Petroleum Mining Law and Policy (CEPMLP), International Nuclear Law Association (INLA), Ghana Nuclear Society (GNS), African Nuclear Law Association (ANLA), University of South Florida, Carnegie Global Scholars Exchange Program, International Consortium on Law and Strategic Security, and many other institutions and people provided funding, resource, and other vital support as well as opportunities for study, research, interview, participation and observation methods utilized in this study. International Consortium on Law and Strategic Security (sponsored my observation of, and participation in, NPT & UN Security Council Resolution 1540 Meetings and Symposia in New York)

⁶⁵ *See id.*

The third step *validated* the relevance of the evaluation framework with outcomes and feedback from seminar presentations organized by the Ghana Nuclear Society, GAEC, ORID, and also at the University of Ghana's Graduate School of Nuclear and Allied Sciences, Faculty of Law, and USF. Further *validation* of the safety framework was done through follow-up interviews; and a questionnaire survey that sought to have a qualitative public perception on nuclear power risk and how it should be regulated in Ghana. The fourth step used the validated evaluation framework to *assess (evaluate)* Ghana's existing nuclear regulatory regime (including the Nuclear Authority Bill) to *identify gaps* if any. The fifth step *developed and proposed* key elements that might have to be included in an effective nuclear regulatory framework in Ghana.

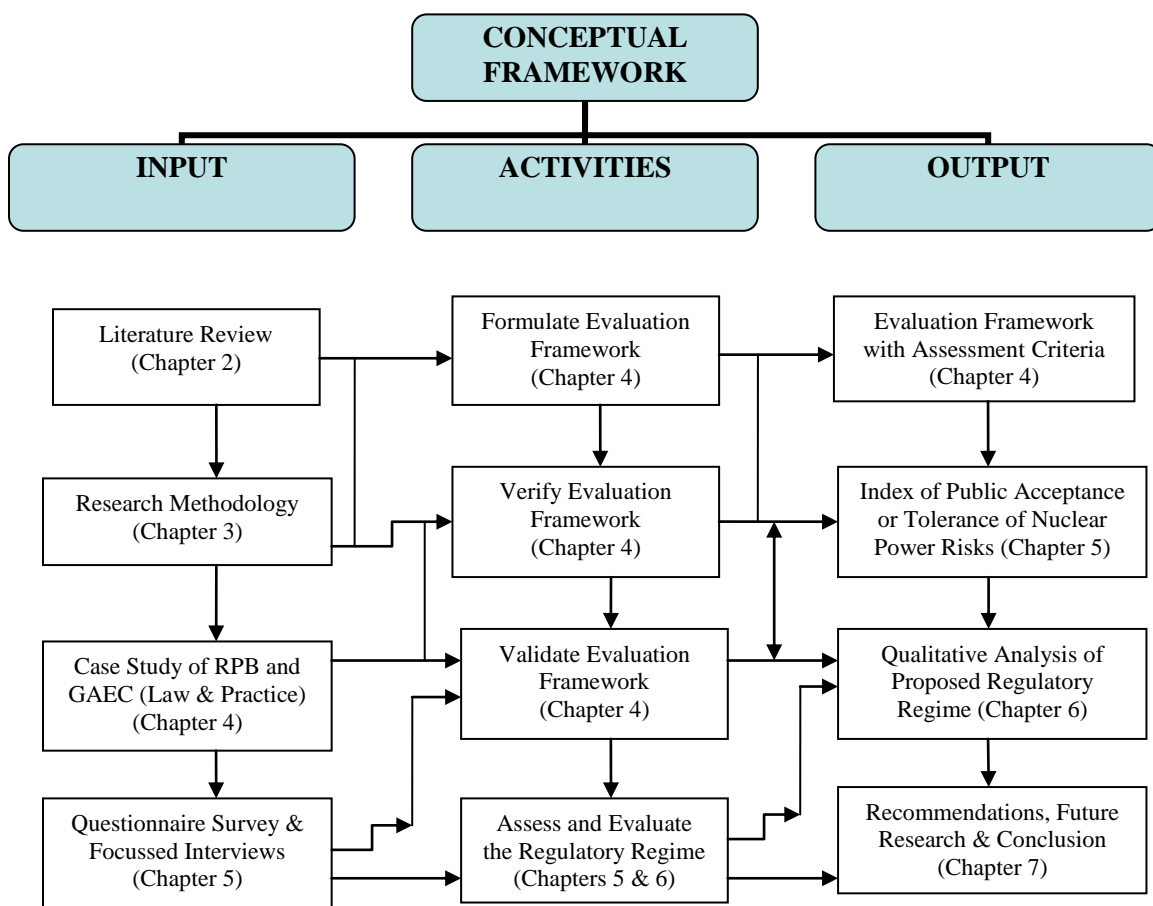


Figure 1.3: Conceptual Framework for the Research Study

The conceptual framework for this study follows a pattern similar to a logical framework matrix. It summarizes the main elements of the programme of work by connecting them to each other. It aids the process by which those elements are formulated, verified by triangulation, validated and utilized progressively to achieve outputs (results) and outcomes (objectives) that address stated goals (problem statement aims or hypotheses tested) (Dale 2003:58-59). The expected outputs or results of this study include: (a) an evaluation framework comprising specified factors within the '3S'+liability set of criteria for evaluating nuclear regulatory sufficiency and effectiveness in Ghana, (b) qualitative analysis of a sufficiently effective nuclear regulatory regime, (c) a survey result of public perception on nuclear power, (d) a proposed nuclear power regulatory regime for Ghana, (e) area for future research, and (f) conclusions.

1.7. The Significance of the Research Study

The significance of this research study is that it provides an opportunity to revisit research concerns on the topical subject of nuclear power which, paradoxically, has not been thoroughly addressed in Ghana and make fresh and original legal and scholarly contributions, focused on Ghana, that add to the corpus of knowledge in the nuclear field globally. This study thus introduces and develops new knowledge on effective regulation of nuclear power for electricity generation in Ghana. It extensively and exhaustively deals with both prongs of the '3S'+liability concept for the development of an effective nuclear regulation by aptly analysing the concept. The public perception survey and its analysis also provide primary and original data to contextualize this research inquiry. These inputs should contribute considerably to the development of a sufficiently effective nuclear power regulatory regime to respond to serious questions and issues on nuclear safety, security, safeguards, and liability; and further address deeply held public concerns about radioactivity in Ghana.

In terms of timeframes, the resuscitation of Ghana's nuclear power project is recent and ongoing. It is thus vital to have a rigorous research and analysis that considers the possible radiological impact on public health and the environment and their legal consequences; and legal issues on environmental degradation, thermal pollution, grid zoning, emergency preparedness and response, liability for harm, etc. It is particularly important to do so for a project that is still being planned, as in Ghana's case. It should add to the efforts in the nuclear energy sector to consider the multivariate challenges a nuclear power project faces and how they may be addressed, at least from the legal and regulatory point of view. The study should also be useful in contributing information on the implementation of Ghana's policy and strategy on nuclear power and some of its impact on electricity generation.

A study of this value can best be expressed in a well-structured, detailed and analytical research on optimal regulatory options for Ghana as this academic thesis seeks to do. Use of legal analysis and socio-legal approaches further enhance the instrumental role of law in devising a nuclear regulatory regime that is in tune with Ghana's development agenda. This thesis provides assessment criteria for evaluating or proposing an effective regulatory regime. It also provides good historical, empirical and analytical context to guide on-going efforts to enact a nuclear power regulatory law in Ghana. This study has the potential of serving as a useful academic resource for students of law, nuclear science, engineering, sociology, public administration and environmental studies. It should also be of interest to all those concerned about nuclear power and its future, and in particular, its impact on the health and safety of the public; and on trans-generational equitable and sustainable development.

1.8. Organization and Structure of the Thesis

This thesis comprises seven chapters in alignment with the conceptual framework (described in section 1.6.2. & Figure 1.3. *above*). The current Chapter provides an introduction to the study.

Chapter 2 is a literature review. It provides a background to nuclear power regulation. It traces nuclear energy's history and how it has been regulated to date from its very beginnings to distil persistent regulatory patterns that have endured in nuclear power countries for more than half a century to provide useful lessons for this inquiry. It provides the historical analysis in a comparative law inquiry. It also discusses the key concepts that frame the analysis, *viz.*, nuclear energy regulation, safety, security, safeguards, liability, public perception on radioactivity, the environment, and regulation approaches as understood in international law. It then explores and analyzes the laws, institutions, and policy rationales for nuclear power in Ghana with the overriding view of identifying the gaps that this study should fill in order to make an original and useful contribution to this field. It then uses the literature review insights to identify key elements that are relevant in formulating an evaluation framework to assess the effectiveness of nuclear energy regulations. (The real *formulation* of the evaluation framework is done in Chapter 4).

Chapter 3 describes the methodology used to conduct this study. It discusses the doctrinal and comparative legal analysis method that was used to investigate and critique the substantive content of norms. It further describes the socio-legal approach that was used to provide context for the legal analysis, and identify origin and legal nature of norms. It also provides information on the qualitative research methods adopted for this study. These include literature research, legislation analysis, case study based on an observation and participatory method, follow-up focussed in-depth interviews, questionnaire-based survey of expert and public views on nuclear power and its regulation in Ghana as well as analysis and synthesis of data gathered.

Chapter 4 is on the formulation, verification and validation of the evaluation framework. It uses a case study of GAEC and Radiation Protection Board, as well as literature review insights on key elements of a nuclear energy regulatory evaluation framework to *formulate* an evaluation

framework that is attuned to Ghana's context. It *verifies and validates* the proposed framework using the literature review and the case studies output, views of seasoned international nuclear law experts, data from *validation* follow-up interviews, and a questionnaire survey that sought to have a qualitative public perception index on nuclear power risk and how it should be regulated in Ghana. The verification and validation seeks to do three things: it triangulates the relevance of each evaluation criteria element, ensures that the evaluation framework is comprehensive, and that all the relevant criteria for assessing a nuclear regulatory regime apposite to the systems, institutions and laws of Ghana are incorporated within the evaluation framework. Outcomes and feedback from experts, and ordinary views on nuclear energy regulation add crucial value to the relevance of the evaluation framework. This Chapter further provides empirical data that addresses the *second* research question – (in Chapter One's Section 1.3. *above*) – on the need to involve public in decision making to improve public perception, tolerance and confidence.

Chapter 5 tackles the pith of the *first* research question – (in Chapter One's Section 1.3. *above*) – *i.e.*, the sufficiency of Ghana's regulatory regime to deal with the serious questions that nuclear power triggers: safety, security, safeguards, liability, etc., and how any gaps in Ghana's nuclear regulatory regime should be addressed. It builds upon the detailed work and analysis undertaken in Chapters 1, 2, 3, and 4; and uses the validated assessment criteria comprised in the evaluation framework to evaluate and explore possible ways of strengthening the nuclear regulatory regime. It comparatively investigates and identifies practical and optimal options on effective nuclear regulatory regimes that comply with international law and other international requirements. It also explores how to reconcile international requirements with Ghana's domestic context and resources, especially capacity building and strengthening, and maintaining high safety standards.

Chapter 6 focuses on the proposed Nuclear Regulatory Authority Bill. It analyzes the Bill, makes specific and general recommendations to enhance some of its provisions and proposes its enactment by Parliament. It crafts a legislative instrument template to guide the drafting of an effective regulatory regime for safe nuclear power generation in Ghana. Finally, the conclusion (Chapter 7) summarizes the key findings of this study and makes recommendations to enhance the effectiveness of the regulatory regime for Ghana's nuclear power programme.

1.9. Limitations of the Study

The study adopted the '3S'+Liability concept (safety, security, safeguards, liability) in nuclear power regulation but it focused on *safety* mainly. This thesis' analysis of security, safeguards and liability was not extensive: they have to be reviewed in-depth in future research studies. When it comes to *safety*, this study is limited to the regulation of safety in nuclear power generation (fuel use in the reactor, or conversion of nuclear fission energy to electricity, and the storage of both fresh and spent fuels at the reactor), not nuclear waste safety, nuclear transport safety, radioactive material transport safety, etc. These other types of nuclear safety could form the key focus of future research studies to provide relevant information to guide the implementation of Ghana's proposed nuclear power project. Other areas for future research may include detailed multidisciplinary inquiries on nuclear regulatory management systems, cost-benefit analysis of regulatory framework options, nuclear Spent Fuel and Radioactive Waste Management in Ghana, and the other prongs of the '3S'+Liability concept.

This study is essentially a qualitative study with very limited quantitative research analysis. But legal analysis and qualitative or impressionistic information is usually desirable for studies of a subjective nature like this which is concerned with issues of meaning, truth as seen by the participants in the study and purpose (Twala 2007:217; Trochim 2006). Although this approach is based on rationale explained in the research methodology (Chapter 3 *infra*), yet, it is characterised by some weaknesses:

- The survey sample for questionnaires administration to obtain survey data for this study was a non-probability sample. Consequently, the weighting of the views of the participants was not statistically representative but rather indicative. This study focused more on obtaining views than numbers, although much effort went into obtaining a fairly large survey sample of 546 respondents. The weighting of the views by the number of the participants was necessary in order to obtain a reasonable overall average rating of the views and opinions.
- Moreover, the respondents were based in Accra mainly, so the sampling of respondents was not nationwide in scope for a full representative study. However, the cosmopolitan nature of Accra and its residents provided the study with a very widely representative survey sample.
- Not all the respondents targeted for the survey participated. Some of them declined and gave reasons; others returned their questionnaires uncompleted, while others did not respond to or return the questionnaires at all and gave no reasons.

Literature on the subject was unavailable in Ghanaian libraries. Time was also a scarce resource in the research and writing activities for this thesis: In the first year of my PhD studies, I was at post as a full-time lecturer and Law Faculty Examinations Officer. Given the specialized nature of nuclear energy law, time for extensive reading and interviews, observation and participation in the activities of nuclear energy related entities and experts were crucially needed to enhance my understanding of the subject. UG eventually granted me study leave, funding, space to write, and opportunities for my work to be critiqued and improved. Thus, notwithstanding the time and resource limitations, and the surveys not being statistically representative, the study nevertheless appears to have uncovered all the qualitative considerations regarding the framework for evaluating safety of nuclear power generation as investigated in this study. This research should thus considerably contribute to educative resources that guide rational responses to the emotive question of nuclear power generation safety.

CHAPTER 2: HISTORICAL BACKGROUND & LITERATURE REVIEW

“Literature” for purposes of this review includes materials which are usually excluded from ‘literature’ reviews (such as reports). The extensive thorough critical research on the existing body of knowledge on the subject aimed at identifying gaps to be filled by the study and provide information on Ghana’s nuclear regulation, considering the dearth of literature on the subject in Ghana. To maximize space, convenience, and enhance user-friendliness of the study, standard Social Science and Harvard Blue Book footnoting styles were both used in this thesis by design.

2.1. Nuclear Safety Regulation

Establishing and maintaining strong regulatory frameworks for nuclear safety is a core industry requirement globally (EC 2012:7; Handl 2003:7; IAEA 2011:2; Jankowitsch 2006:157; Reyners 2010; Stoiber et al 2003:4; Tonhauser & Wetherall 2010:158; Tromans 2010; Wetherall 2005:71; Zillman 2008). The main nuclear safety objective is to protect people and the environment from harmful effects of ionizing radiation (IAEA 2011:2; IAEA 2006:4). A regulatory system for nuclear safety must assess, manage and control exposure to radiation and reduce radiation risks as low as reasonably achievable (Stoiber et al. 2003:63). Principle 2 of IAEA’s ten Fundamental Safety Principles also requires that an “effective legal and governmental framework for safety, including an independent regulatory body, must be established and sustained” (IAEA 2006:6; IAEA 2010). Domestic regulatory requirements on nuclear power must take due account of international standards (CNS/RM 2005:3; Handl 2003:14; Jankowitsch 2006; McMillan 2000).

IAEA, in its authoritative Handbook on Nuclear Law, authored by Stoiber et al. (2003), and its Implementing Legislation supplement (Stoiber et al. 2010), provides an apt summary of nuclear regulatory law; and they also emphasize that there is no single model for regulation. Stoiber et al. (2003:viii) note “there is no definitive, single model of how to draft nuclear energy legislation or

of which institutional framework can best implement a national nuclear law.” An effective nuclear legislation must fit into a State’s overall legal and regulatory structure and reflect its nuclear programme’s level and direction (Stoiber et al. 2010:2). Common identifiable features of nuclear energy regulation are evident in the interrelations between safety, security and safeguards which must be reflected in a regulatory regime in a comprehensive and consistent manner (Horbach 1999; Stoiber et al. 2010:2). As Zillman (2008:328) sums nuclear regulation, “a government is required to license many of the crucial aspects of nuclear operations including the building and operation of a nuclear generating plant. [G]rant of license to construct and operate the plant is followed by a lifelong plan for inspections and relicensing by the government agency.” Regulation (to authorize, inspect & enforce) must conform to international standards and best practices on nuclear safety (CNS/RM 2005:3; Jankowitsch 2010:15).

In the area of *safety*, there are four key multilateral conventions and several codes, standards and requirements that States seeking to use nuclear power are expected to adhere to.⁶⁶ Of the four (4) conventions, Ghana has ratified the 1994 Convention on Nuclear Safety (in 2011), and acceded to the 1997 Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (in June 2011), but it is not a party to the 1986 Assistance and 1986 Early Notification Conventions.⁶⁷ In addition to international standards on nuclear power regulation, countries must also have consistency between national nuclear power regulations and

⁶⁶ Convention on Early Notification of a Nuclear Accident (INFCIRC/335); Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (INFCIRC/336); Convention on Nuclear Safety (CNS) (INFCIRC/449); Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (INFCIRC/546); Code of Conduct on Safety and Security of Radioactive Sources (2004); Guidance on Import and Export of Radioactive Sources (IMP-EXP/2005); Code of Conduct on the Safety of Research Reactors (2006); International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources (SAFETY SERIES NO. 115); Regulations for the Safe Transport of Radioactive Material (SAFETY SERIES NO. TS-R-1 (ST-1, REVISED 2009)); Legal and Governmental Infrastructure for Nuclear, Radiation, Radioactive Waste and Transport Safety Requirements (GS-R-1 2010) [See *International Legal Framework on Nuclear Power* in Section 2.2. *infra*] [CNS and Joint Conventions are the core preventative nuclear safety conventions. Early Notification and Assistance conventions focus essentially on cure. Nuclear safety conventions herein refers to preventative ones]

⁶⁷ See IAEA, Nuclear Safety and Security: Conventions and Codes, at <http://www-ns.iaea.org/conventions/default.asp?s=6&l=44> [See Section 2.2. *infra* for a discussion on the substantive norms of the International Legal regime on nuclear safety]

other domestic laws on the environment and related fields. Though nuclear safety's international treaty regime, described as a singular accomplishment of nuclear energy law (Pelzer 1995:197), appears to have "the major elements" of the IAEA's planned "international legal regime on nuclear safety ... finally in place [with the entry into force of the Joint Convention in 2001]" (Handl 2003:7), and there is "arguably no international perception that the existing instruments have become obsolete or irrelevant" (Jankowitsch 2010:30), yet the system has its criticisms.

Boustany (1998:39) describes nuclear safety lawmaking as the "art of legal 'evasion'" resulting in nuclear safety laws that are "caught in the trap of 'soft law' and 'nebulous law'" with "[o]ne soft law [giving] rise to another, as in a perpetual motion imposed, despite itself, by the evasiveness of Governments." This critique of the apparent "soft law" nature of the nuclear safety regime "differ in scope and intensity, [but] they virtually all evince unease about the normative quality, the "softness" of many of the Conventions' substantive provisions" (Handl 2003:12). To Washington (1999:213), the nuclear safety conventions do not appreciably advance the internationalisation of the nuclear safety regime. To others, they are "in-ward looking, insular [in] character" (Kaminga 1994:881), safety requirements have "mother and apple pie sentiments" (Cameron 1999:127), "critically important substantive provisions ... suffer from normative indeterminacy or are subject to very significant reservations" (Handl 2003:12),⁶⁸ "are merely hortatory, encouraging Contracting Parties to take action but defining the obligation in the softest of soft terms" (Cameron 1999:126), "[k]ey operational safety obligations ... are qualified by ... 'weasel words' as 'reasonably practical' and 'as soon as practicable'" (Handl 2003:12),⁶⁹ it lacks clearly established, sufficiently specific, or legally meaningful international safety provisions (Marple & Cerullo 2000:1222); and "normative significance" is compromised (Handl 2003:12).

⁶⁸ Criticizing CNS' preamble emphasis on IAEA's fundamental safety principles ... rather than of the detailed safety standards.

⁶⁹ Referring to Article 6 of the Convention on Nuclear Safety (1996)

Nuclear safety conventions are characterised as “incentive conventions” in their preambles; and they are based on the two key pillars of soft substantive provisions and “non-coercive procedural mechanism” of peer reviews to achieve safety objectives (Handl 2003:8; Stoiber 1999:110). Soft enforcement procedures in nuclear safety conventions (Birnie & Boyle 2002:463; Jankowitsch 2006:164; Stoiber 1999:100) attract continuing debate that has brought to the forefront some of the eternal polemic policy issues of whether or not to subject national nuclear power facilities of sovereign States to a coercive international jurisdiction and control regime or use facilitative, cooperative approaches rather (Lang 1998:382; Stoiber 1999:100; Washington 1999:215). Relying on “international peer pressure” and incentives of “enlightened self interest of states” (Jankowitsch 2010:30), in an inclusive institutional setting with collegial interactive review discussion among peers (States) seems well attuned to the nuclear industry where discourse, continuous improvement and assessment of safety culture are core requirements.

Discourse among States or their expert representatives on a highly beneficial technology defined by its intrinsic deleterious potential, inspires legitimate expectations of interactional self-regulation, information sharing and transparency to deepen cooperation and commitments, and eventually expand undertakings (CNS/RM 2011; Downs et al. 2000:467; Haas & Sundgren 1993:406). Stoiber (1999:110) observes: “The ‘incentive’ character of the CNS puts issues of compliance and non-compliance in a much different light than for other multilateral instruments. No sanctions or penalties flow from the fact that a nation has failed to comply ... and in any case peer review meetings will not be marking findings of non-compliance regarding any individual Contracting Party.” Necessitating this approach is the inherent complexity of devising “uniform international regulations for traditionally disparate national nuclear power technologies [and] safety philosophies and regulatory systems, [and] the political sensitivity of subjecting national

nuclear power facilities to international jurisdiction and control” (Handl 2003:8). Normative softness and variability of sanctions, evident in the safety conventions and laws, result in a socio-legal engineering and efforts by governments to “induce certain behaviour” by formulating “certain expectations” (Wetherall 2005:72; Rautenbach et al. 2006). Soft law, good practices, international norms, national legal framework, and ultimately a safety culture, are vital ‘co-existing components’ of an integrated international nuclear safety regime primarily enforced at the national levels by “conscientious application of existing safety principles, standards and good practices at each plant, and within each regulatory body making best use of national legal frameworks and working practices” (Jankowitsch 2006:157). “Content of the norm,” “legitimacy of the process by which it is adopted”, international context and “institutional follow-up” seems to impact on state decisions to comply or not to comply with specific norms (Wetherall 2005).

In 2001, the IAEA organized an International Conference on “Topical Issues in Nuclear Safety” (IAEA 2001). Issues discussed over a decade ago at the Conference still remain valid, and provide lessons apposite to *Fukushima* among other pertinent issues. Five topical issues were clustered and discussed: (1) Risk-informed decision making, (2) Influence of external factors on safety, (3) Safety of fuel cycle facilities, (4) Safety of research reactors, and (5) Safety Performance Indicators (IAEA 2001). The 2005 triennial Review Meeting of State Parties to the Convention on Nuclear Safety (CNS), after analyzing the needs and trends of regulatory regimes as required by Articles 4, 7, 8 and 9 of the Convention, acknowledged ongoing key regulatory reforms.⁷⁰ These reforms include first, a merger of regulatory responsibilities, previously separated among different agencies, into a single regulatory body; second, a convergence towards risk-informed regulatory approaches within the regulatory bodies of some States; third,

⁷⁰ Article 4 requires that “each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention”.

modern management systems being developed in regulatory organizations; and fourth, integrated safety oversight programmes including the use of performance indicators were also being developed (CNS/RM 2005:4). Evolution of these trends into standard nuclear industry regulatory practices is ongoing globally (Kadak & Matsuo 2007; Keller & Modarres 2008; CNS/RM 2011).

The IAEA in September 2011, with the unanimous approval of its General Conference of 153 Member States at the time, “in the light of the Fukushima accident”, adopted an Action Plan covering 12 main actions, each with corresponding sub-actions, for the sole purpose of defining “a programme of work to strengthen the global nuclear safety framework.” (IAEA/GOV 2011:2). It reaffirms the fundamental principle of responsibility in nuclear energy which at all times rest with the operator: “ensuring the application of the highest standards of nuclear safety and for providing timely, transparent and adequate response to nuclear emergencies, [and] addressing vulnerabilities revealed by accidents, lies with each Member State and operating organization” (IAEA/GOV 2011:1). The 12 main action points for nuclear safety urge member States to:

1. Undertake assessment of the safety vulnerabilities of nuclear power plants in the light of the lessons learned to date from the accident
2. Strengthen IAEA peer reviews in order to maximize the benefits to Member States
3. Strengthen emergency preparedness and response
4. Strengthen the effectiveness of national regulatory bodies
5. Strengthen the effectiveness of operating organizations with respect to nuclear safety
6. Review and strengthen IAEA Safety Standards and improve their implementation
7. Improve the effectiveness of the international legal framework
8. Facilitate the development of the infrastructure necessary for Member States embarking on a nuclear power programme
9. Strengthen and maintain capacity building
10. Ensure the on-going protection of people and the environment from ionizing radiation following a nuclear emergency
11. Enhance transparency ... communication and improve dissemination of information
12. Effectively utilize research and development

Nuclear power regulation mostly focuses on the *generation* aspect of the electricity value chain.

Electricity generation in this context refers to the nuclear power plant including its siting, design,

construction, commissioning, operation, and decommissioning. Other aspects of the electricity cycle are often covered by general laws and regulations applicable to the sources of electricity in the energy mix. Nuclear power regulation nevertheless has cross-cutting links in the electricity cycle which spans four main areas: *electricity generation, transmission, distribution, and supply* (Patterson 1999; Pollitt 1997).⁷¹ This thesis focuses on the very limited area of safety regulation in nuclear power generation. In relation to the nuclear fuel cycle (NFC),⁷² it deals with fuel use in the nuclear power reactor, or the conversion of nuclear fission energy to electricity, and the storage of both fresh and spent fuels at the reactor, as well as issues relating to siting, design, construction, commissioning, operation (and decommissioning) of nuclear power reactors. It does not focus on regulation of nuclear fuel cycle *front-end activities*⁷³ or *back-end activities*,⁷⁴ but addresses those subjects only to emphasize nuclear power generation safety-related issues such as regulating spent fuel safety management and radioactive waste safety management.

2.1.1. Global Use of Nuclear Power

Nuclear energy has emerged as an issue of global and local importance, propelled in large part by increased costs of fossil fuels, rising energy needs, concerns over inefficiencies in the energy mix, security of energy supply, climate change, its cleanness as less carbon polluting than fossil fuels, raw material availability, technicians and scientists' interests, high performance and safety

⁷¹ Electricity is often generated and supplied in a value chain which often comprises of the following: "*generation* which converts energy sources into electricity; *transmission* which occurs when electricity is transmitted over high voltage networks to major demand centres; *distribution* which is the process by which transmitted power flows to the final consumers such as factories and homes; and *supply* – the name given to the metering, billing and other services – provided to the final consumers." Pollitt 1997:3

⁷² Nuclear fuel cycle spans radioactive ore mines, milling plants, nuclear fuel fabrication plants, research and test reactors, power reactors, spent fuel storage facilities, enrichment plants, reprocessing facilities, radioactive waste management facilities, etc. (NEA 1985; Beck 1994).

⁷³ The *front end activities* are the mining and milling uranium ore (*i.e.*, yellowcake), purification and conversion of the *yellowcake* into uranium hexafluoride (UF₆) gas, enrichment and fuel fabrication for delivery to reactor site (NEA 1985).

⁷⁴ The *back end activities* occur after the fuel has been used in the reactor. It begins with the removal of spent fuel from the reactor to storage in water pools and focuses on the management of spent fuel, by the 'once-through' or open or 'direct disposal' fuel cycle option; or the 'reprocessing and recycling' or closed fuel cycle option; or even by the 'deferral option' (NEA 1985).

record of nuclear power plants in the past two decades, Fukushima, etc.⁷⁵ Nuclear power supplies a large amount of the world's electricity needs. At the start of 2011, before Fukushima, there were 441 nuclear power plants in operation in thirty (30) countries (IAEA (d) 2011:13). Number of countries with nuclear power increased to 31 in 2012 with the start of Iran's Bushehr power reactor, under construction since 1975. Compared to the historical maximum of 444 reactors in 2002, it appears the past decade power reactor start-ups did not outdo reactor shutdowns.⁷⁶ Fukushima has also added more twists. Nuclear power, in 2010, supplied 13.5% of the total electricity generated worldwide compared to hydro power's 17.85% and renewable energy's 1.71%. Nuclear energy's 13.5% represented 2,630.0TWh of the 19,542TWh electricity supplied from all sources (*nuclear, fossil, biomass, renewable*) in 2010.⁷⁷ After Fukushima, Belgium, Germany, Netherlands, Spain, Sweden, Switzerland and Taiwan announced plans to phase-out nuclear power. As of May 2012, all the nuclear power reactors in Japan were closed (*not final shutdown*) for maintenance, re-assessment of safety and other reasons. Two power reactor units at Ohi in Japan got restart permission in June 2012 (Schneider 2012:4). By July 2012, assuming a final shutdown of the three (3) damaged Fukushima reactors, there were 436 plants in operation globally. Nuclear energy therefore still contributes significantly to global electricity needs.

In 2011, thirteen countries generated more than 30% of their total electricity from nuclear: France generated 77.7% of its electricity from nuclear power, Slovakia had 54%, Belgium 54%, Ukraine 47.2%, Hungary 43.3%, Slovenia 41.7, Switzerland 40.9%, Sweden 39.6%, South

⁷⁵ IEA, *World Energy Outlook 2011* (France: OECD 2011) available at www.worldenergyoutlook.org (noting Fukushima Daiichi has raised questions about the future role of nuclear power, although it has not changed policies in countries such as China, India, Russia and Korea that are driving its expansion.). IAEA, *Energy, Electricity and Nuclear Power: Developments and Projections - 25 Years Past and Future* (2007, Vienna); Schneider (2012)

⁷⁶ Schneider (2012)

⁷⁷ IAEA (d) 2011:13-21 (The global electricity supply from all sources (*including nuclear, fossil, biomass, renewable*) in 2010 was **19,542TWh** and nuclear energy supplied **13.5% (2,630TWh)** of that amount. The global total *nuclear energy electrical generating capacity* was **375.3GW(e)** compared to the global total *electrical generating capacity from all sources* including nuclear, fossil, biomass, renewable, etc., of **5071GW(e)**).

Korea 34.6%, Armenia 33.2%, Czech Republic 33.0%, Bulgaria 32.6%, and Finland 31.6% (NEI 2012) (See Table 2.2 below). By early 2011, construction work on sixty seven (67) nuclear power plants were in progress in fifteen (15) countries;⁷⁸ including Argentina, Brazil, China, China (Taiwan), Finland, France, Japan, India, Pakistan, Russia, Slovakia, South Korea, Ukraine, and United States (IAEA 2011:12-13; NEI 2012) (See Table 2.3). Forty three (43) of the power reactors under construction (almost three-quarters) are located in China, India and Russia. Like Iran's Bushehr plant (on-line on September 3, 2011 after 37 years of "under construction"), there are nine reactors listed as "under construction" for more than 20 years; four others, for 10 years or more; and some have now been abandoned like the two units in Bulgaria.⁷⁹ Delays in nuclear power plant construction affects developed nations as well. The US Watts-Bar-2 project started in 1973, but eventual grid connection planned for 2012 is now delayed to "late 2015 or 2016".⁸⁰

Nuclear power is only a very small fraction of Africa's energy supply. Apart from South Africa, no African country has a nuclear power plant yet.⁸¹ South Africa commissioned two (2) nuclear power plants in 1984 to generate electricity.⁸² In 2011, South Africa's nuclear power share of its total electricity capacity was 5.2%.⁸³ Of the 67 nuclear power plants under construction globally in 2011, none was in Africa. Many African countries have however expressed interest in utilizing nuclear energy for electricity: Algeria, Egypt, Ghana, Kenya, Morocco, Namibia, Nigeria, Senegal, Tunisia, Uganda, etc.⁸⁴ Egypt in February 2011, *before* Fukushima, postponed nuclear

⁷⁸ *Id.*, at p.13

⁷⁹ Schneider (2012) *supra* note 76

⁸⁰ *Id*

⁸¹ IAEA (d) 2011:13; NEI 2012

⁸² IAEA, *Country Profiles: South Africa* (Vienna: IAEA 2010), available in the IAEA's online database at, http://www.pub.iaea.org/MTCD/Publications/PDF/CNPP2010_CD/pages/countryprofiles.htm (started operating in 1984 & 1985)

⁸³ NEI 2012

⁸⁴ WNA, *Emerging Nuclear Energy Countries* (June 2012 revision) available at <http://www.world-nuclear.org/info/inf102.html>

power processes *indefinitely* due to the political situation in the country. It is uncertain how Fukushima may affect continued operation of existing nuclear plants and new constructions. But Ghana's nuclear power policy, like many other countries', has not changed:⁸⁵ Abu Dhabi, China, India, Saudi Arabia, South Africa, South Korea, Turkey, US, UK, Vietnam, etc., have cautiously re-emphasized their nuclear power expansion plans (Joskow & Parsons 2012:12; IAEA 2011(a)).

Table 2.1: TOTAL NUMBER OF NUCLEAR POWER PLANTS IN OPERATION PER COUNTRY GLOBALLY (END OF 2010).

COUNTRY	NO.	COUNTRY	NO.	COUNTRY	NO.	COUNTRY	NO.
Argentina	2	Finland	4	Netherlands	1	Sweden	10
Armenia	1	France	58	Pakistan	2	Switzerland	5
Belgium	7	Germany	17	Romania	2	Taiwan, China	6
Brazil	2	Hungary	4	Russia	32	U.K.	18
Bulgaria	2	India	19	Slovakia	4	U.S.	104
Canada	18	Japan	54	Slovenia	1	Ukraine	15
China	13	Korea Rep.	21	South Africa	2		
Czech RP	6	Mexico	2	Spain	8	TOTAL	441

SOURCE: IAEA, NUCLEAR POWER REACTORS IN THE WORLD, page 12-13
(In IAEA, Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 (2011))

Table 2.2: NUCLEAR ENERGY'S ELECTRICITY GENERATION (%) SHARE PER COUNTRY GLOBALLY IN 2011

COUNTRY	%	COUNTRY	%	COUNTRY	%	COUNTRY	%
Argentina	5.0	Finland	31.6	Mexico	3.6	Spain	19.5
Armenia	33.2	France	77.7	Netherlands	3.6	Sweden	39.6
Belgium	54.0	Germany	17.8	Pakistan	3.8	Switzerland	40.9
Brazil	3.2	Hungary	43.3	Romania	19.0	Taiwan, China	19.0
Bulgaria	32.6	India	3.7	Russia	17.6	U.K.	15.7
Canada	15.3	Iran	0.0	Slovakia	54.0	U.S.	19.3
China	1.9	Japan	18.1	Slovenia	41.7	Ukraine	47.2
Czech RP	33.0	Korea Rep.	34.6	South Africa	5.2		

SOURCE: NEI, WORLD NUCLEAR POWER GENERATION AND CAPACITY (2012 Excel Spreadsheet Data)

TABLE 2.3: TOTAL NUMBER OF NUCLEAR POWER PLANTS UNDER CONSTRUCTION GLOBALLY AS AT 2010.

COUNTRY	NO.	COUNTRY	NO.	COUNTRY	NO.	COUNTRY	N
Argentina	1	France	1	Pakistan	1	Ukraine	2
Brazil	1	India	6	Russia	11		
Bulgaria	2	Iran	1	Slovakia	2		
China	28	Japan	2	Taiwan, China	2		
Finland	1	Korea Rep.	5	United Sates	1	TOTAL	67

SOURCE: IAEA, NUCLEAR POWER REACTORS IN THE WORLD, page 12-13
(In IAEA, Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 (2011))

⁸⁵ See, World Nuclear News, *Ghana Coordinates Nuclear Planning Activities* (Nuclear Power News, May 17, 2012)

2.1.2. Brief History of Nuclear Energy: Lessons on Regulation

Nuclear energy was conceived and born in wartime, outdoored as atomic bomb and grew up in the cold war clothed in secrecy, suspicion and fear. Although it has been born-again, renamed “atoms for peace,” and offered a hand of fellowship into the UN peaceful family, yet it’s paradoxical dual nature – devastatingly deleterious, but yet, serving exceedingly useful peaceful purposes – frame its identity. To understand how nuclear power must be regulated, it is crucial to know the “why and how” of its regulatory evolution.⁸⁶ A dry analysis of the nuclear regulatory framework is not enough: Nuclear regulation has evolved by practice, experience, tradition and accident – Three Mile Island (TMI), Chernobyl, etc., and now Fukushima. (TMI triggered INPO in USA; and Chernobyl fast-tracked WANO, some international conventions, practices, etc).⁸⁷ In the ensuing sub-sections, we will distil persistent regulatory patterns: those that have endured in nuclear power countries for more than half a century, and those that have been reformed during the period to provide useful lessons for this inquiry. As the philosopher George Santayana once wrote, “Progress, far from consisting in change, depends on retentiveness. When change is absolute there remains no being to improve and no direction is set for possible improvement: and when experience is not retained, as among savages, infancy is perpetual. Those who cannot remember the past are condemned to repeat it” (Santayana 1905).

2.1.2.1. The First Nuclear Reactor

The first nuclear reactor in the world was constructed in “a doubles squash court at Stagg Field, a sports-stand at Chicago University”⁸⁸ by Enrico Fermi.⁸⁹ Known as “*Pile-1*” it was constructed

⁸⁶ See David Fischer, *History of the International Atomic Energy Agency: The First Forty Years* (IAEA, Vienna 1997)

⁸⁷ See WNA, *Cooperation in Nuclear Power* (WNA, April 2012), at <http://www.world-nuclear.org/info/inf38.html>

⁸⁸ Tromans (2010) p.6-7

⁸⁹ Enrico Fermi before then, in 1938, was the Nobel Prize Laureate for Physics for his work on neutron irradiation and his related discovery of nuclear reactions brought about by slow neutrons. Born in Rome in 1901, Fermi is generally recognized as one of

in 17 days in November 1942 by “stacking layers of graphite and uranium on a wooden frame, with control rods consisting of cadmium sheet nailed to 13-foot wooden strips which had to be inserted and removed by hand. On 2 December 1942 the last control rod was [...] removed by six-inch increments, allowing a self-sustaining nuclear reaction [...] for 4.5minutes.”⁹⁰ The experiment was successful. No hitch. At 3:25 pm on December 2, 1942, the nuclear age was born; marking the first man-made self-sustaining nuclear fission chain reaction that initiated the *controlled release of nuclear energy* and first artificial production of plutonium.

2.1.2.2. The First Nuclear Reactor: Regulatory Concerns

Nuclear energy’s birth had a seeming disregard for the *broader aspects* of regulatory limits on scientific inquiry (e.g., authorization, location, societal and environmental safety due processes). *Detailed technical safety measures* were however meticulously observed. The demonstration of the first nuclear reactor (the Chicago *Pile-1*) in 1942 at the University of Chicago provides basic lessons on nuclear regulation. Construction of the first nuclear reactor was coordinated by Arthur Holly Compton, a Nobel Prize Laureate in Experimental Physics. It was Compton who allowed Fermi to build the *Pile-1* in the west stands of the Stagg Field. Writing on this event, Tromans (2010:7) observes: “this gigantic step in the development of nuclear power highlights the relationship between the new technology and *legal responsibilities* in an interesting way.”⁹¹

“[Compton] chose not to inform the President of the University of Chicago, Robert Maynard Hutchins, [about the experiment to demonstrate *Pile-1* at the Stagg Field] reasoning that **he should not ask a lawyer to judge a matter of nuclear physics. ‘The only answer he could have given would have been – no [based on considerations of the University’s welfare]. And this answer would have been wrong. So I assumed the responsibility myself.’**”⁹²

the brilliant scientists of the 20th century. He died from ulcer in 1954. See, William H. Cropper, *Great Physicists: The Life and Times of Leading Physicists from Galileo to Hawking*, 361 (Oxford Univ. Press: 2001). Fermi had the support and intellectual input of colleagues like Leo Szilard in the *Pile-1* research.

⁹⁰ Tromans 2010 p. 7 (emphasis mine) (noting that the money for the experiment was provided by the US Federal Government)

⁹¹ *Id.* (emphasis mine)

⁹² *Id.* (bold emphasis mine) (internal quotations and cross-references omitted)

Though Compton was ‘risking a small Chernobyl in the midst of a crowded city’⁹³ he argued that “we did not see how a nuclear explosion such as that of an atomic bomb could possibly occur”⁹⁴ not only because ‘Fermi, as he knew, was a formidably competent engineer’⁹⁵ but also, the fuel was not enriched to weapon grade.⁹⁶ The beginnings of nuclear energy and the first reactor thus speaks volumes about how experts in their passion to experiment and research into complex science and technology matters are usually driven by a value structure that *may* at times result in scepticism to *broad* regulatory oversight or authorization. Detailed technical safety measures were however put in place by Fermi to address contingencies. Using precocious *defence-in-depth* techniques, Fermi designed multiple safety measures into the experiment.

In the setup were three sets of control rods. The primary set was not used for safety at all but was designed for fine control of the nuclear chain reaction. The other two control rods served safety functions. One set was automatic. It could be controlled by manual interaction and the other was an emergency safety rod. The automatic control rod was operated by an electric motor and responded to a high instrument reading from a radiation counter.⁹⁷ Attached to one end of the emergency rod was a rope running through the pile and weighted heavily on the opposite end. During testing, the rod was withdrawn from the pile and tied down by another rope. It was the job of the “Safety Control Rod Axe Man” to stand-by ready to cut the rope with an axe should something unexpected happen, or in case the automatic safety rods failed. *The acronym SCRAM*

⁹³ See William H. Cropper, *Great Physicists: The Life and Times of Leading Physicists from Galileo to Hawking*, 356 (Oxford University Press: 2001) (quoting Richard Rhodes, *The Making of the Atomic Bomb* (Simon and Schuster: 1995))

⁹⁴ *Id.*

⁹⁵ *Id.*, p.354 (noting that chain reaction was realized in controlled fashion in nuclear reactors and in uncontrolled fashion in nuclear weapons)

⁹⁶ *Fuel grade* is often critical in the making of atomic bombs; and they are designed to spark off an *uncontrolled* nuclear fission chain reaction. WNA, *The Safety of Nuclear Reactors* (WNA May 2012), at <http://www.world-nuclear.org/info/inf06.html>

⁹⁷ See William H. Cropper, *Great Physicists: The Life and Times of Leading Physicists from Galileo to Hawking*, 357-8 (Oxford University Press: 2001); See also Richard Rhodes, *The Making of the Atomic Bomb* (Simon and Schuster: 1995) and; Emmanuel A. Amoako *et al.*, *Environmental and Safety Concerns for Nuclear Power Generation in Ghana*, EREM Vol.1(55) 49 at p. 50

(Safety Control Rod Axe Man) *is still used today in reference to the rapid (automatic) shutdown of a nuclear reactor.* Fermi did not rely on mechanical devices only, but added other safety measures to the control rods. A liquid-control squad stood on a platform above the pile ready to respond to any mechanical failure of the control rods by pouring cadmium-salt solution over the experiment. Fermi achieved the first man-made self-sustaining nuclear reaction without a hitch.

2.1.2.3. Over A Century of Atomic Research: X-Ray to Nuclear Fusion

Prior to Fermi's experiment, several research inquiries to understand the atom had been made.⁹⁸

In November 1895, about half a century before Fermi's experiment, Wilhelm Conrad Rontgen (a German physicist) discovered X-rays emitted from a cathode-ray tube and observed the X-rays penetrate many kinds of matter.⁹⁹ In an apparent discount on *safety* measures Rontgen used the 'unknown rays' on his wife in an experiment by taking "an X-ray photograph of his wife's hand which clearly revealed her wedding ring and her bones" a week after the discovery.¹⁰⁰ In 1896, Henri Becquerel discovered radioactivity and later got radiation burn carrying a vial of radium in his pocket. Marie and Pierre Curie isolated radioactive elements polonium and radium from uranium ore. Pierre Currie later suffered from ill-health that was alleged to be radiation sickness; and his hands got inflamed and painful from radium rays.¹⁰¹ The research zeal into radiation and the atom therefore at times affected even detailed safety measures.

⁹⁸ See Cropper, *Great Physicists supra* note 89; see also See Tromans (2010) p. 4-6

⁹⁹ See Nobel Prize, *Biography: Wilhelm Conrad Rontgen and the Nobel Prize in Physics* (1901) (Noting that "on 8 Nov, 1895, Wilhelm Conrad Rontgen (accidentally) discovered an image cast from his cathode ray generator, projected far beyond the possible range of the cathode rays (now known as an electron beam). Further investigation showed that the rays were generated at the point of contact of the cathode ray beam on the interior of the vacuum tube that they were not deflected by magnetic fields, and they penetrated many kinds of matter.") at, http://www.nobelprize.org/nobel_prizes/physics/laureates/1901/rontgen-bio.html

¹⁰⁰ *Id* (narrating how the photograph aroused great scientific interest in the new form of radiation). Rontgen named the new form of radiation X-radiation 'X' standing for "Unknown".

¹⁰¹ See Tromans (2010) p. 4-6 (noting that several scientific discoveries occurred in that era: Henri Becquerel observed naturally occurring radioactivity; J.J. Thomson of Cavendish Laboratory in Cambridge demonstrated the existence of electrons in 1897. Marie and Pierre Currie, Ernest Rutherford, Frederick Soddy, Villard, Max Born, Leo Szilard, James Chadwick, Otto Hahn, Fritz Strassman, Hans Halban, Lew Kowarski, Neils Bohr, etc., made various discoveries about nuclear energy and radioactivity.) *Id.* See also Cropper, *Great Physicists supra* note 89

Ernest Rutherford identified alpha and beta particles as two forms of radiation with alpha being readily absorbed and beta being more penetrative; and Villard later discovered high energy gamma radiation as a third type.¹⁰² Frederick Soddy and Rutherford discovered half-life of radioactive elements by observing the transmutation of radioactive thorium into non-radioactive gaseous element argon.¹⁰³ In 1938, Otto Hahn and Fritz Strassmann discovered nuclear fission as earlier theorized by Lise Meitner and Otto Frisch. In 1942 Fermi with support from Leo Szilard, the US Government, other scientists and collaborators demonstrated the first nuclear reactor.¹⁰⁴ Research into nuclear energy continues to be done to date into the production of efficient *nuclear reactors, nuclear fuels*, innovative fuel cycles, utilization of *nuclear fusion*, etc.¹⁰⁵ The pace and nature of research, discoveries and development in atomic energy – where scientists incessantly pushed the technological envelope, built on old technologies and made new breakthroughs with incredible fluidity – provide key lessons for unending regular update of regulations.

2.1.2.4. Atomic Bomb Link: Nuclear Energy Dual-Use Challenge

Nuclear energy also raises serious legal issues by its close association with the atomic bomb. It is a dual use technology. It can be intentionally used for either good or bad purposes or both and it must be carefully regulated. Fermi's work in 1942 was part of the broader '*Manhattan Project*',

¹⁰² *Id*

¹⁰³ *Id*

¹⁰⁴ *Id*. The money for the experiment was provided by US Federal Government of Roosevelt. *See Tromans supra* note 88, at p. 7

¹⁰⁵ *Fusion* is a nuclear process that releases energy by fusing light elements – the direct opposite of nuclear fission. Fusion gives off very little radioactivity; no underground storage needed, no environmental risk of high radioactive fuel leakage in case of an accident; the hot gaseous plasma it generates dissipates if released; and the fuel to create it (deuterium combined with tritium) is abundant. The OECD/IEA Fusion Power Co-ordinating Committee (FPCC) is working with ITER (International Thermonuclear Experimental Reactor) project, IAEA, European Atomic Commission (EURATOM), the International Tokamaks Physics Activity (ITPA), and Nuclear Energy Agency (experiments database) on research and development on nuclear fusion. *See IEA, Fusion Energy*, at <http://www.iea.org/topics/nuclearfissionandfusion/>; *see also Fisher supra* note 86 at p.160 (discussing *fusion* and noting that research on fusion was declassified in 1958 at the UN Conference on the Peaceful Uses of Atomic Energy).

culminating in the building of reactors to produce enriched uranium and plutonium for the World War II Allied Forces.¹⁰⁶ The onset of World War II in 1939 and fears that the Nazis may produce an atomic bomb, given the discovery of nuclear fission in Germany, made several scientists support the Allied effort to beat the Nazis to the nuclear bomb race. Cropper notes that,

“Some of the nuclear scientists who developed the technology of nuclear weapons did their work with a conscience, and some did not. At first, with the prospect of nuclear weapons in the hands of the Nazis, conscience was almost irrelevant. Even Einstein, for most of his life a pacifist, accepted the urgency of the nuclear bomb project. With Leo Szilard and Eugene Wigner, two Hungarian theoretical physicists, Einstein wrote a letter to President Roosevelt in 1939 describing the terrible dangers and the necessity for immediate action. After the war, the threat was the nuclear weapons themselves.” (Cropper 2001: 254)¹⁰⁷

As Boal (2003: 224) puts it, “equivocation between ‘atomic bomb’ and ‘atomic energy’ marks the official narratives of nuclearism from the beginning. Whether the slippage is unconscious or deliberate hardly matters; the point is that from the first days of the so-called atomic age there is profound mystification of ‘atomic history’ ...”¹⁰⁸ Fermi’s experiment itself was a “vital stage in the Allied project to create the atomic bomb ...”¹⁰⁹ It was after Fermi’s experiment that President Roosevelt authorized the *Manhattan Project* and its full-scale plants to produce enriched weapon grade plutonium and enriched uranium. Fermi himself acknowledged the link of his research to atomic bombs in a 1946 speech to the Citizens Board of the University of Chicago:

“You see, these piles that have been constructed have really been constructed for plutonium for atomic bombs and apparently they are quite good in that respect. They produce however, terrific amounts of energy and this energy is wasted. It is wasted for two reasons: first, the piles have been designed in time of war and at a time when energy was not a critical commodity *so they have not been designed for producing energy* but designed for producing plutonium.”¹¹⁰

¹⁰⁶ See Cropper, *Great Physicists supra* note 89

¹⁰⁷ *Id.*, at p. 253 & 342 (noting that some scientists, like *Lise Meitner* opposed nuclear weapons. When she was invited to join a group of British and refugee physicists and engineers who were assigned to the laboratory at Los Alamos, New Mexico, where the bombs were being designed, she refused, “and was the only nuclear physicist of note on the Allied side to do so. Service in Los Alamos would have meant escape from stagnation in Stockholm, and an opportunity to work again with her friends.”)

¹⁰⁸ Iain A. Boal, *Ground Zero: Henry Moore’s Atom Piece at the University of Chicago*, 220, 224 (in Henry Moore: Critical Essays, Jane Beckett & Fiona Russell eds., Ashgate, 2003)

¹⁰⁹ Tromans (2010) p.7; see also Edward Sullivan, *The Ultimate Weapon: The Race to Develop the Atomic Bomb* (Holiday House 2007); David Bodansky, *Nuclear Energy: Principles, Practices and Prospects, 2nd edition* (New York: Springer-Verlag 2004)

¹¹⁰ Boal, *Ground Zero supra* note 108 at p.223 (quoting Fermi’s speech); See also Tromans (2010:7) (on government funding)

2.1.3. Early Years of Nuclear Energy Regulation: 1939 to 1954

Dunlavey (1957:295) has characterized the years 1939 to 1942 as the era of ‘control by secrecy ... initiated by scientists’ with military support after the discovery and recognition of fission in 1939. The ‘control by secrecy’ was continued further by the military in close collaboration with scientists from 1942 to 1946. The goal of this control was the production of the atomic bomb. In 1945, the first atomic bomb was created in USA.¹¹¹ Nuclear research into the atom, development of the first nuclear reactor and atomic bomb were all largely unregulated.¹¹² Tromans (2010) points out that large quantities of ‘radioactive and hazardous wastes were routinely disposed of by dispersion into the environment, leakage from tanks, or by burial’ resulting in very extensive pollution of the environment and aquifers by radioactive isotopes.¹¹³

Towards the end of World War II, the protection of international peace and prevention of world war which the League of Nations failed to achieve was reactivated. On 25 April 1945, fifty (50) countries met in San Francisco, USA and committed themselves to create the UN to harmonize their actions on maintaining international peace and security, developing friendly relations among nations and social progress, better living standards and human rights.¹¹⁴ Ironically, during this UN process, *Little Boy* and *Fat Man* atomic bombs were unleashed on Japan at Hiroshima and Nagasaki on 6th and 9th August 1945 respectively. The UN was set up on 24 October 1945, barely 2 months after the 1945 events at Hiroshima and Nagasaki. The US was the only country that possessed atomic weapons then. Worldwide concern about the potential benefits and grave dangers of atomic energy led to urgent global calls to regulate nuclear energy. The *May-Johnson*

¹¹¹ In 1949, USSR (now succeeded by Russia) became the second country to produce and test a nuclear weapon. UK followed in 1952, France in 1960, and China in 1964. See Fischer (1997:21)

¹¹² See Tromans (2010:8) (citing David Kauzlarich and Ronald C Kramer, *Crimes of the American Nuclear State – at Home and Abroad* 107-11 (Boston, Northeastern University Press, 1988))

¹¹³ *Id.*, at p.7-8

¹¹⁴ See *UN at a Glance: The History of the United Nations*, available at <http://www.un.org/en/aboutun/history/index.shtml>

Nuclear Bill was initiated in the US in 1945. The UN convened its first General Assembly on 10 January 1946, after only two months in existence. The *first* Resolution of the maiden UN General Assembly, passed on 24 January 1946, was on the need to regulate atomic energy.¹¹⁵ It established the United Nations Atomic Energy Commission (UNAEC) to *inter alia* “deal with the problems raised by the discovery of atomic energy” and “make specific proposals ... for the elimination from national armaments of atomic weapons ...” (UNGA 1946). UNAEC in 1946 proposed a plan (*i.e.*, the *Baruch Plan*) under which the US was to destroy its atomic weapons and any atomic energy development, globally, will be subject to UN controls which will permit only peaceful uses of atomic energy. Lack of consensus led to the demise of UNAEC in 1952.

Up to 1946, research into nuclear energy and its exploitation was still under military control and shrouded in secrecy in the US, Russia (USSR), UK, France, China and a few other countries. In 1946, the US rejected the *May-Johnson Nuclear Bill* and passed the Atomic Energy Act (or the McMahon Act) under which control over research and production of nuclear energy was taken from the US military and was rather given to the independent, civilian controlled Atomic Energy Commission.¹¹⁶ But the Act retained a tight government monopoly on atomic endeavours. Its Section 1(a) also provided a window for the US to continue to stockpile nuclear materials and weapons with “the common defense and security” of US as the overriding concern of the law. It provided in relevant part that: “*subject at all times to the paramount objective of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace.*”¹¹⁷

¹¹⁵ UNGA Resolution 1 was passed exactly three (3) months after the coming into force of the United Nations Charter.

¹¹⁶ See Law of 1946, Ch. 724, 60 Stat. 755

¹¹⁷ *Id.* at §1(a) (Emphasis mine)

The Act was drafted to “cover a program that was primarily concerned with building an Atomic arsenal” (Dunlavey 1957:296), and provided *safeguards* to prevent other States from becoming nuclear weapon states.¹¹⁸ The US stated in its 1946 law that, without *safeguards* “there shall be no exchange of information with other nations with respect to the use of atomic energy for industrial [i.e. peaceful] purposes.”¹¹⁹ The UK also passed a similar Act (the Atomic Energy Act of 1946) with the Ministry of Supply having responsibility of nuclear material. Section 1 of the UK Act, gave the Minister of Supply the general power to “promote and control the development of atomic energy”.¹²⁰ The Ministry developed nuclear energy for military purposes until 1954. The first research reactor in the UK began operating in 1949. Two Windscale ‘Piles’ built in 1950 and 1951 produced plutonium, and ‘were not intended to produce electricity, but rather the raw material for nuclear weapons’ (Tromans 2010:11). So, control transitioned from scientists to joint military and scientists, to ‘civilian management’ under strict government control by 1946.

By 1953, the UK had produced its first usable nuclear weapons and was considering production of the more deadly hydrogen bomb. The USSR had by then already produced its nuclear weapon in 1949. This was the “hideous epoch” of the Cold War where nations spent staggering sums of money and effort to build nuclear arsenals.¹²¹ In 1953, US President Dwight Eisenhower made his Atom for Peace speech at the UN General Assembly. Calling the attention of the world community to the devastating horrors atomic weapons can wreak on mankind, he urged the international community to regulate the use of atoms for peaceful purposes only. In 1954, soon

¹¹⁸ The safeguards regime culminated in the Non-Proliferation Treaty (NPT) on July 1, 1968, in force since March 5, 1970. It cut off new Nuclear Weapon States (NWS). NWS like India (1974), Pakistan (1998) and North Korea (2006) are non-NPT members.

¹¹⁹ US Atomic Energy Act, 1946, Section 10(a)(1)

¹²⁰ Atomic Energy Act, 1960

¹²¹ Peter Hennessey, *Having It So Good: Britain in the Fifties* 312 (London, Penguin Books, 2007) (citing a UK Atomic Energy Authority annual budget estimate of £53 million at 1954 prices)

after this speech, US and UK reformed their nuclear energy laws and, respectively, passed the Atomic Energy Act, 1954 (Tromans 2010:10), which superseded the existing 1946 Atomic Energy laws in the US and the UK, and permitted private participation in nuclear energy development and encouraged peaceful uses of nuclear energy under strict government control.¹²²

2.1.4. The First Nuclear Power Plant and Subsequent Developments

In June 1954, the USSR connected the first nuclear power plant to an electricity grid Obninsk near Moscow to provide 5MW of electricity to residences and businesses.¹²³ The project was part of the effort to showcase the civilian and peaceful uses of nuclear energy. The reactor was thus christened “peaceful atom” in Russian. This was barely six months after the ‘Atom for Peace’ speech by US President Eisenhower. The UK in 1956 opened a nuclear power reactor at Calder Hall: the first nuclear power station in the world to produce electricity in commercial quantities. Tromans (2010:9) argues that it rather “produced weapons-grade plutonium, with electricity as a by-product.” The project’s official code-name Pressurized Pile Producing Power and Plutonium (PIPPA) shows the dual function in UK policy, i.e., reactors capable of producing electricity and plutonium (Tromans 2010:11). IAEA’s Statute (of October 1956) came into force in July 1957.

The promotion of civilian nuclear facilities encountered financial obstacles in nuclear technology and reluctance of the insurance industry to insure facilities. US Congress passed the *Price-Anderson Act of 1957* that set a limit of 560 million dollars liability for nuclear accidents of which 60 million dollars was covered by insurance and the remainder borne by government. US

¹²² The United Kingdom Atomic Energy Authority Act 1954; see also the US Atomic Energy Commission Act 1954

¹²³ See IAEA, *Nuclear Power Timeline*, at <http://www.iaea.org/newscenter/news/2004/obninsk.html>. The US had earlier in 1951 produced about 100kW of electricity at Idaho in an experiment. And in the same 1954, the US launched its first nuclear-powered submarine. See American Nuclear Soc., *Nuclear History: Timeline* (ANS 2002). See also, Rosatom, *History of Russian Nuclear Industry*, at http://www.rosatom.ru/wps/wcm/connect/rosatom/rosatomsite.eng/about/nuclear_industry/history/ (the plant was a 5 MW uranium-graphite pressure-tube reactor AM cooled by water. Its name AM from Russian words meaning ‘peaceful atom’.)

established a nuclear power plant in 1957. The Suez Crisis of 1956 and the OPEC oil embargo of the early 1970s also added much impetus to the expansion of nuclear power programmes. UK, US, Russia, Canada, France, Japan, and India added more nuclear power programmes and reformed their nuclear regulatory laws. In the US, AEC both regulated and promoted reactors, but the 1974 Energy Reorganization Act invested AEC's regulatory functions in the NRC.

When the 1986 Chernobyl nuclear accident slowed down nuclear power plant construction, and deepened the concerns raised by the 1978 TMI accident, the US had 100 nuclear power plants, and many plants were being built in US and elsewhere.¹²⁴ Dip in public trust in nuclear power in the decade after 1986 affected plant construction. In 2002, when Finland's parliament decided to grant a license for the construction of a fifth nuclear power plant, it was almost historic, because it was then the first decision to build a new nuclear plant in the whole of Western Europe for more than a decade.¹²⁵ The first decade of this millennium's imperative of reducing greenhouse gas emissions, coupled with serious concerns over energy security, led to a nascent revival of interest in nuclear power in several countries. US Congress in 2005 passed the *Energy Policy Act of 2005* which amended, reinstated and extended the *Price-Anderson Act* for another twenty (20) years and increased the insurance cover to 10 billion dollars. Fukushima has raised fresh questions about the future role of nuclear power, but it has not changed Ghana's nuclear power policy or plans. Ghana does not have a nuclear power plant but in line with its energy policy and a 2008 Cabinet decision to establish a nuclear power plant in Ghana by 2018, several processes and programmes are ongoing to facilitate that initiative: Ghana's Energy Commission (EC) and Ghana Atomic Energy Commission are the key institutions leading the process.

¹²⁴ NEI, *The Nuclear Energy Story: Timeline* (1998), <http://library.thinkquest.org/C005271F/timeline.html> (storing NEI extracts)

¹²⁵ WNA, *Nuclear Power in Finland* (April 2012), <http://www.world-nuclear.org/info/inf76.html>

2.1.5. Brief History of Nuclear Energy Regulation in Ghana

2.1.5.1. Early Years of Nuclear Research in Ghana

Ghana started experimental use of radio-isotopes in 1952.¹²⁶ As a result of potential public health concerns on the hazards of radioactive fallout arising from nuclear weapon tests, Ghana's Ministry of Defence made the University of Ghana (then known as the University College of the Gold Coast) undertake in monitoring services on its behalf in 1958. By the end of 1959, the University Physics Department's proposal for a Health Physics and Radioisotope Unit was accepted.¹²⁷ The Unit provided health protection monitoring services for users of X-rays and other penetrating radiations, monitored radioactive fallout, and established specialized facilities and equipment for work in atomic physics.¹²⁸

2.1.5.2. The Ghana Nuclear Reactor Project: Initial Attempt

In 1961, the government of Ghana decided to initiate the Ghana Nuclear Reactor Project (GNRP) at Kwabinya, Accra to construct a 2MW Soviet research reactor and introduce nuclear science and technology into the country and exploit nuclear energy for peaceful applications for national development.¹²⁹ At that time, the focus was solely a research reactor for research, training, and production of radioisotopes. It was expected that the research reactor would in the long term aid in the development of manpower to promote plans for nuclear power electricity generation in Ghana. The Ghana Atomic Energy Committee was then set up,¹³⁰ but in 1963, it was replaced by a Commission established under an Act of Parliament, Ghana Atomic Energy Commission Act

¹²⁶ These experiments were conducted on monkeys. See, GAEC, *At a Glance*, at http://www.gaecgh.org/gaec_history.htm

¹²⁷ *Id*

¹²⁸ See Kwabinya Nuclear Research Establishment Handbook 5 (1977)

¹²⁹ See Joseph K. A. Amuzu, *The Nuclear Option in Ghana* 173 (in Ghana: Changing Values, Changing Technologies, Ghanaian Philosophical Studies II, Helen Laeur (ed), Council for Research in Values, 2000); See also Enninson and Dzobo, *Nuclear Power and Ghana's Future Electricity Generation*, (2010) (IAEA-CN-164-1P01); *GAEC At a Glance supra* note 126

¹³⁰ Amuzu, *The Nuclear Option in Ghana*, *supra* note 129 at p.175

(Act 204).¹³¹ GAEC, as a statutory body, had responsibility for all matters relating to peaceful uses of nuclear and atomic energy.¹³² The main functions of GAEC included promotion, development and utilization of the peaceful applications of nuclear and biotechnological techniques for economic and social advancement.¹³³ The work of GAEC was mainly entrusted to its oldest institute, the National Nuclear Research Institute (NNRI) which was also established in 1963 by the GAEC Act 204.¹³⁴

On November 25, 1964, the foundation stone for the Nuclear Reactor project was laid by Dr. Kwame Nkrumah, the then President of Ghana. The reactor was to be in operation by the end of 1966. He highlighted the need for nuclear power, and *safeguards* in his speech as follows:

“... We have therefore been compelled to enter the field of Atomic energy because this already promises to yield *the greatest economic source of power* since the beginning of man. Our success in this field would enable us to solve the many sided problems which face us in all the spheres of our development in Ghana and Africa ... *By 1966 the reactor itself should be in operation* and the Research Centre will start on the extensive programme of research... We have always stood for the use of fissionable material *exclusively for peaceful ends* ... Neither this reactor, therefore, nor the laboratories attached to it, nor indeed any other nuclear facilities in Ghana, will be directed to development of *devices for war* ... I dedicate this reactor to the progress of true science, to the application of science to the well-being of man, to the enlargement of his spirit and to the promotion of peace ...” (Nkrumah 1964) (Emphasis mine)

Ghana had signed a bilateral agreement with USSR (now Russia) for the project on build operate and transfer terms where scientists and technicians from USSR were to man the initial stages of the project.¹³⁵ On February 24, 1966, Nkrumah’s government was overthrown in a coup d’état.¹³⁶ The reactor project was on schedule to be completed at the end of that year but was suspended for review. Sir John Cockcroft, a renowned British physicist and consultant for the review,

¹³¹ Ghana Atomic Energy Commission Act, 1963 (Act 204). It established the Ghana Atomic Energy Commission (GAEC).

¹³² *Id*

¹³³ *Id*

¹³⁴ *Id*

¹³⁵ Amuzu, *The Nuclear Option in Ghana*, *supra* note 129 at p.176

¹³⁶ The National Redemption Council (NRC) coup on February 24, 1966 overthrew the CPP government of Dr. Nkrumah

recommended scaling down the project to radioisotope applications and a suspension of the research reactor initiative: reasoning that there was adequate supply of power from Ghana's hydroelectric dam and nuclear power would not be needed for about 20 years.¹³⁷ The project was re-named the National Centre for Radioisotope Applications; and the Health Physics and Radioisotope Unit at the University of Ghana was transferred to the new Centre at Kwabenya.

2.1.5.3. The Ghana Nuclear Reactor Project: Second Attempt

Attempts to reactivate the Ghana Reactor Project in 1973 by the then government, National Redemption Council (NRC), resulted in the creation of a new management committee and Reactor Technical Committee. The State of Hessen in the then Federal Republic of Germany (FRG) decided to donate to Ghana a one megawatt reactor belonging to Frankfurt University. An Agreement was signed and the government made payments for the dismantling and shipment of the reactor to Ghana; but the German government cancelled all the arrangements when another coup d'état toppled the NRC government in 1975.¹³⁸ The Ghana Atomic Energy Commission Act, 1963 (Act 204) however continued in force and the Institute (NNRI) and Centres set up by GAEC pursuant to its mandate and the objects under Act 204 functioned without a reactor.¹³⁹

2.1.5.4. Ghana Nuclear Regulatory and Institutional Reforms

A flurry of nuclear energy institutional, regulatory and other reforms were introduced in Ghana during the early 1990s both *before* and *after* the 1992 Constitution entered into force and the PNDC government of J.J. Rawlings transmuted from military rule into the democratically elected NDC government, again, under J.J. Rawlings. The 1963 GAEC Act 204 was amended by PNDC

¹³⁷ Sir John Cockcroft was of the view that the project will take about one-third of physicists and chemists in Ghana. See Amuzu, *The Nuclear Option in Ghana*, *supra* note 129 at p.176

¹³⁸ *Id*

¹³⁹ RPB, *GAEC at a Glance*, p.7 (RPB/GAEC 1998)

Law 308 to *inter alia* establish the Biotechnology and Nuclear Agriculture Research Institute (BNARI) which had hitherto existed as the Department of Biology, Food and Agriculture under NNRI.¹⁴⁰ Pursuant to PNDC Law 308, the Radiation Protection Board Legislative Instrument 1559 of 1993 was promulgated to establish the Radiation Protection Board as the sole Regulatory Body in Ghana for the regulation of nuclear radiation and waste safety. It has authority under LI 1559 to authorize, license, inspect and control all activities and practices involving radiation sources, radioactive materials, X-rays in hospitals, and issue regulations, codes of practice and guides. The RPB is supported in its work by the Radiation Protection Institute (RPI) of GAEC. A National Radioactive Waste Management Centre was established in July 1995 to set up a radioactive waste management infrastructure for Ghana and support waste safety operations.¹⁴¹

2.1.5.5. The Ghana Nuclear Reactor Project: Third Attempt

In 1994, Ghana with the assistance of IAEA procured a 30kW Research Reactor from China.¹⁴² The National Nuclear Research Institute of GAEC operates the reactor. The reactor provides neutrons for activation analysis of samples for their elemental contents and concentrations. It also produces short-lived radioisotopes for tracer technology. The construction, commissioning, and, operation of the reactor were, and still are, subjected to a strict system of authorization and inspection developed by the Radiation Protection Board with the assistance of the IAEA. The NNRI applied to the RPB for several licences by following standard procedures and meeting the regulatory requirements of RPB including the submission of Interim Safety Analysis Reports,

¹⁴⁰ Ghana Atomic Energy Commission Amendment Law, 1993 (PNDC Law 308)

¹⁴¹ For more information on Radioactive Waste Management in Ghana, see E.T. Glover, *Implementation of the Borehole Disposal Facility in Ghana: Status* (2012); E.T. Glover, *Implementation of the Borehole Disposal Facility in Ghana: Issues and Challenges* (Lisbon: Conference Presentation 2010); UN, *Sanitation Country Profile Ghana* (UN: Agenda 21 2004); E.T. Glover and J.J. Fletcher, *National Waste Management Infrastructure for the Safe Management of Radioactive Waste in Ghana* (Tucson 2000); E.T. Glover and J.J. Fletcher, *Safe Management of Radioactive Waste in Ghana* (IAEA-CN-78/81 1999); E.O. Darko and J.J. Fletcher, *National Waste Management Infrastructure in Ghana*, *Journal of Radiological Protection* 18(4):293-9 (1998)

¹⁴² RPB *supra* note 139. See also J.H. Amuasi *et al.*, *Safety of Ghana Research Reactor (GHARR-1)* p.3 (IAEA-CN-82/05, 2001)

written procedures, several supporting documents based on IAEA guidelines. On March 1, 1994, the RPB issued a constructional license (GHARR-1-94-01) to the NNRI.¹⁴³ Other key licenses issued by RPB subsequently include source loading license (GHARR-1-95-04), criticality test license (GHARR-1-95-05), high power test license (GHARR-1-95-06), operator's license and senior operators licenses (GHARR-1-95-01-3) and a provisional operational license (GHARR-1-95-07) which was subject to specified Operating Limits and Conditions.¹⁴⁴ The operators were licensed upon passing written and oral examinations. The licensed operators are examined every two years to renew their license; and they also undertake periodic training.

The IAEA under Technical Assistance Project GHA/1/010 in 1994 provided equipment, experts, funds, etc., for the provision and installation of the research reactor; and also provided all the equipment to make the reactor critical. An IAEA INSARR mission was conducted in February 1997 under an IAEA Supply Agreement (INFCIRC/468/1994) to review the regulatory, radiation protection, nuclear safety and operations of the reactor. The recommendations of the INSARR Mission enabled RPB and the operator or licensee (NNRI) to enhance the regulatory oversight and operational safety of the research reactor, with the assistance of IAEA. NNRI completed a Final Safety Analysis Report and submitted it to the RPB in 2000. Several IAEA missions to Ghana have been conducted on *safety, security and safeguards*. The IAEA INSARR Mission to Ghana in 2009 commended the operators (NNRI of GAEC) for the strict adherence to RPB regulations.¹⁴⁵ The collegial relations between RPB and GAEC also facilitate collaboration.

¹⁴³ See Amuasi *supra* note 142 at p.2

¹⁴⁴ *Id.* For more information on the research reactor and its utilization, see B.J.B. Nyarko *et al.*, *The 30kW Research Reactor Facility in Ghana: Past, Present and Future Programmes* (GAEC/IAEA 2007)

¹⁴⁵ See IAEA, *Report of the Follow-Up Integrated Safety Assessment of Research Reactors (Follow-Up INSARR) Mission to the Ghana Research Reactor-1*, Accra, Ghana (2009); Geoffrey Emi-Reynolds, *Impact of Multinational Support for the Control of Nuclear and Radiation Sources in Ghana* (IAEA-CN-177/18, 2010); E.T. Glover, *Implementation of the Borehole Disposal Facility in Ghana: Issues and Challenges* (Lisbon: Conference Presentation 2010); Amuasi *supra* note 142 at p.2

2.1.5.6. Nuclear Power and Ongoing Nuclear Initiatives in Ghana

The GAEC Act of 1963 (Act 204) as amended, was replaced in 2000 by Ghana Atomic Energy Commission Act, 2000 (Act 588). Act 588 amended and consolidated the law relating to the establishment of GAEC. It provided for the commercialization of research and development results through Institutes of GAEC.¹⁴⁶ Concerned about the decline in nuclear professionals (Nyarko et al. 2007:3; Amuasi 2009), GAEC through the IAEA and the University of Ghana Faculty of Science established the postgraduate School of Nuclear and Allied Sciences (SNAS) in 2006 under IAEA's GHA/0/010 project aimed at training human resource for the introduction of nuclear power in Ghana. Nuclear Law and Legislation is a core mandatory course at SNAS to help the nuclear scientists appreciate the role of law and regulation in nuclear energy. As at December 2011, SNAS had in its six (6) years existence trained 285 nuclear scientists with 21 of them undertaking PhD degrees in Radiation Protection, Applied Nuclear Physics, Nuclear Engineering, Nuclear Environmental Protection, Nuclear Law and Regulation, etc. In 2009, a National Radioactive Waste Management Regulation was promulgated. On September 12, 2011, Ghana inaugurated a Radioactive Waste Storage Facility, with technical assistance and funding support from IAEA-AFRA and the US Department of Energy under its Global Threat Reduction Initiative (GTRI) programme.¹⁴⁷ GAEC is working with EC, A-Gs Dept, IAEA, etc to implement a nuclear power generation roadmap pursuant to Cabinet's 2008 approval of the Nuclear Power Planning Committee's (NPPC 2007-8) recommendation that nuclear power should be introduced in Ghana.¹⁴⁸ The 'once-through cycle' nuclear power fuel use seems a preferred option in Ghana.

¹⁴⁶ Section 3(1)(d) of the Ghana Atomic Energy Commission Act, 2000 (Act 588)

¹⁴⁷ See Glover, *Implementation of the Borehole Disposal Facility in Ghana: Status* (2012); See also GNA, *Ghana Inaugurates Radioactive Waste Storage Facility* (Tuesday, 13 September 2011), available at, http://www.ghana.gov.gh/index.php?option=com_content&view=article&id=7415:ghana-inaugurates-radioactive-waste-storage-facility&catid=96:top-headlines

¹⁴⁸ B.J.B Nyarko et al., *Nuclear Power for Future Electricity Generation in Ghana: Issues and Challenges* (IAEA-CN-164-2S03)

2.2. International Law and Nuclear Safety: Conventions, Codes, Cases and Norms

The global legal order for the safe and peaceful uses of nuclear energy is based on a mix of binding norms and advisory regulations (ElBaradei et al. 1995; Fischer 1997; Jankowitsch 2010). This mix keeps changing with non-binding advisory regulations evolving into legally binding norms and commitments (Nanda 2005). Some examples of such evolution include the IAEA's transport regulations, physical protection regulations, notification of nuclear accident and emergency assistance, nuclear safety, and many others which have all evolved into binding conventions and norms. Many non-binding regulations of the IAEA have been accepted as bases for national nuclear legislation and thereby, several States have voluntarily undertaken to comply with international norms that may formally be non-binding advisory rules or recommendations.

A discussion of the international law on nuclear energy might have to begin with Article 38(1) of the Statute of the International Court of Justice.¹⁴⁹ Article 38(1) is a generally accepted definitive statement of the sources of international law. It requires ICJ to apply *inter alia* (a) international conventions whether general or particular, establishing rules expressly recognized by the contesting states; (b) international custom, as evidence of a general practice accepted as law; (c) the general principles of law recognized by civilized nations; and (d) subject to the provisions of Article 59 (on the inapplicability of *stare decisis* in international law), judicial decisions and the teachings of the most highly qualified publicists of the various nations, as subsidiary means for the determination of rules of law. The IAEA Statute is a multilateral treaty under international law.¹⁵⁰ It binds the State parties thereto and gives the IAEA a definitive mandate, *inter alia*, to

¹⁴⁹ See ICJ, Statute of the International Court of Justice, at, <http://www.icj-cij.org/documents/index.php?p1=4&p2=2&p3=0>; see also Black's Law Dictionary, 8th Ed. (defining an international legal instrument as a body of binding decisions, other than judicial and arbitral decisions, concerning specific situations and disputes) (This definition appears restrictive since it does not elucidate on the auxiliary or subsidiary role judicial or arbitral decisions play in clarifying international law, e.g., *Trail Smelter Arbitration*)

¹⁵⁰ See *supra* note 4

establish or adopt international norms or standards in the field “safety” (IAEA 1956: III.A.6.)¹⁵¹

The substantive provision of the Statute does not define the legal nature of IAEA standards, but clearly, the standards are not necessarily binding international norms. Depending on the text, context, and State practice, some may be deemed binding, or at least as *ius definitivum*.¹⁵²

2.2.1. Applicable International Law and Conventions on Nuclear Safety

The four main international framework conventions on Nuclear Safety were all adopted after the Chernobyl accident in 1986. The principles and requirements of these conventions were however already in existence, and in many cases they were non-binding requirements developed under the auspices of the IAEA over a period of about half a century in response specific felt needs of international nuclear activities and the nuclear industry (WANO 2012; Stoiber et al. 2003). Even though establishing international conventions or treaties is not specifically listed as a function of the IAEA under its Statute (IAEA 1956: III), yet, nothing prevents member states of IAEA, an international organization, from elaborating, concluding, and applying agreements under general international law that are covered by the objectives of that organization (Jankowitsch 2010: 26). Moreover, Article II of the IAEA Statute has a seemingly *omnibus* provision that defines IAEA’s work and indirectly mandates it to draft and negotiate international agreements. Under Article II, the IAEA “seeks to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world. It shall ensure that, so far as it is able, that assistance provided by it or at its request or under its supervision or control is not used in such a way as to further any military purpose” (IAEA 1956: II). The fastest ever codification process achieved by the IAEA was in relation to the *Early Notification and Assistance* Conventions which were adopted a

¹⁵¹ Article III.A.6 of the IAEA Statute, 1956, available at http://www.iaea.org/About/statute_text.html#A1.21

¹⁵² See *supra* notes 3 to 14 and accompanying text (discussing legal nature and scope of application of IAEA Standards including *IAEA Regulation for the Safe Transport of Nuclear Material (2009 ed.)*). See also *supra* note 66 (listing several Standards)

few months after the Chernobyl nuclear power plant accident of April 26, 1986. Preceding these Conventions, the IAEA Board of Governors in May 1986 having “considered the ... reactor accident at Chernobyl Nuclear Power Station and other accidents in the past” and noting “the evident need for greater co-operation in nuclear safety ...” decided on the setting up of groups of government experts “to draft on an urgent basis, international agreements” on early notification and information about nuclear accidents and radiological releases; and coordination of assistance in such an event (IAEA/GOV/OR-649 1986).

2.2.1.1. The Convention on Early Notification of Nuclear Accident

This Convention is based on the IAEA’s existing *Guidelines*,¹⁵³ which was codified as the key foundation of the Early Notification Convention in the wake of Chernobyl. It was signed in September 1986, under the auspices of the IAEA, while the effect and lessons of Chernobyl were still unfolding. The main impetus was to create an opportunity for information sharing and for neighbouring countries to be informed to take precaution on the Chernobyl accident and future nuclear accidents, if any occurs. Chernobyl occurred during the Cold War, albeit at the end thereof, when issues on nuclear energy were of strategic importance to nuclear weapon states and non-nuclear weapon states alike; and secrecy, suspicion and mistrust were the order within the East-West polarized world. Soviet Union (Russia), then under Gorbachev, was not under any international law treaty obligation to inform its neighbours of the incident (Fischer 1997).

The Convention applies in the event of any accident involving specified facilities or activities of a State party, or of legal persons or legal entities under its jurisdiction or control, from which a release of radioactive material occurs or is likely to occur, and which has resulted, or may result

¹⁵³ IAEA, *Guidelines on Reportable Events, Integrated Planning and Information Exchange in a Transboundary Release of Radioactive Materials* (INFCIRC/321)

in an international transboundary release that could be of radiological safety significance to another State (Article 1(1)). The facilities and activities to which the Convention applies are listed Article 1(2) as follows: (a) any nuclear reactor wherever located; (b) any nuclear fuel cycle facility; (c) any radioactive waste management facility; (d) the transport and storage of nuclear fuels or radioactive wastes; (e) the manufacture, use, storage, disposal and transport of radioisotopes for agricultural, industrial, medical and related scientific and research purposes; and, (f) the use of radioisotopes for power generation in space objects.

2.2.1.1.1. Issues of Concern Pertinent to the Early Notification Convention

Article 1(1) “*accidents*” and *transboundary* releases of radiological *safety significance* to another State raise issues: ‘Accident’ restricts scope – it excludes terrorism and sabotage threats. Also, gauging the *likelihood* of transboundary release is at a State’s discretion. Again, in accident situations, it may be difficult to assess safety implications (*significance*) of transboundary release of radiological materials well. A State may, based on this Article and without any malice, decide not to inform the IAEA or neighbours based on its *estimation* of *safety significance* of the transboundary release. It betters *Trail Smelter Arbitration’s* clear and convincing injury evidence standard, by using *likelihood* as co-standard, but appears to fall short of the *precautionary principle* which mandates that “where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation” (Rio 1992:15). Article 3 seeks to cure this defect but its provisions are not mandatory: “With a view to minimizing the radiological consequences, States Parties *may* notify in the event of nuclear accidents other than those specified in Article 1.”

It may however be argued that the Convention seeks to achieve minimum standards of safety and prompt reporting or notification. Consequently, Article 9 leaves open the window for bilateral or

multilateral arrangements on the Convention's subject matter. Article 8's radiation monitoring system establishment assistance from IAEA may offer a richer solution, but again, the assistance seems only available to State Parties to the Convention which do not have nuclear activities itself and 'borders on a State having an active nuclear programme *but not* Party [to the Convention]'. This derogation may not make Article 8 beneficial to a State Party, bordering another State Party with an active nuclear programme. Here, Articles 3, 9 and lawful self-help may be options. The harmful hazards of radioactivity make Article 11's dispute settlement unattractive in such cases.

2.2.1.1.2. Early Notification Obligations of State Parties and IAEA

In the event of an accident, the state party must directly or through the Agency notify States which are or may be physically affected of the accident, its nature, the time of the occurrence, and exact location if necessary (Article 2(a)(b)). Articles 6-10 deal with the consultations the affected State could make in radiological incidents (Article 6), the competent authorities and focal persons to contact (Article 7), and the freedom of members to make bilateral agreements in addition to the provisions of the Convention (Article 9). The Convention does not affect any existing relationships under other international agreements (Article 10). IAEA must promptly inform State parties, and other states which are, or may be physically affected, and the relevant international organisations of any such notification received (Article 4(a)(b)). IAEA is required to maintain an up-to-date list of national authorities and points of contact as well as points of contacts of international organisations and to provide these to state parties and the relevant international organisations (Article 7(3)). Article 11 deals with dispute settlement. It requires the parties (whether States, or a State Party and the IAEA) to consult and settle the dispute by negotiation or by any other peaceful means of dispute settlement acceptable to them (Article 11(1)). If after one year the dispute is unresolved, then it shall, at a party's request, be submitted to arbitration or the ICJ for decision (Article 11(2)). Parties may derogate from Article 11(2).

2.2.1.1.3. Significance of the Early Notification Convention

Customary international law recognizes well-established environmental law principles including good neighbourliness with duty to inform or notify, consult, and negotiate, the precautionary principle and are captured in soft law legal instruments (Stockholm 1972; Rio 1992). Professor Alan Boyle explains this in simple terms as follows: “States are required to cooperate with each other in controlling transboundary pollution and environmental risks” (Boyle 1990:278). But there was no treaty obligation on this. The Convention therefore strengthens the international response to nuclear accidents by providing a mechanism for rapid information exchange in order to minimise transboundary radiological consequences. It enables states to seek help and as early as possible. It marked the beginning of multilateral cooperation in the field of nuclear power regulation at the international level. Triggered by an accident, negotiated and drafted urgently, and requiring just three countries to consent as signatories, and seventeen ratifications for it to enter into force, it is a novel multinational treaty, which continues to successfully serve as the basis for the system to function. This is a significant -- an earlier mid-1960s multilateral agreement initiative on the subject “was eventually decided as being unattainable” (Rautenbach et al. 2006:9). Ghana has not signed or ratified this Convention, so it is not yet a State Party.

Moreover, the IAEA recognizing the shortcomings in this (and the Assistance Convention), which were both adopted almost a generation ago, has in accordance with relevant decisions and resolutions of the IAEA’s Board of Governors and the General Conference expanded the scope of the practical operation of the system and the role of the IAEA Incident and Emergency Centre (IEC) as a 24-hour warning and operational focal point (Rautenbach et al. 2006:10; Tonhauser & Wetherall 2010:160). According to Ahiadeke (2009), Ghana, (although a non-Party to either Convention) utilized the system to get help in relation to ‘an industrial radiography source stuck

outside its housing.’ The IAEA’s Incident and Emergency System covers “nuclear accidents” as in the Early Notification Convention and also timely notification and response in the event of nuclear and radiological *emergencies*, irrespective of the cause, be it *inter alia* “criminal or intentional unauthorised acts” from which a release of radioactive material, that could be of radiological safety significance for another country, occurs or is likely to occur (Rautenbach et al. 2006:10; Tonhauser & Wetherall 2010:160). However, this is done only by way of non-binding supporting documents, plans and mechanisms including the Emergency Notification and Assistance Technical Operations Manual (ENATOM 2004; ERNET 2002; RANET; ConvEx1-3; Rautenbach et al. 2006:10; Tonhauser & Wetherall 2010:160). An enhanced binding legal regime that fosters greater cooperation, transparency, and expanded scope seem preferable.

2.2.1.2. The Assistance Convention

The Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency is based mainly on the IAEA’s pre-existing Guidelines for Mutual Assistance Arrangements in Connection with a Nuclear Accident or Radiological Emergency (INFCIRC/321). Triggered by Chernobyl, it was adopted by the General Conference of the IAEA in September 1986 concurrently with the Convention on Early Notification. Both have similar objectives in their preambles which are *inter alia* to prevent nuclear accidents and minimize consequences of any such accident, should it occur; strengthen international co-operation in the safe development and use of nuclear energy, for an international framework; facilitate prompt provision of assistance in the event of a nuclear accident or radiological emergency; and, mitigate its consequences by facilitating prompt bilateral and multi-lateral assistance and support when requested. It provides an international framework to facilitate prompt requests for and provision of assistance in the event of ‘*nuclear accident*’ or ‘*radiological emergency*’. It does not define those terms or events but, it promotes, facilitates and supports cooperation between State parties in such events.

2.2.1.2.1. The Role of State Parties and IAEA

If a State Party needs assistance, whether or not the accident or emergency originates within its territory, jurisdiction or control, it may call for such assistance from any other State Party, directly or through the IAEA, and from the IAEA, or, where appropriate, from other international intergovernmental organizations, and specify or agree on the scope and type of assistance required (Art. 2(1)(2)). The State Party to whom the request is made has to promptly decide and notify whether it can render the requested assistance and its scope and terms (Art 2(3)). Assistance may be offered without costs taking into account the needs of developing countries and the particular needs of countries without nuclear facilities (Art 7).

The convention provides for privileges, immunities and facilities to the personnel of the assisting party for the performance of their functions. The immunity includes freedom from arrest, detention and legal processes in respect of acts or omissions in the performance of their duties (Art 8(1)(2)). Assistance is also exempted from taxation both on income, equipment and property brought into the country (Article 8(3)). Claims and compensation due to or brought against personnel from the assisting State are borne by the requesting State (Art 10(2)). The assistance may be terminated by a mutual agreement initiated by either party (Art 11). IAEA serves as a focal point for cooperation by channelling information, supporting efforts, and providing its available resources allocated for such purpose (Articles 2 and 5). Article 5 requires IAEA to collect and disseminate information to State Parties who will also in turn notify the IAEA of available experts, equipment, materials, methodologies, techniques, good offices, for providing assistance. The IAEA is further expected to establish and maintain liaison with relevant international organizations to obtain and exchange information.

2.2.1.2.2. Significance of the Assistance Convention

It strengthens international response to a nuclear accident or radiological emergency, including a terrorist or other malicious attack. It provides for mutual assistance mechanisms for the purpose of minimising the consequences of such accidents or emergencies; and to protect life, property and the environment against the effect of radioactive releases. The Convention reassures States of assistance availability if the need arises. Accidents and contingencies are unpredictable and may expose even the well prepared to situations of need. It is thus assuring to have an international community ready to offer assistance when needed. Ahiadeke (2009) indicates that it has been invoked and help received by some State Parties.¹⁵⁴ The Convention encourages States to enter into bilateral and multilateral agreements to enhance information sharing and assistance.

A number of countries have expressed objections to parts of the Convention, and have indicated an intention not to be bound by the articles on privileges, immunities and facilities (Art. 8), transit of personnel, equipment and property (Art. 9); and claims and compensations (Art. 10). These objections indicate an inherent flexibility of the Convention to accommodate the needs, interests and reservations of State Parties. Article 6 enhances the need for confidentiality and coordinating information with requesting States before releasing public statements. Information management is critical since it can prevent public fear and panic that may arise if information is not handled well (Ahiadeke 2009). It has dispute settlement options; and provides a basis for international cooperation between States and the IAEA (Art. 5). It has aided the development of safety standards, codes of conduct and guidelines that help to prevent and deal with radiological emergencies (Art. 5; Stoiber et al. 2003). Ghana is not a Party to this Convention yet.

¹⁵⁴ See Margaret Ahiadeke, *Some International Nuclear Legal Instruments* (OLA/GAEC: Unpublished Manuscript 2009) (Copy on file with author) (Noting that according to an IAEA General Conference Report of 17th August 2000, the convention was formally invoked in 1999 by Turkey and Peru in relation to incidents involving overexposure to radiation sources.) Though she also mentions Ghana in relation to 'an industrial radiography source stuck outside its housing', it is likely that support to Ghana, if any, might not have been under the Assistance Convention directly since Ghana is not yet a State Party to that Convention.)

2.2.1.3. Convention on Nuclear Safety (CNS)

The CNS was triggered by the Chernobyl accident but it took almost ten years for it to be adopted. Its political origins and motivations were unlike the Assistance and Early notification Conventions: it sought to prevent rather than cure.¹⁵⁵ In 1990, Member States of the then European Community proposed the convening in 1991, an international conference on “Safety of Nuclear Power: Strategy for the Future,” as a contribution by the IAEA to the UN Conference on Environment and Development (Rio 1992). “Major Findings” of the 1991 Safety Conference culminated in the 35th regular session of the IAEA General Conference giving its support for a “framework convention for the promotion of an international nuclear safety regime” in 1991 (Jankowitsch 2006). The CNS was eventually adopted in June 1994; opened for signature in September 1994 and entered into force in 1996. It is substantially based on the IAEA Safety Fundamentals.¹⁵⁶ CNS does not give *detailed* safety standards but it is a commitment of State Parties to the application of *fundamental* safety principles for nuclear installations (Preamble viii). It is a key pillar in the international legal framework on nuclear safety.

The CNS focuses on the safety of land-based civil nuclear power plants including storage, handling and treatment facilities for radioactive materials on the same site and directly related to the operation of the nuclear power plant. It thus excludes decommissioning. It has three sets of “objectives”: to legally commit State Parties to achieve and maintain a high level of safety by setting international standards for the operation of land-based nuclear power plants worldwide

¹⁵⁵ Odette Jankowitsch-Prevor, *The Convention on Nuclear Safety* 155, 156 (in *International Nuclear Law in the Post-Chernobyl Period*, OECD 2006); Gunther Handl (2003:9)

¹⁵⁶ *Id.*, at p.158 (noting that in 1991, it was a draft document titled “Safety Fundamentals: The Safety of Nuclear Installations, but it was published in 1993 as “The Safety of Nuclear Installations” (Safety Series, No. 50 1993). The latest approved publication was in 2006, i.e., IAEA, *Fundamental Safety Principles (SF-1 2006)*. Known as the IAEA Safety Standard for Protecting People and Environment, it was co-sponsored by, EURATOM, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP, and the WHO.

via enhanced national measures and international cooperation including safety-related technical cooperation (i.e. a Safety Objective; Article 1(i)); to establish and maintain effective defences in nuclear installations against potential radiological hazards to protect individuals, society and the environment from harmful effects of ionizing radiation from such installations (i.e. Radiation Protection Objective; Article 1(ii)); and, prevent accidents with radiological consequences and mitigate the consequences if they occur (i.e. Technical Safety Objective; Art. 1(iii)). It gives priority to safety and does not have detailed provisions on security and physical protection (Art 10; CNS/RM 2002). However, in recognition of the importance of protecting power reactors against threats to their physical security, the CNS Preamble Paragraph (vi) refers to the Convention on the Physical Protection of Nuclear Material (1979) as an important law.

2.2.1.3.1. Obligations of the CNS State Parties

Obligations of Parties are contained in Chapter 2 of the CNS. Jankowitsch (2006) differentiates two types of obligations: (1) general obligation *de moyens* (best efforts); (2) reporting and peer review requirement. The general obligation requires (i) legislative, regulatory and administrative measures (to implement) (ii) general safety and (iii) safety of installations obligations.

(i) Legislative and Regulatory Requirements

Rules on the legislative and regulatory framework to govern nuclear installations safety are in Articles 4, 7, 8 and 9. Under Article 7(2), the legislative and regulatory framework must provide for “(i) the establishment of applicable national safety requirements and regulations (ii) a system of licensing, and the prohibition of the operation of a nuclear installation without a license (iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and terms of licences (iv) the enforcement of applicable regulations and of terms of licences” coupled with sanctions including “suspension, modification and

revocation.” The regulatory body must have “adequate authority, competence and financial and human resources to fulfil its assigned responsibilities” (Article 8(1)). Functions of the regulatory body should be effectively separated from those of bodies concerned with the “promotion or utilization of nuclear energy” (Article 8(2)); and licensees’ prime safety responsibility (Art. 9).

(ii) General Safety Requirements

These obligations cover the availability of adequate financial and human resources comprising “sufficient numbers of qualified staff with appropriate education, training and retraining for all safety-related activities ... throughout the life of each nuclear installation” (Art. 11), priority on safety (Art. 10); quality assurance, assessment and verification of safety, radiation protection, and emergency preparedness for both “on-site and off-site emergencies” and provision of appropriate information to residents and “competent authorities of the States in the vicinity of the nuclear installation” “in so far as they are likely to be affected by a radiological emergency” (Articles 13-16); and ensuring “that the capabilities and limitations of human performance are taken into account” (Art. 12).

(iii) Safety of Installations Requirements

It covers siting, design, construction, and operation of civil nuclear power plants (Articles 17-19). The safety of installations provisions are entirely based on the IAEA’s Safety Fundamentals document (“Technical Aspects of Safety”) and they focus on the nuclear installation itself, rather than on general issues concerning all nuclear safety matters. It provides for the evaluation of “all relevant site-related factors likely to affect the safety of a nuclear installation” “likely safety impact” “the continued safety acceptability” and the obligation to consult Contracting Parties in the vicinity of a proposed installation (Art. 17). Article 18 focuses on design and construction and emphasizes concepts like “defence in depth” i.e. several layers of protection against release

of radioactive materials into the environment and a “specific consideration of human factors and the man-machine interface”. Article 19 has eight clauses on the operation of a nuclear installation covering all of its stages from initial authorization to operate up to the treatment and storage of spent fuel and radioactive waste, and thus excludes decommissioning (Art. 2(i)).

(iv) Reporting and Peer Review Obligations

The Reporting and Peer Review requirements provide a mechanism where substantive issues on nuclear safety are discussed (Stoiber 1999). Contracting Parties with or without operational nuclear power stations are obliged under Articles 5 and 20 to provide a detailed written report explaining the measures taken “to implement each of the obligations of the Convention”. Articles 5 and 20 require State Parties to submit reports on the implementation of their obligations for peer “review” at meetings of the Parties. Article 21(3) makes such meetings triennial in frequency, at the very least. The first Peer Review meeting under the terms of the Convention was held in Vienna in April 1999, and subsequent ones in April 2002, 2005, 2008 and the latest (the fifth) in April 2011. Reasonable opportunity to discuss reports by State Parties (peers) and to seek clarification of such reports is guaranteed under Article 20(3). Reporting, discussions and debates are very open and transparent but are also subject to confidentiality rules (Article 27).

2.2.1.3.2. Obligations of the IAEA

Article 28(1) of the Convention requires IAEA to provide the secretariat for the meetings of the Contracting Parties. Under Article 28(2), the secretariat provided by the IAEA is required to convene, prepare and service review meetings by conducting all the preparations, transmission of information received or prepared to the Contracting Parties and servicing the meeting etc. The IAEA bears the costs of carrying out such functions from its regular budget. Other services

which Contracting Parties may require “in support” of the review meetings shall also be provided by IAEA “within its programme and regular budget” or voluntarily funding from another source.

2.2.1.3.3. Dispute Resolution

The CNS has an unusual provision on dispute resolution. No reference is made to a court, arbitral body, or even a permanent political or administrative body. In the event of a disagreement between two or more Contracting Parties concerning the interpretation or application of the Convention, the parties shall consult within the framework of a review meeting with a view to resolving the disagreement (Article 29). It provides for only a simple consultation mechanism to resolve any disputes referred to in the CNS as “disagreements”. The provision is in keeping with the pragmatic peer group approach devised by the negotiators (Jankowitsch 2006:167).

2.2.1.3.4. Significance of the Convention on Nuclear Safety

CNS is an incentive instrument like the other safety related conventions (CNS Preamble (vii)). It is designed to ensure Parties’ fulfilment of obligations through common interest to achieve higher levels of safety, rather than through control and sanctions. These are further developed and promoted through regular meetings (Stoiber 1999:100). Its most significant feature is the ‘peer review mechanism’ which allows open discussion of common problems and sharing of ideas on solutions. Such peer review and reporting mechanisms comprise effective managerial (Chayes et al. 1998:39), transformational (Downs et al. 2000:467), interactional (Brunee & Toope 2000:19; Haas & Sundgren 1993:406), facilitative cooperative approach (Handl 1997:29) or an “iterative process of discourse” that “progressively elaborates the meaning of relevant obligations through cooperative processes of consultation, analysis and persuasion, rather than coercive measures” (Chayes et al. 1998:41). The reports and peer review ensure that the nuclear safety regime is implemented and ‘enforced’ effectively (Handl 2003:10; Stoiber 1999:110).

The CNS does not provide for any specific authority, focal point or a national institution to be created for the purpose of its implementation. The “Implementing Measures” under Article 4 merely provides that “Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this convention.” It does not prescribe any specific national law to be adopted, unlike, for example Article 7 of the Convention on the Physical Protection of Nuclear Material (CPPNM) which lists acts that are “to be made punishable offences under national law.” It is therefore an instrument that “can be implemented by countries with very different industrial, regulatory and legal systems, at different stages of development, and even with widely differing approaches to nuclear power” (Jankowitsch 2006:168).

The CNS has cross-references to both existing and evolving international standards and criteria. The “extra-conventional safety standards, criteria and principles” “provide interstitial normative materials that fill outright gaps”, or compensate for any “relative lack of normative specificity” in the CNS (Handl 2003:14). As Tonhauser & Wetherall (2010:161) observes: “CNS is no longer just a triennial exercise but instead is an ongoing process that looks to continually promote the advancement of nuclear safety” with a “commitment to openness and transparency” including public outreach activities, posting National Reports on public websites, communication with the media and changes to rules and guidelines to enable parties to retain insights and knowledge from meetings without reservation. The IAEA Website has information on Review Meeting Reports and detailed national reports dating back to 1999 and beyond.¹⁵⁷

¹⁵⁷ See IAEA, *Convention on Nuclear Safety*, available at <http://www-ns.iaea.org/conventions/nuclear-safety.asp>

2.2.1.4. The Joint Convention

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (The Joint Convention) was opened for signature on 29 September 1997 and entered into force on 18 June 2001, 90 days after the twenty-fifth instrument of ratification was deposited (Art. 40(1)). It has its roots in the 1991 Nuclear Safety Conference that eventually gave birth to the 1994 Convention on Nuclear Safety. Preamble (ix) of the CNS affirmed “the need to begin promptly the development of an international convention on the safety of radioactive waste management ...” Preamble paragraph (x) of the CNS also referred to “safety of other parts of the nuclear fuel cycle” which “in time” would be covered by “international instruments.” According to Jankowitsch (2006:161), those two paragraphs reflect the political compromise reached after protracted negotiations, “to limit the scope of the [CNS] to land-based civil nuclear power plants, but to express, at the same time, a commitment to developing an instrument on the safety of waste management ...” Consequently, there was much international cooperation and goodwill in negotiating and crafting the Joint Convention as a common solution to the problem of radioactive waste and spent fuel. It however took three years of drafting and negotiation for it to be finally adopted in 1997, and another four years for it to enter into force in 2001.

It is the first and only international legally binding treaty on the subject (Handl 2003:8; Tonhauser & Jankowitsch 2006:209). The same safety objectives are applicable to both spent fuel and radioactive waste management (Preamble (ii)). These objectives span three sets of Safety Objectives: (i) General Nuclear Safety Objective; (ii) Radiation Protection Objective; and (iii) Technical Safety Objective (Stoiber et al. 2003:64). Article 1(i) is a General Nuclear Safety objective: “to achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management, through the enhancement of national measures and international co-operation including where appropriate safety-related technical cooperation.” Article 1(ii) is a Radiation Protection Objective spiced with

sustainable development and environmental protection goals to protect “individuals, society and the environment” “from harmful effects of ionizing radiation” with “effective defenses against potential hazards” to meet “the needs and aspirations of the present generation” “without compromising the ability of future generations to meet their needs and aspirations.” Article 1(iii) is a Technical Safety objective “to prevent accidents with radiological consequences should they occur during any stage of spent fuel or radioactive waste management.”

It directly addresses on a global scale, issues related to spent fuel and radioactive waste resulting from the operation of civilian nuclear reactors. It does not apply to the safety management of spent fuel or radioactive waste within military and defence programmes. But it applies to the safety management of such materials from military and defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes. The Convention gives recognition to global environmental policy: Paragraphs (xv) and (xvi) of the Preamble respectively mention Chapter 22 of Agenda 21 adopted at the Rio Conference on Environment and Development in 1992 as reaffirming the importance of safe management of radioactive waste; and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989), Article 1(3) of which the Joint Convention seems to “dis-apply”. The Convention impacts on international trade and transportation of nuclear and radioactive materials by providing a strict regime on transboundary movement (Art. 27).

2.2.1.4.1. Obligations of the Parties

Tonhauser and Jankowitsch (2006) group obligations into two categories: (1) general obligation *de moyens* (best efforts), and (2) reporting and peer review requirement (Articles 30-36) as in the CNS. The general obligation *de moyens* may be grouped into four different categories: (i) Safety of Spent Fuel Management obligations (Articles 4-10), (ii) Safety of Radioactive Waste Management

obligations (Articles 11-17) (iii) General Safety obligations (Articles 18-26), and (iv) Obligations on Transboundary Movement and Disused Sealed Sources (Articles 27, 28).

The Joint Convention requires Parties to establish and maintain an institutional, legislative and regulatory framework to govern the safety of spent fuel and radioactive waste management (Articles 18-21); and to ensure that individuals, society and the environment are adequately protected against radiological and other hazards, in the siting, design and construction of facilities and by making provisions for ensuring the safety of facilities both during their operation and after their closure (Articles 4-10, 11-17 and 24). Parties are also to ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and if necessary off-site emergency plans (Article 25(1)); to take the appropriate steps for the preparation and testing of emergency plans for its territory likely to be affected in the event of a radiological emergency at a spent fuel or a radioactive waste management facility in the vicinity of its territory (Article 25(2)). On reporting and peer review, it is to submit a national report, on measures taken to implement each of the obligations of the Convention, to each review meeting of contracting parties (Article 32); to attend meetings of the Contracting Parties or be represented at such meetings by a delegate and advisers for the purpose of reviewing submitted reports (Articles 30-31 and 33).

Article 27 is on transboundary movement of spent fuel and radioactive waste. It codifies the concepts contained in the IAEA Code of Practice on the International Transboundary Movement of Radioactive Waste (1990). It provides for prior notification and consent of the destination state, and compliance with transit provisions. Authorization for such transport depends on the technical and administrative capacity and regulatory structure needed to manage such materials in the recipient state and a “take-back” provision to allow re-entry into national territory if a transboundary movement is not or cannot be completed or alternatively arranged (Article 27(1)). Article 27(2)

prohibits the shipment of such materials to any destination south of latitude 60 degrees (as in the 1959 Antarctic Treaty). Article 27(3) guarantees the freedom of navigation under international law and the right of states to reprocess and return products or waste resulting from reprocessing operations. Article 28(1) is on taking appropriate steps, in the framework of national law, to manage disused sealed sources safely. Article 28(2) allows for re-entry into a State's territory of disused sealed sources, if in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

2.2.1.4.2. Obligations of IAEA and Dispute Resolution

IAEA is the secretariat for the meetings and it facilitates all the necessary processes to ensure the success of the meetings (Article 37). As in the CNS, under Article 37(2) of the Joint Convention the secretariat provided by the IAEA is required to convene, prepare and service review meetings by conducting all the preparations, transmission of information received or prepared to the Contracting Parties and servicing the meeting etc. IAEA bears the costs of carrying out such functions from its regular budget. Under Article 37(3), other services which Parties may by consensus require "in support" of the review meetings shall also be provided by IAEA "within its programme and regular budget" or voluntarily funding from another source. Since nuclear waste or spent fuel issues are often emotive, dispute resolution in Article 38 is similar to that of the CNS where Parties are expected to "consult within the framework of a review meeting" but States may resort to mediation, conciliation, and arbitration mechanisms provided for in international law if consultations prove unproductive.

2.2.1.4.3. Significance of the Joint Convention

The Joint Convention in June 2001 crowned the IAEA's efforts to create a robust nuclear safety regime. The obligations of the Contracting Parties to the Joint Convention are based on the principles contained in IAEA's 1995 Safety Fundamentals document "The Principles of Radioactive Waste

Management”. The Convention essentially codified those non-binding principles into a binding instrument. The Convention also precociously frames a “mixed” spent fuel and radioactive waste regime in one single binding document essentially under same safety objectives and principles of safe management. This is particularly striking given that spent fuel is considered a resource and part of the nuclear energy production cycle and could not legally be included in the definition of radioactive waste or be associated with a material for which no further use is foreseen.¹⁵⁸ The Convention, with its parallel sets of requirements, one on safety of spent fuel management, and another on safety of radioactive waste management, in an order reflecting logical sequence of the nuclear fuel cycle, and providing an exception for spent fuel at reprocessing facilities, obviated the need for two Conventions or an additional protocol to a Convention and their attendant risk of two sets of Contracting Parties which can result in a gap in the safety regime for those materials, since some States may choose not to sign or ratify one of the Conventions or the Protocol, if the Joint Convention had been so divided. As Tonhauser and Jankowitsch (2006:207) observe, “as it turned out later, it was in fact the inclusion of spent fuel ... that ensured that there would be no gap with the scope of application of the [CNS].”

Moreover, the Joint Convention has created an important relation with the CNS. The scope of application of the CNS, which included “storage, handling and treatment facilities for radioactive materials as are on the same site and are directly related to the operation of the [land-based civil] nuclear power plant”, leave room for possible different interpretations as to what is located “on site” – possibly including radioactive waste and or spent fuel – and it also makes the CNS overlap with the Joint Convention. Such an overlap occasions double reporting but prevents any gaps that would have been created in the reporting mechanism, if either Convention had allowed Parties to keep sites, facilities or wastes outside the report. Also, the Joint Convention has eliminated any possibility of a

¹⁵⁸ See Article 2 of Joint Convention; see also Tonhauser and Jankowitsch (2006:207)

gap between it and the CNS on the issue of decommissioning. Article 2(i) of the CNS excludes nuclear installations for which “a decommissioning programme has been agreed to by the regulatory body” from its scope of application. Article 2(i) of the Joint Convention has expanded the definition of the term “radioactive waste management” to include “decommissioning” as follows: “radioactive waste management” means “all activities, including decommissioning activities, that relate to the handling, pretreatment, treatment, conditioning, storage, or disposal of radioactive waste, excluding off-site transportation ...”

Article 27 is largely based on the IAEA’s 1990 Code of Practice on International Transboundary Movement of Radioactive Waste; and has thus transformed a non-binding good state practice document into a binding international legal instrument. Besides, Article 27 pre-empts the Basel Convention on Transboundary Movement of Hazardous Waste (Tonhauser and Jankowitsch 2006:209). This is due to Article 1(3) of the 1989 Basel Convention: “Wastes which as a result of being radioactive, are subject to other international control systems, including international instruments, applying specifically to radioactive materials, are excluded from the scope of this Convention” (Jankowitsch 2010:204). The Article 1(3) compromise was to make up for gaps in that field, but Article 1(3) is positively pre-empted by the Joint Convention (Reyners 2010:176). Article 27 provides an elaborate strict system of transboundary movement but guarantees the right of innocent passage (Art. 27(3)). It provides for “disused sealed sources” in Article 28, although such materials are at times deemed extraneous to radioactive waste.

The Joint Convention makes explicit references to environmental aspects of safe management of spent fuel and radioactive waste. Paragraph (xi) of the Joint Convention’s Preamble espouses an environmental policy principle which the UN General Assembly on Sustainable Development (UNGASS) reiterated during its Special Session in June 1997, that, “radioactive waste should as far

as is compatible with the safety of the management of such material, be disposed of in the State in which it was generated.” Besides, Paragraph (xv) of the Preamble mentions Chapter 22 of Agenda 21 of the 1992 Rio Conference on Environment and Development as reaffirming the importance of safe management of radioactive waste. Consequently all major technical articles in the Convention such as those on General Safety (Art. 11), Siting of Proposed Facilities (Art. 6 & 12), Design and Construction (Art. 7 & 14), Safety Assessment (Art. 8 & 15), contain explicit references to the environment. In line with Agenda 21, Articles 6 and 7 further address issues of potential transboundary effects of radioactive waste and spent fuel in siting proposed facilities.

Besides, the Convention cross-references international standards and principles (Preamble (xiv) and Articles 1, 4, 11, 24). This establishes a link to a secondary level of normative concepts and standards which although not binding, now have a binding effect on convention State Parties due to their adoption by reference into the convention. Their legal significance is a function of the normative status of the adopting or referring provision, rather than the referred standards’ status. This is an indirect legislation technique that seems well established in international law (Contini & Sand 1972: 37; Chinkin 2000: 22; Handl 2003:15; Kirgis 1995:109; Oxman 1991:109).

Reporting requirements in Article 32 are distinguishable from that of the CNS: national reports address not only the measures taken by State Parties to implement each of the obligations of the convention, but also, they should contain a national list of radioactive waste and of spent fuel management facilities, their location, main purpose and essential features, and an inventory of spent fuel and radioactive waste that is in storage, that has been disposed of, or for radioactive waste that has resulted from past practices; and a description of the materials in the inventory including available information on mass, activity; and a list of the nuclear facilities being decommissioned and

the status of decommissioning activities. Article 32 thus has comprehensive reporting obligations on specified matters including facilities, materials and activities.

The Joint Convention's Article 3(3) provide for voluntary submission of military spent fuels and radioactive waste to the Convention's provisions, and applies the Convention to such materials from military or defence programmes, if and when they are transferred permanently to and managed within exclusively civilian programmes; and Paragraph (viii) of the preamble to the Joint Convention also requires that such fuel and waste in military programmes "should be managed in accordance with the objectives stated in the Joint Convention". Moreover, Article 36(3) has extensive confidentiality clauses on information relating to such military spent fuel and waste, and guarantees the "exclusive discretion" of Parties to decide (i) whether such information is classified; (ii) whether to provide such information; and (iii) what conditions of confidentiality are attached to such information provided in the context of the Convention. Yet, it appears such provisions may enable military spent fuels and wastes to be managed at a lower safety level than that accorded to similar material from civilian nuclear applications.

2.2.2. Applicable International Codes on Nuclear Power Generation Safety

'Code' is a classical polysemic term (Reyners 2010:171), derived from the Latin 'Codex'. It is sometimes used in reference to a collection of regulations that represent efforts to "formulate certain expectations to induce certain behaviour" (Wetherall 2005:72) (Elbaradei et al. 1995:17; Fatouros 1980:123; Kirgis 1995:86; Oppenheim 9th ed. 1992; Schachter 1977:303). Deemed "quasi-legal" (Jankowitsch 2010: 24), it may, depending on the context, be legally binding (e.g. US Code of Federal Regulations, *Code de la Sante* in France), or non-binding legally, albeit definitive, persuasive, authoritative and *formally* binding (e.g. IAEA Code of Conduct on the Safety and Security of Radioactive Sources (2003); IAEA Code of Conduct on the Safety of Research Reactors

(2004); IAEA Code of Practice on Transboundary Movement of Radioactive Waste (1990); FAO Codex Alimentarius Commission Guidelines for Radionuclides in Foods (1989); ILO Code of Practice: Radiation Protection of Workers (Ionizing Radiations) (1987)).

The IAEA Codes of Conduct are prepared by working groups of experts from IAEA Member States, and are then approved by the IAEA Board of Governors and endorsed by the IAEA General Conference comprising all IAEA Member States. Although the IAEA codes are “not legally binding *per se*” they receive political support and commitments through the General Conference endorsement (Wetherall 2005:72; Reyners 2010:180). Whether such commitments are generally observed is a matter of empirical research and not normative analysis, but State practice seem to indicate a relatively high level of compliance which Reyners (2010:185) terms as “prudently optimistic” in relation to the codes on radioactive sources and research reactors.

Two IAEA Codes which are most relevant to this inquiry on safe generation of nuclear power are the Code of Conduct on the Safety and Security of Radioactive Sources (2003) and Code of Conduct on the Safety of Research Reactors (2004). The Guidance on the Import and Export of Radioactive Sources (2005) is part of the radiation sources regime. The Code of Practice on International Transboundary Movement of Radioactive Waste is now incorporated in the Joint Convention’s Article 27 (discussed in Section 2.2.1.4.1. *supra*), but that code is not on nuclear safety directly. This section therefore discusses the codes on radioactive sources and research reactors.

2.2.2.1. Code of Conduct on the Safety and Security of Radioactive Sources

Attention to the safety of radioactive sources (and their security) culminating in the 2003 Code on the subject, seems to have gained momentum in the 1990s: (i) after radiological accidents in Goiania (Brazil) in 1987, San Salvador (El Salvadore) in 1990, Soreq (Israel) in 1993, Tamniku (Estonia) in

1998; (ii) the publication of the International Basic Safety Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources in February 1996 (co-sponsored by FAO, IAEA, ILO, OECD/NEA, PAHO and WHO) (it has been superseded by the September 2011 Interim Edition approved by the IAEA Board of Governors)¹⁵⁹ and (iii) the September 1998 IAEA Conference on the Safety of Radiation Sources and Security of Radioactive Materials, held in France (Rautenbach et al. 2006:17; Reyners 2010:178).

As Reyners (2010:178) recalls, “reports submitted to the conference highlighted the inadequacy in many countries of the institutional and legal framework necessary to manage these sources.” The IAEA General Conference of 1998 also expressed concerns on how to improve national systems on the safety and security of radioactive sources. It asked the IAEA Secretariat to report on the feasibility of formulating international undertakings in that area (IAEA/GC(42)/Res/12). This resulted in a 2000 version which was subsequently reviewed to incorporate lessons learnt from the 9/11 terrorist events in New York. The reviewed text was adopted by the IAEA Board of Governors and endorsed by the General Conference in 2003 (GC47/Res/7.B). In September 2004, the Guidance on the Import and Export of Radioactive Sources was also adopted by the General Conference and eventually published in 2005.¹⁶⁰

Significance of the Radioactive Sources Code and the Import/Export Guidance

Though not legally binding, the Code offers guidance “for the development and harmonization of ... national policies, laws and regulations and set[s] forth the desirable attributes for the management of safety” (Tonhauser & Wetherall 2010:162). It integrates both the safety and security aspects of

¹⁵⁹ Published directly from the IAEA Board of Governors document GOV/2011/42 in 2011 as General Safety Requirements Part 3, it is titled *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards: Interim Edition* (2011)

¹⁶⁰ The Guidance on the Import and Export of Radioactive Sources (IAEA/CODEOC/IMP-EXP/2005)

radioactive sources (Para. 2 to 22). It supplements radioactive materials covered by the Convention on the Physical Protection of Nuclear Materials (as amended in 2005) (Para. 23 to 26). It expects countries to establish effective national legislative system of control over the management and protection of radioactive sources. The IAEA General Conference in endorsing the Code, asked each member state to write to the Director General undertaking to support the IAEA's efforts to enhance the security and radioactive sources and to comply with the requirements of the code; and the list of States making such a commitment published (IAEA/GC47/7.B paragraph 6). A written political commitment was also expected from States on the Import-Export Guidance (IAEA/GC48/10 paragraph 8). By 2010, 99 States had expressed a commitment to the Code and 59 States to the Guidance (Tonhauser & Wetherall 2010:163).

The Guidance and its optional assessment questionnaire provide detailed practical information on the control of international movement of sources (Category 1 and 2) and also enable States to provide relevant information on practices for review purposes. Periodic meetings, voluntary "exchange of information, [discussion of] lessons learned and evaluation of progress made by States towards implementing the provisions of the code" has also been instituted to enhance transparency (Tonhauser & Wetherall 2010:164; Reyners 2010:168; IAEA/GC(49)/RES/9 2006; Rautenbach et al. 2006:17).

2.2.2.2. Code of Conduct on the Safety of Research Reactors

Research reactors are often located at universities and research centres in densely populated areas; and there are many in countries with no nuclear power programme like Ghana (Stoiber et al. 2003:72; Amuasi 2001:1). But some research reactors are used in the nuclear fuel cycle's research and development activities on nuclear power generation (Stoiber et al. 2003:63). With the exclusion of research reactors from the CNS' scope, there was a lack of an international agreement on the subject. In 1998, the International Nuclear Safety Advisory Group (INSAG) raised concerns about this lacuna

to the IAEA Director General and, in 2000, suggested adoption of a Protocol to the CNS or an equivalent legal instrument to address the gap. The IAEA set up a working group of legal and technical experts to produce the Code of Conduct which was adopted by the IAEA Board and endorsed by the General Conference in 2004 (Reyners 2010:181; Wetherall 2005:81).

Significance of the Code of Conduct on the Safety of Research Reactors

The objective of the Code is to achieve and maintain a high level of safety in civilian research reactors worldwide through the enhancement of national measures and international cooperation including, where appropriate, safety related technical co-operation (Para. 4). The objective of the Code spans three areas: (i) General Safety; (ii) Radiation Protection; and (iii) Technical Safety, which respectively involve ‘proper operating conditions’ to prevent accidents, protection of ‘workers, members of the public and environment against radiation hazards’ and mitigation of radiological consequences should accidents occur (Paragraphs 4 and 22 to 32).

It balances the need for academic freedom and innovative research and development with the legitimate demand for high levels of safety in nuclear research which must be accomplished through national safety regulations pertaining to all stages of life of research reactors and the use of IAEA safety standards relevant to research reactors (Para. 5 and 20(a)-(u)). Given the wide range of hazard potential of research reactors, States have flexibility in adopting a *graded* approach to the application of the Code’s guidelines, commensurate with the hazard potential, albeit within a strong nuclear safety culture. The Code addresses role of States (Para. 9 to 18), national regulatory bodies (Para. 19 and 20), and research reactor operators (Para. 21-32).

States are to establish and maintain legislative and regulatory framework to govern the safety of research reactors; and place prime responsibility for safety on the operating organization. The

regulatory body must ‘implement a process of issuing authorizations’ (Para. 19(a)); ‘undertake regulatory inspections and assessments to ascertain compliance’ (Para. 19(b)) ‘enforce applicable regulations and authorizations’ via ‘suspension, modification or revocation of an authorization’ (Para. 19(c)); and review and assess operating body’s submissions on safety.

The Code has extensive provisions on the specific and general roles of the operating organization spanning ‘assessment and verification of safety’ ‘financial and human resources’ ‘quality assurance’ ‘human factors or capabilities and limitations’ ‘radiation protection’ ‘emergency preparedness’ ‘siting’ ‘design, construction and commissioning’ operation, maintenance, modification and utilization’ ‘extended shutdown’ and ‘decommissioning’ (Para. 21 to 35). In performing these roles, the operating organization should ‘establish its own policies in accordance with the State requirements’ ‘give safety matters the highest priority’ ‘promote a strong nuclear safety culture’ and ‘implement [roles] within a management structure having clearly defined divisions of responsibility and lines of communication’ (Paragraph 21).

Though no peer review mechanism is provided for in the Code, pursuant to a December 2005 arrangement, periodic meetings are organized to discuss topics related to the application of the code, exchange experience, lessons learnt, identify good practices, etc (Tonhauser & Wetherall 2010:164). Reyners (2010: 183) describes this as ‘the emergence of voluntary mechanisms for monitoring application of [this and other codes] by interested countries, based increasingly on the sort of peer review mechanism originally introduced by the CNS.’ The Code’s provisions and guidelines have also been incorporated into appropriate IAEA safety review services such as INSARR (Integrated Safety Assessment of Research Reactors) IRSRR (Incident Reporting System for Research Reactors), technical cooperation projects and extra-budgetary programmes. These IAEA services are in keeping with Paragraph 36(b) of the Code which mandates the IAEA to assist States which call on it regarding

the implementation of the Code. Ultimately, the Code provides guidance to States for *inter alia*, the development and harmonization of policies, laws and regulations on the safety of research reactors (*see* the Preamble of the Code).

2.2.3. International Nuclear Law Safety Principles

Several nuclear energy international safety standards (as supplemented by industry standards and best practice) provide support to States in establishing a consistent and comprehensive regime to achieve the main safety objective of proper protection of people (individually and collectively) and the environment from harmful effects of ionizing radiation (IAEA 2006; 2010; 2011). The IAEA Board having approved the publication of safety standards in the Safety Fundamentals category on the safety of nuclear installations in June 1993 (IAEA 1993), on the safety of radioactive waste management in March 1995, and on radiation protection and the safety of radiation sources in June 1995 (IAEA 1996), later authorized the revision of the three (3) Safety Fundamentals texts to combine them in a unified set of principles “representing a common safety philosophy across all areas of application of the IAEA safety standards” (IAEA 2006:vii).

Consequently, from 2000 to 2006, IAEA in collaboration with several international agencies (including EAEC, FAO, ICRP, ILO, IMO, OECD/NEA, PAHO, UNEP, UNSCEAR, WHO) formulated 10 key safety principles “on the basis of which safety requirements are developed and safety measures are to be implemented in order to achieve the fundamental safety objective” without unduly limiting the operation of facilities or the conduct of activities that give rise to radiation risks; and to facilitate a consistent application of international safety standards in different States (IAEA 2006:5).¹⁶¹ Under Article III.A.6 of the IAEA Statute, the principles are binding on the IAEA in

¹⁶¹ The joint sponsoring organizations of IAEA’s 2006 Fundamental Safety Principles were the EAEC, FAO, ILO, IMO, OECD/NEA, PAHO, UNEP, and WHO.

relation to its operations and on States in relation to operations assisted by the IAEA. States or sponsoring organizations may adopt the principles, at their discretion, for application to their own activities (IAEA 2006, 2010, 2011; IAEA Statute 1956:III.A.6). The three main principles of radiation protection (justification, optimization of protection, and dose limits or minimization) are set out in the Safety Principles 4, 5, and 6 respectively. Principles 7 and 10 reaffirm the need for comprehensive radiation protection for sustainable development. The Fundamental Safety Principles (IAEA 2006:6-15) include the following:

1. The prime responsibility for safety must rest with the person or organization responsible for facilities and activities that give rise to radiation risks.
2. An effective legal and government framework for safety, including an independent regulatory body, must be established and sustained.
3. Effective leadership and management for safety must be established and sustained in organizations concerned with, and facilities and activities that give rise to, radiation risks.
4. Facilities and activities that give rise to radiation risks must yield an overall benefit.
5. Protection must be optimized to provide the highest level of safety that can reasonably be achieved.
6. Measures for controlling radiation risks must ensure that no individual bears an unacceptable risk of harm.
7. People and the environment, present and future, must be protected against radiation risks.
8. All practical efforts must be made to prevent and mitigate nuclear or radiation accidents.
9. Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.
10. Protective actions to reduce existing or unregulated radiation risks must be justified and optimized.

Moreover, *safety*, deemed as the primary requisite for the use of nuclear energy, has evolved as a three-pronged principle encompassing prevention, protection, and precaution principles (Stoiber et al 2003:5-6). The prevention principle deals with exercise of caution and foresight to prevent damage arising from the use of nuclear technology and to minimize any adverse effects resulting from misuse or accidents. The protection principle protects public health, workers, and the environment from radiation risks. On the precautionary principle (explained in page 88 above), “lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent [harm and/or] environmental degradation” “where there are threats of serious or irreversible damage” (Rio

1992:15). The ten Fundamental Safety Principles generally evince key nuclear law principles on (i) safety, (ii) security, (iii) entity primarily responsible for ensuring safety, (iv) permission requisites for nuclear activities, facilities, entities, (v) continuous regulatory control, (vi) independence of the regulatory authority, (vii) transparency by operator, regulator and industry bodies, (viii) sustainable development, (ix) compliance with international obligations, (x) compensation, and (xi) international cooperation to tackle transboundary nuclear impacts and security risks, and share lessons or best practices (IAEA 2006; Rio 1992:13,18).

In 2010, as part of its Safety Standards Series, IAEA published General Safety Requirements on ‘Governmental, Legal and Regulatory Framework for Safety’ to provide for the regulation of facilities and activities that give rise to radiation risks. It sets out a hierarchy of responsibilities for government, regulatory bodies, operating organizations and the persons engaged in activities involving radiation exposure. The government has the responsibility to adopt within its legal system, legislation, regulations, standards and measures as may be necessary to fulfil all its national and international obligations effectively, and establish an independent regulatory body (or bodies) for activities relating to the control of radiation and radioactive material. Regulatory activities include establishing requirements and guidelines, authorizing and inspecting facilities and activities, enforcing legislative and regulatory provisions, and demonstrating leadership in achieving safety (by urging operating organizations to promote and nurture a safety culture, assess safety performance regularly, apply lessons learnt by experience or training, and effective graded approaches of management systems to notify, control, assure, and manage quality). The government is expected to establish systems for nuclear power regulation and ensure that it is effectively implemented. Law thus plays facilitative and regulatory roles in nuclear power programmes by providing the “infrastructure” and enabling framework for the establishment, operation, and regulation of a nuclear power plant.

2.2.4. International Environmental Law Principles and Cases Relevant to Nuclear Safety

As a branch of public international law, Article 38 of the ICJ Statute is the main source of international environmental law; and nuclear energy has played a vital role in its development via an anthropocentric approach to environmental law (Emmerechts 2010:123), not an ecological or value totality approach (Birnie & Boyle 2002:3; Black 1991:370). The ICJ in its 1996 Advisory Opinion on the *Legality of the Threat or Use of Nuclear Weapons* said that “[t]he environment is not an abstraction but represents the living space, the quality of life and the very health of human beings, including generations unborn.” In its 1995 review of the 1973 *Nuclear Tests Case* (New Zealand v. France) on the Request for Indication of Interim Measures of Protection regarding the French government’s atmospheric nuclear testing and its environmental and health impact, the ICJ reiterated the “obligations of States to respect and protect the natural environment.”

These obligations had earlier been echoed in the *Pacific Fur Seal Arbitration* (1893) and the *Trail Smelter Arbitration* (1941), but they were developed into a legal and institutional regime by the 1972 Stockholm Conference – (the UN Conference on the Human Environment was the international community’s first effort at constructing a coherent strategy for developing international environmental law, policy, and institutions such as UNEP). The 1987 Brundtland Report as endorsed by the UN General Assembly; and the 1992 Rio Declaration on Environment and Development, as well as Agenda 21, CBD, UNFCCC which were all initiated during the 1992 Rio Earth Summit further developed international law in the field of sustainable development. The 1998 Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, though inapplicable to Ghana, provides persuasive authority for environmental protection in relation to nuclear power stations and other nuclear reactors. The Convention’s provisions and principles applicable to nuclear activities

include the public's right to know and hence the state's obligation to inform the public about the use of nuclear energy, and the public's participation in the preparation of nuclear regulations.

In its 1996 Advisory Opinion on the *Legality of the Threat or Use of Nuclear Weapons*, the ICJ declared that States' "general obligation ... to ensure that activities within their jurisdiction or control respect the environment of other States or of areas beyond national control is now part of the corpus of international law relating to the environment." This is the "no harm rule." Several 'substantive' and 'procedural' international environmental norms or principles that focus on 'outcomes' and 'means' respectively, are relevant to nuclear safety. Substantive environmental law principles include the "no harm rule", "good neighbourliness and international cooperation", "state sovereignty, responsibility and liability", "common but differentiated responsibility", "polluter pays", and "sustainable development". Procedural ones include "duty to notify, consult and negotiate", "effective public participation in decision making", "prior informed consent", and "precautionary principle". The principles and implementation processes are inter-related.

Judge Weeramantry in the *Gabcikovo-Nagymaros Danube Dam Case* (1997:76-97), for instance, emphasized the link between sustainable development, environmental impact assessment, and continued environmental monitoring as follows: "environmental impact assessment is not merely an assessment prior to the commencement of a project, but a continuing assessment and evaluation as long as the project is in operation ... The greater the size and scope of the project, the greater is the need for continuous monitoring of its effects." The duty to prevent harm is also understood as an obligation of due diligence (Knox 2002:293; Craik 2005:112). It requires an affected State to show that the source State acted unreasonably and the harm in question was foreseeable. So the *no harm principle* has turned towards process: It requires states to carry out prior environmental impact assessments, notify, and consult with states potentially affected by

those activities, but it does not require states to refrain from potentially harmful activities; neither does it require consent of the affected state. Any consent requirement will vest the affected state with veto power over potentially harmful activities in origin state and impose unacceptable limits on sovereignty. A procedurally cooperative and equitable balance of interests in a dyadic regime of transboundary harm imposes due diligence obligations on States for their proposed activities including nuclear energy (Espoo Convention on EIA in a Transboundary Context 1991:2(1); Rio 1992:10, 17). The Espoo Convention and its 2003 Kiev Protocol provide useful and persuasive best practice guide to Ghana on the obligation to apply public participation and consultations in the preparation of an environmental report and plan or program for proposed projects.

The international law principles relating to the environment are further based on several distinct theories (ILC/Rao 2003:42). These include nuisance (excessive and unreasonable hindrance to the private utilization or enjoyment of real property), trespass (direct and immediate physical intrusion into immovable property of another person), negligence (doctrine of public trust and riparian rights), and neighbourhood law. For instance, the *1973, 1974 & 1995 Nuclear Tests Cases* (New Zealand v. France; Australia v. France) were based on a theory of trespass. That is, the radionuclides produced in the atmospheric testing in French Polynesia entered into the airspace of Australia and New Zealand thereby causing harm to persons and property. Several environmental law principles have been discussed and analysed in cases such as the *Trail Smelter Arbitration* (U.S. v. Canada) (1941), *the 1973, 1974 & 1995 Nuclear Tests Cases* (New Zealand v. France), *the ICJ's Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons* (1996), and *the Gabcikovo-Nagymaros Danube Dam Project Dispute* (1997).

In the *Trail Smelter Arbitration*, the US alleged that sulphur dioxide emissions from a smelter located in Trail, Canada were causing substantial damage to a number of farms across the border

in the state of Washington. It was held that a state has the duty not to harm the environment of another state or persons or property in that state by activities within its own territory, i.e., the “no-harm” rule (*sic utere tuo ut alienum non laedas*); and that if a state does cause damage to the environment of another state, the polluter state should pay. This position on a lawful act being considered an internationally wrongful act was affirmed by the International Law Commission, in its Draft Articles on Responsibility of States for Intentionally Wrongful Acts, to encompass an action or omission attributable to a state and constituting *a breach of an international obligation*; and such wrongful act entails international responsibility of that State (ILC 2001:Art. 2(b) & 1). The *1973, 1974 & 1995 Nuclear Tests Cases* also emphasised the obligations of States to respect and protect the natural environment. The *ICJ’s Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons* (1996), as requested by the UNGA, also affirmed the “no-harm” rule as customary international law; and stated that the basic principles of international humanitarian law – e.g., necessity and proportionality – for the protection of civilians and civilian objects, similarly apply to protect the environment against widespread, long-term and severe damage in the pursuit of legitimate military objectives. Armed attacks that may damage the natural environment must comply with principles such as necessity and proportionality.

The *Gabcikovo-Nagymaros Danube Dam Project Dispute* (1997) (Hungary v. Slovakia) primarily addressed environmental issues. Hungary had unilaterally terminated its Dam Project Treaty with Slovakia and abandoned the *Danube Dam Project* that it was jointly pursuing with Slovakia, and cited ecological necessity, impossibility of performance of treaty, fundamental change of circumstances, development of new norms of international law such as precautionary principle as basis for the decision. Although the ICJ did not accept Hungary’s arguments and ordered the two countries to renegotiate the implementation of the project, yet, it nevertheless acknowledged the relevance of the environmental issues raised. According to the ICJ, the

concerns expressed by Hungary for its natural environment and safeguarding the ecological balance in the region affected by the *Gabcikovo-Nagymaros Project* related to an ‘essential interest’ of that State, within the meaning given to that expression in Article 33 of the Draft Articles of the International Law Commission. ICJ opined that “newly developed norms of environmental law are relevant for implementation of the Treaty, and that the parties could, by agreement, incorporate them [into the Treaty, since the Treaty recognizes “the potential necessity to adapt” the project to general obligations on the environment as laid down in Articles 15, 19, and 20 of the Treaty]” (ICJ 1997: Para. 112).

In the *Mox Plant Case* (2001) (Ireland v. U.K.), Ireland sought to prevent UK from commencing operations at a nuclear plant on the basis of Article 206 of the UN Convention on the Law of the Sea (UNCLOS) and inadequacy of the UK’s 1993 EIA. The International Tribunal for the Law of the Sea (ITLOS) affirmed the duty to cooperate as a fundamental principle in the prevention of pollution in the marine environment and general international law (UNCLOS 1982: Part XII; ITLOS 2001: Para. 89). It ordered Ireland and UK to cooperate and enter into consultations in order to: “exchange further information with regard to possible consequences for the Irish Sea arising out of the commissioning of the Mox Plant; monitor risks or the effects of the operation of the Mox Plant for the Irish Sea; devise, as appropriate, measures to prevent pollution of the marine environment which might result from the operation of the Mox Plant (ITLOS 2001:89).

In the *Case Concerning Land Reclamation by Singapore in and Around the Straits of Johar* (2003) (Malaysia v. Singapore), ITLOS gave a ruling similar to the Mox Plant case and stressed on EIA and the duty to cooperate. The States were ordered to conduct a study to determine the effects of Singapore’s land reclamation and propose measures to deal with the reclamation’s adverse effects, if any; exchange information on regular basis; and assess risks or effects.

Singapore was called upon “not to conduct its land reclamation activities in a way that might cause irreparable prejudice to the rights of Malaysia or serious harm to the marine environment.” These international environmental law cases and other nuclear and radioactive related cases that have been settled through negotiations and the payment of compensation (including by the USSR to Canada in 1978 over the crash of USSR’s Cosmos Satellite in Canada; by US to Japan in 1954 over the Fukuryu Maru or Lucky Dragon Claim; by US to Marshall Islands; by US to Spain) emphasise principles and requirements for a nuclear safety regime to protect people and the environment – a breach of which often attracts compensation (Currie 2005:106; Kiss 2005:62; Nanda 2005:191-202; Rodriguez-Rivera 2005:167-184; Van Dyke 2005:219-222).

Preventive measures of EIA, Environmental information, consultation, monitoring, surveillance, etc., are preferred to mitigatory or compensatory measures wherever feasible (World Bank 1989; Espoo 1991; Arhus 1998; CNS 1994; Kiev Protocol 2003). The World Bank’s 1989 Operational Directive 4.01 for instance ensures that development options are assessed for their environmental sustainability consequences at an early stage in the project cycle. Environmental assessment thus evaluates potential environmental risks and impacts in a project’s area of influence; examines project alternatives; identifies ways of improving project selection, siting, planning, design and implementation; and includes the processes of mitigating and managing adverse environmental impacts throughout the implementation of the project (World Bank 1989). Article 17 of the 1994 Convention on Nuclear Safety requires environmental assessments and evaluation of “the likely safety impact of a proposed nuclear installation on individuals, society and the environment”; as well as “all relevant site-related factors likely to affect the safety of a nuclear installation...”, “the continued safety acceptability” and “the obligation to consult Contracting Parties in the vicinity of a proposed installation”.

2.2.4.1. Environmental Law Regulation of Nuclear Power in Ghana

Although there is no specifically enacted legislation on nuclear power in Ghana, some aspects of Ghana's environmental laws deal with nuclear power: e.g., projects that require EIA in Ghana (Environmental Assessment Regulations 1999:Regulations 3-30(1); EPA Act 1994:Section 12), the need to ensure safety and radiation protection (Radiation Protection Instrument 1993; Atomic Energy Commission Act 2000; Ghana Shipping Act 2003; Merchant Shipping Regulation 2004; Labour Regulations 2007; Nuclear Bill 2012), zoning and planning activities (Local Government Act 1993:Sections 13, 54, 55), and criminalizing activities inimical to health, or posing adverse environmental effects, or constituting specified nuisance acts (Criminal Act 1960:Sec. 287-288; Twumasi 1982; Mensa-Bonsu 1996, 2010), or common law torts principles such as nuisance, negligence, trespass, and the rule in *Rylands v. Fletcher* where a person who, in the course of a non-natural user of land, accumulates or is held to be responsible for the accumulation on it of anything likely to do harm if it escapes, is liable for the damage to the land or person of another, which results from the escape of the thing from his land be it intentionally or negligently (without fault) (Kumado 2009; Sarpong 2000; Wolfe & White 1995:79). *Vanderpuye v. Pioneer Shoe Factory* (1981:181) held that non-natural user means special use of land that is not the ordinary use, and not the use for the general benefit, which use brings with it increased dangers. It may be argued that a nuclear power plant is for the general benefit of Ghanaians and thus not subject to the rule in *Ryland v. Fletcher*, but nuclear damage is generally a strict liability matter.

On the issue of nuisance, suitability of the locality for the defendant's activities is very relevant. *Aidoo v. Adjei* (1976:431) has held that it is a nuisance to operate a chop bar or a local restaurant near a residential area. In *Abotchie v. Saad* (1968:19) where the defendant installed a vibrating machine emitting offensive smells, Justice Crabbe granted an injunction to restrain the defendant based on the lack of proof as to the suitability of the locality for the defendant's activity. But

suitability of locality is also of no consequence as a defence if there is proof of sensible injury to property, which injury is substantial and diminishes the value of the property (*St Helens Smelting Co. v. Tipping* 1865:642). The value of a service may influence an outcome as happened in *Sturges v. Bridgman* (1879:852), where a confectioner's 20 year-plus business was restrained from the use of pestles and mortars to abate the annoyance caused to a physician whose new consulting room adjoined the confectioner's kitchen. Also, where a statute has authorised the doing of a particular act or the use of land in a particular way, which act or use will inevitably cause a nuisance, all remedies are taken away provided that every reasonable precaution with the exercise of the statutory powers had been taken to prevent the nuisance from occurring.

In *C.F.C. Construction v. Accra Town and City Council* (1968) the court held that although the defendant council exercised its statutory powers, it acted unreasonably in choosing to dump the refuse only a few yards from the plaintiff's residential area without proper steps being taken to prevent any nuisance being caused to the plaintiffs. The court however refrained from granting injunctive and other reliefs against the defendant because it did not want to open the door for similar suits to inundate the council and eventually prevent it from performing its prescribed statutory public duties. According to Sarpong (2000:102), "the decision is retrogressive" when viewed from an environmental perspective; and "ought not to be followed in present times" given constitutional and international law developments in the field. As *Manchester Corporation v. Farnworth* (1930:171) held, common law does not override statute, but a person discharging a statutory duty may escape liability by proving that he performed the duty reasonably.

Article 36(9) of Ghana's 1992 Constitution, an aspect of the Directive Principles of State Policy, provides that, "The State shall take appropriate measures needed to protect and safeguard the national environment for posterity; and shall seek cooperation with other states and bodies for

purposes of protecting the wider international environment for mankind.” Article 41(k) further provides that every citizen has the duty to protect and safeguard the environment. Although the Directive Principles of State Policy are generally regarded as policy guidelines which inform governmental action, they are justiciable. *Ghana Lotto Operators Association v. National Lottery Authority* [2007-2008] SCGLR 1088 and *New Patriotic Party v. Attorney-General (the 31st December Case)* (1993, 1994) both discuss the legally binding effect of such provisions.

In the *31st December Case*, the Supreme Court rejected the argument that the question whether 31st December should be declared as a public holiday was a political question which was properly determinable by the Executive and the Legislature and not by the Supreme Court. It was held, per their Lordships Adade and Aikins JJSC, that in exercising its constitutional duty of enforcing or interpreting the constitution under Articles 1, 2, 3, and 130 of the Constitution, the Supreme Court might decide cases of a political nature such as cases involving breaches of fundamental human rights (Sarpong 2008:23; Bimpong-Buta 2006:105; Kumado 2009). In *JH Mensah v Attorney-General* (1997) the Supreme Court again held that it had power to determine political questions because the cumulative effect of articles 2(1) (3)-(5) and 130(1) of the Constitution was to invest in the Supreme Court an original jurisdiction to entertain all cases relating to the enforcement or interpretation of any provision of the Constitution and all questions relating to the constitutionality of any enactment or any act or omission by any person.

2.3. The Concept of Regulation and its Applicability in Nuclear Power Programmes

As a slippery term, “regulation is characterized by a kaleidoscope of lenses” (Black 2002:163) including administration, cultural anthropological theory, economics, law, politics, systems theory, and institutionalism (Stigler 1971; Posner 1974; Peltzman 1976; Breyer 1982; Reagan 1987; Ogus 1994; Baldwin & Cave 1999; Ackerman & Heinzerling 2004; Adler & Posner 2006).

The diversity of academic and legal definitions of regulation has been termed as a “conceptual quagmire” (Dubnick & Gitelson 1982:423). Reagan (1987:15) defines regulation as “a process or activity in which government requires or proscribes certain activities or behaviour on the part of individuals and institutions, mostly private but sometimes public, and does so through a continuing administrative process, generally through specially designated regulatory agencies.” Regulation is mainly a prescription by government of the terms of private transactions which affects not only the regulated entity but also what it does in relationship to others, and enforced by a designated agency through continuous supervision ((DeMuth 1983:263; Reagan 1987:14).

Stigler (1971; 1975) questioned “who will receive the benefits or burdens of regulation?” His central thesis was that “as a rule, regulation is acquired by the industry and is designed and operated primarily for its benefit.” He treated the government and political system as a “firm” selling regulation as its product; and to whom the industries go with “demands” for the firm’s products with votes and resources as valuable consideration for the purchase. Peltzman (1976) supplemented Stigler’s demand-oriented regulatory model with a “supply side” position: that is, government officials offer regulation where they see a good “payment” in votes. This fits the classical incentive and self-interest theory advanced by Harold Laswell (1936) in his “Who Gets What, When, How” definition of politics. However, Stigler’s assumption that the effective “demanders” of regulation are producer groups reflects only a limited number of older *economic regulatory instances*. Maybe, Stigler published too soon (Reagan 1987:33) because many of the counter examples, including *social regulation*, were just coming into legislative being in the US at the time Stigler wrote: Environmental Protection Agency (1970), Clean Air Act (1970), Occupational Safety and Health Administration (1970), Clean Water Act (1972), Noise Control (1972), Consumer Product Safety Commission (1972), Safe Drinking Water Act (1974)...

Nuclear regulation is a typical form of social regulation: focused essentially on matters of health, safety, environmental protection and related practices of security, safeguards, etc. For example, the Nuclear Regulatory Commission created in 1975 in the US as a spin-off from the Atomic Energy Commission (AEC) that had overseen the nuclear power industry since 1946, was set up as a result of the growing awareness (even before the Three Mile Island accident in 1978 and the 1986 Chernobyl disaster) that nuclear reactors had severe safety risks (whether or not remote), as well as great potential advantages, and increasing recognition that the AEC's nuclear promotion role strongly inhibited its safety regulation role. Separating promotion or ownership from control or regulation in a corporation enhances oversight and efficiency; and prevents *regulatory capture* (Berle & Means 1932; Dahl & Lindblom 1953; Kahn 1970; Quirk 1981; McCaffrey 1982).

Nuclear regulation is also termed as “risk regulation” since it seeks to define socially acceptable and tolerable levels of risk and focuses on eliminating or reducing health and safety risks. Variants of the social regulation of risk include risk informed regulation, risk management regulation, performance based regulation (industry self-regulation or incentive regulation) as against prescriptive regulation or directives or command-and-control regulation (Marcus 1988; Roberts 1993; Verma, Mitnick & Marcus 1999). The concept of risk management involves deciding what to do about a risk that has been identified, measured in probability and severity, and evaluated as to acceptability (Reagan 1987:92,117-123; Tromans 2010:97). Safety regulation has no absolutist conception of safety. Given nuclear energy's potential deleterious impacts and risks, it might be tolerated by keeping its risk levels under review and reducing it further when possible (Tromans 2010:97). The technical field of risk assessment and its policy aspects of risk management are crucial to the regulation of nuclear power plants safety which has now evolved to embrace an imposition of probabilistic safety criteria. Nuclear utilities have to demonstrate

that they are not only operating below a targeted risk level but also that the unavailability (if any) of some of the critical safety systems are below a targeted level (Mishra & Pandey 2007).

Social regulation is more legislative-like than judicial (Breyer & Stewart 1979:398; Heffron 1983:85-96, 231-251; Schmandt 1984:23; West 1985). It fills in the interstices of the necessarily non-detailed laws by gathering information on a given problem, analysing the degree of risk involved, and the cost of varying ways of reducing the risk by rule-making and enforcement processes. Without rulemaking, a protective statute is merely “an empty declaration of intent” (Schmandt 1984:23). Social regulation requires value judgements on “regulatory science” or the “summaries and interpretation of available knowledge variously, called science, exposure, health, hazard, or risk assessments” (Schmandt 1984:28). Risk assessment (identifying a risk, and measuring its frequency and severity), risk evaluation (deciding what risk is acceptable, safe, tolerable or unreasonable), and risk management (what action to take to eliminate or reduce the risk) are not based purely on technical data and science but also on value judgements (Lowrance 1976:8). Science informs, but does not determine regulatory choices. Even, experts do not always agree on complex technological matters (Roe 1984; Reagan 1987:117). Nuclear energy’s production process is greatly complex and tightly linked in chain reactions – if one part goes wrong (that hardly occurs), the rest will follow quickly (Perrow 1984). Thus, value judgement concerns about nuclear power’s potential large-scale harmful effects on life, health, property and environment, often overshadow and mute the remoteness of nuclear risk (Reagan 1987:121-3).

Nuclear power technical specification and maintenance requirements use both risk analysis and cost-benefit analysis. However, in safety and health regulation, e.g. nuclear power regulation, a cost-benefit analysis (Mishan 1976; Gramlich 1981) may not be very helpful: Certain decisions may be right even if the perceivable benefits do not outweigh the provable costs. Apart from the

criticism that “the numerical values assigned to both costs and benefits are more often the product of imagination than of mathematical skill” (Rourke 1984:176), there are also criticisms about putting an explicit value on life, the rate at which effect on the future are discounted, etc (Lave 1981:24; Mendeloff 1983:569). *Nuclear power risks need to be regulated to assure safety irrespective of cost*. As Kellman (1981) puts it, “refusing to dollar value something is a way of announcing that it is not for sale ... it signals a thing’s distinctive value to others and helps us persuade them to value the thing more highly than they otherwise might [and] expresses our resolution to safeguard that distinctive value” (Kelman 1981:38-39). An alternative approach to the cost-benefit analysis, i.e., *cost-effectiveness* or *utilitarianism* or *instrumentalism*, has thus been proposed as a policy option to the life-valuation problems and value assessment difficulties cost-benefit analysis often creates in social regulation (Lave 1981:20; Reagan 1987:125).

2.4. Summary: Effective Nuclear Safety Regulation via the 3S”+Liability Concept

An adequate legal framework for nuclear energy must address four fundamental subjects namely: safety, security, safeguards, and liability; all of which have common overarching issues that are very relevant to nuclear safety regulation [*See Section 1.1.3 supra*]. Safety deals with unintended conditions or events leading to radiological releases from authorized activities; and requires responses that focus on engineered protections, safety management, regulatory oversight, peer reviews and emergency preparedness. Security focuses on intentional misuse of nuclear or other radioactive materials by non-state elements to cause harm; and requires responses on physical protection, intelligence gathering, law enforcement and penal measures. Safeguards deal with restraining activities by States that could lead to acquisition of nuclear weapons: international legal commitments under the NPT and IAEA Safeguards Agreement, export-import regimes, technology transfer controls and IAEA safeguards verification are key safeguards responses. Liability deals with the *legal regime* to compensate for nuclear damage through insurance, torts,

etc. The four areas have evolved for less than a century: and experienced “major developments over the past decade in terms of new instruments and arrangements” (Stoiber 2012:52).

These four areas comprise the pith of nuclear law. Each area evolved in a discrete manner mostly in response to felt needs historically. In the mid-1940s (1946) to the end of the 1950s, the focus was on curing the lack of international technical and policy institutions to guide the peaceful uses of nuclear energy. IAEA (international) and NEA (Europe) were created in 1957. United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was also created earlier in 1955. The International Commission on Radiological Protection (ICRP) was created in 1950 from the activities of the International Committee on Radiological Units and Measurements (ICRU) which first met in 1925 as the International Congress of Radiology. With the onset of civilian nuclear power plants in the mid-1950s and 1960s, the need for consistent, internationally applied radiation protection standards and liability regimes for nuclear accidents led to the ILO Radiation Protection Convention and Recommendations (1960), IAEA Basic Safety Standards (1962), and Civil Liability Conventions (Paris 1960; Vienna 1963; Brussels 1963; etc).

In the 1970s, concerns on the spread of nuclear weapons to additional States, and the diversion of nuclear materials in international transit, led to adoption of safeguards measures like the Nuclear Non-Proliferation Treaty (NPT) (1968, 1970), Zangger Committee Guidelines (1971), Nuclear Suppliers Group (NSG) Guidelines (1975), Nuclear Free Zone Treaties (e.g., Tlatelolco 1968), IAEA Safeguards Agreements (1973), Convention on Physical Protection of Nuclear Materials (CPPNM 1979). The 1980s and 1990s faced preventive and curative nuclear reactor safety issues following the 1979 Three Mile Island and 1986 Chernobyl accidents. The UN Conference on the Environment and Development (Rio 1992) also added a sustainable development dimension. Several conventions on nuclear safety were adopted during the period: Emergency Assistance

(1986), Early Notification (1986), Nuclear Safety (1994), and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (1997).

The decade of the new millennium (2000 – 2009) tackled issues of nuclear security in reaction to terrorist events, illicit nuclear trafficking concerns, and spread of sensitive nuclear technologies for uranium enrichment and reprocessing. This led to amendment of the Convention on Physical Protection of Nuclear Materials (CPPNM 2005), International Convention for the Suppression of Acts of Nuclear Terrorism (2005), the UN Security Council Resolutions (1373 of 2001, 1540 of 2004, and 1887 of 2009), UN Security Council Sanctions Resolutions (Iran: 1696 of 2006, 1737 of 2006, 1747 of 2007, 1803 of 2008, 1835 of 2008, 1929 of 2010; Iraq: 1284 of 1999, 1441 of 2002; North Korea: 1718 of 2006, 1874 of 2009), Code of Conduct on the Safety and Security of Radioactive Sources (2003), Guidance on the Import and Export of Radioactive Sources (2004), Code of Conduct on the Safety of Research Reactors (2004), etc. As Jankowitsch (2010:29) observed, “[t]he priorities on the international nuclear legal agenda are shifting again. International concern has moved away from the well-regulated field of nuclear safety and related questions towards a redefined global issue of nuclear security. The question is whether this new priority will create a need for new international legal norms.” But a few months later, incidents in Fukushima seriously challenged that outlook and compelled a refocus on nuclear safety.

The reactor accident at Japan’s Fukushima Dai-chi nuclear power plant in 2011 – which occurred 9,000 reactor operation years after the 1986 Chernobyl nuclear accident – has revived nuclear safety concerns, particularly on siting, design, and emergency response in this decade (WNA 2012). This has led to a review of national programmes for nuclear power plant safety and emergency response including stress tests, as well as assessment of key safety issues at IAEA and CNS meetings. E.g. the IAEA in 2011, “in the light of the Fukushima accident”, adopted an

Action Plan covering 12 main actions, for the sole purpose of defining “a programme of work to strengthen the global nuclear safety framework.” (IAEA/GOV 2011:2; *see* Section 2.1. *supra*).

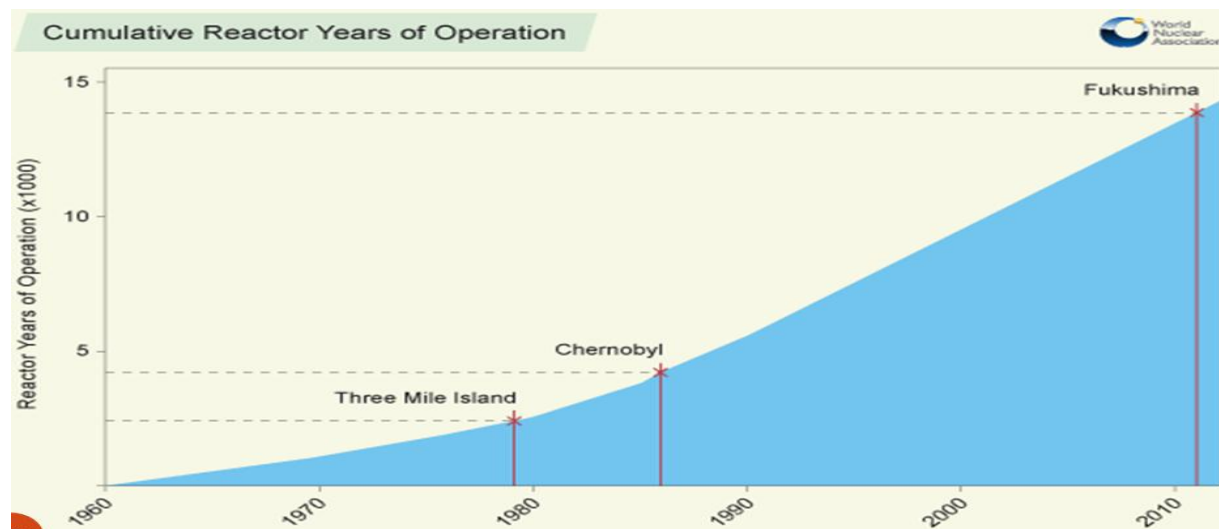


FIG. 2.1: Three Mile Island, Chernobyl & Fukushima Nuclear Accidents (Source: World Nuclear Assoc. 2012)

Institutional, legal and regulatory frameworks to govern safety, security, safeguards and liability are now, in the current decade, developing with cross-fertilization of synergies; and a merger of regulatory responsibilities previously separated among different agencies into a single regulatory body (CNS/RM 2005:4). As Tonhauser and Wetherall (2010:168) observe, IAEA’s legislative assistance programme has “recognized that a new comprehensive approach was required which emphasized the inter-relationships between safety, security, safeguards as well as nuclear liability ... This approach not only recognizes the complex technical and legal inter-relationships as well as the areas of co-existence and diversity of ... international legal instruments but also provides for their practical implementation – so that they may be given effect in a national legislative framework”. The process of integration started after the September 11, 2001 terrorist attack in the US. In 2004, IAEA’s Department of Nuclear Security was incorporated into the IAEA’s Department of Nuclear Safety which had been created in 1996 and renamed Department

of Nuclear Safety and Security. In 2006, the Department developed the Integrated Regulatory Review Service (IRRS) for the conduct of missions on legal and governmental infrastructure on nuclear regulation. IRRS covers requirements for an effective regulatory framework, regulatory activities, and management systems for the regulation and control of nuclear safety, radiation safety, waste safety, transport safety, emergency preparedness and response, and security: Each of these comprised a full review and appraisal service previously. In 2006, the first International Conference on an effectively integrated nuclear regulatory system: “Facing Safety and Security Challenges” was held in Moscow. A second International Conference was held in December 2009 in South Africa, on “Further Enhancing the Global Nuclear Safety and Security Regime.”

The UK has initiated the process of integrating the “3S” concept in a single regulatory regime; and on April 1, 2011, the Office for Nuclear Regulation (ONR) was launched as an agency of the Health and Safety Executive (HSE). The ONR brings together the safety, security and safeguards functions of the Nuclear Installations Inspectorate, Office for Civil Nuclear Security, and the UK Safeguards Office, as well as the Radioactive Materials Transport Division of the Department of Transport for enhanced transparency, efficiency, effectiveness, accountability, consistency, and proportionality. Other countries are also trying to harmonize their national legal and regulatory frameworks to deal with the four areas of safety, security, safeguards, and liability (CNS 2005).

Ghana’s Nuclear Authority Bill (2012) as has been drafted, broadly deals with the “3S”+Liability concept. Clause 1(1) of the Bill defines the scope of application of the Bill as:

- (a) management of radioactive waste resulting from civilian applications in the country;
- (b) regulation and management of the peaceful use of nuclear energy and radiation under the jurisdiction and control of the country, including the production, possession, use, import, export, transportation, transfer, handling and management, or other related activity or practice identified by the Authority; and
- (c) management of spent fuel resulting from the operation of civilian nuclear reactors in the country.

Clause 5(a) of the Bill in specifying the functions of the proposed Nuclear Authority states that, the Authority shall develop national policies on the regulation and management of activities and practices with respect to: (i) nuclear safety; (ii) security of nuclear and radioactive materials; (iii) radiation; and (iv) implementation of safeguards specified under Clause 64. Clauses 68 to 78 provide for liability and compensation in case of nuclear damage and related matters. Clause 72 of the Bill proposes the Vienna Convention on Nuclear Liability as amended or the Convention on Supplementary Compensation as the nuclear liability regime for Ghana. These provisions are intended to harmonize Ghana's legal and regulatory frameworks to deal with the areas of safety, security, safeguards, and liability under a Nuclear Regulatory Authority which will coordinate regulatory safety with other existing institutions including NADMO, EPA, EC, and GAEC.

Several cross-cutting issues on security, safeguards and liability relate to safety. Safety measures and security measures have in common the aim of protecting human life and health and the environment. Safety involves 'the *protection* of people and the environment against radiation risks, and the *safety* of facilities and activities that give rise to radiation risks (IAEA 2010: IAEA 2011: IAEA 2006). The Convention on Nuclear Safety does not contain express obligations related to physical protection. In recognition of the importance of protecting power reactors against threats to their physical security, preambular paragraph (vi) of the CNS however refers to the Convention on the Physical Protection of Nuclear Material as relevant to nuclear safety (Stoiber 2003:148). The Basic Safety Principles for Nuclear Power Plants states in Paragraph 242: "The design and operation of a nuclear power plant should provide adequate measures to protect the plant from damage and to prevent the unauthorized release of radioactive material arising from unauthorized acts by individuals or groups, including trespass, unauthorised diversion or removal of nuclear materials, and sabotage of the plant."

Security measures on Physical Protection, Accounting and Control, Confidentiality and Enforcement measures are closely linked to ensuring safety. Moreover, non-proliferation measures involving Peaceful Use Statement, Safeguards Commitments, State System of Accounting and Control, Export and Import Restrictions, Verification and Inspections have an indirect impact on safety. The nuclear liability principles including Strict (No Fault) Liability, Exclusive Operator Liability, Compulsory Financial Security, 30 year liability time limits, create incentives for operators to maintain high levels of safety in their activities. Safety, security, safeguards and liability measures must thus be designed and implemented in an integrated and well coordinated manner to avoid any compromise or gaps.

Commonalities and differences between safety, security, safeguards and liability; and their synergies must be developed to complement and enhance one another to offer an all-inclusive merger of regulatory responsibilities (in concentric circles, *not* Venn linked circles) to aid comprehensive evaluation. Figure 2.2 proposes a conceptualization of the ‘3S’ prong of nuclear safety as a single multi-layered phenomenon that has safeguards and security embedded within the safety sphere. This approach seems to offer a more integrated conception of the interrelations among safety, security and safeguards; and is preferred to the existing internationally recognized Venn diagram interlinked approach that Figure 2.3 illustrates. This study adopts and uses Figure 2.2 in its analysis of safety.

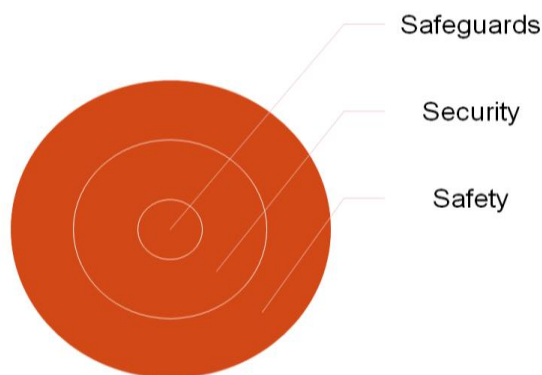


FIG 2.2: All-Inclusive Merger of Regulatory Responsibilities (Concentric Circles Format) (Source: Mine)

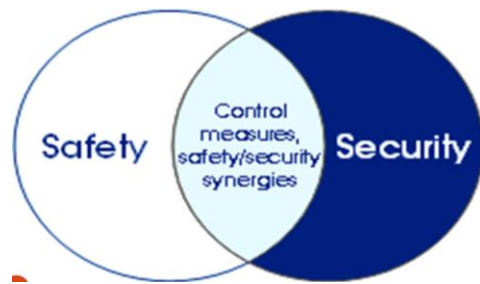


FIG 2.3: Inter-Linked Regulatory Responsibilities (Venn Diagram Format) (Source: IAEA 2012)

The ‘3S’ regulatory responsibilities of assuring safety, security and safeguards in nuclear power generation are further complemented by liability regimes (Figure 2.4.) and several other elements including health and environmental impact, socio-political influence, attitudinal culture, public acceptance, institutional regime, technology, economics, site and facilities, emergency planning, human resource, and stakeholder activity, all of which can be compartmentalized within the safety prong or category of the ‘3S’ concept (*see* Table 4.1 *infra*). The ‘3S’+Liability concept, as simplified and illustrated in Figure 2.4., constitutes this study’s conception of nuclear safety.¹⁶²

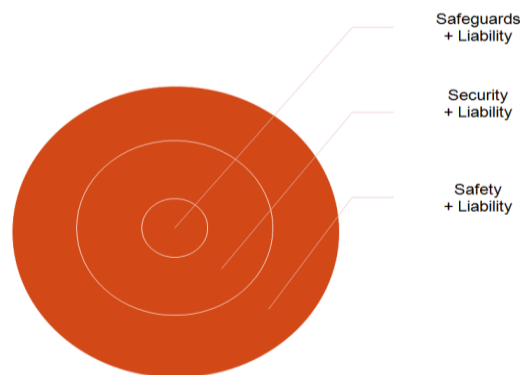


FIG 2.4: The “3S”+Liability Concept in Regulatory Practice (Concentric Circles Format) (Source: Mine)

¹⁶² It is hoped that the impressive and extensive volumes of literature surveyed and reviewed in this study has achieved the aim of contextualizing Ghana’s policy decision to use nuclear power within the regulatory category of nuclear safety. It also provides information to aid proper discussions and analysis of Ghana’s policy decision on nuclear power, so as to propose an effective framework for evaluating the safe regulation of nuclear power generation in Ghana ... “[F]or we do not think that there is an incompatibility between words and deeds; the worst thing to do is to rush into action before the consequences have been properly debated [...]. *We are capable at the same time of taking risks and of estimating them beforehand. Others are brave out of ignorance; and, when they stop to think, they begin to fear. But the man who can most truly be accounted brave is he who best knows the meaning of what is sweet in life and what is terrible, and then goes out undeterred to meet what is to come.*” Thucydides 1954:Para.40 (Quoting Pericles’ Funeral Oration circa 430 B.C. in *History of the Peloponnesian War*, Book B, 1954)

CHAPTER 3: RESEARCH METHODOLOGY

3.1. Introduction: Methodology of the Research Study

The research methodology for this study is mainly based on qualitative research methods due to the subjective nature of the topic “safety regulation of nuclear power generation.” But some quantitative research methods (including questionnaires) helped to identify, verify and validate the elements of an optimally effective nuclear safety regulatory regime for Ghana. Though qualitative methods produce subjective measures, they have nevertheless been used in several research studies where they showed significantly robust correlation between subjective assessments and objective measurements (Twala 2007:61; Oosthuizen 2005; Duncan 1999; Tamanaha 1997). The study further combines doctrinal normative and comparative legal analysis with empirical studies and socio-legal approaches.

The legal analysis constitutes the core of the study. The socio-legal approach then goes beyond the text of law to consider context and, often, subtext:¹⁶³ in an interdisciplinary approach to analyse law, legal phenomena, and the relationships between these and wider society. The socio-legal approach supplements the legal analysis with relevant context by relating it to an examination of law and society relations in regulatory regimes.¹⁶⁴ Empirical studies, public views on nuclear power and its regulation, and the ‘3S’+liability concept also shaped this study’s evaluation framework. Ghana’s legislation, regulatory laws and regulatory options on nuclear power were analysed using assessment criteria comprised in the ‘3S’+liability evaluation framework as terms of reference to identify an optimal nuclear regulatory regime. Chapter One’s conceptual framework provides a synopsis on the overall methodological framework.

¹⁶³ See Brian Tamanaha, *Realistic Socio-Legal Theory: Pragmatism and a Social Theory of Law* (Oxford: Clarendon Press, 1997)

¹⁶⁴ See Amanda Perry-Kessaris, *What Does it Mean to Take a Socio-Legal Approach to International Economic Law?* (In *SOCIO-LEGAL APPROACHES TO INTERNATIONAL ECONOMIC LAW: TEXT, CONTEXT, SUBTEXT*, A. Perry-Kessaris, ed., Routledge, 2012) (Abstract available at SSRN: <http://ssrn.com/abstract=2085007>)

3.2. Research Methodology Structure: Data Collection Methods and Strategies

The study uses multiple research methodology: literature research, case study, empirical studies, non-controlled semi-structured and unstructured participatory observation, structured questionnaire-based survey, focussed in-depth interviews, and quantitative official data. The literature review extensively covered nuclear energy regulation and its history trends and lessons, nuclear power regulatory regime options, international nuclear energy law, national laws (constitutional, statutory, common law) on nuclear energy, environment, land use planning, liability for harm. The literature data is mainly historical and theoretical in nature. Thus, recent *quantitative* official data, interviews, empirical case studies, and questionnaires were used to avoid the probability of literature data providing misleading information on the optimal nuclear safety regulatory regime relevant to Ghana's specific context.

The *case study* focused on both RPB and GAEC as the regulatory and promotional-cum-quasi-regulatory bodies for nuclear energy in Ghana respectively. Relevant documents on Ghana's nuclear power program, including key plans, procedures and the proposed Nuclear Authority Bill were also used as input for the case study. Empirical studies, non-controlled semi-structured and unstructured *observation* and *participatory* methods were used to obtain qualitative primary data from RPB and GAEC on what is currently happening on the nuclear power project. This helped in providing information to aid an understanding of the complex dynamics of nuclear safety regulation in Ghana within its real-life context from key experts including the head of legal at GAEC, the Chief Radiation Protection Officer at GAEC and head of the Radiation Protection Institute, ex-Director-Generals of GAEC, current Director General of GAEC, and some key RPB Board Members.

Observation and *participatory* methods were used as a variant of the focus group technique. It created opportunities for dialogue on nuclear safety regulation, implementation of policies and strategies, and interactive exploration of a range of expert opinions for more insights and deeper understanding than

gained by literature research. This participatory observation method was independent of respondents' willingness to respond and was less demanding of respondents' active cooperation. A protocol was developed as a guide for the case study to control my objectivity in the observation and participation method utilized for some aspects of the case study. The information gathered was supplemented, triangulated and verified with *direct questions* during and after the *observation* and *participatory* sessions (GAEC seminars and workshops, Ghana Nuclear Society board meetings, group discussions, office visits) and *focussed in-depth interviews*. The *interviews* and supplementary questions focused on specific mop-up detailed clarifications to information and data gathered during the observation and participation phase. The *interview questions* were *semi-structured* and therefore provided a flexible approach to questioning. It provided respondents (some GAEC and RPB staff) a free atmosphere to converse on the subject for me to develop the appropriate hypothesis; and to determine the validity with which data, information and observations can be said to indicate some conclusion(s) on trends.

Questionnaire survey of public perceptions on nuclear power was extensively administered to ensure external validity of the proposed nuclear safety regulatory framework since the proposed preferred safety framework is for Ghana – not only for GAEC or RPB. The questionnaire tested: knowledge on nuclear energy, its regulation and laws relevant to nuclear safety regulation in Ghana; expectations on nuclear safety regulatory approaches; and views on the relevance of the criteria for evaluating nuclear safety regulation as well as on whether or not Ghana should pursue nuclear power. These research approaches aimed at generating data and information to verify and validate the strength, robustness and suitability of the theoretical framework and appropriateness of the theoretical predictions (Twala 2007:62; Hesse-Biber & Leavy 2004; Yin 2003; Hancock 2002; Black 1999). A key control question was: “Have you heard of nuclear power for electricity generation in Ghana?” The questionnaires had multiple choice and open-ended questions with a few dichotomous (Yes or No) questions.

3.3. Scope, Focus, and Nature of Questionnaire Survey

Two extensive surveys were undertaken – (1) acceptability of nuclear power in Ghana, and (2) validating the identified elements for the nuclear safety framework. The survey conducted on public perception of nuclear safety and public acceptance of nuclear power in Ghana targeted six hundred and fifty (650) respondents but only 84% (546 of the 650 respondents) responded to the questionnaire survey. So, five hundred and forty six (546) respondents constituted the survey sample for gauging the public acceptability or tolerance for nuclear power as follows:

1. 208 ordinary lay people
2. 61 nuclear science experts, administrators or lawyers at GAEC and RPB
3. 277 professionals, post-graduate science students and students
 - a. Science professionals (28 people)
 - b. Legal professionals (41 people)
 - c. MDAs & Regulatory institutions (including EPA, GSA, NADMO) (18 people)
 - d. Undergraduate science students (52 people) (13 of them were used in pilot survey)
 - e. Postgraduate nuclear science students (94 people) (31 were used in pilot survey)
 - f. Law students (44 people) (11 of them were used in pilot survey)

Of the 546 respondents, 100 people were targeted for the safety framework validation questionnaires comprising two sets of validation questions on relevance and favourability of each of the identified nuclear safety element. Of the 100 questionnaires distributed to those 100 respondents, two (2) people (2% of the respondents) returned their questionnaires without any responses to the questions and eight (8) people (8% of the respondents) did not return their questionnaires at all. Ninety (90) respondents representing 90% of the total target 100 respondent population gave their ratings to all the questions. Thus 90 people comprised the verification and validation exercise survey sample. A majority of the targeted 100 respondents (61 people) (i.e., or 61% or 68% of the survey sample) were from GAEC and they all provided responses that rated the elements on the basis of relevance and favourability. 75% of the GAEC respondents (46 people) had at the time recently completed their

postgraduate studies in nuclear science and were working with GAEC in various capacities; and 25% (15 people) were experienced senior staff and members of GAEC. The external respondents (i.e., 29 people or 32% of the survey sample or 29% of the total target respondents) were from EPA, NADMO, Ministries (Science, Environment, Energy, Finance, Health, Local Government, Transport), CSIR, Ghana Health Service, Ghana Police Service, National Security Council, lawyers, lecturers at University of Ghana (Law, Engineering Sciences, Physics, Business), final year engineering law students of the UG Faculty of Engineering Sciences, and a few ordinary people.

3.4. Conceptual Approach to the Research Study

Legal analysis techniques were used at every stage of the research. Legal analysis was applied in synthesizing the ‘3S’+Liability concept to produce a composite safety evaluation framework to gauge Ghana’s regulatory readiness and identify an optimally effective nuclear safety regulatory regime. It followed five interrelated steps: (1) *formulation*, (2) *verification*, (3) *validation*, (4) *assessment*, (5) *identification, development and proposal*. After *formulating* a framework for evaluating or assessing a nuclear power safety regulatory regime to test its effectiveness using literature review data as input; the study then *verified* the framework conceptually not with the literature review data only, but also by a case study of the Radiation Protection Board including the Radiation Protection Institute, and to an extent, the National Nuclear Research Institute (operators of GAEC’s 30kW Chinese-built tank-in-pool Miniature Neutron Source Research Reactor *viz.*, GHARR-1). The framework verification was enhanced by views of scientists, lawyers, and regulators at institutions including GAEC, RPB, EPA, UG, Energy Commission, and seasoned international nuclear law experts at IAEA, OECD’s Nuclear Energy Agency, International Nuclear Law Association and others.¹⁶⁵

¹⁶⁵ University of Ghana, North West University of South Africa, University of Giessen in Germany, the Ghana Atomic Energy Commission, International School of Nuclear Law in Montpellier, France, Nuclear Law Institute of the IAEA in Vienna, Austria, the University of Dundee’s Centre for Energy Petroleum Mining Law and Policy (CEPMLP), International Nuclear Law Association (INLA), Ghana Nuclear Society (GNS), African Nuclear Law Association (ANLA), University of South Florida, Carnegie Global Scholars Exchange Program, International Consortium on Law and Strategic Security, and many other

The third step *validated* the relevance of the evaluation framework with outcomes and feedback from seminar presentations organized by the Ghana Nuclear Society (GNS) and the Ghana Atomic Energy Commission; and also at University of Ghana’s Graduate School of Nuclear and Allied Sciences, the University of South Florida, ORID and the Law Faculty of the University of Ghana). Further *validation* of the framework was done through follow-up interviews and questionnaire survey. The validated evaluation framework developed through the research methods above was then analysed to *assess (evaluate)* Ghana’s proposed nuclear regulatory regime (the Nuclear Authority Bill 2012) to *identify gaps and strengths* if any through the use of legal and socio-legal research approaches. The final step *developed and proposed* the key elements of an effective nuclear regulatory framework in Ghana. This conceptual framework has been set out in Fig. 1.3 *supra* (and is reproduced below).

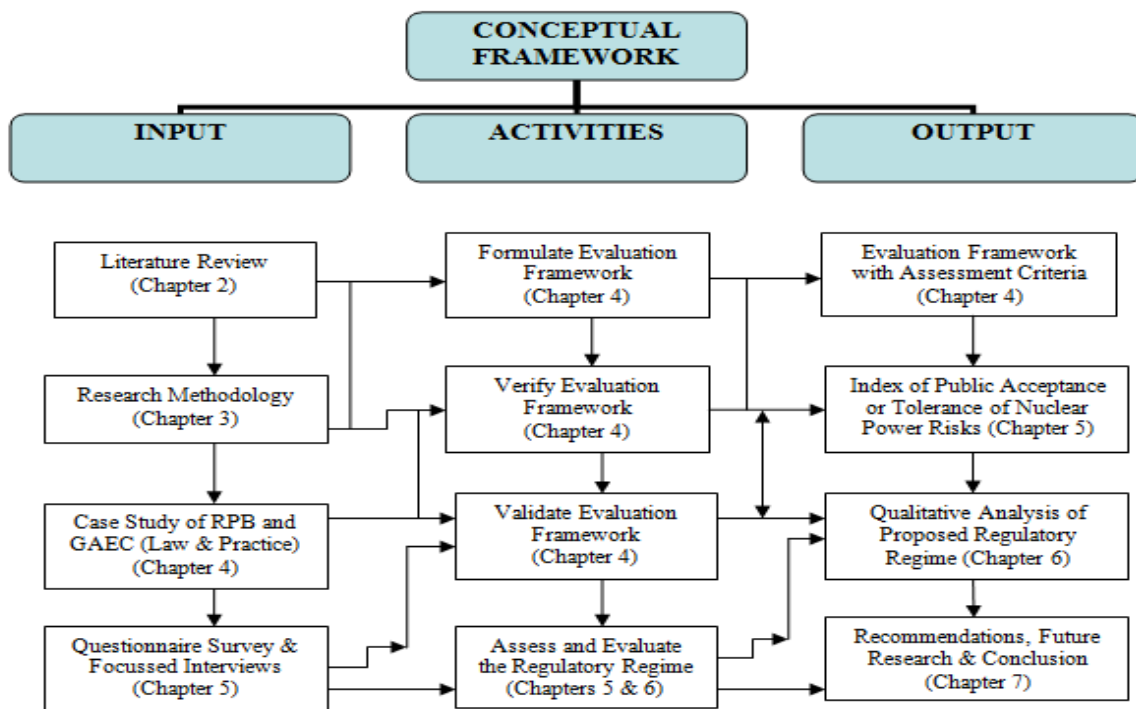


Figure 1.3: Conceptual Framework for the Research Study

institutions and people provided funding, resource, and other vital support as well as opportunities for study, research, interview, participation and observation methods utilized in this study. International Consortium on Law and Strategic Security (sponsored my observation of, and participation in, NPT & UN Security Council Resolution 1540 Meetings and Symposia in New York)

CHAPTER 4: CRAFTING A NUCLEAR POWER SAFETY EVALUATION FRAMEWORK THROUGH RPB AND GAEC CASE STUDY

4.1. Introduction: Crafting the Evaluation Framework through Case Studies

Following the issues analysed in the literature review (NEA/OECD 2011; Faanu et al. 2010; IAEA 2010; Stoiber et al. 2010; Kaufer & Chakraborty 2004; NRC 2003; Stoiber et al. 2003; Fornero 2001; Tiippana 2001; etc), case studies, interviews, and the other research methods applied in this study, a framework for evaluating nuclear safety regulatory effectiveness in Ghana might be designed to encompass the “3S”+Liability concept and six additional key elements: (1) Safety; (2) Security; (3) Nonproliferation (Safeguards); (4) Liability; (5) Health and Environmental Impact; (6) Socio-political Influence; (7) Attitudinal Culture; (8) Institutional Regime; (9) Technology; and (10) Economics.

These elements of an optimal nuclear safety regulatory effectiveness evaluation framework were also further verified with case studies of Ghana’s Radiation Protection Board and Ghana Atomic Energy Commission to make the framework comprehensive and incorporate all the relevant elements, at least from the perspective of GAEC and RPB functionaries and experts and thereby provide an in-depth and appropriate empirical inquiry into the complex emotive and often contentious phenomenon of nuclear safety regulation in nuclear power generation (Yin 2003). The verified framework was eventually validated with external perspectives through questionnaire survey and interviews.

4.2. The Radiation Protection Board of Ghana (RPB) and GAEC

Pursuant to PNDC Law 308, the Radiation Protection Board Legislative Instrument 1559 of 1993 was promulgated to establish the Radiation Protection Board as the sole Regulatory Body in Ghana for the regulation of nuclear radiation and waste safety (Sections 1.1.2. and 1.2. *supra*). Under LI 1559 RPB is empowered to authorize, license, inspect and control all activities and practices involving radiation sources, radioactive materials, X-rays in hospitals. It has authority to issue regulations, codes of

practice and guides and deal with related matters.¹⁶⁶ It is the *de jure* and *de facto* regulatory body on such matters. RPB works through the Radiation Protection Institute (RPI) which is one of the Institutes of GAEC. RPI was created by GAEC in February 2002, in pursuance of Section 3(1)(c) of the Ghana Atomic Energy Act, 2000 (Act 588) which authorises GAEC to establish Institutes. RPB manages GAEC's RPI as RPI's Managing Board; but this raises institutional independence issues. Section 3(1)(c) of Act 588 provides that *GAEC shall exercise control over the Boards of Management of the Institutes established by GAEC*:¹⁶⁷ RPB is thus under the legal control of GAEC in the exercise of its management duties over RPI. Also, under the constitutive legislative instrument of RPB, five of RPB's eleven members work under the auspices of and are directly appointed by GAEC.¹⁶⁸

RPI consists of three (3) divisions namely, Regulatory Control Department, Radiation and Waste Safety Department, and Radiation Safety Training Department. The Chief Radiation Protection Officer of GAEC is the Director and operational head of RPI which has 55 staff (i.e., the Director, 14 research scientists, 5 trainee research scientists, 11 technologists, 2 technicians, and 22 administrative staff); compared to the 1994 total of 21 staff (Schandorf et al. 1995). Although staffing strength has improved and falls within the 30 to 50 minimum staff members necessary for starting the implementation of a nuclear power plant programme (Nyarko et al. 2011:58; IAEA 2007), many issues on institutional staffing capacity still exist. Moreover, even though GAEC is the promotional body for nuclear operations in Ghana¹⁶⁹ it also functions as a nuclear energy regulator in Ghana. Appeals from decisions and actions of RPB regarding cancellation, suspension, refusal to grant or

¹⁶⁶ See Regulation 2 of *Radiation Protection Board Legislative Instrument*, 1993 (LI 1559) for the licensing duties of the RPB.

¹⁶⁷ Section 3(1) of the Ghana Atomic Energy Act, 2000 (Act 588) provides for the functions of GAEC. Section 3(1)(c) states that “[t]he functions of the Commission are ... to establish, for the purposes of research and in furtherance of its functions, Institutes of the Commission and to exercise control over the boards of management of the Institutes”.

¹⁶⁸ LI 1559, Regulations 1, 2, 12, 13, 14, etc (Providing functions and membership of RPB; and appointment by GAEC of key officials including the Chief Radiation Protection Officer of GAEC who automatically becomes a member of the RPB).

¹⁶⁹ See *Ghana Atomic Energy Commission Act*, 2000 (Act 588)

renew a licence, goes to GAEC; and GAEC has the authority to consider the appeal and make such order as it deems proper and any such order of GAEC shall be final.¹⁷⁰ GAEC thus has power to bind licensee(s) and RPB. RPB appears to be eclipsed by GAEC legally. It may however be argued that, RPB's structure and relationship with GAEC effectively utilizes the few technically trained nuclear personnel, aids the seamless exchange of knowledge and information, and enhances transparency. Like the concept of family, RPB and GAEC work together: each knows its roles and responsibilities in a well-structured collegial environment (Faanu et al. 2010:91; Amuasi 2001:1-3).

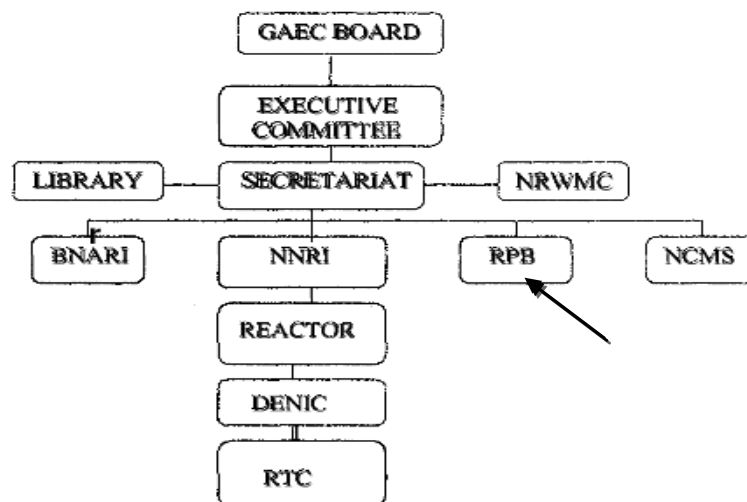


FIGURE 4.1: ORGANOGRAM OF GAEC

Source: GAEC, *At A Glance* (1998) (Arrow inserted)

It is a collegial structure with shared mutual respect, trust and skill in their operations. It does not look like “regulatory capture,” but it rather seems to enhance regulatory practice: it encourages regulators, operators, and promoters to sit down together across the table to decide what should be done. It appears to have enabled Ghana implement a non-prescriptive performance-based self-regulation in its nuclear regulation and practice for decades. A core danger inherent in this approach is the strong reliance on practices or traditions that can result in lack of clearly written rules on requirements. RPB has addressed this and produced several Guides and other documents to provide

¹⁷⁰ LI 1559, Regulation 14

information on minimum requirements. Introducing nuclear power will also require additional Guides and laws. For Ghana's nuclear regulatory system to conform to international norms on clear regulatory independence in nuclear energy regulation, and avoid any semblance of RPB's dependence on GAEC, RPB as constituted under LI 1559 may have to be reformed.¹⁷¹ An independent nuclear regulator is a *sine qua non* for nuclear activities. As noted at the IAEA General Conference (2010):

“Ghana remains committed to the implementation of the relevant international instruments of nuclear safeguards, safety and security and in that regard, is making efforts to ratify relevant international nuclear legal instruments. In pursuance of this, a Bill to establish an *Independent Nuclear Regulatory Authority* will soon be placed before Parliament for approval to pave the way for the establishment of an effective institutional and human capacity to address proposals for the utilization of nuclear energy as an additional source of energy for the country.”¹⁷²

4.3. Nuclear Safety Regulation in Ghana

Despite the lack of an independent nuclear regulator, nuclear and radiation safety regulation of Ghana's research reactor activities remains stringent. Nuclear safety regulation in Ghana focuses on human, organizational, technical and programmatic areas. In 1994, Ghana with the assistance of IAEA under Technical Assistance Project GHA/1/010, procured and installed a 30kW Research Reactor from China.¹⁷³ National Nuclear Research Institute (NNRI) of GAEC operates the reactor. The construction, commissioning, and, operation of the reactor were, and still is, subjected to a strict system of authorization and inspection developed by the RPB with IAEA assistance. On March 1, 1994, the RPB issued a constructional license (GHARR-1-94-01) to the NNRI.¹⁷⁴ Other key licenses issued by RPB subsequently include source loading license (GHARR-1-95-04), criticality test license (GHARR-1-95-05), high power test license (GHARR-1-95-06), operator's license and senior operators licenses (GHARR-1-95-01-3) and a provisional operational license (GHARR-1-95-07)

¹⁷¹ See IAEA, *Fundamental Safety Principles*, Principle 2, para. 3.8 – 3.11 (SF-1, Vienna: IAEA, 2006); See also Carlton Stoiber, *et al.*, *Handbook on Nuclear Law* (Vienna: IAEA, 2003)

¹⁷² See, *Statement by Ghana at the 54th Regular Session of the IAEA General Conference*, p.4 (Vienna: IAEA 20-24 Sept. 2010) (Italics mine)

¹⁷³ See J.H. Amuasi *et al.*, *Safety of Ghana Research Reactor (GHARR-1)* p.3 (IAEA-CN-82/05, 2001)

¹⁷⁴ *Id.*, at p.2

which was subject to specified Operating Limits and Conditions.¹⁷⁵ The operators were licensed upon passing written and oral examinations. They are re-examined every two years to renew their license; and they also undertake periodic training. Both the NNRI and RPB are provided with Government of Ghana annual budgetary allocations for the operation and regulation of the research reactor (Faanu et al 2010; Ampomah-Amoako et al. 2009:62).

An IAEA INSARR mission (Integrated Safety Assessment of Research Reactors) was conducted in Ghana in February 1997 under an IAEA Supply Agreement (INFCIRC/468/1994) to review the regulatory, radiation protection, nuclear safety and operations of the research reactor. The recommendations of the INSARR Mission enabled RPB and the operator or licensee (NNRI) to enhance the regulatory oversight and operational safety of the research reactor, with the assistance of IAEA. NNRI completed a Final Safety Analysis Report and submitted it to the RPB in 2000. In 2000, the 1963 GAEC Act (Act 204) as amended, was replaced by the Ghana Atomic Energy Commission Act, 2000 (Act 588). Its section 3(1)(d) provides for commercialization of research and development results through Institutes of GAEC. INSARR missions were again held in Ghana in 2008 and 2009.

Safety documents governing the reactor's operation include the Safety Analysis Report, Emergency Plan, Periodic Inspection and Maintenance Plan, Maintenance and Quality Assurance Program, Radiation Protection Procedures, Operational Limiting Conditions, and Decommissioning Plan, (Ampomah-Amoako et al. 2009:62). Records are kept daily by NNRI staff on daily operations, maintenance, and radiation monitoring. RPB's regulations are also very strictly adhered to. Close monitoring by the EPA which is also represented on the RPB ensures effective environmental impact assessments. NADMO, the Municipal Authority, Energy Commission and other institutions also

¹⁷⁵ *Id.* For more information on the research reactor and its utilization, see B.J.B. Nyarko et al., *The 30kW Research Reactor Facility in Ghana: Past, Present and Future Programmes* (GAEC/IAEA 2007)

work with RPB and GAEC in various aspects of their operations. Safety analysis is performed for every practice at the reactor site by NNRI in an environment of self-regulation.

The Reactor Safety Committee (RSC) and the Radiation Safety Committee (RadSC) of NNRI advise and review procedures and practices at the facility. Both committees also meet quarterly. Radiation Protection staff of NNRI conduct regular monitoring in and out of the facility to obtain the effluence that emerges from reactor and other activities (Ampomah-Amoako et al. 2009:63). IAEA missions to Ghana have been conducted on *safety*, *security* and *safeguards*. The IAEA INSARR Mission to Ghana in 2009 commended the operators (NNRI) for the strict adherence to RPB regulations (IAEA 2009; IAEA 1997).¹⁷⁶ RPB and GAEC's collegial relations facilitate collaboration on safe operations. Faanu et al. (2010:91) rates NNRI safety culture activities at 73.3% and RPB at 86.7%.

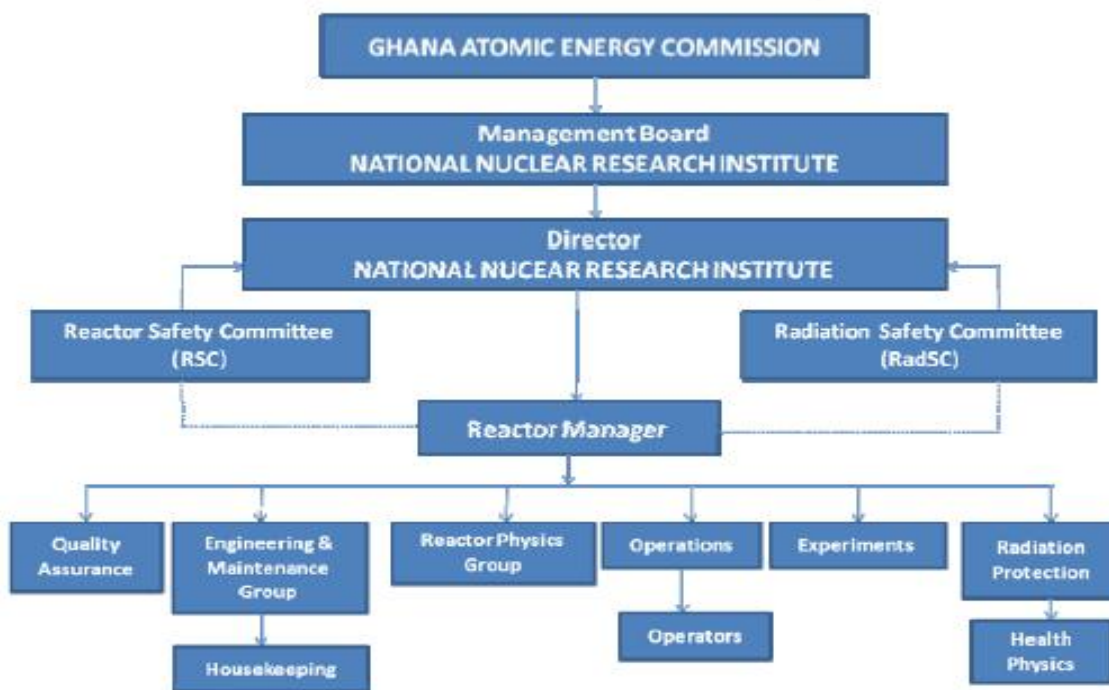


FIG 4.2: ORGANIZATIONAL CHART OF GHARR-1 (Akaho et al. 1995)

¹⁷⁶ See IAEA, *Report of the Follow-Up Integrated Safety Assessment of Research Reactors (Follow-Up INSARR) Mission to the Ghana Research Reactor-1*, Accra, Ghana (2009); Geoffrey Emi-Reynolds, *Impact of Multinational Support for the Control of Nuclear and Radiation Sources in Ghana* (IAEA-CN-177/18, 2010); E.T. Glover, *Implementation of the Borehole Disposal Facility in Ghana: Issues and Challenges* (Lisbon: Conference Presentation 2010); Amuasi *supra* note 142 at p.2

Personnel at NNRI are also trained to ensure safe practice and adherence to regulations. Every user of the reactor facility undergoes Radiation Safety Training after which they are each assessed to test the effectiveness of the training and retention of knowledge and skills taught (Ampomah-Amoako et al. 2009:63). Concerned about decline in nuclear professionals (Nyarko et al. 2007:3; Amuasi 2009), GAEC through IAEA and University of Ghana Faculty of Science established the postgraduate School of Nuclear and Allied Sciences (SNAS) in 2006 under IAEA's GHA/0/010 project to train human resource for the introduction of nuclear power in Ghana. Nuclear Law and Legislation is a core mandatory course at SNAS to help nuclear scientists appreciate the role of law and regulation in nuclear energy. As at December 2011, SNAS had in its six (6) years of existence trained 286 nuclear scientists with 21 of them undertaking PhD degrees in areas including Radiation Protection, Applied Nuclear Physics, Nuclear Engineering, Nuclear Environmental Protection, Nuclear Law and Regulation.¹⁷⁷

SNAS ADMISSIONS

	ANPH	ENVP	NENG	NUAG	NURC	RADP	MPHY	NUES	TOT.
06/07	7	4	7	3	4	6	5	-	36
07/08	5	6	10	5	7	5	3	-	41
08/09	3	7	10	3	4	7	2	4	43
09/10	5	9	9	6	6	15	3	2	45
10/11	4	5	11	5	3	10	4	4	46
11/12	5	7	11	6	2	13	7	3	54
PhD									
	2	3	6	1	3	3	2		20

TABLE 4.1: ADMISSIONS AT SNAS (2006-2012) (Aboh 2012)

Nuclear power generation raises acute safety issues. GAEC, Energy Commission, and other collaborators have since 2007 been working with IAEA to implement a *safe* nuclear power generation roadmap for Ghana: pursuant to Ghana's Cabinet approval in 2008 of the Nuclear Power Planning Committee (NPPC 2007-8) recommendation for the introduction of nuclear power in Ghana.¹⁷⁸

¹⁷⁷ I.J. Kwame Aboh, *Technical Requirements of Ghana Nuclear Reactor Technology for Near Term Deployment* (IAEA, 2011)

¹⁷⁸ B.J.B Nyarko et al., *Nuclear Power for Future Electricity Generation in Ghana: Issues and Challenges* (IAEA-CN-164-2S03)

4.4. Identifying and Verifying the Elements of the Nuclear Safety Evaluation Framework

The primary purpose of any nuclear safety assessment is to determine whether: (1) an adequate level of safety has been achieved for a facility or activity; and (2) basic safety objectives and safety criteria established by the designer, the operating organization and the regulatory body in compliance with the international requirements for protection and safety have been fulfilled (IAEA Safety Assessment 2009:9). Safety requirements focus on: (1) the protection of workers and the public against radiation exposure, and (2) other requirements for ensuring the safety of the facility or activity. Radiation risks may arise from normal operation of the facility or from anticipated operational occurrences or accident conditions where failures or internal or external events have occurred that challenge the safety of the facility or activity; and the consequences of such failures. Deterministic and probabilistic methods of safety analysis aid quantitative assessment of safety compliance and challenges (Fig. 4.3). This study however uses a qualitative and impressionistic evaluation framework to integrate the mesh of safety regulation elements (Fig. 4.4). The main elements and their components are compressed into a manageable evaluation inventory and subsumed under broad headings to increase the efficiency of the evaluation process (Fig. 4.4). This study further focuses on regulatory activities for maintaining safety (Fig. 4.4) as distinguished from operational safety requirements and activities (Fig. 4.3).

The international requirements on nuclear safety may be synthesized into a verified framework with ten key elements: (1) Safety; (2) Security; (3) Non-proliferation (Safeguards); (4) Liability; (5) Health and Environmental Impact; (6) Sociopolitical Influence; (7) Attitudinal Culture; (8) Institutional Regime; (9) Technology; and (10) Economics [Section 4.1. *supra*]. The elements are not exhaustive and each element has other intrinsic components or programmes -- economic issues include investment, funding, commercial competitiveness, cost of technology, national industrial base. The elements should comprise human or organizational, technical, and programmatic areas (Fig. 4.4).

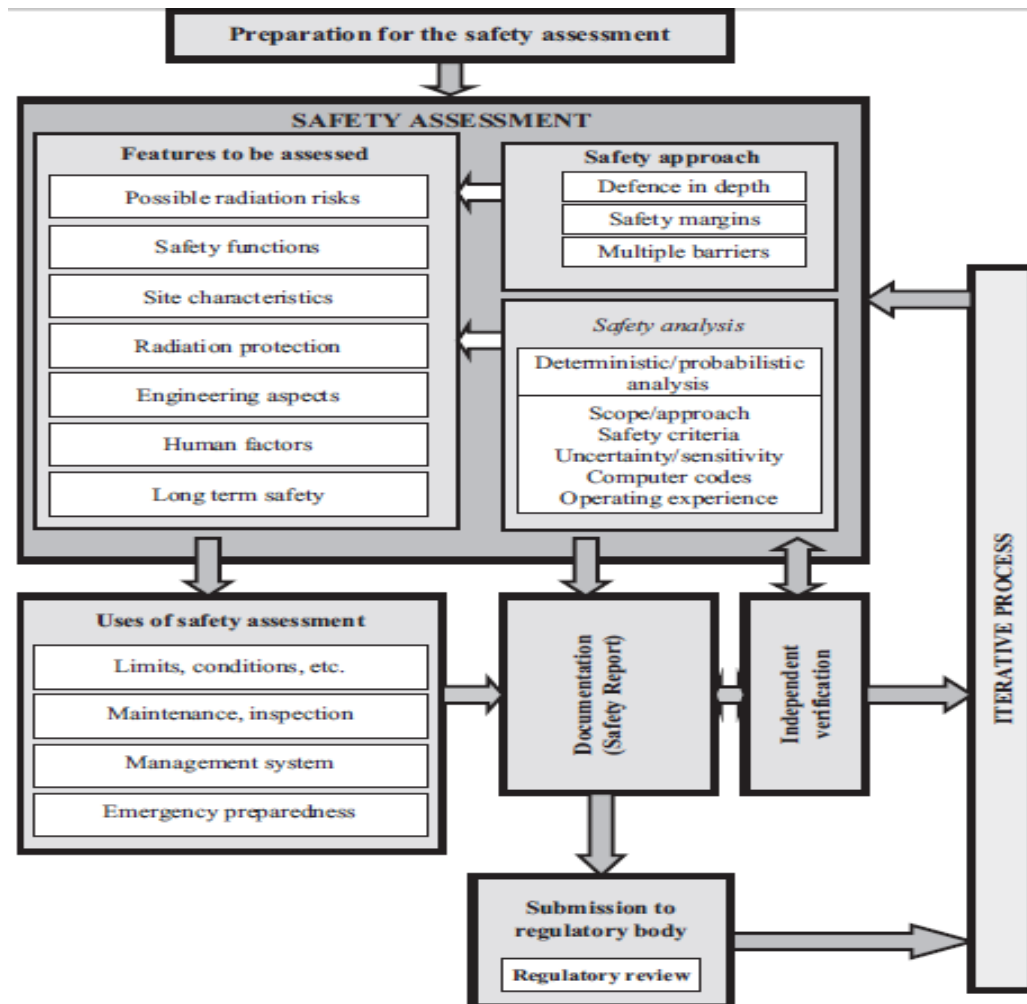


FIG. 4.3: OPERATIONAL SAFETY ASSESSMENT OVERVIEW (Source: IAEA 2009:13)

Safety Areas	Programmes
1. Operating performance	1.1 Organisation and plant management.
	1.2 Operations.
	1.3 Occupational health and safety (non-radiological).
2. Performance assurance	2.1 Quality management.
	2.2 Human factors.
	2.3 Training, examination, certification.]
3. Design and analysis	3.1 Safety analysis.
	3.2 Safety issues.
	3.3 Design.
4. Equipment fitness for service	4.1 Maintenance.
	4.2 Structural integrity.
	4.3 Reliability.
	4.4 Equipment qualification.
5. Emergency preparedness	5.1 Emergency preparedness.
6. Environmental performance	6.1 Environmental management systems.
	6.2 Effluent and environmental monitoring.
7. Radiation protection	7.1 Radiation protection.
8. Site security	8.1 Site security.
9. Safeguards	9.1 Safeguards.

FIG. 4.4: SOME SAFETY AREAS OR ELEMENTS & PROGRAMMES (Source: OECD/NEA 2011:233)

A nuclear power infrastructure generally revolves around safety. E.g., the Presidential Nuclear Power Planning Committee which was set up in May 2007 to advise government on the potential use of nuclear energy, and develop a roadmap for the implementation of a nuclear power plant programme in Ghana identified eleven basic elements of nuclear infrastructure: (1) the position of nuclear power in the electricity market and generation mix; (2) economics of nuclear power; (3) legal regulatory and legislative aspects of nuclear power; (4) environmental and siting aspects of nuclear power; (5) selection of type of reactor; (6) nuclear fuel cycle including waste management; (7) role of government and private sector in nuclear power; (8) availability of industrial base; (9) human resource needs; (10) extent of uranium resources in Ghana and impact on fuel policy; and (11) public acceptance. All of these elements have a direct impact on nuclear safety regulation.

Nyarko, Akaho and Ennison (2009) in their paper on “Nuclear Power for Electricity Generation in Ghana: Issues and Challenges,” presented at the IAEA International Conference on Opportunities and Challenges for Water Cooled Reactors in the 21st Century, identified 19 key issues that relate to nuclear power generation: (1) national position on nuclear power; (2) human resource development; (3) management; (4) funding and financing; (5) legislative framework; (6) regulatory framework; (7) nuclear safety; (8) safeguards; (9) radiation protection; (10) electrical grid; (11) stakeholder involvement; (12) sites and supporting facilities; (13) environmental protection; (14) emergency planning; (15) security and physical protection; (16) nuclear fuel cycle; (17) radioactive waste; (18) industrial involvement; and (19) procurement. Ennison and Akaho (2008) in their paper on “Steps for Conducting Nuclear Power Plant Technology Assessment” focused on the technical safety criteria of simplicity of design, plant availability, economics, and adaptability to grid. They identified *inherent safety* (i.e., the safety system of the plant being less dependent on human intervention – e.g., plants with passive cooling systems, sensitivity to adverse operational conditions, an ability to shut down in such conditions) as a major area of consideration with regard to safety.

Twala (2007:58) in assessing nuclear fuel safety management options for South Africa identified and isolated several criteria for evaluating the framework. Although Twala focused on fuel management, her research has many cross-cutting inter-relationships with pertinent nuclear power generation safety regulatory issues. She identified the main issues as (1) technological; (2) environmental; (3) safety; (4) non-proliferation; (5) economic; (6) security; (7) socio-political; (8) ethical; and (9) institutional. Twala's nuclear fuel safety management criteria are very similar to the elements identified in this study [Section 4.1. *supra*]. The safety evaluation elements identified in this study were first analyzed using relevance, suitability, favourability, sustainability and literature references of each element to distil the ones most relevant to any discussion on the regulation of safety in nuclear power generation.

The elements were verified and weighed using two main sets of questions structured on a five-point scale of 1 to 5. 5 is the most preferred safety related element based on relevance and favourability. The first set of questions was on relevance of the elements to safety regulation in nuclear power generation. It weighed elements on a 5-point scale: (1) *not relevant*; (2) *least relevant*; (3) *somehow relevant*; (4) *relevant*; (5) *most relevant*. The second set of questions addressed issues of preferences and favourability of the elements in nuclear safety regulation: 1 means *not favourable*; 2 means *least favourable*; 3 means *somehow favourable*; 4 means *favourable*; 5 means *most favourable*. The scale aimed at getting extreme and central or moderate opinions that can be averaged to produce an overall rating of the elements for the safety evaluation framework. Ninety (90) respondents (90%) were used in this phase. Literature review impressions on the safety elements were as well averaged, but on a 3-point scale: (1) infrequent, (2) frequent, (3) most frequent. Core issues comprised in each element were identified through a laundry list approach, where respondents were made to write down issues they consider important for each element. This provided an avenue to elicit opinion on each element.

One hundred (100) respondents were targeted for the verification and validation questionnaires: comprising two sets of validation questions on relevance and favourability. Of the 100 questionnaires distributed to 100 respondents, two (2) people (2% of the respondents) returned their questionnaires without any responses to the questions and eight (8) people (8% of the respondents) did not return their questionnaires at all. 90 respondents representing 90% of the total target respondent population however gave their ratings to all the questionnaire questions. Thus 90 people were the survey sample for the verification exercise. The majority (61 people) (i.e., 68% of the survey sample; or 61% of the total number of targeted respondents) were from GAEC and they all provided responses that rated the elements on the basis of relevance and favourability. 75% of this number (46 people) had at the time recently completed their postgraduate studies in nuclear science and were working with GAEC in various capacities; and 25% (15 people) were experienced senior staff and members of GAEC.

Most of these respondents have knowledge about nuclear power regulation and their participation was considered to be representing expert views. A few of those respondents however had only 'pedestrian knowledge' about nuclear power regulation, even though they have expertise in nuclear science and technology. As may be reasonably expected, their 'pedestrian knowledge' was however far above the knowledge that the public had on nuclear power regulation. Their views were thus classified as intermediate-quasi-expert opinion. Respondents from RPB and RPI were included among the GAEC respondents, given the inter-relations between those institutions and their staff. External respondents (i.e., 29 people or 32% of the survey sample or 29% of the total target respondents) were from EPA, NADMO, lawyers, lecturers at University of Ghana (Law, Engineering Sciences, Physics, Business), Ministries (Science, Environment, Energy, Finance, Health, Local Government, Transport), CSIR, Ghana Health Service, Ghana Police Service, National Security Council, final year engineering law students of the Faculty of Engineering Sciences at University of Ghana, and a few ordinary people.

SAFETY ELEMENTS	RELEVANCE	FAVOURABILITY	FREQUENCY IN LITERATURE	WEIGHT (13)
Attitudes	5	5	3	13
Economics	5	5	3	13
Electricity Grid	3	2	1	6
Emergency Planning	5	5	3	13
Ethical	5	4	3	12
Health & Environment	5	5	3	13
Human Resource	5	5	3	13
Industrial Activity	3	3	2	8
Institutional	5	5	3	13
Legislation	5	5	3	13
Liability	5	4	3	12
Management	5	5	3	13
National Policy	3	4	2	9
Nuclear Fuel Cycle	4	3	2	9
Politics	4	3	2	9
Procurement	3	3	1	7
Public Acceptance	5	5	3	13
Radiation Protection	5	5	3	13
Radioactive Waste	5	5	3	13
Regulatory Regime	5	5	3	13
Safeguards	5	5	3	13
Safety	5	5	3	13
Security	5	5	3	13
Site and Facilities	5	5	3	13
Stakeholder Activity	3	3	2	8
Technological	5	5	3	13
Transport	5	5	3	13
Uranium Sources	2	2	1	5

TABLE 4.2: RATING ELEMENTS FOR THE EVALUATION OF SAFETY (Thesis Survey/Research Data 2011)

The validation and weighting processes provided empirically tested ranking of the impressionistic and qualitative list of safety related elements based on their relevance, favourability, and literature review references. Those with higher weight values were deemed the most preferred. They were thus selected and analysed as to their suitability for inclusion in a regulatory safety evaluation framework; and compressed to a manageable evaluation framework size of ten (10) elements [Section 4.1. *supra*].

CHAPTER 5: ANALYZING THE SAFETY EVALUATION FRAMEWORK

5.1. Key Elements Comprising the Criteria for a Nuclear Safety Evaluation Framework

5.1.1. Attitudinal and Ethical Culture

An attitudinal culture on safety (*self-regulation*) (by the operator directly and the regulator or other industry collaborators indirectly) (Keller & Modarres 2008; Rust & Rothwell 1995: 81; Wilpert 2008) relates to human resource capacity: a key part of ‘radiation risk tolerability’ criteria (Tromans 2010). Safety culture is attitudinal, structural, and relates to both organizations and individuals (Faanu et al. 2010:88-91). It is ‘assembly of characteristics and attitudes in organizations and individuals [which establish], as an overriding priority, that nuclear plant safety issues receive attention warranted by their significance’ (INSAG 1991; Stoiber et al. 2003:23). The term ‘safety culture’ was introduced by the International Nuclear Safety Advisory Group (INSAG) after the 1986 Chernobyl accident when INSAG in its post-accident investigation reported that “[t]he vital conclusion drawn is the importance of placing complete authority and responsibility for the safety of the nuclear plant on a senior member of the operational staff of the plant. Formal procedures, properly reviewed and approved, must be supplemented by the creation and maintenance of a ‘nuclear safety culture’” (INSAG 1986).

Faanu et al. (2010) in their authoritative inter-comparison study of ‘Safety Culture Within Selected Practices in Ghana Utilizing Ionizing Radiation’ *inter alia* gauged management and NNRI operating staff commitment to research reactor safety to be 73.3%. They used performance indicators on issues including general safety, safety policy, safety practices, clear procedures, clear lines of communication, definition of responsibility, staff training, safety of the facility physical structure and emergency plans. They found the use of log books and availability of competent, qualified and licensed reactor operators as core strengths of the research reactor facility (Faanu et al 2010).

Of the many practices using ionizing radiation in Ghana (conventional radiography, research reactor, gamma irradiator, radiotherapy, X-ray scanner, gamma scanner, etc) none was able to satisfy all the requirements or safety attributes for a 100% level of safety culture (Faanu et al. 2010:91). Emergency planning, radiation safety policy, radiation protection programmes, etc are areas to be strengthened to ensure full compliance. A self-regulatory, self-disciplined and best practice safety attitude beyond the legislative and regulatory requirements nurtures an effective safety culture. Key attributes or building blocks of safety culture include roles, priority to safety, openness, etc (Alexander 2004; IAEA 1998).

ATTRIBUTES	Jacobs and Haber	IAEA	NEA	Lee	INPO	NEI (Dugger)	Murley	Whitcomb	Utility Service Alliance	Donald and Canter	INSAG 15	TOTAL
Roles/responsibilities/accountabilities	X	X	X		X		X	X	X	X		8
High priority to safety	X	X	X	X			X		X		X	7
Openness and communications	X	X	X	X		X		X			X	7
Organizational learning	X	X	X	X	X				X		X	7
Top management commitment to safety		X		X	X		X			X	X	6
Initial and continuing training	X		X	X			X			X		5
Employees have a questioning attitude		X		X	X						X	4
Recognizing employee's efforts		X		X		X				X		4
Appreciation of risks					X		X			X	X	4
Self-assessment	X	X				X	X					4
Technical competence	X	X						X	X			4
Compliance w/regs and procedures		X				X			X			3
Finding problems and fixing them	X					X			X			3
Organizational knowledge	X	X	X									3
Proceduralization	X	X	X									3
Proper resource allocation	X	X	X									3
Working conditions (pressure/workload/stress)		X		X						X		3
Management leadership/oversight								X	X			2
Organization culture	X		X									2
Exchanges of info with other plants							X		X			2
Relationship between managers and employees		X			X							2
Relationship with regulators		X					X					2
Role of managers		X	X									2
Time focus	X	X										2

TABLE 5.1: FREQUENTLY CITED SAFETY CULTURE ATTRIBUTES (Source: Alexander 2004:14)

5.1.2. Economic Factors

Nuclear power systems are capital intensive. A plant suitable for Ghana should have low capital cost and be built in a short time. Given capital constraints, a small to medium reactor (SMR) with least relative cost is preferred for Ghana (Ennison & Akaho 2008:21). Laws and a regulatory body are vital to an institutional regime of safety inspections, monitoring and enforcement but it has to be backed by adequate provision of all necessary resources to enable RPB to duly carry out its functions (Schandorf et al. 1995:235). Technical skills of RPB's workforce and senior management, commitment to safety, resources, equipment and tools and well established institutional processes aid safety in Ghana but it is weakened by inadequate government funding (Faanu et al. 2010:91). Financing of a nuclear power plant could be done by government, private equity, public and private partnership or through bilateral negotiation. Construction cost of a nuclear plant can vary widely, but the current indicative value is about \$1.5-2million per MW of electrical capacity (Nyarko et al. 2011:59). The major costs involve the human resources required, including their requisite training and skills development to implement a nuclear power programme. Developing facilities for the power plant – grid network, operations, fuel storage, waste management, decommissioning, etc – also adds to the costs. The initial high capital cost is usually offset by the low operating and fuel costs that make the cost of nuclear power generated electricity very competitive compared to other sources such as hydro or gas (Nyarko et al. 2011:59). Ghana's draft Nuclear Authority Bill 2012 has provisions for financial arrangements for collecting funds during the plant's operation to cover financial liabilities (Clauses 22 to 25).

TYPE OF POWER PLANT	CAPACITY (MW)	GENERATION COST (CENTS/KWH)
Bui Hydro	400	6.9
Juale Hydro	87	8.1
Pwalugu Hydro	48	9.3
Awisam Hydro	50	12.6
Hemang Hydro	80	11.4
Takoradi Gas Combined Cycle	300	5.0– 5.5
AP 600 – Nuclear	600	4.0 – 6.0

TABLE 5.2: Comparison of Costs Associated with Electricity Sources in Ghana (Source: Nyarko et al. 2011:59)

5.1.3. Health, Environmental and Waste Management Impact

All forms of energy production or use have environmental impact and this applies to all energy chains (Ampomah-Amoako et al 2011:53). The environmental impacts associated with nuclear power are radiation, air pollution, greenhouse gas (GHG) emissions, and radioactive waste. UNSCEAR has established that radiation from nuclear power plants in normal operation is comparatively low. Average radiation dose from nuclear power production is one ten-thousandth of the dose from natural background sources such as cosmic rays, naturally occurring radioactive substances in the air (e.g., radon), in food and water (e.g., potassium) and in the earth (IAEA 2006). Although Ghana does not have a coal fired power plant, it is instructive to note that someone living within 50 miles of a coal fired power plant will receive an average dose of $0.3\mu\text{Sv}$, whilst someone living within 50 miles of a nuclear power plant will receive $0.09\mu\text{Sv}$. Both are over ten thousand times less than the average dose from natural background radiation and over one thousand times less than the average dose received by people in US from X-rays and other medical procedures. But radiation from nuclear power activities can nevertheless be harmful, especially spent fuel, nuclear waste or in case of uncontrolled chain reaction, radiological releases or radiation exposure situations occasioned by an accident.

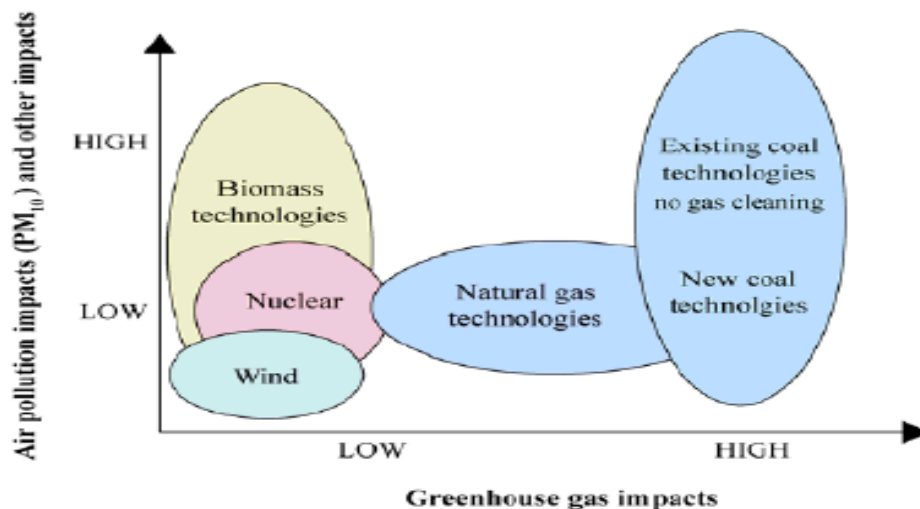


FIG. 5.1: Relative Environmental Impacts from Emissions of Different Electricity Generating Technologies
(Source: IAEA 2006; cited in Ampomah-Amoako et al. 2011:55) (NB: Ghana does not have a coal power plant)

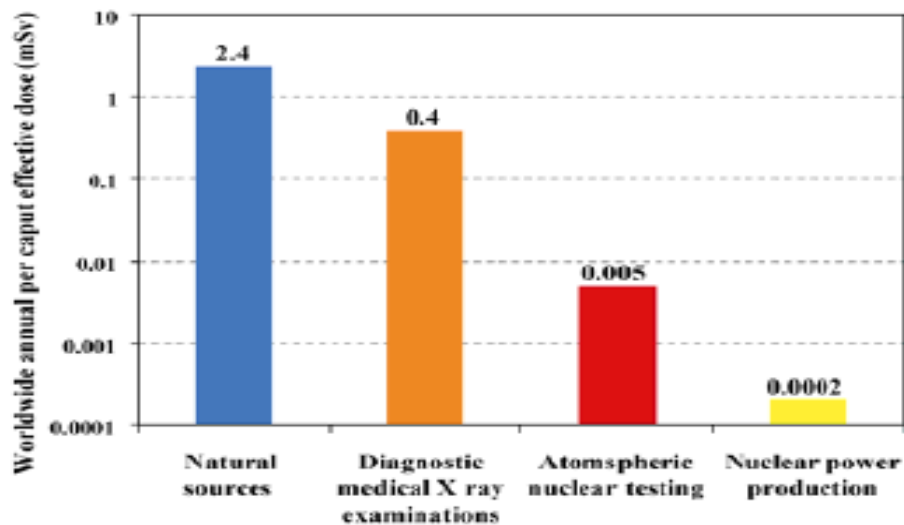


FIG. 5.2: Worldwide Average Annual per capita Dose from Natural and Anthropogenic Radiation
(Source: IAEA 2006; cited in Ampomah-Amoako et al. 2011:55)

The Environmental Protection Agency of Ghana is set up to secure the control and prevention of discharge of waste into the environment and the protection and improvement of the quality of the environment. Section 12 of the EPA Act 1994 (Act 490), and Environmental Assessment Regulations 1999 (LI 1652), Regulations 1, 3, 9, 10 and 30 (1)) require all undertakings including plans and programmes, likely to have significant environmental impact, to be subjected to environmental assessment in their inception and planning (i.e., Strategic Environmental Assessment, Preliminary Environmental Impact Statement), and Environmental Impact Assessment at the execution stage. LI 1652 makes EIA mandatory for nuclear power plants (Regulation 3). Section 15 of the EPA Act empowers environmental protection inspectors or any person authorized by the Agency's Board to enter any premises at any reasonable time for the purpose of ensuring compliance with the laws pertaining to environmental protection. Both the Environmental Protection Act and LI 1652 deal with *radiological issues* and *non-radiation issues* such as avoiding environmental deterioration, thermal pollution, improper land usage, etc; yet they do not provide for assessment of applicable legal and institutional framework and relevant international conventions in the EIA approval process.

Cases like *ICJ's Advisory Opinion on the Legality of the Threat or Use of Nuclear Weapons*, *Trail Smelter Arbitration*, the 1973, 1974 and 1995 *Nuclear Tests Cases*, *Gabcikovo v. Nagymaros Dam Dispute*, *Mox Plant Case* and *Singapore Land Reclamation Case*, also emphasize environmental protection [see Section 2.2.4. *supra*]. On occupational health, the *Factories, Offices and Shops Act, 1970 (Act 328)* provides for registration of factories, the health, welfare and safety of persons employed in factories, offices, shops and other places, and matters connected therewith. A Chief Inspector keeps a register of factories. Under Section 4 of the Act, no person shall commence or permit or cause to be commenced (a) the building of any premises intended to be used as a factory; or (b) any works to alter or add to any factory or premises intended to be used as a factory, unless he has first submitted to the Chief Inspector or to the Inspector for the district not less than one month before such commencement proper plans of such building works, alterations or additions accompanied by the particulars set out in the Second Schedule to the Act.

Section 25 of the *Factories, Offices and Shops Act, 1970 (Act 328)* provides for protective clothing and appliances: suitable protective clothing and appliances, including, where necessary, suitable gloves, footwear, goggles and head coverings, shall be provided and maintained for use. Section 28 provides for first aid. Nothing except appliances or requisites for first aid shall be kept in a first aid box or cupboard; and each first aid box or cupboard shall be placed under the charge of a responsible person, who shall if possible be a person with knowledge of first aid and who shall always be readily available during working hours. Under Section 11 of the Act, a written notice of every dangerous occurrence occurring in any factory, office or shop shall, whether death or disablement is caused or not, forthwith be sent by the occupier in the prescribed form containing the prescribed particulars to the Chief Inspector or the Inspector for the district. Dangerous occurrences include all cases of explosion, fire, collapse of buildings, accidents, etc.

Clauses 50 to 59 of the Nuclear Authority Bill 2012 provide for radioactive waste management in Ghana, and prohibit the importation or re-importation of such waste into Ghana. The ‘once-through’ or ‘open’ or ‘direct disposal’ fuel cycle option is Ghana’s spent fuel policy option (Clauses 26.8.g & 56-58): Ghana does not intend to dispose of spent fuel in Ghana as nuclear waste, rather, spent fuel will be returned to the fuel supplier. So whether the fuel supplier’s country’s laws permit importation of spent fuel is vital; and shipment responsibilities should also be well defined to avoid opportunism. Contractual provisions must specify the party who bears the cost of packaging and transporting or shipping the spent fuel to the supplier under the once-through or direct disposal fuel cycle.

5.1.4. Institutional Regime

Ghana’s regulatory body for nuclear energy and radiation protection (RPB) is currently part of the promoting body (GAEC). RPB’s structure which subsumes it under GAEC raises issues on apparent lack of independence. Arguably, it effectively utilizes the few technically trained personnel, fosters seamless exchange of knowledge and information, enhances transparency; and like the concept of *family*, RPB and GAEC work together, but each knows its roles and responsibilities. It is a structure with shared mutual respect, trust and skill in their operations. RPB and GAEC operate in a collegial culture of independence and cooperation, not a “regulatory capture.” It enhances regulatory practice: by making regulators, operators, and promoters to sit down together across the table to decide what should be done. It has enabled Ghana to implement a non-prescriptive performance-based self-regulation in its nuclear regulation and practice for decades (Amuasi 2001). A danger inherent in this approach is the strong reliance on practices or traditions and may result in lack of clearly written rules on requirements. However, RPB has produced several Guides and documents to provide information on minimum requirements. Introducing nuclear power require more regulatory guides and policies to complement the detailed rules proposed in the Nuclear Regulatory Authority Bill 2012 (Clause 5(a)).

The proposed Nuclear Regulatory Authority is well-structured to work with independence. Under Clause 8 of the Nuclear Regulatory Authority Bill 2012, the governing body of the Authority is a Board comprising seven (7) members appointed by the President in consultation with the Council of State in accordance with Article 70 of the 1992 Constitution. Clause 8(3) mandates the Board to ensure the proper and effective performance of functions of the Authority. In discharging its duties, the Board shall not be subject to the control or direction of any person or authority (Clause 8(4)). The members serve for up to three (3) years for a maximum of two consecutive terms (Clause 9). The Board has power to appoint a Complaints Panel to hear parties and make recommendations to the Board (Clause 91-92). Any appeal from the decision of the Board goes to the High Court (Clause 93)

To achieve regulatory independence, three (3) things are usually required (Malsh 2011). First, there is a need for structural independence or a regulatory body with adequate regulatory powers and defined relationships with other governmental bodies that assure no undue influence. A second requirement is operational independence in terms of the availability of adequate technical and financial resources for the regulatory activities. Finally, cultural independence or the establishment and fostering of a strong safety culture among the institution's management and employees (Malsh 2011). The institutional delineation of regulatory authority from promotional activities or external control avoids regulatory capture, and strengthens the regulatory body to function independently.

Several countries have gone through regulatory independence transitions. In the *US* for example, the Atomic Energy Commission regulated and promoted nuclear reactors from 1946 up to 1974 when Energy Reorganization Act of 1974 invested AEC's regulatory functions in the Nuclear Regulatory Commission (NRC) and constituted the NRC as an independent nuclear energy regulator in the US. The NRC has an annual budget of over \$1 billion, including about \$790 million for reactor oversight (Marsh 2011) which is more than double the NRC's annual budget of \$410 million almost 30 years

ago (Ahearne 1988:216 citing NRC 1986 Annual Report). NRC's 1988 staff strength of 3400 employees including 2200 employees devoted to reactor regulation (Ahearne 1988:216) has also increased to 3,800 full time employees including 2,900 full time employees devoted to reactor regulation (Marsh 2011). In 2000, *Canada* reformed its Atomic Energy Control Board which had been created under the Atomic Energy Control Act of 1946 by establishing the Canadian Nuclear Safety Commission (CNSC) under the Nuclear Safety and Control Act 1997. The CNSC provides a model of nuclear power regulation based on safety. It makes independent decisions on licensing of nuclear related activities, establish binding regulations, and set regulatory policy direction on health, safety, security and environmental matters. This provides nuclear regulatory lessons for Ghana.

India commissioned the Atomic Energy Regulatory Board (AERB) in 1983 pursuant to section 27 of the Atomic Energy Act 1962 to carry out regulatory and safety functions which were hitherto being done by the Safety Review Committee of the Department of Atomic Energy (DAE) under sections 16, 17, and 23 of the 1962 Act (Puthucherril 2008). AERB is still not deemed independent because it *inter alia* reports to the Secretary of DAE who is also responsible for the Nuclear Power Corporation of India Limited (NPCIL) which constructs and operates all power reactors in India: evidencing lack of effective separation between regulatory and promotional agencies in India. India is however considering a Bill to create an autonomous Nuclear Regulatory Authority (Gopalakrishnan 2011).

Institutional, legal and regulatory regimes to govern safety, security, safeguards and liability are also now cross-fertilizing synergies, and merging regulatory responsibilities previously separated among different agencies into a single regulatory body (CNS/RM 2005:4; Tonhauser and Wetherall 2010:168). IAEA's Department of Nuclear Security was incorporated into IAEA's Department of Nuclear Safety and renamed Department of Nuclear Safety and Security in 2004. In UK, the Office for Nuclear Regulation (ONR), an agency of the Health and Safety Executive (HSE), has since in

April 2011 brought together the safety, security and safeguards functions of the Nuclear Installations Inspectorate, Office for Civil Nuclear Security, and the UK Safeguards Office, as well as the Radioactive Materials Transport Division of the Department of Transport (ONR 2011). Ghana's Nuclear Authority Bill (2012) as has been drafted, broadly deals with the "3S"+Liability concept.

Clause 1(1) of the Bill defines the scope of application of the Bill as:

- (a) management of radioactive waste resulting from civilian applications in the country;
- (b) regulation and management of the peaceful use of nuclear energy and radiation under the jurisdiction and control of the country, including the production, possession, use, import, export, transportation, transfer, handling and management, or other related activity or practice identified by the Authority; and
- (c) management of spent fuel resulting from the operation of civilian nuclear reactors in the country.

Clause 5(a) of the Bill in specifying the functions of the proposed Nuclear Authority states that, the Authority shall develop national policies on the regulation and management of activities and practices with respect to: (i) nuclear safety; (ii) security of nuclear and radioactive materials; (iii) radiation; and (iv) the implementation of safeguards specified under this Act. Clauses 68 to 78 provide for liability and compensation in case of nuclear damage and related matters. Clause 72 of the Bill proposes the Vienna Convention on Nuclear Liability as amended or the Convention on Supplementary Compensation as the nuclear liability regime for Ghana. These provisions are intended to harmonize Ghana's legal and regulatory frameworks to deal with the four areas of safety, security, safeguards, and liability under a single Nuclear Regulatory Authority which will coordinate regulatory safety with other existing institutions like NADMO, EPA, GAEC, etc.

5.1.5. Liability

For most injuries, the person who caused the injury is usually liable only if the person owes the injured party a duty of care, but acted "negligently" (did not use "due diligence" as required by the activity or situation), and the injured party is able to prove that he or she suffered damage as a result of a breach of that duty of care. Nuclear energy however falls under those activities which by their risky nature and propensity to cause serious injuries, require a high standard of liability characterized

as “strict liability”. Even where an activity does not involve a high degree of risk, strict liability may still result, if the non-high level risk carries with it the possibility of mischief or widespread harm that makes it ‘abnormally dangerous’ (Kelson 1972:279-80; *Rylands v. Fletcher* 1868:330). Liability and safety regulation thus jointly promote safety (Lee 2011:555; Cane 2002:305; Schmitz 2000:371; Dewees 1992:446; Ackerman 1991; Menell 1991; Shavell 1987; Landes and Posner 1987)).

Landes and Posner (1984:417) observe that “regulation and tort law are alternative methods (though often used in combination) for preventing accidents.” Regulation requires a potential tortfeasor to take measures to prevent an accident from occurring, whereas liability regimes seeks to deter the accident by making the potential tortfeasor liable for the costs of the accident should it occur. As Professor Boyle explained: “The arguments for using a standard more demanding than due diligence to shift the burden of unavoidable loss back to the polluter remain strong, particularly where the source is an ultra-hazardous activity, such as a nuclear power plant. In the absence of reciprocal acceptance of risk, making the victim suffer is not an attractive policy” (Boyle 1990:296; Birnie and Boyle 2002:188-89). Where insurance is obtained to indemnify the potential tortfeasor from liability in case of an accident, the payment of higher insurance premiums on an accident record is deterrence against negligence or laxity and makes the insured careful to prevent an accident. Consequently, torts law’s compensation for personal injuries is arguably considered by some commentators as virtually destroyed by private liability insurance and other schemes of loss distribution. However, as Professor Kumado (2009) perceptibly inquires,

“Should we replace Torts law as a framework for our system of compensation for personal injuries with an administrative law scheme that employs concepts of strict liability and compensation from a fund financed by premiums or by tax? For us ... in Ghana, an answer to such a question must depend on a number of factors:

1. The cost of the new system.
2. The availability of administrative resources to manage the scheme.
3. The likelihood or otherwise of adverse effects on the economy.

For the foreseeable future therefore, we are justified in assuming that Torts law will remain central to [Ghana’s] system of compensation for personal injuries and property damage.”

A range of harms, economic, environmental, physical and psychological, to individuals, property and ecosystems, are involved in liability claims. It is often argued that liability threats that are potentially unlimited in time and amount, and for which there is little or no likelihood of obtaining adequate insurance in the normal course of business, may cause financial ruin (Landes & Posner 1984:417). Moreover, some commentators opine that tort law may not address catastrophic accidents effectively due to the likely existence of a massive number of victims in torts cases making it unlikely for tortfeasor to pay all the accident claims (the “floodgates argument”); and the causal link to a particular victim is often unclear because injury may show up so many years after the accident occurred that proof of negligence may be difficult since it may be harder to exclude other causal factors (Landes & Posner 1984:417). However, the *Hillsborough* group of actions in the UK (*Alcock v. Chief Constable of South Yorkshire Police* [1992] 1 AC 310; *White & Others v. The Chief Constable of South Yorkshire Police*, etc); the Texas City disaster; oil spill torts claims arising from the *Exxon Valdez* accident (*Exxon Shipping Co. v. Baker* 554 U.S. 471 (2008), etc), *BP’s Deepwater Horizon* accident where BP placed USD\$20 billion in escrow to compensate private individuals and businesses through an independent Gulf Coast Claims Facility, etc emphasize the continued relevance of tort law in mass and/or hazardous tort claims. However, the Hillsborough soccer match disaster decision of *Alcock v. Chief Constable of South Yorkshire Police* [1992] 1 AC 310 and the Texas City disaster decisions in *Dalehite v. U.S.*, 346 U.S. 15 (1953) and *France v. U.S.*, 290 F.2d 395 (5th Cir. 1961) have been criticized as cases where the courts used a less candid device, respectively, to “reduce the number of claimants” and “absolve the defendant under the pretence that not all elements of liability had been established” with or without openly avowing that the real reason was the “fear of imposing an intolerable or disproportionate burden” (Fleming 1994:510).

International nuclear law has developed principles that seem to prefer insurance to tort liability as a remedy for nuclear harm (Schwartz 2010:308). International conventions on civil nuclear liability

have sought to do away with ordinary rules of tort law, and rather impose liability and compensation rules in a “special regime” that applies only to a “nuclear incident” occurring at a facility with highly dangerous substances or where highly dangerous processes are carried out or during the transport of such substances. Liability principles have consequently been developed to create incentives for nuclear operators to maintain high levels of safety in their activities, provide remedies for victims, and protect the nuclear industry from financial ruin. These principles include: Strict (No Fault) Liability, Exclusive Operator Liability (or legal channelling as opposed to US economic channelling approach and subrogation), Compulsory Financial Security (via private insurance, bank guarantee, operator pooling system as in US and Germany, self-insurance by a State, or State guarantee or indemnity), 30 year liability time limits, limits on the amount of compensation, etc.

Ghana has not yet signed on to any nuclear liability convention but the Nuclear Regulatory Authority Bill 2012 recommends the Vienna Convention as amended and the Convention on Supplementary Compensation (Clause 72); and makes insuring against nuclear liability mandatory (Clause 73). It also adopts the international approach to nuclear liability by providing for a strict liability regime, exclusive operator liability, limits on amount of compensation, 30 year liability time limits, etc. Acts of God or natural disasters is not listed or mentioned in the exceptions to liability under Clause 77. Thus unlike in Japan where statute expressly excludes ‘liability’ for nuclear injury or harm caused by a natural disaster (given Japan’s special geographical context), or in the UK where Section 13(4)(b) of the Nuclear Installations Act 1965 imposes liability even “where the occurrence, or the causing thereby of the injury or damage, is attributable to a natural disaster, notwithstanding that the disaster is of such exceptional character that it could not reasonably have been foreseen”, Ghana’s statutory law and Nuclear Regulatory Authority Bill 2012 are silent on the effect of natural disaster on nuclear liability. Since the common law makes an Act of God or extraordinary natural disaster an unlikely defence to an action based on *Rylands v. Fletcher*’s absolute (strict) liability for non-natural use of

land and escape of something likely to do mischief from the land, it appears the Nuclear Regulatory Authority Bill 2012 maintains the common law position on the matter. Thus, the violent thunderstorm exception to the flooding in *Nichols v. Marsland* (1876) seems faulty, considering Baron Bramwell's statement in *Ruck v. Williams* (1858) that 'there is nothing so certain as that which is unexpected' and the holding in *Greenock Corporation v. Caledonian Railway Co.* (1917) that an extraordinary and unprecedented rainfall was not an act of God (Simpson 1984:219; Kumado 2009:110-111).

Ghana has a lot of laws that seek to protect the environment and impose liability for activities or conduct that breach their regulatory provisions [see Section 2.2.4.1. *supra*]. Even where a statute has authorised the doing of a particular act or the use of land in a particular way, which act or use will inevitably cause a nuisance, all remedies are taken away provided that every *reasonable* precaution with the exercise of the statutory powers had been taken to prevent the nuisance from occurring (*C.F.C. Construction v. Accra Town & City Council* (1968); Section 2.2.4.1. *supra*). Nuclear liability regimes seek to balance the public need for protection and compensation in case of nuclear accident, with the fears of potential investors, builders, suppliers of equipment, services and technology, operators, etc about liability claims that might be instituted by innocent victims after an accident; and such claims may be financially debilitating (Landes & Posner 1984:417).

In several torts cases, the common law courts base their decisions on the balancing of the rights of parties, especially where a party owes a duty of care in respect of which he ought to be aware. In *Dixon v. Bell* (1816), a master who entrusted a loaded gun to a young servant was held liable for the injury caused to a third party since the gun was in a state of doing mischief. In *Heaven v. Pender* (1883), Lord Justice Cotton stated that "[a]nyone who ... without due warning supplies to others for use an instrument or thing which to his knowledge, from its construction or otherwise, is in such a condition as to cause danger ... is liable for injury caused to others by reason of his negligent act." In

Dominion Natural Gas Co. v. Collins (1909) where plaintiff was injured by an explosion of a gas apparatus negligently installed by the defendants who were held liable, Lord Denning advised that, “what that duty (of care) is will vary according to the subject-matter of the things involved. It has, however, again and again, been held that, in the case of articles dangerous in themselves, such as loaded firearms, poison, explosives and other things ‘*ejusdem generis*’, there is a peculiar duty to take precaution imposed upon those who send forth or install such articles when it is necessarily the case that other parties will come within their proximity.”

Silkwood v. Kerr-McGee Corp. (1984) provides persuasive authority on application of tort principles in nuclear incidents, nuclear power regulation, USA federal pre-emption doctrine and applicability of punitive damages for radiation exposure. The main question in *Silkwood* was whether the US Nuclear Regulatory Commission’s (NRC’s) exclusive authority to establish safety standards for the operation of nuclear plants forecloses the availability of state tort remedies? It was held in *Silkwood* that the NRC’s exclusive authority to establish safety standards for the operation of nuclear power plants does not foreclose the availability of state tort law remedies. *Silkwood* may be distinguished in cases of nuclear liability on the grounds that the US had at the time not subscribed to any international nuclear liability convention – to date, has ratified only the 1997 Convention on Supplementary Compensation for Nuclear Damage, and is thus not bound by any liability convention in force. USA relies mainly on its domestic laws on nuclear liability (i.e. Section 170 of the Atomic Energy Act 1954 as repeatedly amended, and the said section 170 comprises the 1957 Price Anderson Act as amended which provides for economic channelling of liability and compulsory financial security arrangements). As noted earlier, Ghana has also not yet ratified any international convention on nuclear liability and may thus use tort law, insurance pooling arrangements, financial guarantees, and other best practices from the US and other countries to streamline the legal regime for nuclear liability in Ghana.

5.1.6. Safeguards (Non-proliferation)

Non-proliferation measures involving Peaceful Use Statement, Safeguards Commitments, State System of Accounting and Control, Export and Import Restrictions, Verification and Inspections have an indirect impact on safety. Ghana has assumed non-proliferation obligations under the Nuclear Non-Proliferation Treaty which it signed in 1968 and ratified in 1970, IAEA Safeguards Agreement (i.e., the Application of Safeguards in connection with the Treaty on the Non-Proliferation of Nuclear Weapons (with Protocol) which it signed on 6 July 1973 and it entered into force in Ghana on 17 February 1975), African Nuclear-Weapon-Free-Zone Treaty (Pelindaba Treaty) which it signed on 11 April 1996 and entered into force in July 2009, and several other laws. Safeguards ensure that nuclear energy is used safely for peaceful purposes only (Amuzu 2000:176; Nyarko 2011:57). Having signed IAEA's Revised Supplementary Agreement Concerning the Provision of Technical Assistance by the IAEA (RSA) on 30 January 1989, Ghana is further committed to use nuclear energy for peaceful uses only, and apply IAEA safety standards to projects for which the IAEA provides technical assistance. The Nuclear Regulatory Authority Bill 2012 makes proposals for the adoption of a strict safeguards regime in Ghana to prevent use of nuclear energy for non-peaceful uses (Clauses 5(a)(iv) and 64).

5.1.7. Safety

Safety covers plant or equipment design (technical), management (human or organizational), or other regulatory (programmatic and crosscutting) issues on radiation protection, transport, waste, etc. IAEA places emphasis on the graded approach to safety assessment in line with Principle 5 of the Fundamental Safety Principles. It mandates that resources devoted to safety by the licensee, scope and stringency of regulations and their application must be commensurate with the magnitude of the possible radiation risks and their amenability to control (IAEA 2009:7). *Safety* relates to *radiological risks* (i.e., justification for use of radiation, dose limitation or tolerability of the risk, and optimization of radiation exposure using ALARA or as low as reasonably achievable standards to keep exposures

below prescribed limits) (Courades 1999; Lazo 2010); and *accident risks* (general nuclear safety and technical safety via defense-in-depth measures, emergency preparedness, etc) (Stoiber et al. 2003). Safety has been given due attention in the proposed Nuclear Authority Bill 2012 (e.g., Clauses 26 to 49 on safety; 94 and 95 on regulations, guidelines, standards and procedures; 79 to 83 on inspection and enforcement; 50 to 58 on radioactive waste management; 59 on radioactive material transport; 60-63 on decommissioning). Atomic Energy Commission Act, 2000 (Act 588) established GAEC (under which is established RPB) “to supervise the carrying out of all requirements designed to serve the safety and health of radiation workers and the environment” and to ensure that nothing on its premises or elsewhere suffers nuclear damage [*see* Section 5.1.3. *supra* on Health, Environment, etc].

5.1.8. Security

Safety measures and security measures have in common the aim of protecting human life and health and the environment. Safety is defined by the IAEA to mean ‘the *protection* of people and the environment against radiation risks, and the *safety* of facilities and activities that give rise to radiation risks (IAEA 2010; IAEA 2011; IAEA 2006). The Basic Safety Standards series of IAEA also have the objective “to establish basic requirements for protection against the risks associated with exposure to ionizing radiation [...] and for the *safety of radiation sources* that may deliver such exposure” (IAEA 2011, 1996, emphasis mine). The term “safety of sources” encompasses security of sources; and paragraph 2.34 of the BSS provides for the “security of sources” as follows:

“Sources shall be kept secure so as to prevent theft or damage and to prevent any unauthorized legal person from carrying out any of the actions specified in the General Obligations for practices of the Standards by ensuring notably that control of a source not be relinquished, the obligation to inform the relevant authority on decontrolled, lost, stolen or missing source, the prohibition of transfer of source without authorization and periodic inventories of movable sources to confirm that they are secure.”

Finely intertwined within the IAEA’s conception of safety is security and physical protection of nuclear material, sources and facilities. The Convention on Nuclear Safety does not contain express obligations related to physical protection. However, in recognition of the importance of protecting

power reactors against threats to their physical security, the preambular paragraph (vi) refers to the Convention on the Physical Protection of Nuclear Material as relevant to nuclear safety (Stoiber 2003:148). The Basic Safety Principles for Nuclear Power Plants states in Paragraph 242: “The design and operation of a nuclear power plant provide adequate measures to protect the plant from damage and to prevent the unauthorized release of radioactive material arising from unauthorized acts by individuals or groups, including trespass, unauthorised diversion or removal of nuclear materials, and sabotage of the plant.” Security measures on physical protection, accounting and control, confidentiality and enforcement are all very closely linked to ensuring safety. Safety and security measures must thus be designed and implemented in an integrated manner so that they do not compromise each other. Security and safety infrastructure must be developed in a well coordinated manner. Organizations involved need to be made aware of the similarities and differences between safety and security so as to factor both into development plans. Synergies between safety and security must be developed for them to complement and enhance each another. Clause 5(a) of the NRA Bill empowers the Nuclear Authority to integrate nuclear safety and security of nuclear and radioactive materials in national policies on the regulation and management of nuclear activities and practices.

5.1.9. Socio-Political Influence

Socio-political influence encompasses *political will* to undertake, finance the capital, operational and part of the liability costs of nuclear power (Faanu et al., 2010; Froggatt 2005; Clauses 22 to 25 of the Nuclear Authority Bill 2012 proposes establishment of a nuclear authority fund); and *public tolerance* (i.e. tolerability of radiation risks based on considerations of public opinion and expert assessment) (HSE 1992; Tromans 2010:97). “Psychological hesitation” has to be overcome for nuclear power to be more widely utilized (Nakatani 2008:493; Tromans 2010). An extensive survey was conducted on public perception of nuclear safety and public acceptance of nuclear power in Ghana. Six hundred

and fifty (650) respondents were targeted but only 84% (546 of the 650 respondents) responded to the questionnaire survey. So, five hundred and forty six (546) respondents constituted the survey sample:

4. 208 ordinary lay people
5. 61 nuclear science experts, administrators or lawyers at GAEC and RPB
6. 277 professionals, post-graduate science students and students
 - a. Science professionals (28 people)
 - b. Legal professionals (41 people)
 - c. MDAs & Regulatory institutions (EPA, GSA, etc) (18 people)
 - d. Undergraduate science students (52 people)
 - e. Postgraduate nuclear science students (94 people)
 - f. Law students (44 people)

Of the 546 survey sample 47.5% (259 people) did not support nuclear power in Ghana, 48.9% (i.e., 267 people) support it, and 3.6% (i.e., 20 people) were undecided. This is consistent with Birikorang et al.'s finding of 53% in favour of nuclear power and 47% against it among people aged 50+ (Birikorang et al. 2012:69). Each respondent provided a "Yes", "No", "Don't Know" or "Undecided" answer to whether or not Ghana should opt for nuclear power. The responses show a very sharply divided public opinion on acceptance of nuclear power (48.9% for nuclear power and 47.5% against).

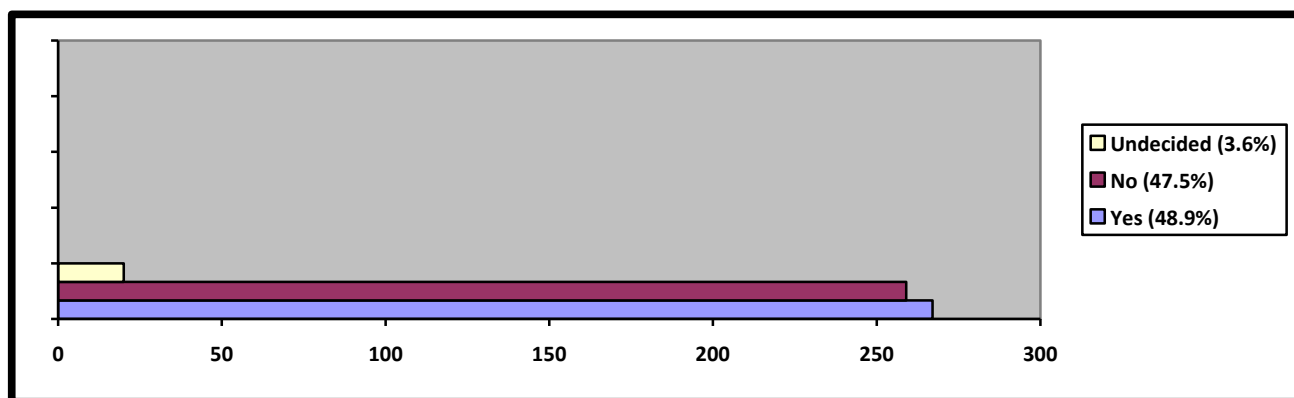


FIG. 5.3: SURVEY DATA ON PUBLIC ACCEPTABILITY OF NUCLEAR POWER GENERATION IN GHANA
(Source: Thesis Research Questionnaire Survey Data from 546 Respondents 2009-2011)

Moreover, there is no ‘absolutist conception of safety’ (HSE 2001; Miller 1989:11), and so there cannot be a duty for a nuclear power station to be so designed and operated that no harmful occurrence could occur. Consequently ‘a willingness to take a risk as it is’ once nuclear power is adopted (acceptability), must be distinguished from the need for such risk to be tolerated by ‘keeping it under review and reducing it further’ when possible (tolerability) (Tromans 2010:97). The public perception index of attainability of nuclear safety in Ghana was rated using questions structured on a five-point scale (1 to 5) as follows: (1) *not attainable*; (2) *poorly attainable*; (3) *attainable*; (4) *highly attainable*; (5) *very highly attainable*. The five-point scale aimed at getting extreme and central or moderate opinions that can be averaged to produce an overall rating of public perception on the attainability of nuclear power generation safety in Ghana.

The public perception index of whether or not nuclear power generation safety is attainable in Ghana shows that the lay public (194 people or 35.5% of 546 respondents) had a very low rating of nuclear power safety in Ghana: to them it is *not attainable* (148 people or 27.1%) or *poorly attainable* (46 people or 8.4%). This perception seems to flow from the trepidation, deep fears, strong objections, and gravely wild lurid imaginations with which many people react to radioactivity (Tromans 2010:2). But nuclear science experts, administrators and legal experts at RPB and GAEC (61 people or 11.2%) had very high rating of the attainability of safety in nuclear power generation in Ghana: they all responded that it is *very highly attainable*. Two hundred and ninety one (291) of the 546 people or 53.3% were also of the view that nuclear power generation safety is *attainable* or *highly attainable* in Ghana: *attainable* (263 people or 48.2%) and *highly attainable* (28 people or 5.1%). The two hundred and ninety one (291) people comprised the following classes of professionals and people:

1. Science professionals (28 people or 9.6% of the 291 respondents)
2. Legal professionals (41 people or 14% of the 291 respondents)
3. Regulatory institutions, MDAs (18 people or 6.1% of the 291 respondents)
4. Undergraduate science students (52 people or 17.8% of the 291 respondents)

5. Postgraduate nuclear science students (94 people or 32.3% of the 291 respondents)
6. Law students (44 people or 15.1% of the 291 respondents)
7. Lay public (14 people or 4.8% of the 291 respondents)

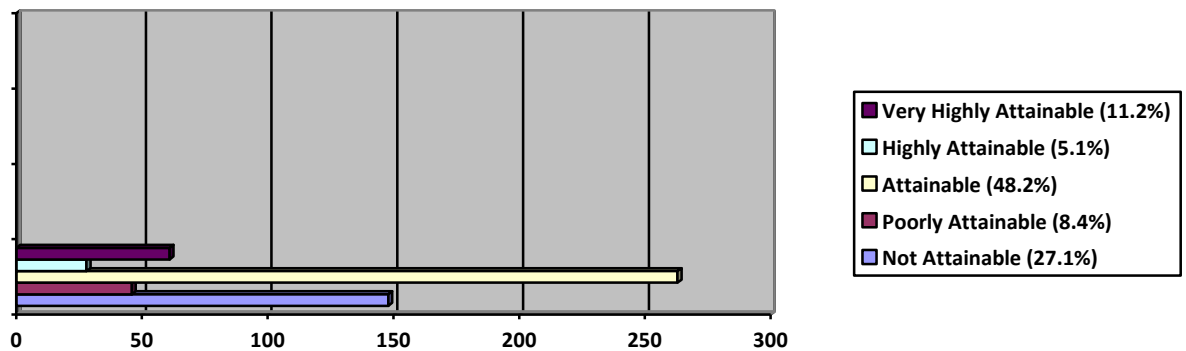


FIG. 5.4: NUCLEAR SAFETY PERCEPTION INDEX AMONG 546 SURVEY RESPONDENTS
(Thesis Survey Data 2009 to 2011)

The view of nuclear science experts and professionals in Ghana that nuclear power safety is very highly attainable in Ghana may find a support in reports of international regulatory and safety review missions in Ghana such as IAEA's INSARR (Emi-Reynolds 2010; Glover 2010; Ampomah-Amoako et al. 2009:63; IAEA 2009; Amuasi 2001; IAEA 1997), and research by Faanu et al. (2010) on 'Safety Culture Within Selected Practices in Ghana Utilizing Ionizing Radiation.' Faanu et al. (2010:91) gauged management and NNRI operating staff commitment to Ghana's research reactor safety to be 73.3% after analysing performance indicators on general safety, safety policy, safety practices, clear procedures, clear lines of communication, definition of responsibility, staff training, safety of the facility physical structure and emergency plans, etc. Use of log books and availability of competent, qualified and licensed reactor operators were the core strengths of the research reactor facility. Despite the high levels of safety performance practices identified by Faanu et al. (2010) in their research, none of the several practices using ionizing radiation in Ghana (including conventional radiography, research reactor, gamma irradiator, radiotherapy, X-ray scanner, gamma scanner, etc) was able to satisfy all the requirements or safety attributes for a 100% level of safety culture.

Ghana's political history also depicts the relevance of political will to establishing a nuclear power plant. Lack of adequate political will has the probability of translating into inadequate resources (legal, institutional, human, funding, technical, etc) for nuclear power. Consequently, it was not surprising, as noted earlier, that although the government of Ghana decided to initiate the Ghana Nuclear Reactor Project (GNRP) at Kwabenya in 1961 and the foundation stone for the that project was laid by Dr. Kwame Nkrumah, the then President of Ghana on November 25, 1964, the reactor project which was on schedule to be completed at the end of 1966 was suspended and scaled down to radioisotope applications by successive governments after Nkrumah's government was overthrown in a coup d'état on February 24, 1966. Attempts to reactivate the Ghana Reactor Project in 1973 by the National Redemption Council (NRC) government also failed as a result of socio-political issues.

It was later on in 1994 that Ghana with the assistance of IAEA procured a 30kW Research Reactor from China under a strict system of authorization and inspection developed by RPB with IAEA assistance. In a period of almost 30 years (1966 to 1994) the research reactor project initiated by Dr. Nkrumah remained a mirage because the successive governments who ruled Ghana during the period could not muster the political will to complete the project. Factors like political will and international support are obviously crucial to the successful implementation of a nuclear project.

5.1.10. Technological Factors

Reactor design should be simple to facilitate local construction, operation and maintenance: e.g., Canada developed CANDU reactors (Canada Deuterium Uranium) by using simple reactor designs. India, South Korea, China and many other countries used technology transfer, capacity building, etc to develop domestic competence in nuclear technology (Puthucherril 2008:557; Yoon 1999). For example, India nuclear reactors are based on Canada's CANDU technology (Puthucherril 2008:588). The safety system of a nuclear power plant must be less dependent on human intervention. Inherent

safety system of passive cooling, sensitivity to adverse operational conditions, automatic shut down (scram), etc are crucial. Due to Ghana's weak industrial base, a standardized nuclear plant of a specific make or brand fitted with components that are of standardized specifications will enable easy procurement of broken down parts as opposed to a custom-made one (Ennison and Akaho 2008).

Several issues are relevant to technology: proven technology, standardization, constructability, unit size, plant life, simplification, design margins, ease of operation, maintenance, plant performance, manoeuvrability, operation cycle, man-machine interface, siting, local infrastructure, electrical grid infrastructure, assurance of critical materials and components, local participation, technology transfer, human resource development, industrial infrastructure, non-electrical applications, etc. Should engineering, technical design and operational protections be prescribed in a regulatory law? Should the law be technology specific? Or it should be flexible to allow operators to adapt practices and designs to new technologies without requiring any significant changes in the law? According to most of the respondents, laws and regulations may provide detailed rules on technology, but flexibility is needed so as not to impede technological development. Clauses 44(c), 45(d), 46(a)-(b), 47(b), 94(l)-(o),(v),(y)&(ee) of the Bill provide opportunities for the regulatory authority to develop guidelines, standards and procedures to flexibly review, assess and regulate technology and its related issues.

5.2. Conclusion: The '3S'+Liability Concept in the Evaluation of Nuclear Power Safety

In evaluating the safety of nuclear power generation, the key focus is often on the elements that are deemed as fundamental requisites for nuclear power generation safety (nuclear safety). As seen in Section 5.1 *supra*, the elements comprising the framework for evaluating safety also include the four basic subjects that the '3S'+Liability concept covers: safety, security, safeguards, and liability. Invariably, a framework for nuclear safety addresses all the elements that are needed to establish an adequate legal regime for nuclear energy generally. Nuclear safety is an all-encompassing integrating

principle with profound specificity and an abiding intrinsic capacity to adopt the ‘3S’+liability fields and other key elements into the regulatory category of *nuclear safety regulation*. Nuclear safety has thus been used in this thesis as an interpretative key for discerning the ‘3S’+liability concept and the other key components required for a nuclear safety regulatory framework.

Although this inquiry into the sufficiency of Ghana’s regulatory regime for *safe* nuclear power generation focuses on *safety* exclusively, it addresses the other components of the ‘3S’+Liability concept since they form the core elements of any safety regime; and they complement and enhance one another in an all-inclusive comprehensive safety regulatory regime. It must however be noted that the discussion of security, safeguards and liability and their interactions with safety in this thesis does not provide an extensive study on those subjects since the critical focus is on nuclear safety. Areas for future research may thus include the other prongs of the ‘3S’+Liability concept: i.e., security, safeguards and liability. Moreover, when it comes to *safety*, this study is limited to the regulation of safety in nuclear power generation. It does not deal with safety as it relates to nuclear waste, nuclear transport or the transport of radioactive materials, radiation safety, etc. These are all subjects that could form the focus of extensive and detailed research studies to provide relevant data and information that will guide the implementation or otherwise of Ghana’s nuclear power project. Based on the scope of the elements analysed in this chapter, it may be concluded that the framework for evaluating nuclear safety regulatory effectiveness in Ghana might be well-designed by using the “3S”+Liability concept as a core criteria. The six (6) additional key elements of health and environmental impact; socio-political influence; attitudinal culture; institutional regime; technology; and economics can all be subsumed under safety; security; nonproliferation (safeguards); and liability which comprise the “3S”+liability concept.

CHAPTER 6: THE POTENTIAL OF THE 2012 NUCLEAR REGULATORY AUTHORITY BILL TO ENSURE NUCLEAR SAFETY REGULATORY READINESS TO FACILITATE SAFE NUCLEAR POWER GENERATION IN GHANA

6.1. Introduction: The Nuclear Regulatory Authority Bill 2012

The explanatory memorandum to the Nuclear Regulatory Authority Bill 2012 (NRA Bill) provides that

“[t]he increase in peaceful uses of nuclear materials and radioactive substances for health, agriculture, industry etc. makes it imperative that the necessary structures are put in place to ensure that these materials and substances are well regulated for the safety of persons and the environment and the physical protection of materials and substances. The country’s research and educational facilities cannot do without delving into the areas of nuclear technology and ionizing radiation and their effects ... An independent regulatory authority will better provide for the protection of the present generation and posterity against the harmful effects of ionizing and non-ionising radiation for the safety and security of radiation sources, nuclear materials and radioactive waste. It will also ensure that radioactive sources and nuclear materials (including radioactive waste) both from within and outside the country are properly controlled” (NRA Bill 2012:1).

As has been discussed in the literature review (Section 2.2. *supra*), under international law and by the provisions of some international treaties and conventions to which Ghana is a Party, the Radiation Protection Board is expected to be completely independent from promoters and other users of nuclear energy and radioactive sources. The current situation where the Radiation Protection Board is part of the Ghana Atomic Energy Commission is not appropriate. The activities of the GAEC need to be regulated beyond the current system of self-regulation. The NRA Bill seeks to establish the Nuclear Regulatory Authority (NRA) as an independent body with its functions and responsibilities clearly defined to regulate activities of all entities utilizing nuclear and radiation sources including GAEC.

The NRA is structured to provide for the beneficial and peaceful uses of nuclear energy; adequate protection of individuals, society and the environment, now and in the future against the harmful effects of nuclear and radioactive materials; establish a regulatory control system of licensing, inspection, enforcement, etc; and enable Ghana to meet its obligations under the relevant international

legal instruments. The NRA Bill has been crafted to “apply to all activities and practices involving the peaceful use of ionising and non-ionising nuclear and radioactive material in Ghana, including production, possession, use, import, export, transport, transfer, handling and management of radioactive material or any other related activity or practice identified by the NRA including applicable consumer products” (NRA Bill:Clause1.1). It also applies to the management of radioactive waste resulting from civilian applications and the management of spent fuel resulting from the operation of civilian nuclear reactors in Ghana. Although it does not focus on nuclear power only, several of its provisions are intended to provide for the regulation of nuclear power safety in Ghana. The main safety related provisions of the NRA Bill are culled and discussed under the broad elements of the nuclear power safety regulatory framework as verified herein (*see* Sections 4.4. & 5.1. *supra*).

6.1.2. The NRA Bill on Attitudinal and Ethical Culture

Although the Bill does not mention ethics, included in the objects of the NRA under Clause 4 of the Bill is the pursuing and ensuring of strict compliance with the Act (Bill) and the Regulations. Such strict compliance is attained in a culture that values nuclear safety and security. Clause 42 makes an operator responsible for ensuring the safe and secure conduct of any activity or practice associated with that operator’s facility. Under Clause 5(i), the NRA is mandated to ensure that operators provide training, information and guidance on nuclear safety, security, safeguards, and radiation protection. Clause 6(1) further mandates it to conduct inspections to assess compliance with safeguard conditions and radiation safety and security conditions imposed by the NRA on a licensee. These are core processes by which operators and their staff can develop a nuclear safety and security culture.

Clause 26(1) prohibits persons from engaging in an activity or a practice involving the use of nuclear material or any radiation unless that person is licensed by the NRA. In screening applications for the grant of a license the NRA shall verify the necessary technical and organizational measures taken by

the applicant to ensure adequate safety and security including effective protection against radiological hazards (Clause 26(8)(c)); and also that the applicant has in place programmes for recruiting qualified persons and training them in safety and security of the radioactive materials and sources used (Clause 26(8)(i)). An applicant must have adequate understanding of the fundamental principles of radiation protection (Clause 26(8)(d)). Under Clause 29(b) a person licensed to conduct an activity or practice involving nuclear or radioactive material, nuclear or radioactive waste, or radiation, is responsible for the safe and secure conduct of the activity or practice in compliance with the Act (Bill).

Moreover, Clauses 47, 48, and 49 provide for the review and assessment of safety at the pre-commissioning, commissioning and operation stages of a nuclear power installation. Clause 47(g) requires a review of the arrangements for training and qualification of personnel for the installation, including staffing levels and fitness for duty requirements. Clause 80 authorizes that appointment of inspectors and analysts to verify and analyse practices and nuclear installations. All these provisions seek to institutionalize or cultivate an attitude or culture of safety and security in nuclear operations.

6.1.2. The NRA Bill on Economic Factors

The focus of the Bill is essentially on safety and most of the provisions on technology design, siting, radiation protection, quality assurance of organization and programme for operation are premised on safety rather than cost (Clause 43-49, 94, etc). However, in considering an application for a nuclear license, the NRA should take into account social, economic, and other relevant factors (Clause 26(8)(a)); and ensure that the applicant has in place *inter alia* adequate financial arrangements to safely and securely manage the nuclear operations as well as the radioactive waste, where it is not possible to return the radioactive waste to the supplier; and to undertake decommissioning activities (Clause 26(8)(f)). Economic issues are therefore provided for in the Bill.

Clause 22 establishes a Nuclear Authority Fund (the “Fund”) while clause 23 provides that the Fund is to be applied on projects and activities aimed at achieving the objects of the Authority as provided under the Bill. Subclause (2) of clause 23 places a financial obligation on the Authority to ensure that money is provided from the Fund to the Waste Management Centre at the Ghana Atomic Energy Commission to assist the centre in carrying out its mandate. Clause 24 provides for the sources of money for the Fund; these are moneys approved by Parliament, grants received from Government and donors, fees charged by the Authority in the performance of its functions, fundraising activities and returns from investments made by the Authority.

Clause 25 deals with the management of the Fund. The Board (i.e., the governing authority of the NRA) is responsible for the management of the Fund and for that purpose may, formulate policies to generate money for the Fund, determine the allocation to be made towards achieving the objects of the Authority, determine annual targets of the Fund, and with the approval of the Controller and Accountant-General, appoint a Fund Management Committee to advise the Board on the management of the Fund. The Fund Management Committee comprise of three members of the Board and any other persons the Board in consultation with the Minister determines. The Board may, in consultation with the Minister responsible for Finance, invest part of the moneys in the Fund in approved investments. Payments shall be made from the fund only on the authorisation of the Executive Director and the Director of Finance, evidenced by their signatures (Sub-clause (6)).

Fees or charges for permits, levies for categories of activities and practices, penalties, etc are provided for under Clauses 79, 94(2), etc. Clause 96 deals with the annual budget of the NRA. The NRA is to submit to the Minister, an annual budget in respect of the ensuing financial year, not later than three months before the end of each financial year. The Board is to approve the annual budget of the NRA before its submission to the Minister for Finance (Subclause (2)). Clause 97 is on accounts

and audit. The Board is to keep books of accounts and proper records in relation to them in a form approved by the Auditor-General; and submit the accounts of the NRA to the Auditor-General for audit within three months after the end of the financial year, and the Auditor-General is to audit the accounts and make a report on the audited accounts within three months after receipt of the accounts and forward a copy of the audit report to the Board and the Minister.

Clause 98 deals with annual report and other reports. The Board is to submit to the Minister an annual report covering the activities and the operations of the Authority for the year to which the report relates, within one month after receipt of the audit report. The annual report is to include the report of the Auditor-General (Subclause (2)). The Minister is to submit the report to Parliament with a statement the Minister considers appropriate, within one month after the receipt of the annual report (Subclause (3)). Subclause (4), requires the Board to submit to the Minister any other report which the Minister may require in writing. Financial reporting and transparency is therefore required.

Clause 63 obliges an applicant for a licence to construct and operate a nuclear facility to ensure that adequate financial resources are available when needed to cover the costs associated with a safe decommissioning, including the management of the resulting waste during the operation of the facility (Subclause (1)). The amount of the financial resources to be made available for decommissioning activities is to be commensurate with the facility's specific cost estimate and is to be varied if the cost estimate increases or decreases (Subclause (2)). The estimated cost is to be reviewed as part of the periodic review of the decommissioning plan (Subclause (3)). Subclause (4) requires the Authority to establish the necessary mechanisms to enforce a licensee's obligations under provisions of the Act, acting on the advice of the Ministry of Finance and Economic Planning, Accountant-General's Department and Bank of Ghana. For purposes of facilities in existence before the commencement of provisions of the

Act (Bill) and for which financial resources are not available, proof of financial assistance is to be required by the Authority before the renewal or extension of a licence (Subclause (5)).

6.1.3. The NRA Bill on Health, Environmental and Waste Management Impact

Under Clause 5 of the NRA Bill, the NRA is to regulate the introduction of radiation sources, nuclear materials, equipment or practices that expose persons and the environment to radiation; issue, modify, suspend or revoke licences and permits, and determine conditions for licences and permits; regulate research on radiation and nuclear safety and security, and of radioactive waste matters. Clause 7(h) mandates the Authority to ensure that the polluter pays principle is applied in the management of nuclear and radioactive waste in Ghana. Clause 50 prohibits a person or entity from operating a radioactive waste management facility, unless the person or entity is licensed. Clause 51 specifies how a licence could be procured to operate a radioactive waste management facility. An application is to be submitted to the Authority together with a plan for the discontinuation of the operation of the facility, and the Authority is required to approve the plan before granting authorisation for the operation of the facility. Clause 52 specifies the duties of a person licensed to manage radioactive waste under the NRA Bill. Clause 53 obliges a person licensed to manage a radioactive waste management facility to ensure the safety and security of the facility throughout its operational life.

Clause 54 gives power to the Minister acting on the advice of the Authority, to make Regulations that ensures the safe and secure management of radioactive waste in the country, and in particular, to establish the safety and security requirements; for the protection of the public and the environment from adverse impacts of radioactive waste management activities; to establish a system of institutional control for radioactive waste management activities, including regulatory inspection, documentation of the inspection and report on the inspection; and to establish a system of enforcement to ensure compliance with applicable Regulations and the terms and conditions of each licence for radioactive waste management

activities. Clause 55 prohibits the importation of radioactive waste generated in another country into Ghana for any purpose. Clause 56 however allows a licensee to export waste generated within the country after the Authority has granted a permit under clause 34(6) to the licensee for the export and the destination of the export for storage or disposal should not be beyond latitude 60 degrees south.

Clause 57 specifies the conditions to be met by a licensee before the Authority issues a permit to a person for an export. The conditions include, that the applicant has established procedures that ensure that the importing country is notified of the transfer of the radioactive waste or spent fuel and has consented to the transfer before its receipt; an undertaking that movement of the exported material will be conducted in conformity with relevant international obligations in any country through which the material will transit; and that the importing country possesses the administrative and technical capacity as well as the regulatory structure needed to manage the exported radioactive waste or spent fuel in a manner that ensures its safety and security, consistent with relevant internationally recognised standards, and in particular those promulgated by the IAEA.

Clause 58 deals with the return of radioactive waste exported out of the country. The provision states that, if a permitted export of radioactive waste cannot be completed in conformity with provisions of the Bill, the radioactive waste shall not be re-imported into Ghana, unless the permit holder has provided an alternative safe and secure arrangement approved by the Authority. A contravention of this provision is an offence and the offender is liable on summary conviction to a fine not more than two thousand five hundred penalty units or to imprisonment for a term not more than five years or to both the fine and the imprisonment. Clause 59 (1) requires a person who intends to transport radioactive waste to obtain a permit from the Authority under clause 33(6) of the Act Sub clause (2) specifies the technical requirements of the for the safe transport of radioactive materials made by the International Atomic

Energy Agency as the law that will apply to the transport of radioactive or nuclear material in the absence of Regulations made under clause 94(2)(j).

Clause 60 deals with decommissioning. It places an obligation on the Authority to publish a notice in the *Gazette*, specifying the procedure for the decommissioning of a nuclear facility. The notice is to include, steps to be taken to resolve any safety and environmental issues and conditions of the end state of decommissioning; limits and conditions for the removal of regulatory controls for an installation that contains radionuclides; and criteria for the clearance of material during and after decommissioning. The Authority is to require an applicant for a licence to, construct and operate a nuclear facility, to perform a baseline survey of the site to develop information for comparison with the end state after decommissioning, including radiological conditions before the construction (Subclause (3)). The Authority is to ensure that relevant documents and records are prepared by the licensee and maintained for a specified period of time before, during and after decommissioning (Subclause (4)). The Authority is to evaluate the end state of the facility after decommissioning activities have been completed to ensure that relevant regulatory requirements have been met (Subclause (5)). The facility is to remain under the regulatory control of the Authority until the licensee has demonstrated that the end state in the decommissioning plan has been reached, and any other additional regulatory requirements have been met (Subclause (6)). The Minister shall on the advice of the Authority, by legislative instrument, make Regulations establishing the criteria for determining when a nuclear facility or part of a nuclear facility may be permanently shut down (Subclause (7)).

Clause 61 deals with the decommissioning plan. This clause requires an applicant for a licence to construct and operate a nuclear facility to prepare a decommissioning plan at the design stage of the nuclear facility, for approval by the Authority. The Authority is to ensure that interested parties are

provided an opportunity to review and comment on the decommissioning plan before it is approved by the Authority (Clause (2)). The Authority is to require the licensee to provide periodic reviews and updates of the decommissioning plan and is to specify the maximum time intervals between the reviews and the updates. The licensee is to revise, update and resubmit for approval the decommissioning plan at the request of the Authority, if specific circumstances could result in significant changes to the initial decommissioning plan. (Subclause (4)). The Authority is to require a proposed final decommissioning plan to be submitted for approval two years before the cessation of licensed activities, unless an alternative schedule for submitting the final decommissioning plan is specifically authorised by the Authority (Subclause (5)). Subclause (6) requires the Authority to ensure that a programme to implement and monitor compliance with remaining regulatory requirements is established for sites where decommissioning has been completed, including restrictions on future use of the site.

Clause 62 specifies a licensee's obligations during decommissioning. A licensee is, for purposes of a decommissioning of that licensee's facility to, submit to the Authority a decommissioning plan which is commensurate with the type and status of the facility, and hazards that may be associated with its decommissioning; prepare safety and environmental impact assessments necessary for the implementation of the decommissioning plan for the approval of the Environmental Protection Agency; conduct a baseline survey of the site in an effective and timely manner; be responsible for the safety, security and protection of persons and the environment, including any activities conducted by contractors or subcontractors; design new features or facilities and systems during the operation of the facility, which could facilitate eventual decommissioning of the facility, submit to the Authority for approval, new or untried methods for the decommissioning of the facility; submit a final decommissioning plan two years before a permanent cessation of operation, and inform the Authority of a decision to permanently shut down the facility two months before shutting down; maintain the facility in a safe configuration for effective and adequate decommissioning in the future in the case of deferred dismantling; maintain a management and human

resource development system within the organisation to ensure that decommissioning can be completed safely, and that responsible persons possess the necessary skills, expertise and training relevant to safe decommissioning; maintain an emergency planning arrangement correlative with associated hazards and to report significant incidents to the Authority; and arrange for adequate financing at each stage of the decommissioning process including provisions for loss of life or personal injury up to thirty years from the date of decommissioning.

6.1.4. The NRA Bill on Institutional Regime for Nuclear Regulation

The NRA is proposed as the key regulatory institution to develop national policies on the regulation and management of activities and practices with respect to nuclear safety, security of nuclear and radioactive materials, radiation, and the implementation of safeguards as provided for in the Bill (Clause 5). The Authority is also to regulate the introduction of radiation sources, nuclear materials, equipment or practices that expose persons and the environment to radiation; issue, modify, suspend or revoke licences and permits, and determine conditions for licences and permits; regulate research on radiation and nuclear safety and security, and of radioactive waste matters; regulate the use of radioactive materials in the exploration, exploitation and extraction of oil and gas, and the mining and milling of radioactive ores and other ores associated with radioactive and nuclear materials; define the detailed obligations of persons who possess radiation sources and nuclear materials, including financial conditions; establish and maintain a national register of radiation sources and of persons authorised to carry out any activity or practice related to a source of radiation; collaborate with the National Disaster Management Organisation to establish plans and procedures for coping with any radiological emergency and abnormal occurrence involving a nuclear material, radiation source or any other radioactive source; advise the Minister on the preparation of Regulations for the effective implementation of the Act; establish regional and other offices as it may consider necessary for the proper performance of its functions; and appoint auditors for the Authority and approve the

fees to be paid to the auditors (Clause 5). The governing board of the Authority comprising seven (7) members appointed by the President in consultation with the Council of State (Clause 8(1) and (2)) is not subject to the control or direction of any person or authority in the discharge of its duties of ensuring the proper and effective performance of the functioning of the Authority (Clause 8(3)&(4)).

6.1.5. The NRA Bill on Nuclear Liability

Clause 68 allows the Authority to consider installations of one operator located at the same site as a single nuclear installation for purposes of clauses 70 to 76 which deals with liability for nuclear damage. Clause 69 clause 70 to 76 applies to a person without discrimination on the basis of nationality, domicile or residence. Clause 70 states the liability of the operator. Subject to other provisions of the Act, the operator of a nuclear installation is made liable for nuclear damage, if it is proved that the damage has been caused by a nuclear incident at the nuclear installation of that operator; or involving nuclear material coming from or originating from the installation of that operator. An operator who was last authorised to possess a particular nuclear material is liable for nuclear damage caused by that nuclear material if the nuclear material is stolen, lost or abandoned (Subclause (2)), and liability for nuclear damage shall apply to nuclear damage wherever suffered (Subclause (3)).

Clause 71 deals with liability during the transportation of nuclear material. Subclause (1) makes the sending operator liable for nuclear damage until the receiving operator has taken charge of the nuclear material being transported. The carrier of a nuclear material may at its request be made liable for nuclear damage resulting from the nuclear material it is contracted to transport, if the sending operator and receiving operator have entered into a written agreement with the carrier to shift that liability to the carrier at any stage of transportation (Subclause (2)). In a case where the nuclear material has been sent to a person within the territory of a State that is not party to either the Paris or Vienna Conventions on

Nuclear Liability, or the Convention on Supplementary Compensation, the sending operator is liable until the nuclear material has been unloaded from the means of transport by which it is sent and delivered to receiving operator (Subclause (3)). Also, in a case where the nuclear material has been sent from a person within a State that is not party to either the Paris or Vienna Conventions on Nuclear Liability, or the Convention on Supplementary Compensation, the receiving operator becomes liable for nuclear damage resulting from the nuclear material being transported only after that nuclear material has been loaded on the means of transport by which it is to be carried from the territory of that non-contracting State.

Clause 72 states the minimum liability of an operator for nuclear damage. Subject to any protocols to the Vienna Convention or Ghana becoming a party to the Convention on Supplementary Compensation, the minimum amount of liability for nuclear damage of an operator of a nuclear installation is three hundred million Special Drawing Rights (SDRs) (Subclause (1)). Liability for nuclear damage occurring in a non-contracting State that has nuclear installation on its territory at the time of a nuclear incident is an amount not lower than the Cedi equivalent of seven hundred million SDR's or the transitional amount of three hundred and fifty million Euros to the extent that the State does not afford reciprocal benefits of an equivalent amount to Ghana (Subclause (2)). Clause 73 requires an operator of a nuclear installation to be insured against the operator's liability for nuclear damage when the damage is proved to have been caused by the nuclear installation of the operator. NRA in consultation with National Insurance Commission, is to set the terms and conditions of an insurance policy covering liability for nuclear damage (Subclause (2)).

An insurer is not to insure an operator against liability for nuclear damage, unless the operator has been issued a licence by NRA, authorising the operator to operate that installation (Subclause (3)).

Clause 74 provides that the nature, form and extent of compensation that may be given to persons who have suffered nuclear damage as well as the equitable distribution of the compensation is to be

in accordance with law and as ordered by a court of competent jurisdiction (Clause 71(1)). Where claims for nuclear damage exceed or are likely to exceed the maximum amount required by the Authority to be set aside by an operator for compensation for nuclear damage caused by a nuclear incident, claims for compensation for any loss of life or personal injury shall take precedence over claims for other loss or damage (Subclause (2)). Interest and costs awarded by the court for compensation for nuclear damage are exclusive of the minimum liability amounts required under clause 72 for purposes of clauses 71, 73, 75, 76, 77 and 78.

Clause 75 specifies the limitation period on a person's right to compensation for nuclear damage: An action to establish a claim may be brought within three years from the date on which the person suffering damage had knowledge or ought reasonably to have had knowledge of the damage and of the operator liable for the damage. In any case, an action shall not be brought more than thirty years after the incident causing the damage. An action may also be brought thirty years from the date of the nuclear incident, in the case of loss of life or personal injury; or ten years from the date of the nuclear incident, in the case of any other form of nuclear damage (Clause 75(1)). Also, a person who claims to have suffered nuclear damage and who has submitted a claim for compensation which is not barred by the Act may subject to the rules of court, amend the claim to take into account any aggravation of the damage, even after the expiration of that period in a final judgment in respect of the claim has not been entered. Clause 76 confers on the High Court jurisdiction in respect of matters for compensation for nuclear damage caused by a nuclear incident occurring within Ghana or within the Exclusive Economic Zone of Ghana. Under this clause, a person who has a right to compensation for nuclear damage is permitted to commence an action for compensation against a liable operator or directly against the insurer.

Clause 77 specifies exceptions to nuclear liability. An operator of a nuclear installation is not liable for nuclear damage that is proved to be directly caused by any armed conflict, hostility, civil war or insurrection,

or a nuclear installation under construction on the site where the installation is located. Also an operator is not liable for nuclear damage to any property on the same site which is used or is to be used in connection with a nuclear installation. An operator is also not liable for nuclear damage suffered by an individual as a result of an act done by that individual with intent to do mischief (Subclause (1)). Where the operator proves that the nuclear damage resulted wholly or partly either from the gross negligence of the person suffering the damage or from an act or omission of the person done with intent to cause damage, the operator may be relieved, wholly or partly, from the obligation to pay compensation in respect of the damage suffered by that person (Clause 77(2)). The exceptions do not include Acts of God or severe natural disasters.

Clause 78 requires the High Court to recognise and enforce the final judgment given by a foreign court of competent jurisdiction awarding compensation for nuclear damage as if it were a judgment of the High Court. The exceptions to this requirement is where the judgment was obtained by fraud; or the party against whom the judgment was pronounced was not given a fair opportunity to present the case of that party; or the judgment is contrary to the public policy of Ghana or is not in accord with fundamental standards of justice (Subclause (2A)).

6.1.6. The NRA Bill on Safeguards (Non-proliferation)

The NRA Bill makes proposals for the adoption of a strict safeguards regime in Ghana to prevent use of nuclear energy for non-peaceful uses (Clause 5(a)(iv)). Clauses 7 and 64 provide for safeguards. It prohibits the use of nuclear material for non-peaceful uses. The Authority is to facilitate the conduct of inspections by designated inspectors of the IAEA to verify design information, inspections and complementary access as provided for in the Safeguards Agreement and the Additional Protocols (Clause 7(a)); collect, collate and provide information to the IAEA in accordance with the Safeguards Agreement and any additional protocols to that Agreement (Clause 7(c)); establish a control system

for the import and export of nuclear material, radioactive sources and other controlled items in cooperation with the Customs, Excise and Preventive Division of the Ghana Revenue Authority; and exchange information and co-operate with regulatory authorities of other countries and relevant international organisations on matters of nuclear safety, nuclear security and safeguards (Clause 7(e)).

Clause 64 requires a person to use nuclear material exclusively for peaceful activity and in accordance with national and international treaties and legal instruments (Clause 64(1)). Subclause (2) prohibits a person from manufacturing, possessing, controlling or acquiring, directly or indirectly a nuclear weapon or other nuclear explosive device in Ghana, or receiving any assistance directly or indirectly in the manufacture of a nuclear weapon or other nuclear explosive device Ghana. A licensee is to grant any inspector of the Authority and inspectors from the IAEA, access to any premises, installation or facility in respect of which inspections are required to be conducted for the purpose of verifying activities identified under the Safeguards Agreement and its Protocols (Subclause (4)). A person engaged in an activity specified in the Safeguards Agreement and any Protocols to that Agreement shall, submit to the NRA information and data required by the NRA to meet its reporting obligations under that Agreement (Subclause (3)).

Clause 36 specifies matters to be considered before granting an export or import permit to a person under provisions of the Bill, to export or import a controlled item: Whether the receiving State has made a binding commitment to use the item being exported and information in respect of that item for a peaceful purpose only; or there is any International Atomic Energy Agency safeguards requirement applicable to the item to be exported; or whether the receiving State has placed its nuclear material and nuclear facilities under International Atomic Energy Agency safeguards; or whether approval of the Authority has been given for the transfer to a third State, of an item or technology previously

transferred into the country; whether the requirements in the Convention on the Physical Protection of Nuclear Material for the transport of the material to be exported has been met.

6.1.7. The NRA Bill on Safety and Security

The provisions of the NRA Bill deal with safety and security mainly. Clauses 26 to 49 deal with several issues on safety and security including application for licence, suspension and revocation of a licence, obtaining information, obligations of a licensee, radiation safety and security, medical practices, protection of patients, national register of radiation sources, suspension and revocation of a permit, national register of export, import, trans-shipment and transport of radioactive sources, export and import of controlled items, recovery of orphan sources, emergency plans, national plan for nuclear or radiological emergencies, trans-boundary emergencies, construction and operation of nuclear installation, responsibility of the operator, national site evaluation process for nuclear installations, site evaluation for nuclear installations, preconstruction review and assessment of nuclear installations, construction review and assessment of nuclear installations, pre-commissioning review and assessment before commissioning a nuclear installation, review and assessment before commissioning of a nuclear power installation, review and assessment during operation of nuclear installations.

Clauses 94 and 95 also deal with regulations, guidelines, standards and procedures; 79 to 83 focus inspection and enforcement; 50 to 58 deal with radioactive waste management; 59 is on radioactive material transport; and 60-63 are on decommissioning. Under Clause 4 of the Bill, the objects of the NRA include to pursue and ensure strict compliance with the Act (Bill) and the Regulations. Clause 42 makes an operator responsible for ensuring the safe and secure conduct of any activity or practice associated with that operator's facility. Clause 5(i), mandates the Authority to ensure that operators provide training, information and guidance on nuclear safety, security, safeguards, and radiation protection. Clause 5(a)(i) and (ii) also authorizes the Authority to develop national policies on the

regulation and management of activities and practices with respect to *inter alia* nuclear safety and security of nuclear and radioactive material.

Clause 6(l) mandates it to conduct inspections to assess compliance with safeguard conditions and radiation safety and security conditions imposed by the NRA on a licensee. Clause 26(1) prohibits persons from engaging in an activity or a practice involving the use of nuclear material or any radiation unless that person is licensed by NRA. In screening applications for the grant of a license NRA verifies the necessary technical and organizational measures taken by the applicant to ensure adequate safety and security including effective protection against radiological hazards (Clause 26(8)(c)); and also that the applicant has in place programmes for recruiting qualified persons and training them in safety and security of the radioactive materials and sources used (Clause 26(8)(i)).

An applicant must have adequate understanding of the fundamental principles of radiation protection (Clause 26(8)(d)). Under Clause 29(b) a person licensed to conduct an activity or practice involving nuclear or radioactive material, nuclear or radioactive waste, or radiation, is responsible for the safe and secure conduct of the activity or practice in compliance with the Act (Bill). Clauses 47, 48, and 49 provide for a review and assessment of safety at pre-commissioning, commissioning and operation stages of a nuclear power installation. Clause 47(g) requires a review of the arrangements for training and qualification of personnel for the installation, including staffing levels and fitness for duty requirements. Clause 80 authorizes the appointment of inspectors and analysts to verify and analyse practices and nuclear installations to nurture a culture of safety and security in nuclear operations. Issues on safety and security have been well crafted into the Authority's regulatory scheme.

6.1.8. The NRA Bill on Socio-Political Influence

Socio-political influence impacts the regulation of nuclear safety. In considering an application for a nuclear license, the NRA is expected to take into account social, economic, and other relevant factors (Clause 26(8)(a)). The NRA is empowered to establish appropriate mechanisms for stakeholder participation in the regulatory process (Clause 6(h)). The NRA is also expected to collect information, documents and views from private and public organizations or persons as may be necessary and appropriate for the discharge of its functions (Clause 7(k)). The Minister is empowered to give policy directives consistent with the provisions of the Bill to the Board and the Board shall give effect to the directives (Clause 15). The Minister shall on the advice of the Authority, by legislative instrument, make Regulations establishing the criteria for determining when a nuclear facility or part of a nuclear facility may be permanently shut down (Clause 60(7)).

Clause 54 gives power to the Minister acting on the advice of the Authority, to make Regulations that ensures the safe and secure management of radioactive waste in the country, and in particular, to establish the safety and security requirements; for the protection of the public and the environment from adverse impacts of radioactive waste management activities; to establish a system of institutional control for radioactive waste management activities, including regulatory inspection, documentation of the inspection and report on the inspection; and to establish a system of enforcement to ensure compliance with applicable Regulations and the terms and conditions of each licence for radioactive waste management activities.

The NRA is to submit to the Minister, an annual budget in respect of the ensuing financial year, not later than three months before the end of each financial year. The Board approves the annual budget of NRA before its submission to the Minister for Finance (Clause 96(2)). Clause 97 is on accounts and audit. The Board is to keep books of accounts and proper records in relation to them in a form

approved by the Auditor-General; and submit the accounts of the NRA to the Auditor-General for audit within three months after the end of the financial year, and the Auditor-General is to audit the accounts and make a report on the audited accounts within three months after receipt of the accounts and forward a copy of the audit report to the Board and the Minister. Clause 98 deals with annual report and other reports. The Board is to submit to the Minister an annual report covering the activities and the operations of NRA for the year to which the report relates, within one month after receipt of the audit report. The annual report includes Auditor-General's report (Clause 98(2)). The Minister is to submit the report to Parliament with a statement the Minister considers appropriate, within one month after the receipt of the annual report (Subclause (3)). Subclause (4), requires the Board to submit to the Minister any other report which the Minister may require in writing.

6.1.9. The NRA Bill on Technology

Several provision in the Bill relate to technology. Under Clause 44 (c), an applicant for a licence to construct and operate a nuclear installation shall, prepare a site evaluation report for assessment and review by the Authority, and the report shall include, the hazards associated with external events that are to be considered in the design of the facility, including the potential combined effects of these hazards with ambient conditions including hydrological, hydro-geological and meteorological condition. The Authority shall before permitting the construction of a nuclear installation review and assess the basic design of the proposed facility, to confirm that it can meet relevant safety, security and physical protection requirements (Clause 45(d)). During the construction of a nuclear installation, the Authority shall review and assess the development of the facility design through documentation submitted by the operator to determine its continued acceptability (Clause 46(a)); and the progress of research and development activities in connection with demonstrating the acceptability of the design (Clause 46(b)); as well as the as-built design of the installation, recording and reporting systems before commissioning.

Regulations for the effective and efficient implantation of the Bill shall provide for *inter alia* the design and performance criteria for radiation emitting devices and equipment containing radionuclides (Clause 94(2)(l)); requirements for licensing nuclear power plants (Clause 94(2)(n)); requirements for licensing nuclear facilities (Clause 94(2)(o)); nuclear power generation (Clause 94(2)(v)); establishment of obligations and standards approved by the IAEA on siting, design, construction, operation, assessment and verification (Clause 94(2)(y)); and the requirements and standards for providing services like personal monitoring using Thermoluminescence Detectors or calibration radiation instruments and consultancy (Clause 94(2)(ee)).

6.2. Proposing a Legislative Instrument to the NRA Bill to Augment its Relevance to Nuclear Safety

The provisions of the Bill cover all the key elements relevant to the evaluation framework for nuclear power generation safety. The NRA is set up to provide for the beneficial and peaceful uses of nuclear energy; adequate protection of individuals, society and the environment, now and in the future against the harmful effects of nuclear and radioactive materials; establish a regulatory control system of licensing, inspection, enforcement, etc; and enable Ghana to meet its obligations under the relevant international legal instruments. The Bill applies to all activities and practices involving the peaceful use of ionising and non-ionising nuclear and radioactive material in Ghana: these include production, possession, use, import, export, transport, transfer, handling and management of radioactive material or any other related activity or practice identified by the NRA including applicable consumer products (NRA Bill:Clause1.1). It also applies to the management of radioactive waste resulting from civilian applications and the management of spent fuel resulting from the operation of civilian nuclear reactors in Ghana. Considering the safety focus of the Bill and its application of the ‘3S’+Liability concept, it should be passed into law expeditiously, to provide an effective nuclear safety regulatory framework in Ghana. Finally, this study has proposed, and added to this Thesis in APPENDIX C, a model legislative instrument (LI) that can be used to ‘operationalize’ the Bill in Ghana effectively.

CHAPTER 7: CONCLUSION, FINDINGS AND RECOMMENDATIONS

7.1. Conclusion

Given that Ghana has officially expressed to the IAEA its intention to introduce a nuclear power plant to augment its electricity generation capacity and has also taken a Cabinet decision to go nuclear, it is incumbent on the government to develop a legal framework for the operation of nuclear power facilities in Ghana, and establish an independent well-resourced regulatory body for the regulation and enforcement of technical standards for nuclear safety and radiological protection. Increased safety expectations and concerns on nuclear power reactors in a post-Fukushima world has resulted in stringent nuclear safety reviews, nuclear regulatory reassessment and nuclear plant stress tests in almost all countries that have nuclear power plants. The Fukushima accident was a tragedy for the people affected and has badly undermined public confidence in the safety of nuclear power. In the din of the current cacophony of reviews and critique, one issue remains clear: nuclear safety regulatory effectiveness is a core pre-requisite of nuclear power or peaceful applications of nuclear energy; and it must be *improved continuously* (IAEA 2011).

This study is a contribution to the efforts on nuclear safety regulatory effectiveness. It has revisited research concerns on the topical subject of nuclear power safety which, paradoxically, has not been thoroughly addressed in Ghana. It has made fresh and original legal and scholarly contributions, focused on Ghana, that add to the corpus of knowledge in the nuclear field globally. This study has met the objectives it set for itself in Section 1.5. *supra* and has introduced and developed new knowledge on the effective regulation of safety in the nuclear power generation of electricity in Ghana. In terms of timeframes, the resuscitation of Ghana's nuclear power project is recent and ongoing. It is thus vital to have this and other rigorous research and analysis that consider the possible radiological impact on public health and the environment and their legal consequences. It is vital to

do so for a project that is still being planned, as in Ghana's case. The study should therefore add to the efforts in the nuclear energy sector to consider the multivariate challenges a nuclear power project faces and how they may be addressed, at least from the legal and regulatory point of view.

7.2. Research Findings

Several findings were made in this research. The findings addressed the two main research questions identified in the conception of this study: i.e., whether Ghana's nuclear power regulatory regime is sufficiently effective to deal with the stern questions on the dangers of nuclear power; and, what key issues are relevant in assessing and developing an optimally effective nuclear regulatory regime in Ghana? And whether it is necessary, and if so, how to involve lay public in all aspects of nuclear energy with candour and transparency despite the technical nature of the field? It provided answers to the hypotheses that were tested in this study. The research findings include the following:

Findings Relevant to Hypothesis #1

- (1) GAEC has *good safety record* in using *research reactor* for extensive public services under the regulatory oversight of RPB;
- (2) Ghana's few existing nuclear energy laws do not provide for nuclear power, except references in Environmental Assessment Regulations 1999 (LI 1652) to Environmental Impact Assessments for nuclear power projects;
- (3) Evaluating nuclear energy regulatory effectiveness, often conceptually focuses on regulatory body's operations only;
- (4) Such a conceptual approach is narrow and may omit other key actors and factors that play a part in nuclear energy regulation: public, environment, liability regimes, etc;

(5) The two-pronged “3S”+*liability* nuclear energy regulation gauge, covering four elements (safety, security, safeguards and liability for nuclear damage), offers an all-inclusive merger of regulatory responsibilities (in concentric circles, *not* Venn linked circles) to aid comprehensive evaluation;

(6) Each of the four elements has well-tested conceptual and analytical framework norms for evaluating its regulatory effectiveness; and *safety* may be assessed with ten core items:

- (1) Attitudinal Culture
- (2) Economics
- (3) Health and Environmental Impact Safety
- (4) Institutional Regime
- (5) Liability
- (6) Nonproliferation (Safeguards)
- (7) Safety
- (8) Security
- (9) Socio-political Influence; and
- (10) Technology

(7) For over six decades, international law and several States treat the four elements discretely;

Findings Relevant to Hypothesis #2

(8) Ghana’s nuclear regulation does not tackle all the regulatory elements vital for nuclear power regulatory effectiveness;

(9) Efforts to develop a nuclear power legal regime in Ghana are ongoing and have culminated in the draft Nuclear Regulatory Authority Bill (2012);

Findings Relevant to Hypothesis #3

(10) Effective regulation requires the regulator, operator, licensees, government, public, and relevant collaborators to influence and contribute to a safety and security conscious nuclear industry;

(11) Regulatory effectiveness requires both direct and indirect normative and performance indicators.

(12) Regulatory readiness is an endless continuum of a sufficient and effective safety culture regime that is driven by a nuclear industry risk-informed performance-based self-regulation value structure.

Findings Relevant to Hypothesis #4

(13) The applicability of *Rylands v. Fletcher* and its acts of God exceptions to nuclear power in Ghana are unclear, even under the draft nuclear power law of Ghana, particularly considering the apparent limitation of *Rylands v. Fletcher* to neighbours, and the potential impact of a nuclear disaster beyond the neighbourhood of a nuclear plant.

(14) Torts and insurance pools can be used to support the safety regulatory regime for nuclear power.

(15) Ghana has not signed or ratified any of the international conventions on nuclear liability

Findings Relevant to Hypothesis #5

(16) Of the 546 respondents who formed the survey sample (84% of the targeted 650 respondents):

(a) 47.5% did not support nuclear power in Ghana, 48.9% support it, and 3.6% were undecided.

(b) 35.5% (194 people comprising lay public) had a very low rating of nuclear power safety in Ghana: *not attainable* (27.1% or 148 people) or *poorly attainable* (8.4% or 46 people).

(c) 53.3% (291 people comprising regulators, civil servants in MDAs relevant to the research, lawyers, scientists, students, etc) see nuclear power generation safety as *attainable* or *highly attainable* in Ghana: *attainable* (48.2% or 263 people) and *highly attainable* (5.1% or 28 people).

(d) 11.2% (61 people comprising nuclear science and legal experts at RPB and GAEC) said nuclear power generation safety is *very highly attainable* in Ghana.

(17) Respondents' expect the operator and regulator of nuclear power to consider lay public opinion in their decision making processes by asking and acting on questions such as;

(i) What should we do on this issue to reach out to, inform, and involve the public in what is being planned?

- (ii) How do we explain actions in language(s) the public can understand?
- (iii) What forms of accessible channels of communication and information dissemination should be used to interact with the public frequently and periodically as the case may be?
- (iv) How best can we involve the public before the fact, not after the fact, with sufficient notice?
- (v) How do we nurture a culture of full confidence in the public's ability to make intelligent judgments and provide feedback to guide decisions?
- (vi) To what extent will this decision respond to areas of public concern identified in the interaction?
- (vii) How may we effectively involve the public in monitoring and evaluation?

These questions may be summed up as follows:

What should we do on this issue to reach out to, inform, and involve the public in what is being planned, through easily accessible channels of communication and interaction, before the fact, not after the fact, with sufficient notice, and explain actions in language the public can understand, with full confidence in the public's ability to make intelligent judgments and provide feedback to guide decisions that respond to areas of public concern identified in the interaction, and improve monitoring and evaluation processes?

7.3. Recommendations

1. Safety should be used as a key for implementing the '3S'+liability nuclear regulatory requirements in Ghana. Safety is an all-encompassing integrating principle with profound specificity and a capacity to adopt the '3S'+liability concept into its regulatory category.
2. Nuclear regulation in Ghana should interlink or merge responsibilities on safety, security and safeguards as has been instituted by the UK Office of Nuclear Regulation (ONR).
3. The Nuclear Authority Bill uses the '3S'+Liability concept to comprehensively and effectively deal with nuclear power regulation issues. It should be enacted into legislation quickly.

4. The applicability of *Rylands v. Fletcher* and its acts of God exceptions to nuclear power in Ghana should be clearly stated in the nuclear legislation to eliminate ambiguity since the Nuclear Authority Bill is not clear on that issue.
5. Ghana should sign and ratify an international convention on nuclear liability (the Vienna Convention or the Supplementary Compensation Convention) if it is to go nuclear.
6. Nuclear power risks should be regulated to assure safety irrespective of cost. Ghana should thus use a cost-effectiveness approach in its nuclear power cost-benefit analysis.
7. An LI containing detailed regulations may have to be crafted, along the lines proposed in the sample draft, (*see* Section 6.3. *supra*, and Appendix C *infra*) to operationalize the proposed NRA Bill.
8. EPA, NADMO and other existing institutions that are expected to collaborate in nuclear power regulation, operations, and emergency response should have their capacities built.
9. All the elements for an effective nuclear safety regulatory regime should be continuously improved in an attitudinal environment that nurtures and enforces safety as a culture.
10. The sharply divided public tolerance (acceptability) index for nuclear power in Ghana calls for much education, advocacy, research studies and surveys on the subject.
11. More studies and research on nuclear law and regulation should be undertaken in Ghana, especially, detailed multidisciplinary inquiries on nuclear regulatory management systems, cost-benefit analysis of regulatory framework options, nuclear Spent Fuel and Radioactive Waste Management in Ghana, the applicability of both torts law and insurance to address nuclear liability issues in Ghana, nationwide referendum or quantitative research on the acceptability index for nuclear power in Ghana, etc.

APPENDICES

APPENDIX A: QUESTIONNAIRES

General Introduction

Ghana has taken a Cabinet decision to utilize nuclear power in its energy mix options. Given the need to tap the benefits of nuclear energy in an environment that assures safety and protection from the potential deleterious radioactive effects of nuclear materials, Ghana's regulatory readiness for safe nuclear power generation is being evaluated in this academic study to identify the key elements of an effective regulatory regime that conforms to international nuclear laws and best practices on siting, design, construction, commissioning, operation, (decommissioning), etc., of nuclear facilities. The key research question is whether Ghana has an effective nuclear power safety regulatory regime, and what are (or should be) the main elements of such a regime?

Based on literature review and interviews, several elements have been identified as relevant to the development of a nuclear safety regulatory framework in Ghana.

Those elements informed the set of questions that were crafted to develop this questionnaire, the objective of which is to verify and validate the relevance of: (a) the elements as to whether they are comprehensive enough to generate the information required, (b) public acceptance of nuclear power in Ghana's energy mix, (c) public perception index of whether or not nuclear power generation safety is attainable in Ghana, (d) involving lay public in all aspects of nuclear energy with candour and transparency despite the technical nature of the field, and (e) general issues.

QUESTIONNAIRE 1: RELEVANCE & FAVOURABILITY OF ELEMENTS

Kindly assist in completing the following questionnaire. Please make comments and suggestions where necessary. Thank you for your cooperation. Kindly return your completed questionnaire and your comments, if any, to Samuel Obeng Manteaw or his duly authorized representative.

On a scale of 1, 2, 3, 4, 5; rate the **relevance** and **favourability** of the under-listed safety regulation elements.

On the issue of RELEVANCE, 1 means *not relevant*; 2 means *least relevant*; 3 means *somehow relevant*; 4 means *relevant*; and 5 means *most relevant*.

On the issue of PREFERENCES and FAVOURABILITY of the elements in nuclear safety regulation: 1 means *not favourable*; 2 means *least favourable*; 3 means *somehow favourable*; 4 means *favourable*; 5 means *most favourable*.

	SAFETY ELEMENTS	DEFINITION, NATURE AND THE SCOPE OF THE	RELEVANCE 1, 2, 3, 4, 5	FAVOURABILITY 1, 2, 3, 4, 5	COMMENTS
1	Attitudes	Organizational safety culture that promotes organizational capability for effective human resource management & safety of workers, the public & environment			
2	Economics	Cost effectiveness approaches that maximize resource optimization and yields high positive economies of scale			
3	Electricity Grid	The capacity of the electricity grid to transmit power generated by the nuclear power plant as well as others already being transmitted or to be added onto the grid in the very short term			
4	Emergency Planning	Emergency planning, response, and systems, structures, capacity & vigilance needed to deal with radiological and nuclear emergencies and accidents			
5	Ethical	Fairness and equity in balancing inter & intra-generational resource allocation, as well as & open decision making that protects interests of future generations			
6	Health & Environment	Radiological impact in direct ionising radiation exposures to workers & public; non-radiological impact such as restrictions on land use, habitats disturbance, noise & socio-economic factors			
7	Human Resource	Capacity building, training & recruitment in aid of effective succession planning & sustenance of confidence in operations			
8	Industrial Activity	The level of industrialization, utilization of the power generated, and the scale of local content input to equipment, supplies, maintenance, etc.			
9	Institutional Structure	The legal, organizational, and regulatory framework within which nuclear power generation is made operational, authorizing and monitoring of various actors, etc.			
10	Legislation	The broad legal framework within which nuclear power activities and entities find legitimacy and legal authority.			
11	Liability	The legal regimes for ensuring fair, just & due compensation for radiological & nuclear damage, as well as administration of deterrence & justice			
12	Management	Decision making, operational leadership, and management of nuclear operations in a risk-informed self-regulatory field.			

13	National Policy	Comprehensive national policy on nuclear power that fits into the general national energy development plan and strategy.			
14	Nuclear Fuel Cycle	Fuel use in nuclear reactor, or conversion of nuclear fission energy to electricity, storage of fresh and spent fuels at the reactor, <i>front-end activities & back-end activities</i> .			
15	Politics	Political support based on a well-investigated strategy influenced by key policy concerns, public response and political will for nuclear power.			
16	Procurement	Transparent and well-explained due processes of participating in the supply, distribution, etc of services, equipment, resources, etc.			
17	Public Acceptance	Public acceptance of nuclear power vis-à-vis the perceived risks associated with nuclear power generation			
18	Radiation Protection	Optimization and dose limitation measures & principles to adhere to, in order to have low radiological risks and high protection against radionuclide releases and radiation doses.			
19	Radioactive Waste	Safety management of radioactive waste at plant site as spent fuel, during transport, and final disposal arrangements at assures due protection to the environment and the public			
20	Regulatory Regime	Legal and institutional arrangements for the regulation of nuclear power activities to ensure safety and security.			
21	Safeguards	Positive statement against weaponization of nuclear energy, or use of nuclear energy for non-peaceful ends, promoting proliferation resistance through material & technical barriers.			
22	Safety	Safety requirements for nuclear power should comply with requirements to protect human health and the environment in terms of siting, design, construction and operation of plants.			
23	Safety from Radiological Risks	Measures to ensure low radiological risks and high protection against radiological releases & radiation doses to workers and the public during normal operations and transportation			
24	Safety from Accident Risks	High defence in depth measures to reduce the probability of a severe accident that can result in off-site releases, and the mitigation of the consequences of any such release.			
25	Security	Theft and sabotage protection to prevent use of nuclear energy & radiation sources for wicked purposes that may pose a hazard to personnel, the public and the environment.			

26	Site and Facilities	The feasibility studies and expert opinion that must go into the selection of a site, the nature of the facilities and how to secure them to ensure safety and security			
27	Stakeholder Activity	Monitoring, engagement, licensing, and due authorization of stakeholders and actors in the nuclear energy arena as well as public opinion, <u>institutional collaboration initiatives, etc.</u>			
28	Technology	The balancing of positive (beneficial) uses and negative (disadvantageous) costs of any item of technology that can be used in the industry			
29	Technology Affordability	Consideration of the cost of technology which does not impose undue economic hardship on the country, or displace other essential activities <u>and which does not compromise safety.</u>			
30	Technology Availability	Available proven technology that satisfies both technical & regulatory requirements of the country should be preferred to custom made <u>technology that has no proven record.</u>			
31	Technology Suitability	Technology should be fit for the purpose in its (inter)operability, reliability, maintainability & compatibility with existing systems as well as <u>country specific conditions & requirements</u>			
32	Technology Sustainability	Technology must complement human resource and not contribute to human displacement, or compromise safety, deplete resources or lead to <u>increased environmental pollution</u>			
33	Transport	Conforming to international trans-modal rules on transport safety issues, and ensuring security of radioactive materials during transport.			
34	Uranium Sources	Security of supply of nuclear fuel, safety of fuel management systems, processing, reprocessing, and fabrication of nuclear fuel, and protecting against refinement of uranium to weapon grade.			

Thank you. Please, as indicated above, kindly return your completed questionnaire and your comments, if any, to Samuel Obeng Manteaw or his duly authorized representative.

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NOTE WELL: One hundred (100) respondents, considered as nuclear experts or quasi-experts, were targeted for this phase of verification and validation of the key nuclear safety regulatory framework elements. This questionnaire was eventually completed by ninety (90) respondents.

QUESTIONNAIRE 2: PUBLIC ACCEPTANCE OF NUCLEAR POWER

1. Have you heard of nuclear power for electricity generation in Ghana?

Yes No Other

2. Should Ghana opt for nuclear power for electricity generation?

Yes No Don't Know Undecided

3. On a scale of 1, 2, 3, 4, 5; rate the attainability of nuclear power generation safety in Ghana, where (1) means *Not Attainable*; (2) means *Poorly Attainable*; (3) means *Attainable*; (4) means *Highly Attainable*; (5) *Very Highly Attainable*.

NOTE WELL: Five hundred and forty six (546) respondents constituted the survey sample for gauging the public acceptability or tolerance for nuclear power in Ghana.

QUESTIONNAIRE 3: INVOLVING LAY PUBLIC IN NUCLEAR POWER

1. Should the operator of nuclear power consider lay public opinion in their decision making processes?

Yes No Other

2. Should the regulator of nuclear power consider lay public opinion in their decision making and regulatory processes?

Yes No Other

3. In what way(s) may the lay public be involved in such decision making processes?

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QUESTIONNAIRE 4: QUESTIONS ON NUCLEAR POWER SAFETY REGULATION IN GHANA

1. What do you think about Ghana's decision to utilize nuclear energy to generate electricity?
.....
2. Would you recommend the nuclear power option for electricity in Ghana? **Yes** **No**
3. Does utilizing nuclear energy to generate electricity in Ghana pose any risk? **Yes** **No**
4. What kind of risk(s) may nuclear power pose?
-
5. Do the benefits of nuclear power outweigh its risks, hazards or threats? **Yes** **No**
6. Do Ghana's laws provide for regulation of nuclear power? **Yes** **No** **Don't Know**
7. If **Yes**, what authority or authorities is/are in charge?
-
8. Do Ghana's laws provide for regulation of nuclear materials? **Yes** **No** **Don't Know**
9. If **Yes**, what authority or authorities is/are in charge?
-
10. Do Ghana's laws provide for regulation of radiation sources? **Yes** **No** **Don't Know**
11. If **Yes**, what authority or authorities is/are in charge?
-
12. What are some of the Ghana laws on radiation and nuclear energy?
-
-
-
13. Should the study of nuclear science be promoted in Ghana? **Yes** **No** **Don't Know**
14. What best practice approaches would you recommend for regulating the safety of nuclear power generation in Ghana?
-
-
-
15. Please add any other suggestions or recommendations for utilizing nuclear power in Ghana
.....
-

Thank you. You may please provide further information on the attached sheet.

APPENDIX B: NUCLEAR REGULATORY AUTHORITY BILL, 2012**NUCLEAR ACT, 2012
ARRANGEMENT OF SECTIONS**

Section

Application

1. Application
2. Act to bind the Republic

The Nuclear Authority

3. Establishment of the Authority
4. Objects of the Authority
5. Functions of the Authority
6. Powers of the Authority
7. Duties of the Authority
8. Governing body of the Authority
9. Tenure of office of members
10. Meetings of the Board
11. Disclosure of interest
12. Establishment of committees
13. Advisors and consultants
14. Allowances
15. Ministerial directives

Administration and staff of the Authority

16. Appointment of Executive Director
17. Functions of the Executive Director
18. Deputy Executive Director
19. Appointment of other Staff
20. Secretary to the Board
21. Directorates and structure of the Authority

Establishment and management of the Nuclear Authority Fund

22. Establishment of a Nuclear Authority Fund
23. Application of the Fund
24. Sources of money for the Fund
25. Management of the Fund

Regulatory activities of the Authority

26. Application for licence
27. Suspension and revocation of a licence
28. Obtaining information
29. Obligations of a licensee
30. Radiation safety and security
31. Medical practices
32. Protection of patients
33. National register of radiation sources
34. Suspension and revocation of a permit
35. National register of export, import, trans-shipment and transport of radioactive sources
36. Export and import of controlled items

37. Recovery of orphan sources
38. Emergency plans
39. National plan for nuclear or radiological emergencies
40. Trans-boundary emergencies

Nuclear installations

41. Construction and operation of nuclear installation
42. Responsibility of the operator
43. National site evaluation process for nuclear installations
44. Site evaluation for nuclear installations
45. Preconstruction review and assessment of nuclear installations
46. Construction review and assessment of nuclear installations
47. Pre-commissioning review and assessment before commissioning a nuclear installation
48. Review and assessment before commissioning of a nuclear power installation
49. Review and assessment during operation of nuclear installations

Radioactive waste management

50. Operating a radioactive waste management facility
51. Radioactive waste disposal plan
52. Radioactive waste management
53. Responsibility for safety and security of radioactive waste
54. Safe and secure management of radioactive waste
55. Prohibition of import of radioactive waste
56. Permit for the export of radioactive waste
57. Criteria for export of radioactive waste
58. Re-import of radioactive waste

Transportation of radioactive materials

59. Requirements for transportation of radioactive materials

Decommissioning of nuclear facilities

60. Decommissioning of nuclear facilities
61. Decommissioning plan
62. Licensee's obligations when decommissioning
63. Financing of decommissioning

Safeguards and prohibitions

64. Prohibitions on non-peaceful uses of nuclear materials

Mining and processing of radioactive materials

65. Processing of radioactive materials resulting from mining and processing operations
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A BILL ENTITLED NUCLEAR ACT, 2012

AN ACT to establish a Nuclear Authority; to provide for the regulation and management of peaceful use of nuclear material or energy, radioactive material, or radiation; to provide for the adequate protection of persons and the environment against the harmful effects of radiation hazards; to ensure the effective implementation of the country's international obligations and for related matters.

PASSED by Parliament and assented to by the President

Application

Application

1. (1) This Act applies to the

- (a) management of radioactive waste resulting from civilian applications in the country;
- (b) regulation and management of the peaceful use of nuclear energy and radiation under the jurisdiction and control of the country, including the production, possession, use, import, export, transportation, transfer, handling and management, or other related activity or practice indentified by the Authority; and
- (c) management of spent fuel resulting from the operation of civilian nuclear reactors in the country.

(2) This Act does not apply to any exposure, the magnitude of which is not amenable to control through the requirements and standards determined by the Authority.

Act to bind the Republic

2. This Act binds the Republic.

The Nuclear Authority

Establishment of the Authority

3. (1) There is established by this Act a body corporate with perpetual succession to be known as the Nuclear Authority.

(2) In exercising its right to acquire property, the Authority may, where there is a hindrance to the acquisition of the property, acquire the property under the State Property and Contracts Act, 1960 (C.A. 6) or the State Lands Act, 1962 (Act 125), and the cost of the acquisition shall be borne by the Authority.

Objects of the Authority

4. The objects of the Authority are to

- (a) ensure that radiation and nuclear energy is used by only persons licensed or issued with a permit under this Act, for peaceful purposes;
- (b) provide adequate protection of the environment and persons against the harmful effects of radiation hazards; and
- (c) pursue and ensure strict compliance with this Act and the Regulations.

Functions of the Authority

5. To achieve its objects, the Authority shall

- (a) develop national policies on the regulation and management of activities and practices with respect to
 - (i) nuclear safety;
 - (ii) security of nuclear and radioactive materials;
 - (iii) radiation; and
 - (iv) the implementation of safeguards specified under this Act;
- (b) regulate the introduction of radiation sources, nuclear materials, equipment or practices that expose workers, patients, the public and the environment to radiation;
- (c) issue, modify, suspend or revoke licences and permits, and determine conditions for licences and permits;
- (d) regulate research on radiation and nuclear safety and security, and of radioactive waste matters;
- (e) regulate the use of radioactive materials in the exploration, exploitation and extraction of oil and gas, and the mining and milling of radioactive ores and other ores associated with radioactive and nuclear materials;
- (f) define the detailed obligations to be placed on persons who possess radiation sources and nuclear materials, including financial conditions;
- (g) establish and maintain a national register of radiation sources and of persons authorised to carry out any activity or practice related to a source of radiation;
- (h) collaborate with the National Disaster Management Organisation to establish plans and procedures for coping with any radiological emergency and abnormal occurrence involving a nuclear material, radiation source or any other radioactive source;
- (i) ensure that the operators provide training, information and guidance on nuclear safety, security and safeguards, and radiation protection;
- (j) advise the Minister on the preparation of Regulations for the effective implementation of this Act;
- (k) establish regional and other offices as it may consider necessary for the proper performance of its functions; and
- (l) appoint auditors for the Authority and approve the fees to be paid to

the auditors.

Powers of the Authority

6. The Authority may, for purposes of section 5, exercise the following powers:

- (a) define the exposures that are excluded from the scope of application of this Act;
- (b) establish the process for removal of a facility or activity from regulatory control;
- (c) impose an administrative penalty on a licensee including a prohibition or confiscation of the nuclear and radioactive material or equipment and its source, for non-compliance with this Act and any Regulations;
- (d) establish and levy fees with the approval of Parliament, for licences and permits;
- (e) collaborate with the Ministries responsible for National Security and the Interior in determining what constitutes a domestic threat for the variety of nuclear and radioactive materials used within the country and assess the Republic's vulnerability to each threat;
- (f) establish in collaboration with the Customs, Excise and Preventive Division of the Ghana Revenue Authority and the Ghana Immigration Service, a control system for the import and export of nuclear material, radioactive sources and other controlled items;
- (g) establish and maintain a national system for registering, licensing, and accounting for nuclear materials and radiation sources;
- (h) establish appropriate mechanisms for stakeholder participation in the regulatory process;
- (i) define radiation exposures that are excluded from the scope of application of this Act on the basis of their being unamenable to regulatory control;
- (j) set conditions for issuing a licence and issue, amend, suspend or revoke a licence;
- (k) grant exemptions concerning the possession and use of radiation sources, and the safe management of radioactive materials;
- (l) conduct inspections to assess compliance with safeguard conditions and radiation safety and security conditions, imposed by the Authority on a licensee;
- (m) establish a system for tracking inventories and movement of nuclear material; and

- (n) establish procedures for reporting to the International Atomic Energy Agency in accordance with section 64;

Duties of the Authority

7. The Authority shall

- (a) facilitate the conduct of inspections by designated inspectors of the International Atomic Energy Agency to verify design information, inspections and complementary access as provided for in the Safeguards Agreement and the Additional Protocols;
- (b) test and assess periodically, the plans and procedures established under section 5;
- (c) collect, collate and provide information to the International Atomic Energy Agency in accordance with the Safeguards Agreement and any additional protocols to that Agreement;
- (d) establish a control system for the import and export of nuclear material, radioactive sources and other controlled items in cooperation with the Customs, Excise and Preventive Division of the Ghana Revenue Authority;
- (e) exchange information and co-operate with regulatory authorities of other countries and relevant international organisations on matters of nuclear safety, nuclear security and safeguards;
- (f) take the necessary measures to mitigate undue threats of exposure to radiation by enforcing the requirements specified under this Act;
- (g) collaborate with the Environmental Protection Agency to identify activities and practices that may require Environmental Impact Assessment and develop environmental guidelines for those activities and practices;
- (h) ensure that the polluter pays principle is applied in the management of nuclear and radioactive waste in the country;
- (i) ensure compliance with safeguards specified under section 62;
- (j) review nuclear safety assessment and safety analysis reports from licensees;
- (k) collect information, documents and views from private and public organisations or persons as may be necessary and appropriate for the discharge of its functions;

- (l) make available information on accidents and incidents, abnormal occurrences, and other relevant information;
- (m) categorise activities involving the exposure to radiation, in particular, the possession, production, processing, manufacture, purchase, sale, import, export, handling, use, transformation, transfer, trading, assignment, transport, storage and disposal of any controlled nuclear radioactive material and any apparatus emitting radiation; and
- (n) ensure that the operators provide training, information and guidance on nuclear safety, security and safeguards, and radiation protection.

Governing body of the Authority

8. (1) The governing body of the Authority is a Board consisting of

- (a) the chairperson;
- (b) the Executive Director;
- (c) one representative of the Environmental Protection Agency;
- (d) one representative of the National Security Council; and
- (e) three other members with cognate background and experience in nuclear and allied sciences one of whom at least is a woman.

(2) Members of the Board shall be appointed by the President in accordance with article 70 of the Constitution.

(3) The Board shall ensure the proper and effective performance of the functions of the Authority.

(4) The Board shall, in the discharge of its duty under subsection (3), not be subject to the control or direction of any person or authority.

Tenure of office of members

9. (1) A member of the Board appointed otherwise than by reason of that member's office shall, hold office for a period not exceeding three years and is eligible for re-appointment but a member shall not be appointed for more than two consecutive terms.

(2) Despite subsection (1), the chairperson and two other members of the Board first appointed shall, hold office for a period of four years.

(3) A member of the Board who is absent from three consecutive meetings of the Board without sufficient cause ceases to be a member of the Board

(4) The office of a member of the Board appointed otherwise than by office becomes vacant if the member at anytime resigns from office in writing addressed to the President through the chairperson of the Board.

(5) The President may by a letter addressed to a member revoke the appointment of that member.

(6) Where a member of the Board is for sufficient reason, unable to act as a member, the Minister shall determine whether the inability would result in the declaration of a vacancy.

(7) Where there is a vacancy

(a) under subsection (3) or (4) or section 11(3),

(b) as a result of a declaration under subsection (6), or

(c) by reason of the death of a member

the Minister shall notify the President of the vacancy and the President shall appoint a person to fill the vacancy.

Meetings of the Board

10. (1) The Board shall meet at least once every three months for the despatch of business at times and in places determined by the chairperson.

(2) The chairperson shall at the request in writing of not less than one-third of the membership of the Board convene an extraordinary meeting of the Board at the place and time determined by the chairperson.

(3) The Executive Director may discharge the duty of the chairperson under subsection (2) in the absence of the chairperson.

(4) The quorum at the meeting of the Board is five members of the Board or a greater number determined by the Board in respect of a particular matter.

(5) The chairperson shall preside at meetings of the Board and in the absence of the chairperson, a member of the Board elected by the members present from among their number shall preside.

(6) Matters before the Board shall be decided by a majority of the members present and voting, and in the event of an equality of votes, the person presiding shall have a casting vote.

(7) The Board may co-opt a person to attend a Board meeting but that person shall not vote on a matter for decision at the meeting.

Disclosure of interest

11. (1) A member of the Board shall disclose in writing any personal interests or otherwise that the member has in the activities or practices regulated by the Authority.

(2) A member of the Board who has an interest in a matter for consideration

(a) shall disclose the nature of the interest and the disclosure shall form part of the record of the consideration of the matter; and

(b) shall not participate in the deliberations of the Board in respect of that matter.

(3) A member ceases to be a member of the Board, if that member has an interest in a matter before the Board and

(a) fails to disclose that interest; or

(b) participates in the deliberations of the Board in respect of that matter.

Establishment of committees

12. (1) The Board may establish committees consisting of members of the Board or non-members or both to perform a function.

(2) Without limiting subsection (1), the Board shall have a Technical Committee which shall be chaired by a person who is not a member of the Board.

(3) Section 11 applies to members of committees of the Board.

Advisors and consultants

13. (1) The Board may appoint consultants to carry out any of its functions under this Act.

(2) A consultant appointed under this section may with the approval of the Board, co-opt other persons to assist in the carrying out of an assigned function.

(3) A person other than an employee of the Authority co-opted by the Board shall, hold office in accordance with the terms of the letter by which the person is appointed.

(4) A person

(a) appointed by the Board as a consultant, or

(b) co-opted by a consultant under subsection (2),

shall disclose any interest in an activity or practice involving radioactive or nuclear materials.

(5) The appointment of a person who contravenes subsection (4) shall be revoked.

(6) The Executive Director shall notify the chairperson of the Board of any vacancy resulting from a revocation of appointment under subsection (5).

Allowances

14. Members of the Board and members of a committee of the Board shall be paid the allowances approved by the Minister in consultation with the Minister responsible for Finance.

Ministerial directives

15. The Minister may, in writing, give policy directives that are consistent with the provisions of this Act to the Board and the Board shall give effect to the directives.

Administration and staff of the Authority

Appointment of Executive Director

16. (1) The President shall appoint an Executive Director for the Authority in accordance with article 195 of the Constitution.

(2) The Executive Director shall be a person of proven integrity and shall have qualification and practical experience in nuclear law or the application of nuclear energy, radiation, nuclear safety and security, safeguards and radiation protection.

(3) The Executive Director shall hold office in accordance with the terms and conditions specified in the letter of appointment.

(4) The Executive Director shall be removed from office for incapacity, malfeasance or incompetence.

Functions of the Executive Director

17. (1) The Executive Director is responsible for the day to day administration of the affairs of the Authority and is answerable to the Board in the performance of functions under this Act.

(2) The Executive Director shall perform other functions determined by the Board.

Deputy Executive Director

18. (1) The President shall in accordance with article 195 of the Constitution appoint a Deputy Executive Director for the Authority.

(2) The Deputy Executive Director shall hold office in accordance with the terms and conditions specified in the letter of appointment

(3) The Deputy Executive Director shall assist the Executive Director in the administration of the Authority

Appointment of other staff

19. (1) The President shall in accordance with article 195 of the Constitution appoint other staff of the Authority that are necessary for the proper and effective performance of its functions.

(2) Other public officers may be transferred or seconded to the Authority or may otherwise give assistance to it.

(3) The Executive Director shall vet and interview persons to be transferred or seconded to the Authority.

(4) A person seconded or transferred to the Authority shall declare in writing any personal interest in an activity or a practice involving nuclear or radioactive materials.

(5) Civil proceedings may not be brought against any member or other person acting on behalf or under the direction of the Authority for anything done, reported or said in good faith in the course of the performance of a function, exercise of a power or discharge of a duty, or purported performance of a function, exercise of a power or discharge of a duty of the Authority under this Act or for an alleged neglect or default in the performance of that function, exercise of that power or discharge of that duty.

(6) Nothing in this section relieves the Authority of liability in respect of a tort or contract.

Secretary to the Board

20. The Board shall appoint an officer of the Authority who shall be the Secretary to the Board.

Directorates and structure of the Authority

21. (1) The Board shall establish directorates necessary for the operation of the Authority.

(2) A directorate established pursuant to subsection (1) of this section shall be headed by a Director.

Establishment and management of the Nuclear Authority Fund

Establishment of a Nuclear Authority Fund

22. There is established by this Act a fund to be known as the Nuclear Authority Fund.

Application of the Fund

23. (1) The Authority shall apply moneys in the Fund on projects and activities aimed at achieving the objects of the Authority under this Act.

(2) Despite subsection (1), the Authority shall ensure that money is provide from the Fund to the waste management centre of the Ghana Atomic Energy Commission to assist the centre in carrying out its mandate.

Sources of money for the Fund

24. The sources of money for the Fund are

- (a) moneys approved by Parliament;
- (b) grants received from the Government and donors;
- (c) fees charged by the Authority in the performance of its functions;
- (d) moneys obtained from fundraising activities; and
- (a) returns from investments made by the Authority.

Management of the Fund

25. (1) The Board is responsible for the management of the Fund and for that purpose may,

- (a) formulate policies to generate money for the Fund;
- (b) determine the allocation to be made towards achieving the objects of the Authority;
- (c) determine annual targets of the Fund; and

(d) with the approval of the Controller and Accountant General, appoint a Fund Management Committee to advise the Board on the management of the Fund.

(2) A Fund Management Committee appointed under subsection (1)(d) shall comprise at least three members of the Board and any other persons the Board shall in consultation with the Minister determine.

(3) The Board may, in consultation with the Minister responsible for Finance, invest part of the moneys in the Fund in approved investments.

(4) Moneys for the Fund shall be paid into a bank account opened by the Authority with the approval of the Controller and Accountant General.

(5) Payments may be made from the Fund only on the authorisation of the Executive Director and the Director of Finance, evidenced by the signatures.

Regulatory activities of the Authority

Application for licence

26. (1) A person shall not engage in an activity or a practice which involves the use of nuclear material, radioactive material or any radiation, unless that person is licensed by the Authority.

(2) Subject to this Act, a person who intends to engage in any activity or practice involving

(a) nuclear material or radioactive material,

(b) nuclear waste or radioactive waste, or

(c) radiation

shall apply to the Authority in writing for a licence.

(3) The application shall be addressed to the Executive Director.

(4) On receipt of an application, the Executive Director shall acknowledge receipt of the application not later than five days after receipt of the application.

(5) The Authority shall subject to subsection (6), consider the application and may grant or refuse the licence within thirty-five days from the date of acknowledging receipt of the application and inform the applicant in writing about the decision.

(6) The Authority shall, where an application made under subsection (2) is refused, state the reasons for the refusal.

(7) The Authority may request the applicant to provide further information and may for that purpose extend the period for the grant of the licence.

- (8) The Authority shall, in considering an application made under subsection (2), ensure that
- (a) the benefits of the activity or practice for which the licence is sought outweighs any radiation detriment which may be suffered as a result of that activity or practice, taking into consideration social, economic and other relevant factors;
 - (b) the applicant has taken the necessary steps to protect humans and the environment by keeping doses of radiation within reasonably acceptable and authorised limits and that all reasonable steps are taken to minimize the adverse effects on persons and the environment;
 - (c) it verifies the necessary technical and organisational measures taken by the applicant to ensure adequate safety and security, including effective protection against radiological hazards;
 - (d) the applicant has adequate understanding of the fundamental principles of radiation protection;
 - (e) the applicant establishes an appropriate emergency preparedness and response plan to respond to incidents, accidents or emergencies;
 - (f) the applicant has in place adequate financial arrangements to safely and securely manage the radioactive waste and to undertake decommissioning activities, where it is not possible to return the radioactive waste to the supplier;
 - (g) the applicant has in place the necessary arrangements for the return of the radioactive waste to the supplier after its useful life;
 - (h) the applicant establishes a system of accounting and control of nuclear or radioactive material at the facility level;
 - (i) the applicant has in place programmes for recruiting qualified persons and training them in safety and security of the radioactive materials and sources used; and
 - (j) the applicant has a detailed plan for discontinuing the activity or practice for which the licence is sought.

(9) For purposes of subsection (8)(b), doses of radiation exposure is reasonably acceptable and within the authorised limit, if it is within the range prescribed by Regulations for the activity or practice for which the licence is sought.

(10) A person dissatisfied with a decision of the Authority made under subsection (5) may appeal to the High Court.

Suspension and revocation of licence

27. (1) The Authority may suspend the licence of a licensee where

- (a) allegations of misconduct have been made against the licensee;
 - (b) a false declaration was made in an application for a licence issued to the licensee; or
 - (c) the licensee has contravened a provision of this Act or the Regulations.
- (2) The Authority shall revoke a licence if
- (a) the licensee is convicted of an offence under this Act or the Regulations; or
 - (b) is convicted to a term of imprisonment for a criminal offence.

Obtaining information

28. (1) For purposes of section 26 (6) , the Executive Director, an employee or any other person authorised by the Executive Director shall have access to the relevant records, books or facilities of the person requested to provide the information.

(2) The applicant shall make available any information considered necessary by the Authority.

Obligations of a licensee

29. (1) A person licensed to conduct an activity or a practice under section 26(5)

- (a) shall not transfer a right or an obligation under the licence to another person;
- (b) is responsible for the safe and secure conduct of the activity or practice in compliance with this Act;
- (c) shall ensure that appropriate measures are taken to handle and finally dispose of radioactive waste arising from the licensed activity or practice in a safe manner;
- (d) shall ensure that appropriate measures are put in place for the decommissioning and dismantling of facilities in which the licensed activity or practice is conducted;
- (e) shall ensure that persons employed for purposes of the licensed activity or practice and the public are protected from radiological injury;
- (f) shall ensure compliance with requirements and dose limits established by the Authority,
- (g) shall ensure that radiation doses to the public, the number of persons exposed and persons employed for purposes of the activity or practice,

including doses released into the environment, are within reasonably acceptable and authorised limits taking into consideration social and economic factors;

- (h) shall before the cessation of the licensed activity or practice, inform the Authority of its decision to cease the activity or practice;
- (i) shall maintain records required by the Authority and make them available for inspection as required; and
- (j) shall provide
 - (i) information to the Authority as required by the Authority; and
 - (ii) the Authority access to its premises for purposes of verifying compliance with applicable Regulations and licence conditions.

(2) A licensee who contravenes subsection (1) commits an offence is liable on summary conviction to a fine of not less than seven hundred and fifty penalty units and more than two thousand five hundred penalty units or to a term of imprisonment of not less than three years and not more than five years or to both the fine and imprisonment.

Radiation safety and security

30. (1) The Authority shall establish dose limits for exposure of persons to radiation in respect of an activity or a practice that is subject to licensing under this Act.

(2) The Authority shall in determining a dose limit take into account any recommendation from the International Atomic Energy Agency and any other related international body.

(3) Despite subsection (1), the Authority shall determine the activities and practices to be exempted from regulatory control based on the following criteria:

- (a) that radiation risk for persons is sufficiently low to be of any regulatory concern;
- (b) that the collective radiological impact is sufficiently low that regulatory control is not warranted;
- (c) that the activity or practice is considered to be inherently safe, without the likelihood of creating a situation that could result in a failure to meet the criteria in (a) or (b).

(4) The Authority shall, by Regulations, prescribe measures aimed at preventing exposure of a person from radiation.

(5) The Authority shall establish levels or values below which radioactive material or objects within licensed activities and practices may be released from regulatory control.

Medical practices

31. (1) A person shall not apply a medical diagnosis or therapy which utilises nuclear material, radioactive material or any radiation on another person, unless the person possesses the qualification prescribed by the Authority and is licensed under section 26(5).

(2) A person who contravenes subsection (1) commits an offence and is liable on summary conviction to a fine of not less than one thousand penalty units and not more than two hundred and fifty thousand penalty units or to a term of imprisonment not less than four years and not more than five years or to both the fine and imprisonment.

Protection of patients

32. A person licensed to apply a medical procedure shall ensure that the patient is not administered with a diagnostic or therapeutic exposure, unless the exposure is prescribed by a medical officer who is assigned to the patient for purposes of delivering that medical therapy.

National register of radiation sources

33.(1) The Authority shall establish and maintain a national register of radiation sources.

(2) The categorisation of radiation sources in the national register shall take account of their potential to cause injury to humans and the environment.

(3) The Authority shall adopt measures to protect information contained in the national register to ensure that the safety and security of a registered radiation source is not compromised.

National register of export, import, trans-shipment and transport of radioactive sources

34. (1) The Authority shall determine and publish in the *Gazette* any radioactive or nuclear material, equipment or technology that is subject to control as a national policy and in the interest of the security of Ghana.

(2) A person shall not export, import, trans-ship or transport a controlled item without a permit from the Authority.

(3) A person who intends to export, import, trans-ship or transport a controlled item shall apply to the Authority in writing, for a permit.

(4) The application shall be addressed to the Executive Director and submitted with the prescribed fee and information prescribed by Regulations for purposes of the permit sought.

(5) On receipt of an application, the Authority shall acknowledge receipt of the application not later than five days.

(6) The Authority shall after consultation with institutions the Authority considers appropriate, consider the application and may grant or refuse the permit not later than twenty-five days after acknowledging receipt of the application.

(7) The Authority shall inform the applicant of its decision not later than ten days after taking the decision, and where the decision is to refuse the application, state the reasons for the refusal.

(8) A person dissatisfied with the decision of the Authority under subsection (6) may appeal to the High Court.

Suspension and revocation of a permit

35. (1) The Authority may suspend the permit of a licensee where

- (a) a false declaration was made in an application for a permit issued to the permit holder; or
- (b) the permit holder has contravened a provision of this Act or the Regulations.

(2) The Authority shall revoke a permit if

- (a) the permit holder is convicted of an offence under this Act or the Regulations; or
- (b) is convicted to a term of imprisonment for a criminal offence.

Export and import of controlled items

36. The Authority shall

- (a) before granting a permit to an applicant to export an item which is subject to control by the Authority, consider the following:
 - (i) that the receiving State has made a binding commitment to use the item being exported and information in respect of that item for a peaceful purpose only;
 - (ii) any International Atomic Energy Agency safeguards requirement applicable to the item to be exported;
 - (iii) whether the receiving State has placed its nuclear material and nuclear facilities under International Atomic Energy Agency safeguards;
 - (iv) whether approval of the Authority has been given for the transfer to a third State, of an item or technology previously transferred into the country;
 - (v) whether the requirements in the Convention on the Physical Protection of Nuclear Material for the transport of the material to be exported has been met; and
 - (vi) any information provided by the applicant in respect of the end use and end user of the nuclear material, equipment or information to be transferred that confirms the legitimate peaceful use of the nuclear material, equipment or information; and

- (b) before granting a permit to an applicant to import an item which is subject to control by the Authority, consider the following:
- (i) whether the material, equipment or technology to be imported is not prohibited by any law or regulatory provision in the country;
 - (ii) whether the designated recipient of the imported item is subject to a licensing requirement under another enactment and the licence has been granted;
 - (iii) whether the end user of the imported item has the technical and administrative capability and resources to use the imported item in a safe and secured manner.

Recovery of orphan sources

37. (1) A licensee issued a permit under section 34(6) or who has lost control of a radioactive source shall, promptly report the loss or any other incident that could pose a significant risk to the safety or security of persons and the environment, to the Authority.

(2) The Authority shall collaborate with the Ministry responsible for National Security and the National Disaster Management Organisation, to develop a national strategy for the prompt recovery and control over an orphan source in respect of which control is lost.

(3) The Authority shall manage any orphan source to ensure its security and safety.

Emergency plans

38. (1) A person shall not be licensed unless that person has in place an appropriate emergency preparedness and response plan approved by the Authority for the

- (a) operation of that person's facility or a source the person possesses or uses; and
- (b) activity or practice for which the licence is sought.

(2) The plan shall consist of both on-site and off-site emergency plans.

(3) An applicant shall in preparing an emergency plan, take into account

- (a) an assessment of the nature, likelihood and potential magnitude of resulting damage, including the population and area potentially at risk from an accident, malicious act or incident;
- (b) the results of any accident analysis and lessons learned from that accident or incidents that have occurred in connection with similar activities or practices.

(4) An emergency plan shall

- (a) identify the conditions that could create a need for emergency intervention;
 - (b) require the applicant to immediately notify the Authority and other government agencies determined by the Authority, of any situation or incident that poses a risk of radiological injury and requires emergency intervention;
 - (c) allocate responsibilities for
 - (i) initiating intervention; and
 - (ii) notifying relevant emergency intervention and response organisations;
 - (d) specify procedures, including communications arrangements, for contacting and obtaining assistance from emergency intervention organisations;
 - (e) specify intervention levels for protective actions and the scope of their application, taking into account the possible severity of emergencies that could occur;
 - (f) describe the methods and instruments necessary for assessing an emergency situation and its consequences;
 - (g) specify the procedure for terminating each emergency response or action;
 - (h) specify the training required of emergency responders and for conducting appropriate practice exercises to test the adequacy of the plan and to ensure that persons who may be involved in the emergency interventions are adequately informed and prepared for possible emergencies;
 - (i) ensure persons likely to be affected by an emergency are well educated and informed about the potential risks of that emergency; and
 - (j) be prepared in consultation with relevant emergency intervention or emergency responders, including the traditional authority, the local authority, and district, regional and national administrative authorities.
- (5) An emergency plan shall be reviewed annually and updated.
- (6) In the event of a nuclear or radiological emergency, the licensee shall implement the emergency plan as approved by the Authority.

National plan for nuclear or radiological emergencies

39. (1) The Authority shall in collaboration with the National Disaster Management, Organisation develop and maintain a national emergency plan for responding to potential nuclear or radiological emergencies.

(2) The Minister responsible for Science and the Minister responsible for Interior shall be approve the plan.

(3) The national emergency plan for nuclear or radiological emergencies will take into account existing emergency response plans or programmes.

(4) The national emergency plan for nuclear or radiological emergencies shall detail an allocation of responsibilities and actions among relevant governmental and non-governmental bodies, including arrangements for communications and public information.

(5) The Authority shall in collaboration with the National Disaster Management Organisation review and update the plan every two years.

(6) The updated plan shall be approved in accordance with subsection (2).

Trans-boundary emergencies

40. (1) In the event of a nuclear or radiological emergency that poses a risk of radioactive contamination spreading beyond the boundaries of Ghana, the Authority shall immediately notify the International Atomic Energy Agency and the relevant authorities of any State that could be affected by the release.

(2) The Authority shall, in collaboration with the organisations responsible for disaster management, serve as the point of contact for providing any information or assistance regarding nuclear or radiological emergencies under the terms of relevant international instruments, including the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

Power installations

Construction and operation of nuclear installations

41. (1) A person shall not construct or operate a nuclear installation and conduct a related activity unless the person is licensed by the Authority under section 26.

(2) A person who intends to undertake maintenance, expansion, or an alteration or any activity related to the site or structure of a licensed facility shall notify the Authority and obtain a permit before the commencement of the activity.

Responsibility of the operator

42. An operator is responsible for ensuring the safe and secure conduct of any activity or practice associated with that operator's facility.

National site evaluation process for nuclear installations

43. (1) The Authority shall establish a process consistent with procedures contained in the national nuclear development plan for the evaluation of proposed sites for nuclear installations in the country.

(2) The Authority shall approve the proposed location for the development of a nuclear installation and associated facilities before the detailed evaluation of that site and preconstruction review and assessment of the proposed facility are commenced.

- (3) The process for site evaluation shall include an assessment of the following:
- (a) the effects of external events occurring in the region, either of natural origin or human induced;
 - (b) the characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released;
 - (c) the population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.

Site evaluation for nuclear installations

44. An applicant for a licence to construct and operate a nuclear installations shall, prepare a site evaluation report for assessment and review by the Authority, and the report shall include,

- (a) the frequency and severity of external natural and human induced events and the phenomena that could affect the safety of the facility;
- (b) the foreseeable evolution of natural and man - made factors in the proposed area that may have a bearing on safety during the projected life span of the facility;
- (c) the hazards associated with external events that are to be considered in the design of the facility, including the potential combined effects of these hazards with ambient conditions including hydrological, hydro-geological and meteorological conditions;
- (d) additional matters relating to safety, including the storage and transport of nuclear and other radioactive materials, fresh and spent fuel and radioactive waste;
- (e) the possible non-radiological impact of the facility due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products;
- (f) the potential for interactions between nuclear and non-nuclear effluents;
- (g) the potential radiological impact in operational state and its conditions on persons within the area, including impacts outside of Ghana; and
- (h) in so far as possible, the total nuclear capacity to be installed on the site, with provision for re-evaluation of the site if the installed capacity is to be significantly increased beyond the level assessed in a previous site evaluation.

Preconstruction review and assessment of nuclear installations

45. The Authority shall before permitting the construction of a nuclear installation review and assess

- (a) the competence and capability of the applicant to meet relevant permit or licence requirements;
- (b) the site evaluation report prepared under section 44 to confirm its acceptability and related information needed for the design of the proposed facility;
- (c) the potential environmental impact of the proposed facility;
- (d) the basic design of the proposed facility, to confirm that it can meet relevant safety, security and physical protection requirements;
- (e) the quality assurance organisation and programme of the applicant or operator and vendors;
- (f) research results and development plans related to demonstration of the acceptability of the design; and
- (g) arrangements for the management of radioactive waste and decommissioning.

Construction review and assessment of nuclear installations

46. The Authority shall review and assess the following during the construction of a nuclear installation:

- (a) the development of the facility design through documentation submitted by the operator to determine its continued acceptability; and
- (b) the progress of research and development activities in connection with demonstrating the acceptability of the design.

Pre-commissioning review and assessment before commissioning a nuclear installation

47. The Authority shall before commissioning a nuclear installation, review and assess the

- (a) commissioning programme of the nuclear installation and if necessary establish a schedule for further review and assessment;
- (b) as-built design of the installation;
- (c) limits and conditions for radiation protection;
- (d) provisions for radiation protection;
- (e) adequacy of operating instructions and procedures, especially the main administrative procedures, general operating procedures and emergency operating procedures;
- (f) recording and reporting systems;

- (g) arrangements for training and qualification of personnel for the installation, including staffing levels and fitness for duty requirements;
- (h) quality assurance organisation and programme for operation;
- (i) emergency preparedness programme;
- (j) accounting measures for nuclear and radioactive materials; and
- (k) adequacy of physical protection measures.

Review and assessment before commissioning of a nuclear power installation

48. The Authority shall before permitting the loading of nuclear fuel or initial criticality, complete the review and assessment of the following:

- (a) the results of non-nuclear commissioning tests;
- (b) arrangements for periodic testing, maintenance, inspection, and control of modifications and surveillance.

Review and assessment during operation of nuclear installations

49. The Authority may during the operation of a nuclear installation,

- (a) review, assess and approve any changes in operational limits and conditions or significant safety-related modifications; and
- (b) make periodic reviews of the operator's compliance with relevant terms and conditions related to the safety and security of the installation.

Radioactive waste management

Operating a radioactive waste management facility

50. A person or entity shall not operate a radioactive waste management facility, unless the person or entity is licensed under section 26(6).

Radioactive waste disposal plan

51. (1) An application for a licence to operate a radioactive waste management facility shall be submitted to the Authority together with a plan for the discontinuation of the operation of the facility.

(2) The Authority shall approve the plan before granting authorisation for the operation of the facility.

Radioactive waste management

52. A person licensed to manage radioactive waste under this Act shall, in managing the waste, ensure that

- (a) the public and the environment are adequately protected against radiological and other hazards;
- (b) the generation of radioactive waste is kept at a minimum;
- (c) relationships at the different levels in radioactive waste and spent fuel management are taken into account at all times;
- (d) protective measures for radioactive waste management in the country are implemented in a manner that reflects internationally recognised criteria, standards and guidance and in particular those adopted by the International Atomic Energy Agency;
- (e) biological, chemical and other hazards that may be associated with radioactive waste management are adequately addressed;
- (f) criticality and removal of residual heat generated during radioactive waste and spent fuel management are adequately addressed;
- (g) activities that may impose reasonably predictable impacts on future generations greater than those permitted for the current generation are avoided; and
- (h) undue burdens on future generations are avoided.

Responsibility for safety and security of radioactive waste

53. A person licensed to manage a radioactive waste management facility shall ensure the safety and security of the facility throughout its operational life.

Safe and secure management of radioactive waste

54. To ensure the safe and secure management of radioactive waste in the country, the Minister shall, on the advice of the Authority, by legislative instrument, make Regulations

- (a) to establish the safety and security requirements;
- (b) for the protection of the public and the environment from adverse impacts of radioactive waste management activities;
- (c) to establish a system of institutional control for radioactive waste management activities, including regulatory inspection, documentation of the inspection and report on the inspection; and
- (d) to establish a system of enforcement to ensure compliance with applicable Regulations and the terms and conditions of each licence for radioactive waste management activities.

Prohibition of import of radioactive waste

55. Radioactive waste generated in another country shall not be imported into the country for any purpose.

Permit for the export of radioactive waste

56. (1) Radioactive waste generated within the country may be exported by a licensee after the Authority has granted a permit to the licensee under section 34(6) for the export.

(2) The Authority shall not permit radioactive waste to be exported for storage or disposal to a destination beyond latitude 60 degrees south.

Criteria for export of radioactive waste

57. The Authority shall not issue a permit to a person for an export, unless the person satisfies the following conditions:

- (a) that the applicant has established procedures that ensure that the Regulatory Authority in the recipient's country will be notified of the transfer of radioactive waste or spent fuel prior to its receipt and has consented to the transfer;
- (b) movement of the exported material will be conducted in conformity with relevant international obligations in any country through which the material will transit; and
- (c) the importing country possesses the administrative and technical capacity as well as the regulatory structure needed to manage the exported radioactive waste or spent fuel in a manner that ensures its safety and security, consistent with relevant internationally recognised standards, and in particular those promulgated by the International Atomic Energy Agency.

Re-import of radioactive waste

58. (1) If a permitted export of radioactive waste cannot be completed in conformity with this Act, the radioactive waste shall not be re-imported into Ghana, unless the permit holder has provided an alternative safe and secure arrangement approved by the Authority.

(2) A person who contravenes subsection (1) commits an offence and is liable on summary conviction to a fine not more than two thousand five hundred penalty units or to imprisonment for a term not more than five years or to both the fine and the imprisonment.

Transportation of radioactive material

Requirements for transportation of radioactive material

59. (1) A person shall not transport a radioactive material unless the person has been granted a permit under section 33(6).

(2) The transport of radioactive material shall be carried out in accordance with this Act and Regulations.

(2) Where Regulations have not been made under section 94(2)(j), the transport of radioactive or nuclear material shall be carried out in accordance with the applicable technical

requirements of the regulations for the safe transport of radioactive materials made by the International Atomic Energy Agency.

Decommissioning of nuclear facilities

Decommissioning of nuclear facilities

60. (1) The Authority shall, by a notice published in the *Gazette*, specify the procedure for the decommissioning of a nuclear facility.

(2) The notice shall include

- (a) steps to be taken to resolve any safety and environmental issues and conditions of the end state of decommissioning;
- (b) limits and conditions for the removal of regulatory controls for a facility that contains radionuclides; and
- (c) criteria for the clearance of material during and after decommissioning;

(3) The Authority shall require the applicant for a licence to construct and operate a nuclear facility to perform a baseline survey of the site to develop information for comparison with the end state after decommissioning, including radiological conditions before the construction.

(4) The Authority shall ensure that relevant documents and records are prepared by the licensee and maintained for a specified period of time before, during and after decommissioning.

(5) The Authority shall evaluate the end state of the facility after decommissioning activities have been completed to ensure that relevant regulatory requirements have been met.

(6) The facility shall remain under the regulatory control of the Authority until the licensee has demonstrated that the end state in the decommissioning plan has been reached and that any other additional regulatory requirements have been met.

(7) The Minister shall on the advice of the Authority, by legislative instrument, make Regulations establishing the criteria for determining when a nuclear facility or part of a nuclear facility may be permanently shut down.

Decommissioning plan

61. (1) An applicant for a licence to construct and operate the nuclear facility shall at the design stage of a nuclear facility, prepare a decommissioning plan for approval by the Authority.

(2) The Authority shall ensure that interested parties are provided an opportunity to review and comment upon the decommissioning plan before it is approved by the Authority.

(3) The Authority shall require the licensee to provide periodic reviews and updates of the decommissioning plan and shall specify the maximum time intervals between the reviews and the updates.

(4) If specific circumstances could result in significant changes in the initial decommissioning plan, the licensee shall, at the request of the Authority, revise and update the plan to reflect these changed circumstances and submit it to the Authority for approval.

(5) The Authority shall require that a proposed final decommissioning plan be submitted for approval two years before the cessation of licensed activities, unless an alternative schedule for submitting the final decommissioning plan is specifically authorised by Authority.

(6) The Authority shall ensure that a programme to implement and monitor compliance with remaining regulatory requirements is established for sites where decommissioning has been completed, including restrictions on future use of the site.

Obligations of licensee for decommissioning

62. A licensee shall, for purposes of the decommissioning of that licensee's facility

- (a) submit to the Authority a decommissioning plan which is commensurate with the type and status of the facility, and hazards that may be associated with its decommissioning;
- (b) prepare safety and environmental impact assessments necessary for the implementation of the decommissioning plan for the approval of the Environmental Protection Agency acting on the advice of the Authority;
- (c) conduct a baseline survey of the site in an effective and timely manner;
- (d) be responsible for the safety, security and protection of persons and the environment, including any activities conducted by contractors or subcontractors;
- (e) design new features or facilities and systems during the operation of the facility, that can facilitate eventual decommissioning of the facility;
- (f) submit to the Authority for approval, new or untried methods for the decommissioning of the facility;
- (g) submit a final decommissioning plan two years before a permanent cessation of operation, and inform the Authority of a decision to permanently shut down the facility two months before shutting down;
- (h) maintain the facility in a safe configuration for effective and adequate decommissioning in the future in the case of deferred dismantling;
- (i) maintain a management and human resource development system within the organisation to ensure that decommissioning can be completed safely, and that responsible persons possess the necessary skills, expertise and training relevant to safe decommissioning;

- (j) maintain an emergency planning arrangement correlative with associated hazards and to report significant incidents to the Authority; and
- (k) arrange for adequate financing at each stage of the decommissioning process including provisions for loss of life or personal injury up to thirty years from the date of decommissioning.

Financing of decommissioning

63. (1) An applicant for a licence to construct and operate a nuclear facility shall ensure that adequate financial resources are available when needed to cover the costs associated with a safe decommissioning, including the management of the resulting waste during the operation of the facility.

(2) The amount of the financial resources to be made available for decommissioning activities shall be commensurate with the facility's specific cost estimate and shall be varied if the cost estimate increases or decreases.

(3) The estimated cost shall be reviewed as part of the periodic review of the decommissioning plan.

(4) The Authority shall on the advice of the Ministry of Finance and Economic Planning, Accountant-General's Department and Bank of Ghana establish the necessary mechanisms to enforce a licensee's obligations under this Act.

(5) For purposes of facilities in existence before the commencement of this Act for which financial resources are not available, proof of financial assistance shall be required before the renewal or extension of a licence.

Safeguards and prohibitions

Prohibitions on non-peaceful uses of nuclear materials

64. (1) A person shall use nuclear material exclusively for peaceful activity and in accordance with national and international treaties and legal instruments.

(2) Without limiting the generality of subsection (1), a person shall not

(a) manufacture, possess, control or acquire, directly or indirectly, or

(b) receive any assistance directly or indirectly in the manufacture of

a nuclear weapon or other nuclear explosive device in the country.

(3) A person engaged in an activity specified in the Safeguards Agreement and any Protocols to that Agreement shall, submit to the Authority information and data required by the Authority to meet its reporting obligations under that Agreement.

(4) Each licensee shall grant any inspector of the Authority and inspectors from the International Atomic Energy Agency, access to any premises, installation or facility in respect of

which inspections are required to be conducted for the purpose of verifying activities identified under the Safeguards Agreement and its Protocols.

Mining and processing of radioactive materials

Processing of radioactive materials resulting from mining and processing operations

65. (1) A person shall not conduct mining and processing operation that involves any material that could pose a health and safety risk from exposure to ionizing radiation, including

- (a) any exploration activity that involves a possible exposure to radiation;
- (b) the removal of uranium or thorium from the site for testing or evaluation, unless exempted by the Authority;
- (c) the excavation activities at a site, and a test mine, for evaluation or delineation of the ore body;
- (d) the siting, construction or operation of a mine or processing facility;
- (e) the transport of the product of mining or milling activities;
- (f) the decommissioning or closure of a mine or processing facility; and
- (g) radioactive waste management

unless the person is licensed under section 26.

(2) The Minerals Commission shall ensure that persons licensed under the Minerals and Mining Act, 2006 (Act 703) to engage in any of the activities listed under subsection (1) are licensed in accordance with this Act before commencing operation.

(3) A person who contravenes this section commits an offence and is liable on summary conviction to a fine not less than one thousand and not more than two thousand five hundred penalty units or to a term of imprisonment not less than four years and not more than five years or to both the fine and the term of imprisonment.

Licensing for mining of radioactive materials

66. (1) An applicant for a licence to conduct mining or to process activity that involves uranium or thorium ore from a site shall, provide information to the Authority on the following:

- (a) the mining lease;
- (b) the site characteristics, including geology and mineralogy;
- (c) the siting or construction plans;

- (d) the conceptual design of the mining or processing facility;
- (e) proposed work activities, extraction techniques and types of equipment involved;
- (f) quantities of uranium or thorium to be removed with the ore;
- (e) transportation of the ore;
- (f) estimates of exposures and doses for workers;
- (g) the measures to be taken for radiation protection;
- (h) the procedures for accident prevention;
- (i) the plans for effluent management systems and procedures;
- (j) procedures for dealing with accidental releases of radioactive or non-radioactive contaminants to the environment, including mitigation of hazards;
- (k) impacts on public health and safety and the environment;
- (l) the siting of tailings and storage facilities or stockpiles of ore and waste rock;
- (m) the proposed decommissioning plans, including financial arrangements for decommissioning; and
- (n) security measures.

Responsibilities of the licensee

67. (1) The licensee is responsible for ensuring the safety and security of any mining and processing activity conducted pursuant to the relevant licence.

(2) The licensee shall comply with relevant Regulations and licence conditions imposed by the Authority.

(3) The licensee shall notify the Authority of its intention to modify any activity or practice it is licensed to undertake, if the modifications could have significant implications for the safety and security of persons and the protection of the environment, but not implement those modifications until the notice is received and the modifications approved by the Authority.

Liability for nuclear damage

Nuclear installation

68. For purposes of section 70 to 76, the Authority may consider installations of one operator located at the same site as a single nuclear installation.

Non-discrimination

69. Section 70 to 76 applies to a person without discrimination on the basis of nationality, domicile or residence.

Liability of the operator

70. (1) Subject to this Act, the operator of a nuclear installation is liable for nuclear damage, if it is proved that the damage has been caused by a nuclear incident

(a) at the nuclear installation of that operator; or

(b) involving nuclear material coming from or originating from the installation of that operator.

(2) An operator who was last authorised to possess a particular nuclear material is liable for nuclear damage caused by that nuclear material if the nuclear material is stolen, lost or abandoned.

(3) Liability for nuclear damage shall apply to nuclear damage wherever suffered.

Liability during transportation

71. (1) A sending operator is liable for nuclear damage until a receiving operator has taken charge of the nuclear material being transported.

(2) A carrier is liable for nuclear damage caused by the nuclear material it is contracted to transport, if at the request of the carrier to be responsible for that liability, the sending operator and receiving operator have entered into a written agreement with the carrier to shift that liability to the carrier at the stage of transportation.

(3) In a case where the nuclear material has been sent to a person within the territory of a State that is not party to either the Paris or Vienna Conventions on Nuclear Liability, or the Convention on Supplementary Compensation, the sending operator is liable until the nuclear material has been unloaded from the means of transport by which it is sent and delivered to the receiving operator.

(4) In a case where the nuclear material has been sent from a person within a State that is not party to either the Paris or Vienna Conventions on Nuclear Liability, or the Convention on Supplementary Compensation, the receiving operator is liable only after the nuclear material has been loaded on the means of transport by which it is to be carried from the territory of that non-contracting State.

Amount of liability

72. (1) Subject to any amendments to the Vienna Convention or the country becoming a party to the Convention on Supplementary Compensation, the minimum amount of liability of an operator of a nuclear installation is three hundred million SDRs

(2) Liability for nuclear damage occurring in a non-contracting State that has nuclear installation on its territory at the time of a nuclear incident, may be fixed at an amount not lower than the Cedi equivalent of seven hundred million or the transitional amount of three hundred and fifty million Euros to the extent that the State does not afford reciprocal benefits of an equivalent amount.

Insuring against nuclear liability

73. (1) The operator of a nuclear installation shall maintain an insurance policy to cover the liability of the operator in the event of a nuclear damage proved to have been caused by the nuclear installation of the operator.

(2) The Authority shall in consultation with the National Insurance Commission, set the terms and conditions of an insurance policy covering liability for nuclear damage.

(3) An insurer shall not insure an operator against liability for nuclear damage, unless the operator possesses a licence issued by the Authority, authorising the operator to operate the installation.

Compensation

74. (1) The nature, form and extent of compensation, as well as the equitable distribution of the compensation shall be in accordance with law and as ordered by a court of competent jurisdiction.

(2) Where claims exceed or are likely to exceed the maximum amount required by the Authority to be set aside by an operator for compensation for nuclear damage caused by a nuclear incident shall, the claims shall be settled in the following order:

- (a) claims for compensation for any loss of life or personal injury;
- (b) claims for other loss or damage after all claims under paragraph (a) have been satisfied.

(3) Interest and costs awarded by the court for compensation for nuclear damage does not include the minimum liability amount required under section 72 for purposes of sections 71, 73, 75, 76, 77 and 78.

Limitation on right to compensation

75. (1) A person is barred from making a claim for compensation for nuclear damage under this Act, if the action to establish the claim is not brought within

- (a) three years from the date on which the person suffering damage had knowledge or ought reasonably to have had knowledge of the damage and of the operator liable for the damage, but in any case not more than thirty years after the incident causing the damage;
- (b) thirty years from the date of the nuclear incident, in the case of loss of life or personal injury; or
- (c) ten years from the date of the nuclear incident, in the case of any other form of nuclear damage.

(2) Subject to the rules of court, a person who claims to have suffered nuclear damage and who has submitted a claim for compensation which is not barred by this Act may amend the claim to take into account any aggravation of the damage, even after the expiration of that period if a final judgment in respect of the claim has not been entered.

Jurisdiction

76. (1) A claim made under this Act for compensation for nuclear damage caused by a nuclear incident occurring within the country or within the Exclusive Economic Zone of the country shall lie to the High Court as a court of first instance.

(2) A person who has a right to compensation for nuclear damage under this Act may bring an action for compensation against the liable operator or directly against the insurer.

Exceptions to liability

77. (1) The operator of a nuclear installation is not liable for nuclear damage

- (a) that is proved to be directly caused by any armed conflict, hostility, civil war or insurrection;
- (b) to the nuclear installation itself or any other nuclear installation, including a nuclear installation under construction on the site where the installation is located;
- (c) to any property on the same site which is used or to be used in connection with a nuclear installation; or
- (d) if the damage suffered by an individual is a result of an act done by that individual with an intent to do mischief.

(2) If the operator proves that the nuclear damage resulted wholly or partly either from the gross negligence of the person suffering the damage or from an act or omission of the person done with intent to cause damage, the operator may be relieved, wholly or partly, from the obligation to pay compensation in respect of the damage suffered by that person.

Judgments

78. The High Court shall recognise and enforce the final judgment by a foreign court awarding compensation for nuclear damage as if it were a judgment of the High Court, except where

- (a) the judgment was obtained by fraud;
- (b) the party against whom the judgment was pronounced was not given a fair opportunity to present the case of the party; or
- (c) the judgment is contrary to the public policy of Ghana or is not in accord with fundamental standards of justice.

Inspection and enforcement

Annual levies of licensed persons

79. The Authority may, by legislative instrument, make Regulations to establish a graded levying system for

- (a) minimum compensation for nuclear damage arising from a licensed activity or practice; and
- (b) management and permanent disposal of radioactive waste.

Appointment of inspectors and analysts

80. (1) The Authority shall appoint inspectors and analysts to verify and analyse practices and nuclear installations licensed or proposed to be licensed.

(2) The Authority shall issue to an inspector or analyst, an identification card establishing the credence and work specialty of that inspector or analyst.

Powers of the inspector and the analyst

81. An inspector or an analyst may

- (a) at any time during normal working hours of a nuclear installation or as may be determined by the Authority, enter any premises, vehicle, ship or aircraft without hindrance and with any equipment required by the inspector for the performance of the inspector's duty;
- (b) inspect any plans, drawing, record, register or documents pertaining to
 - (i) the design, siting, construction, testing, development operation, activity or abandonment of an installation;
 - (ii) the health and safety, security or environmental aspect of any activity covered by this Act; and
 - (iii) any matter relevant to the enforcement of this Act;
- (c) carry out tests and take samples, measurements and photographs of the facility;
- (d) ask the occupant of any premises, driver of a vehicle, master of a ship, commander of an aircraft or a person who has duties on or in connection with any premises, vehicle, ship or aircraft, to provide the inspector with information relating to the premises, vehicle, ship or aircraft as required by the inspector;
- (e) obtain information from an operator about the status of safety and security of radiation sources, nuclear materials and any other radioactive material on the nuclear installation of the operator;
- (f) verify compliance of each operator with this Act and the Regulations;

- (g) investigate any incident or accident involving radiation sources, nuclear materials and any other radioactive materials;
- (h) question any person who has duties which may be pertinent to the Authority's enquiries regarding the possession and use of radioactive and nuclear materials; and
- (i) provide the Authority with any requested assistance in the performance of its functions.

Report on inspection

82. (1) An inspector or an analyst shall record in both electronic and hard copies, any observation made during an inspection conducted and make a copy of the record available to the licensed person.

(2) An inspector or analyst shall submit to the Authority a report on an inspection or investigation conducted for appropriate action.

Cessation of activities

83. (1) The Authority may make an order for a temporary cessation of activities, in the case of an imminent or actual hazard to the public or the environment.

(2) The Authority shall order an immediate cessation of the activities of an operator when a situation for which the operator is responsible poses an imminent safety or security hazard to humans and the environment, and shall ensure that the operator resolves the safety and security concerns.

(3) Where there is

- (a) a significant release of nuclear or radioactive material into the environment; or
- (b) a persistent or serious breach of this Act, the Regulations or the conditions of the licence,

the Authority shall order the operator to rectify any unsafe condition that might have resulted from the nuclear or radioactive material released into the environment or the breach, and shall order an immediate cessation of operations if the unsafe condition persists.

(4) The Authority may also modify, suspend or revoke the licence.

(5) The Authority shall indemnify an inspector against a liability incurred in the course of discharging a duty as inspector.

Offences, penalties and appeals

Notice to remedy a contravention

84. The Authority shall issue a warning notice to a licensee who contravenes a minor safety or security requirement or procedure, and shall prescribe in the notice the remedial action to be taken by that person within a time specified in the notice.

False statement and obstruction of inspectors

85. (1) A person who knowingly makes a false or misleading statement to the Authority, or obstructs an officer, an analyst or an inspector of the Authority in the exercise of the functions of the officer, analyst or inspector commits an offence and is liable on summary conviction to a fine of not less than two thousand penalty units and more than five thousand penalty units.

(2) A person who carries on an activity or practice without a licence or who is found in possession of nuclear material or a radiation source without a licence commits an offence and is liable on summary conviction to a fine of not less than five thousand and not more than ten thousand penalty units.

(3) In addition to the provisions in subsections (1) and (2), the Authority shall confiscate and properly dispose of a nuclear material or radiation source that a person possesses within the country without a licence, at the cost of the person found in possession of that material.

Handling of radioactive and nuclear materials and devices

86. (1) A person who without a licence, receives, transfers, alters or disposes of a radioactive material or device or a nuclear material or device

(a) with the intent to cause

(i) death or bodily injury to a person; or

(ii) substantial damage to property or the environment, or:

(b) which causes or is likely to cause

(i) death or bodily injury to a person; or

(ii) substantial damage to property or the environment,

commits an offence and is liable on summary conviction to a fine of not more than ten thousand penalty units or to a term of imprisonment of not more than ten years or to both the fine and the term of imprisonment.

(2) A person commits an offence if the person

(a) steals a radioactive or nuclear material; or

(b) embezzles or fraudulently obtains a radioactive material or nuclear material;

and is liable on summary conviction to a fine of not less than five thousand penalty units or not more than seven thousand five hundred penalty units or to a term of imprisonment of not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

(3) A person who demands a radioactive material or device or nuclear material or device from another person,

- (a) by use of threat;
- (b) by use of force; or
- (c) by any other form of intimidation under circumstances which indicate the imminence of the threat

commits an offence and is liable on summary conviction to a fine of not less than five thousand penalty units and not more than seven thousand five hundred penalty units or to a term of imprisonment of not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

Unlawful use of radioactive or nuclear material

87. A person who uses or makes a threat to use,

- (a) radioactive material or device unlawfully; or
- (b) nuclear material or device unlawfully

to compel another person, a State or an international organisation to do or refrain from doing any act, commits an offence and is liable on summary conviction to a fine of ten thousand penalty units or to a term of imprisonment of not less than ten years or to both the fine and the term of imprisonment.

Offences relating to nuclear facilities

88. (1) A person commits an offence if that person

- (a) damages a nuclear facility by interfering with the operation of that facility with the knowledge that the damage is likely to cause death or bodily injury, or substantial damage to property or the environment; or
- (b) does an act directed at a nuclear facility and in a manner that
 - (i) results in the release of radioactive material; or
 - (ii) risks the release of radioactive material

with the intent that the act will cause death or bodily injury, or substantial damage to property or the environment.

(2) A person who contravenes subsection (1) is liable on summary conviction to a fine of not less than five thousand penalty units and not more than seven thousand five hundred penalty units or a term of imprisonment not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

(3) A person who demands access to a nuclear facility,

- (a) by use of threat;
- (b) by use of force; or
- (c) by any other form of intimidation under circumstances which indicate the credibility of the threat

commits an offence and is liable on summary conviction to a fine of not less than five thousand penalty units or to a term of imprisonment of not less than three years or to both the fine and the term of imprisonment.

- (4) A person who engages in an act to sabotage a facility which uses
 - (a) radioactive material or device; or
 - (b) nuclear material or device,

commits an offence and is liable on summary conviction to a fine of five thousand penalty units or to term of imprisonment not more than five years or to both the fine and the term of imprisonment.

Decision of inspector or analyst subject to appeal

89. (1) A person aggrieved by a decision or measure taken by an inspector in a report submitted to the Authority under section 82(2) may appeal to the Board.

(2) A pending appeal against a decision or a measure taken by an inspector or analyst shall, until the appeal is disposed of, not operate as a stay of that decision or measure.

Complaints procedure

90. (1) A person aggrieved by a decision or action of an inspector, analyst or other employee other than the Executive Director of the Authority may, submit a complaint in writing to the Executive Director of the Authority.

(2) The complaint shall be submitted to the Board within thirty days from the date the complainant becomes aware of the decision or action to which the complaint relates.

- (3) The complaint shall
 - (a) contain the issues objected to; and
 - (b) have attached to it, a copy of the decision objected to and any relevant document for consideration and determination of the complaint;

Appointment of Complaints Panel

91. (1) The Board shall within fourteen days of receipt of a complaint appoint a panel consisting of

- (a) one representative each of the following:

- (i) the Ministry responsible for the affairs of the Authority not below the rank of a Director;
 - (ii) the Attorney-General's Department not below the rank of a Senior State Attorney;
 - (iii) the Ministry with responsibility for the undertaking not below the rank of a director; and
- (b) two persons with specialisation in the complainant's field of operation or industry.

(2) Each panel member shall submit a written statement of disclosure of interest or otherwise in activities related to the nuclear materials or substances.

Hearing by the complaints panel

92. (1) The Board shall refer the complaint to the panel, which shall give a fair hearing to the parties concerned.

(2) The proceedings of the panel shall be recorded and documented.

(3) The panel shall make a recommendation after hearing the parties and submit the recommendation to the Board stating the reasons for the recommendation.

(4) The panel shall submit the recommendation referred to in subsection (3) to the Board within sixty days from the date the complaint is referred to the panel.

(5) The Board may accept the recommendation of the panel or proceed to take its own decision in the interest of the nation, and shall give reasons for either accepting the recommendation or taking its own decision.

(6) The recommendation of the panel shall be recorded and documented.

(7) The panel shall cause copies of the record of proceedings and recommendations to be sent to the Board.

Judicial appeal

93. (1) A person aggrieved by a decision of the Board may appeal to the High Court.

(2) The Court shall on receipt of the appeal call for the record of proceedings and a copy of the decision of the Board with its reasons.

(3) The Court may invite relevant and neutral international experts to give evidence on the subject before the Court.

(4) The proceedings at the Court shall be in camera.

Regulations and guidelines

Regulations

94.(1) The Minister, on the advice of the Board, may, by legislative instrument, make Regulations for the efficient and effective implementation of this Act.

- (2) Without limiting subsection (1), the Regulations shall provide for
- (a) the safety and security of nuclear materials and facilities and non-ionising protection;
 - (b) the types of licences and their duration, renewal, suspension, modification and revocation;
 - (c) the programme and procedure of inspection;
 - (d) how an inspection is to be conducted and the status and powers of an inspector;
 - (e) dose justification, dose limitation, dose optimization, and radiation protection requirements;
 - (f) the regulation of radiation protection, occupational exposure, public exposure, medical, chronic and emergency exposure;
 - (g) the criteria for the categorisation of radioactive sources;
 - (h) a list of levies and licensing fees for categories of activities and practices,
 - (i) penalties for non compliance with licensing conditions in addition to prohibitions and confiscation;
 - (j) for the transportation of radioactive material consistent with the technical requirement of regulations for the safe transport of radioactive materials of the International Atomic Energy Agency, including
 - (i) a list of controlled items;
 - (ii) requirements for notification prior to shipment of exports, where notification is made a condition of the licence;
 - (iii) the establishment procedures for the participation of stakeholders at appropriate stages during the assessment, permission and review process, including persons residing in the vicinity of a proposed nuclear facility;
 - (iv) the criteria for the evaluation of an application and the grant of a permit;

- (v) the periodic revision or updating of the list of controlled items to reflect developments in technology or changes in relevant circumstances;
 - (vi) a Schedule of fees or charges for the issue of permits;
 - (vii) provisions for trans-shipment of material or commodities otherwise not requiring permission for export; and
 - (viii) requirements for records to be kept regarding licensed activities;
- (k) in respect of persons applying a medical procedure which utilises nuclear material, radioactive material or any radiation,
- (i) the qualification of persons who will apply the procedure;
 - (ii) refresher training requirements for persons who the procedure;
 - (iii) measures for the protection of persons who operate the radiation emitting device and equipment containing radionuclides, applied in the procedure; and
 - (iv) measures for protecting patients, including justification for the use of the procedure and the maximum dose limit a patient is to be exposed; and
- (l) the design and performance criteria for radiation emitting devices and equipment containing radionuclides;
- (m) the processes for mining uranium and thorium;
- (n) requirements for licensing nuclear power plants;
- (o) requirements for licensing nuclear facilities;
- (p) the management of nuclear and radioactive waste;
- (q) the licensing requirements for petroleum and natural gas exploration and extraction where radioactive materials are used or where there is a naturally occurring radioactive material;
- (r) the segregation, characterisation, conditioning, storage and treatment of radioactive waste;
- (s) the basic content of a decommissioning plan and for the financial aspects of a decommissioning exercise;

- (t) the transportation and storage of nuclear and radioactive materials and waste;
- (u) transport of radioactive material and sources in accordance with International Atomic Energy Agency (TSR- I) requirements;
- (v) nuclear power generation;
- (w) the qualification and certification of personnel to man facilities;
- (x) administrative sanctions to be imposed on persons who possess nuclear material and radiation sources;
- (y) the establishment of obligations and standards approved by the International Atomic Energy Agency on siting, design, construction, operation, assessment and verification;
- (z) standard information on airborne and liquid radioactive discharges into the environment from nuclear reactors and reprocessing plants in normal operation.
- (aa) the basic content of an emergency preparedness plan, whether on site and off site, and trans-boundary emergencies;
- (bb) safety and security of radiation sources and irradiation facilities;
- (cc) the control of illicit trafficking of nuclear material;
- (dd) the implementation of additional Protocols to the Non-Proliferation Treaty and Safeguards Agreement;
- (ee) the requirements and standards for providing services like personal monitoring using Thermoluminescence Detectors or calibration radiation instruments and consultancy to licensed practices; and
- (ff) implement other international conventions which relate to nuclear technology and to which Ghana is signatory and has ratified.

Guidelines, standards and procedures

95. (1) The Authority may also develop guidelines, standards and procedures on the following:

- (a) notification, licensing and exemptions of practices and activities;
- (b) radiation protection and safety requirements for workers, the public and the general environment;
- (c) security measures for deterring, detecting and delaying unauthorised access to, the theft of, loss or unauthorised use or removal of radioactive sources or nuclear material;

- (d) inspection and reporting procedures; and
- (e) any other subject matter of relevance for the safety and security of the employees of the Authority.

(2) The Authority shall cause the guidelines, standards and procedures to be published in the *Gazette*.

Miscellaneous provisions

Annual budget of the Authority

96. (1) The Authority shall, not later than three months before the end of each financial year, cause to be prepared and submitted to the Minister, an annual budget in respect of the ensuing financial year.

(2) The Board shall approve the annual budget of the Authority before its submission to the Ministry of Finance.

Accounts and audit

97. (1) The Board shall keep books of accounts and proper records in relation to them in a form approved by the Auditor-General.

(2) The Board shall submit the accounts of the Authority to the Auditor-General for audit within three months after the end of the financial year.

(3) The Auditor-General shall audit the accounts and make a report on the audited accounts within three months after receipt of the accounts and forward a copy of the audit report to the Board and the Minister.

Annual report and other reports

98. (1) The Board shall within one month after receipt of the audit report, submit to the Minister an annual report covering the activities and the operations of the Authority for the year to which the report relates.

(2) The annual report shall include the report of the Auditor-General.

(3) The Minister shall, within one month after the receipt of the annual report, submit the report to Parliament with a statement the Minister considers appropriate.

(4) The Board shall also submit to the Minister any other report which the Minister may require in writing.

Interpretation

99. In this Act, unless the context otherwise requires, "activity" includes

- (a) the design, manufacture, construction, import, export, distribution, sale, loan, commissioning, use, operation, maintenance, repair, transfer, decommissioning or possession of radiation sources for industrial, education, research, agriculture and medical purposes;
- (b) the transport of radioactive material;
- (c) the mining and processing of radioactive ores;
- (d) the closing down of associated facilities;
- (e) the cleanup of sites affected by residues from past activities;
- (f) the development, production and use of nuclear energy;
- (g) radioactive waste management activities, including the discharge of effluents;
- (h) an activity involving a nuclear material as defined in the Safeguards Agreement; and
- (i) an activity involving a nuclear material in a nuclear installation;

“Additional Protocol” means the Protocol Additional to the Agreement between the Government of the Republic of Ghana and the International Atomic Energy Agency for the application of safeguards in connection with the Treaty on the Non-proliferation of Nuclear Weapons, which entered into force on the 12th of June 1998;

“applicant” means a person who has applied for a licence or a permit under this Act;

“authorised person” means the holder of permit granted for a practice or a source and who has recognised rights and duties for the practice or source, particularly, in relation to safety of persons, security of the practice or source and for the protection of the environment;

“Authority” means the Radiation Protection Authority established under section 3;

“baseline survey” means initial assessment of the site to be decommissioned before commencement of the decommissioning process.

“Board” means the governing board of the Authority constituted under section 8(1);

“civilian nuclear reactor” means non-military nuclear reactor;

“clearance” means the removal of radioactive materials or radioactive objects within authorised practices from any further control by the regulatory body;

“consignee” means a person or government which receives a consignment.

“consignor” means individual, organisation or government which prepares a consignment for transport, and is named as consignor in the transport document;

- “consignment” means any package or load of radioactive material and nuclear material presented by a consignor for transportation;
- “controlled items” means items identified by this Act as requiring regulation;
- “controlled practice” means practices identified by this Act as requiring regulation;
- "discharge" means planned and controlled releases into the environment, as a legitimate practice, within limits authorized by the regulatory body, or liquid or gaseous radioactive materials that originate from regulated nuclear facilities during normal operation;
- “dose” means a measure of the energy deposited by radiation in a target’
- “end state” means the state of radioactive waste in the final stage of radioactive waste management in which the waste is passively safe and does not depend on institutional control;
- “Executive Director” means the Executive Director appointed under section 16;
- “exemption” means a determination by the Authority that a source or practice or some aspects of the source or practice need not be subjected to regulatory control on the basis that the exposure (including potential exposure) due to the source or practice is too small to warrant the application of those aspects;
- “exclusion” means the exemption of a particular category of exposure from the scope of this Act on the grounds that it is not considered amenable to control;
- “export” means the physical transfer of nuclear material and related equipment, information and technology determined by the Authority as originating from Ghana, into an importing State;
- “facility” includes a reactor, a critical facility, a conversion plant, a fabrication plant, a reprocessing plant, an isotope separation plant or a separate storage installation; or any location where nuclear material in amounts of one effective kilogram is customarily used;
- “Fund” means the Nuclear Authority Fund established under section 22;
- “man - made factors” includes settlements and related activities likely to impact on safety of a nuclear installation;
- “import” means the physical transfer, into Ghana, originating from an exporting State, of nuclear material and related equipment, information and technology, as defined by the Authority;
- "intervention" means any act intended to reduce or avert exposure or the likelihood of exposure to sources which are not part of a controlled practice or which are out of control as a consequence of an accident;
- "licence" means the written permit granted by the Authority to a person who has submitted an application to carry out an activity or practice. A licence may take the form of a licence, permit or registration as determined by the Authority; it may be accompanied by specific requirements and conditions to be complied with by the authorised person;

“location outside facilities” means an installation or location, which is not a facility, where nuclear material is customarily used in amounts of one effective kilogram or less;

"ionizing radiation " means, for the purposes of radiation protection, radiation capable of producing ion pairs in biological materials;

“measures of reinstatement” means any reasonable measures which have been approved by the Authority and which aim to reinstate or restore damaged or destroyed components of the environment, or to introduce, where reasonable, the equivalent of these components into the environment;

“mine or mill processing radioactive ores” means installation for mining, milling or processing ores that contain uranium series or thorium series radionuclides;

“Minister” means the Minister responsible for the Authority;

"notification" means a document submitted to the Authority by a person of an intention to carry out a activity or practice;

“nuclear damage” means

- (a) loss of life or personal injury;
- (b) loss of property or damage to property;
- (c) economic loss arising from loss, injury or damage referred to under paragraph (a) or (b), and incurred by a person entitled to claim in respect of that loss, injury or damage;
- (d) the costs of measures taken or to be taken to reinstatement an impaired environment, except where the impairment is insignificant;
- (e) loss of income derived from an economic interest in any use or enjoyment of the environment, incurred as a result of a significant impairment of that environment;
- (f) the cost of preventive measures, and further loss or damage caused by those measures;
- (g) any other economic loss, other than that caused by the impairment of the environment, if permitted by the general law on civil liability of a court of competent jurisdiction; and
- (h) in the case of paragraphs (a) to (e) and (g) above, to the extent that the loss or damage arises out of or results from ionizing radiation emitted by any source of radiation inside a nuclear installation, or emitted from nuclear fuel or radioactive products or waste in, or of nuclear material coming from, originating in, or sent to, a nuclear installation, whether so arising from the radioactive properties of that matter, or from a combination of radioactive properties with toxic, explosive or other hazardous properties of that matter;

“nuclear energy” means energy released in nuclear fission or fusion;

“nuclear fuel” means any material which is capable of producing energy by self-sustaining chain process of nuclear fusion;

“nuclear incident” means any occurrence or series of occurrences having the same origin which

- (a) causes nuclear damage, but with respect to preventive measures only, or
- (b) creates a grave and imminent threat of causing that damage;

“nuclear installation” means

- (a) nuclear power plant, enrichment plant or reprocessing facility;
- (b) any nuclear reactor other than one with which a means of sea or air transport is equipped for use as a source of power, whether for its propulsion or for any other purpose;
- (c) any factory using nuclear fuel for the production of nuclear material, or any factory that processes nuclear material, including any factory for the re-processing of irradiated nuclear fuel; and
- (d) any facility where nuclear material is stored, other than storage incidental to the carriage of the material;

"nuclear material" means,

- (a) the material of the atomic nucleus;
- (b) nuclear fuel, other than natural uranium and depleted uranium, capable of producing energy by a self-sustaining chain process of nuclear fission outside a nuclear reactor, either alone or in combination with some other material; and,
- (c) radioactive products or waste;

“nuclear reactor” means any structure containing nuclear fuel arranged in a manner to create a self-sustaining chain process of nuclear fission that can occur without an additional source of neutrons;

"operator" means the person legally recognised as responsible for the operation of a nuclear installation or the person designated by the legally recognised operator;

“ore” means geological material that may contain nuclear or radioactive material or substances;

“orphan source” means a radioactive source which is not under regulatory control because it has never been under regulatory control, or because it has been abandoned, lost, misplaced, stolen, or transferred without proper authorisation;

“peaceful use” means non military use of nuclear and radioactive material or technology;

"practice" means any human activity that introduces additional sources of exposure or exposure pathways or extends exposure to additional people or modifies the network of exposure pathways from existing sources, so as to increase the exposure or the likelihood of exposure of people or the number of people exposed;

“preventive measure” means any reasonable measure approved by the Authority to be taken by a person to prevent or minimize a nuclear damage after an incident has occurred;

"radiation" means anything that may cause radiation exposure, such as by emitting ionizing or non-ionizing radiation or releasing radioactive substances or materials;

“radioactive material” means

- (a) anything containing radio nuclides that may cause radiation exposure;
or
- (b) a naturally occurring radioactive material;

“radioactive products” means any material made radioactive by exposure to radiation incidental to the production or utilisation of nuclear fuel, but does not include radioisotopes which have reached the final stage of fabrication and can be used for any scientific, medical, agricultural, commercial or industrial purpose;

"radioactive source” means radioactive material that is permanently sealed in a capsule or closely bonded, in a solid form and which is not exempt from regulatory control and includes any radioactive material released through the breakage or leaking of the source, but does not include nuclear material or material encapsulated for disposal;

“radioactive waste” means material, in whatever physical form, remaining from practices or interventions and for which further use is not foreseen

- (a) that contains or is contaminated with radioactive substances and has an activity or activity concentration higher than the level set for clearance from regulatory requirements, and
- (b) exposure to which is not excluded from this Act or Regulations;

“reasonable measure” means a measure permitted under the laws of Ghana as being appropriate and proportionate to the damage, having regard among other things to

- (a) the nature and extent of the damage incurred or, in the case of preventive measures, the nature and extent of the risk of that damage;

- (b) the extent of effectiveness of the measure at the time it was taken; and
- (c) relevant scientific and technical expertise;

“Regulations” means Regulations made under this Act;

“Safeguards Agreement” means an Agreement between the Government of the Republic of Ghana and the International Atomic Energy Agency for the application of safeguards in connection with the Treaty on the Non-proliferation of Nuclear Weapons, which entered into force on 17 February 1975 for the purpose of implementation of safeguards;

“sealed source” means radioactive material that is

- (a) permanently sealed in a capsule; or
- (b) closely bounded and in a solid form;

“security” means measures to prevent unauthorized access or damage to, loss, theft or unauthorised transfer of, radioactive sources or nuclear material;

“source” means anything that may cause radiation exposure, including

- (a) the emission of ionizing radiation;
- (b) the release of radioactive substances or materials;
- (c) materials that emit radon in the environment,
- (d) a sterilization gamma irradiation unit; or
- (e) an x-ray unit;

“source material” means a material which is a source; and

“spent fuel” means, (a) nuclear fuel removed from a reactor following irradiation that is no longer usable in its present form because of depletion of fissile material, poison build up or radiation damage; (b) nuclear fuel that has been irradiated and permanently removed from a reactor core;

“unamenable” includes sources of radiation exposure that cannot be controlled from the point of view of protection and safety and cosmic rays at ground level and potassium 40 in the environment.

Revocation and savings

100. (1) The Radiation Protection Instrument, 1993 (LI 1559) is revoked.

(2) Despite the revocation under subsection (1), an authorisation granted to a person under the Radiation Protection Instrument, 1993 (L.I. 1559) to engage in an activity or a practice to which this Act applies shall, subject to modifications to bring it into conformity with this Act, be deemed to be a licence or permit issued under this Act and shall continue to be in force until its revocation or expiration.

Consequential amendments

101. The enactments specified under Column 1 of the Schedule are amended to the extent corresponding under Column 2 of that Schedule.

SCHEDULE

(Section 101)

Consequential amendments

Column 1 <i>(Enactment)</i>	Column 2 <i>(How affected)</i>
<p>1. Ghana Atomic Energy Commission Act, 2000, (Act 588)</p> <p>2. Environmental Protection Agency Act, 1994 (Act 490)</p> <p>3. Factories, Shops and Offices Act, 1970 (Act 328)</p> <p>4. Minerals and Mining Act, 2006 (Act 703)</p>	<p>Section 3(1) (a) and (e) and 14 repealed.</p> <p>Section 12 is amended by inserting after subsection (2)</p> <p>“(3) Despite subsection (1), the Nuclear Authority established under section 3 of the Nuclear Act, 2011 (NRA Bill) shall issue the appropriate notice, where the activity or practice to be undertaken involves a nuclear or radio-active material.”.</p> <p>Section 83(2) is amended by</p> <p>(a) deleting “and” after paragraph (g);</p> <p>(b) inserting “and” after paragraph (h); and</p> <p>(c) inserting after paragraph (h), paragraph (i)</p> <p>“(i) the premises of a facility as defined under the Nuclear legislation.”.</p> <p>1. Section 62 is amended by substituting for subsections (2) and (3) the following:</p>

	<p>“(2) Where a radio-active mineral is discovered in the course of exercising a right under this Act or under another enactment, the holder of the mineral right or another person shall immediately notify the Nuclear Authority, the Commission and the Geological Survey Department of the discovery.</p> <p>(3) Where a radio-active mineral is discovered on land other than land subject to a mineral right, the owner of the land shall immediately notify the Nuclear Authority, the Commission and the Geological Survey Department of the Discovery.”;</p> <p>2. Section 63 is substituted as follows:</p> <p>“63. A holder of a licence or lease under section 62 shall within the first week of each month furnish the Nuclear Authority, the Commission and the Geological Survey Department with a true report in writing of the prospecting and mining operations conducted by the holder in the immediately preceding month with respect to radio-active minerals.”.</p> <p>3. Section 64 is substituted as follows:</p> <p>“64. (1) A person shall not export a radio-active mineral except under or in accordance with the terms and conditions of a permit granted for that purpose by the Nuclear Authority acting after consultation with the Minister.</p> <p>(2) A permit issued under subsection (1) shall be in the form and is subject to the payment of the fee the Minister responsible for the Nuclear Authority acting consultation with the Minister, may on the advice of the Commission determine.</p> ”
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APPENDIX C:

A MODEL LEGISLATIVE INSTRUMENT TO 'OPERATIONALIZE' THE NRA BILL

(This Model LI draws on Stoiber *et al.*, Handbook on Nuclear Law: Implementing Legislation, *supra* note 50)

C.1. Introduction

Given the broad and comprehensive scope of the NRA Bill, Regulations or legislative instrument to implement or operationalize it may have to include detailed provisions on, *inter alia*:

- I. Objectives of the legislative instrument
- II. Scope of the legislative instrument
- III. Definitions of key terms
- IV. The Nuclear Regulatory Authority
- V. Notifications
- VI. Authorizations (licences, permits, etc.)
- VII. Inspection
- VIII. Enforcement
- IX. Responsibilities of licensees, operators, users
- X. Specific Sections for relevant subject areas, such as:
 - Radiation protection
 - Radioactive sources and radioactive material
 - Safety of nuclear facilities and decommissioning
 - Emergency preparedness and response
 - Mining and processing of radioactive material
 - Transport of radioactive material
 - Radioactive waste and spent fuel
 - Nuclear liability and coverage
 - Safeguards
 - Export and import control
 - Nuclear security and physical protection
 - Miscellany of clauses (entry into force, amendments, repeals, etc.)

The Draft NRA Bill has copious provisions on the Regulatory Authority, its establishment, objects, functions, powers, duties, governing body, tenure of office of members, meetings of the Board, disclosure of interest, establishment of committees, advisors and consultants, allowances, and ministerial directives; as well as the administration, staff, and directorates of the Authority. In view of the constraints of time and space for this thesis, this draft LI did not deal with issues of the regulatory body, mining and processing of radioactive material, transport of radioactive material, radioactive waste and spent fuel, nuclear liability and coverage, safeguards, export and import control, nuclear security and physical protection, and related matters.

This proposed draft Model Legislative Instrument to implement the Act and provide for related matters rather focuses on key regulatory functions, and matters related to the regulation of *safety* in nuclear power generation: i.e., Notification, Authorizations (licences, permits, etc.), Inspection, Enforcement, Responsibilities of licensees, operators, users, and only four (4) of the Specific relevant subject areas: radiation protection, radioactive sources and radioactive material, safety of nuclear facilities and decommissioning, and emergency preparedness and response.

C.2. MODEL PROVISIONS ON NOTIFICATION

Regulation ##. Notification

- (1) Any person who intends to engage in an activity or practice involving ionizing radiation shall submit a notification to the Authority of its intention to carry out such activity or practice in the prescribed form and within the time limits required by the Authority as set out in Schedule I herein.
- (2) Notification is required for the purpose of providing prompt information to the Nuclear Regulatory Authority in other areas including, in the case of:
 - (a) An intention to dispose of radioactive sources;
 - (b) An intention to modify any practice or activity that could have consequences for radiation protection;
 - (c) Any incident or accident occurring during the conduct of the practice or activity.

C.3. MODEL PROVISIONS ON AUTHORIZATION (LICENSING)

Regulation ##. Requirement for an Authorization (Licence)

A person shall not engage in an activity or a practice which involves the use of nuclear material, radioactive material or any radiation, unless that person is specifically licensed by the Authority, or unless the practice has been exempted from regulatory control.

Regulation ##. Justification for Authorized (Licensed) Activities or Practices

The Authority shall only issue an authorization (licence) for activities or practices that:

- (a) Can be conducted in a manner that adequately ensures protection of people and environment;
- (b) Will be conducted only for peaceful purposes consistent with the obligations of Ghana under relevant international instruments including the Convention on Nuclear Safety, Joint Convention on the Safety Management of Spent Fuel and the Safety Management of Radioactive Waste ...

Regulation ##. Authorization (Licensing) Process: Application for licence

- (1) Subject to this Act, a person who intends to engage in any activity or practice involving
 - (a) nuclear material or radioactive material,
 - (b) nuclear waste or radioactive waste, or
 - (c) radiationshall apply to the Authority in writing and pay the prescribed fees for a licence.
- (2) The application and prescribed fees, as set out in Schedule II, shall be addressed to the Executive Director.
- (3) On receipt of an application, the Executive Director shall acknowledge receipt of the application not later than five days after receipt of the application.
- (4) The Authority shall subject to subclause (5), consider the application and may grant or refuse the licence within thirty-five days from the date of acknowledging receipt of the application and inform the applicant in writing about the decision.
- (5) The Authority shall, where an application made under subclause (1) is refused, state the reasons for the refusal.

- (6) The Authority may request the applicant to provide further information and may for that purpose extend the period for the grant of the licence.
- (7) The Authority shall, in considering an application made under subclause (1), ensure that
- (a) the benefits of the activity or practice for which the licence is sought outweighs any radiation detriment which may be suffered as a result of that activity or practice, taking into consideration social, economic and other relevant factors;
 - (b) the applicant has taken the necessary steps to protect humans and the environment by keeping doses of radiation within reasonably acceptable and authorised limits and that all reasonable steps are taken to minimize the adverse effects on persons and the environment;
 - (c) it verifies the necessary technical and organisational measures taken by the applicant to ensure adequate safety and security, including effective protection against radiological hazards;
 - (d) the applicant has adequate understanding of the fundamental principles of radiation protection;
 - (e) the applicant establishes an appropriate emergency preparedness and response plan to respond to incidents, accidents or emergencies;
 - (f) applicant has in place adequate financial arrangements to safely and securely manage the radioactive waste and to undertake decommissioning activities, where it is not possible to return the radioactive waste to the supplier;
 - (g) the applicant has in place the necessary arrangements for the return of the radioactive waste to the supplier after its useful life;
 - (h) the applicant establishes a system of accounting and control of nuclear or radioactive material at the facility level;
 - (i) the applicant has in place programmes for recruiting qualified persons and training them in safety and security of the radioactive materials and sources used; and
 - (j) the applicant has a detailed plan for discontinuing the activity or practice for which the licence is sought.
- (8) For purposes of subclause (7)(b), doses of radiation exposure is reasonably acceptable and within the authorised limit, if it is within the range prescribed by these Regulations in Schedule II for the activity or practice for which the licence is sought.
- (9) The Authority shall follow procedures and requirements for public participation in the authorization (licensing) process, as specified in Schedule III herein;

- (10) The Authority shall observe procedures and requirements for the release of information concerning the licensing proceedings, including measures for the protection of classified and proprietary information;
- (11) A person dissatisfied with a decision of the Authority made under subclause (4) may appeal to the High Court.
- (12) A non-payment of any fees required for authorizations (licences) may attract sanctions.

Reg. ##. Suspension, Modification, Renewal, Revocation or Relinquishment of Licences

- (1) Any authorization (licence) issued pursuant to these regulations may be suspended, modified or revoked by the Authority in the event of a violation of its conditions, when the conditions under which it was issued are no longer met, or in any circumstance where the Authority determines that continued activity under the authorization (licence) would pose an unacceptable risk to people or the environment.
- (2) The Authority may suspend the licence of a licensee where
 - (a) allegations of misconduct have been made against the licensee;
 - (b) a false declaration was made in an application for a licence issued to the licensee; or
 - (c) the licensee has contravened a provision of this Act or the Regulations.
- (3) The Authority shall revoke a licence if
 - (a) the licensee is convicted of an offence under the Act or these Regulations; or
 - (b) is convicted to a term of imprisonment for a criminal offence.
- (4) The Authority shall make publicly available a statement providing information on the procedures and requirements for suspension, modification, renewal, revocation or relinquishment of authorizations (licences).
- (5) An authorization (licence) shall not be transferred.
- (6) An authorization (licence) shall cease to be valid when any time limit established by regulation or condition of the authorization (licence) has expired.
- (7) An authorization (licence) may be relinquished by the holder of the authorization (licence) upon notice to the Authority and upon a determination by the Authority that relinquishment will not jeopardize the protection of people or the environment.

Regulation ##. Obtaining information

- (1) For purposes of section 26 (6) of the Act, the Executive Director, an employee or any other person authorised by the Executive Director shall have access to the relevant records, books or facilities of the person requested to provide the information.
- (2) The applicant shall make available any information considered necessary by the Authority.

Regulation ##. Obligations of a licensee

- (1) A person licensed to conduct an activity or a practice under section 26(5) of the Act
 - (a) shall not transfer a right or an obligation under the licence to another person;
 - (b) shall have the primary responsibility for the safe and secure conduct of that activity or practice and for ensuring compliance with the Act, this law and all applicable regulatory requirements and conditions of the authorization (licence) related to that activity or practice
 - (c) shall ensure that appropriate measures are taken to handle and finally dispose of radioactive waste arising from the licensed activity or practice in a safe manner;
 - (d) shall ensure that appropriate measures are put in place for the decommissioning and dismantling of facilities in which the licensed activity or practice is conducted;
 - (e) shall ensure that persons employed for purposes of the licensed activity or practice and the public are protected from radiological injury;
 - (f) shall ensure compliance with requirements and dose limits established by the Authority,
 - (g) shall ensure that radiation doses to the public, the number of persons exposed and persons employed for purposes of the activity or practice, including doses released into the environment, are within reasonably acceptable and authorised limits taking into consideration social and economic factors;
 - (h) shall before the cessation of the licensed activity or practice, inform the Authority of its decision to cease the activity or practice;
 - (i) shall maintain records required by the Authority and make them available for inspection as required;
 - (j) shall provide the Authority with any requested assistance in the performance of its regulatory functions; and
 - (k) shall provide
 - (i) information to the Authority as required by the Authority; and
 - (ii) the Authority access to its premises for purposes of verifying compliance with applicable Regulations and licence conditions.
- (2) A licensee who contravenes subclause (1) commits an offence is liable on summary conviction to a fine of not less than seven hundred and fifty penalty units and more than two thousand five hundred penalty units or to a term of imprisonment of not less than three years and not more than five years or to both the fine and imprisonment.

C.4. MODEL PROVISIONS ON INSPECTION

Regulation ##. Appointment [Designation] of Inspectors and Analysts

- (1) The Authority shall formally appoint (designate) inspectors and analysts possessing required qualifications and training and shall issue them with appropriate identification establishing their credentials, specialty and legal status under the laws of Ghana.

- (2) The inspectors and analysts shall verify and analyse practices and nuclear installations licensed or proposed to be licensed.

Regulation ##. Inspection Programme

The Authority shall

- (a) establish an inspection programme to monitor compliance with the requirements of these Regulations, the Act, applicable regulations, and the terms and conditions of authorizations (licences) issued under its authority.
- (b) establish qualifications for inspectors and a training programme to ensure a high level of competence for inspectors.
- (c) have the authority to station inspectors at the site of an activity or practice where this is determined to be necessary.
- (d) ensure that the inspection programme is supported by adequate financial, technical and human resources to meet its objectives.

Regulation ##. Conduct of Inspections

- (1) The Authority shall have the authority to conduct inspections and to carry out any other such examination as may be necessary to verify compliance with the provisions of these Regulations, the Act, applicable regulations and any applicable conditions of authorizations (licences).
- (2) Inspectors shall have access at any time to all parts of the premises or facilities where activities or practices are carried out, with a view to:
 - (a) Obtaining information about the status of their radiation safety and security;
 - (b) Verifying compliance with the provisions of these Regulations, the Act, any applicable regulations, and the terms and conditions of authorizations (licences);
 - (c) Investigating any incident or accident involving nuclear material or radiation sources;
 - (d) Questioning any person who has duties which in the view of the authorized representatives of the [name of regulatory body] may be pertinent to the inspection being carried out.
- (3) Whenever practicable, reasonable notice that an inspection is to be carried out should be provided to the authorized person (licensee) by the Authority. However, in the event of emergencies or unusual occurrences, or where unauthorized activities or criminal violations may have occurred, inspections may be conducted immediately or upon short notice.
- (4) Inspection results shall be documented and recorded, and be made available to relevant officials and authorized (licensed) persons and other entities as a basis for corrective or enforcement action in particular cases or for development of the regulatory process.

Regulation ##. Powers of the inspector and the analyst

An inspector or an analyst may

- (a) at any time during normal working hours of a nuclear installation or as may be determined by the Authority, enter any premises, vehicle, ship or aircraft without hindrance and with any equipment required by the inspector for the performance of the inspector's duty;
- (b) inspect any plans, drawing, record, register or documents pertaining to

- (i) the design, siting, construction, testing, development operation, activity or abandonment of an installation;
 - (ii) the health and safety, security or environmental aspect of any activity covered by the Act; and
 - (iii) any matter relevant to the enforcement of the Act;
- (c) carry out tests and take samples, measurements and photographs of the facility;
- (j) ask the occupant of any premises, driver of a vehicle, master of a ship, commander of an aircraft or a person who has duties on or in connection with any premises, vehicle, ship or aircraft, to provide the inspector with information relating to the premises, vehicle, ship or aircraft as required by the inspector;
- (k) obtain information from an operator about the status of safety and security of radiation sources, nuclear materials and any other radioactive material on the nuclear installation of the operator;
- (l) verify compliance of each operator with the Act and these Regulations;
- (m) investigate any incident or accident involving radiation sources, nuclear materials and any other radioactive materials;
- (n) question any person who has duties which may be pertinent to the Authority's enquiries regarding the possession and use of radioactive and nuclear materials; and
- (o) provide the Authority with any requested assistance in the performance of its functions.

Regulation ##. Report on inspection

- (1) An inspector or an analyst shall record in both electronic and hard copies, any observation made during an inspection conducted and make a copy of the record available to the licensed person.
- 2) An inspector or analyst shall submit to the Authority a report on an inspection or investigation conducted for appropriate action.

Regulation ##. Cessation of activities

- (1) The Authority may make an order for a temporary cessation of activities, in the case of an imminent or actual hazard to the public or the environment.
- 2) The Authority shall order an immediate cessation of the activities of an operator when a situation for which the operator is responsible poses an imminent safety or security hazard to humans and the environment, and shall ensure that the operator resolves the safety and security concerns.
- (3) Where there is a
 - (a) significant release of nuclear or radioactive material into the environment; or
 - (b) persistent or serious breach of the Act, these Regulations or the conditions of the licence,

the Authority shall order the operator to rectify any unsafe condition that might have resulted from the nuclear or radioactive material released into the environment or the breach, and shall order an immediate cessation of operations if the unsafe condition persists.

- (4) The Authority may also modify, suspend or revoke the licence.
- (5) The Authority shall indemnify an inspector against a liability incurred in the course of discharging a duty as inspector.

C.5. MODEL PROVISIONS ON ENFORCEMENT, OFFENCES AND PENALTIES

Regulation ##. Enforcement

- (1) Where an authorized (licensed) person or entity is found to be in noncompliance with (violation of) these Regulations, the Act, applicable regulations or the terms and conditions of the authorization (licence), the Authority shall take necessary enforcement actions commensurate with the seriousness of the non-compliance (violation).
- (2) In all cases, the person or entity subject to enforcement action shall take the necessary measures to remedy the non-compliance (violation) as soon as possible, as required by the Authority, and take the necessary measures to prevent a recurrence.
- (3) For cases involving non-compliance (a violation) that is of minor safety or security significance, the Authority may issue a warning in writing and determine the period of time during which remedial action must be taken but not later than [specify period].
- (4) For cases representing an immediate safety or security hazard to people or the environment, the Authority may require the person or entity subject to enforcement action to suspend its activities until the situation has been corrected. In such cases, the Authority may also suspend, revoke or modify the terms and conditions of the authorization (licence).
- (5) In cases of persistent or extremely serious non-compliance with (violation of) the terms and conditions of an authorization (a licence) or in cases of significant release of radioactive waste into the environment, the Authority may revoke the authorization (licence) and require the authorized person (licensee) to remedy any unsafe condition.

Regulation ##. Enforcement by Inspectors

- (1) In any case where an inspector of the Authority has determined that an activity or practice is being conducted in violation of these Regulations, the Act, applicable regulations or the terms and conditions of an authorization (a licence) and poses an immediate risk of injury to persons or substantial damage to property or the environment, the inspector may:
 - (a) Immediately order the temporary (or permanent) suspension of the activity or practice; or
 - (b) Order the authorized person or entity to prohibit workers who do not meet applicable requirements from engaging in the activity or practice;
 - (c) Order that nuclear or radioactive material originating from a suspended activity or practice be safely and securely stored.
- (2) Decisions taken by inspectors under para. (1) shall continue to be in force unless and until:
 - (a) Withdrawn by the inspector;
 - (b) Reversed or modified by action of the Authority; or

(c) Altered through an administrative appeal or judicial review.

- (3) In cases of enforcement by inspectors, a report (protocol, dossier) shall be issued containing relevant findings and identifying the evidentiary basis for the findings, including measurements, test results, explanations or other information. This report shall be made available to the authorized person (licensee), who shall have the right to submit explanations or objections within [specify time period] of the issuance of the report.

Regulation ##. Offences Subject to Penalties

Any person who fails to comply with (violates) the terms of these Regulations, the Act, applicable regulations or the terms of any authorization (licence) is guilty of an offence and may be subject to the penalties established by the Act and any applicable laws and regulations.

Regulation ##. Administrative Penalties

Administrative penalties imposed by the Authority may include suspension, modification or revocation of an authorization (licence).

Regulation ##. Civil (Monetary) Penalties

- (1) Where the Authority has determined that a person or entity has failed to comply with the provisions of this Law, implementing regulations or terms and conditions of an authorization (a licence), it may impose a monetary penalty (civil fine) in an amount not to exceed [specify amount in Ghana cedis or penalty points] for any single violation.
- (2) In cases of repeated, especially serious or intentional, acts of noncompliance (violation), an additional penalty not to exceed [specify amount or penalty units] may be imposed.

Regulation ##. Authority of Regulatory Body to Determine Penalties

The Authority shall establish a range of penalties, both administrative and civil (monetary), to be imposed in cases of non-compliance with (violation of) the provisions of these Regulations, the Act, applicable regulatory requirements or the terms and conditions of an authorization (a licence).

Regulation ##. Criminal Penalties

Any person who intentionally and with a criminal motive violates the terms of these Regulations, the Act, applicable regulations or the terms and conditions of an authorization (a licence) is guilty of an offence and may, upon conviction in a court of law, be subject to a fine not exceeding [specify amount in Ghana cedis or in penalty units] or imprisonment for a period not exceeding [number of] years, or to both a fine and such imprisonment.

Regulation ##. Criminal Offences and Process

- (1) The Authority may recommend (refer) to the Police, the Attorney General, or appropriate institution, the prosecution of any person under these Regulations, the Act or other applicable statutes and codes who is believed to have committed a criminal violation.
- (2) A person who knowingly makes a false or misleading statement to the Authority, or obstructs an officer, an analyst or an inspector of the Authority in the exercise of the functions of the officer, analyst or inspector commits an offence and is liable on summary conviction to a fine of not less than two thousand penalty units and more than five thousand penalty units.

(3) A person who carries on an activity or practice without a licence or who is found in possession of nuclear material or a radiation source without a licence commits an offence and is liable on summary conviction to a fine of not less than five thousand and not more than ten thousand penalty units.

(4) In addition to the provisions in subclauses (1) and (2), the Authority shall confiscate and properly dispose of a nuclear material or radiation source that a person possesses within the country without a licence, at the cost of the person found in possession of that material.

(5) A person who without a licence, receives, transfers, alters or disposes of a radioactive material or device or a nuclear material or device

(a) with the intent to cause

(i) death or bodily injury to a person; or

(ii) substantial damage to property or the environment, or:

(b) which causes or is likely to cause

(i) death or bodily injury to a person; or

(ii) substantial damage to property or the environment,

commits an offence and is liable on summary conviction to a fine of not more than ten thousand penalty units or to a term of imprisonment of not more than ten years or to both the fine and the term of imprisonment.

(6) A person commits an offence if the person

(a) steals a radioactive or nuclear material; or

(b) embezzles or fraudulently obtains a radioactive material or nuclear material;

and is liable on summary conviction to a fine of not less than five thousand penalty units or not more than seven thousand five hundred penalty units or to a term of imprisonment of not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

(7) A person who demands a radioactive material or device or nuclear material or device from another person,

(a) by use of threat;

(b) by use of force; or

(c) by any other form of intimidation under circumstances which indicate the imminence of the threat

commits an offence and is liable on summary conviction to a fine of not less than five thousand penalty units and not more than seven thousand five hundred penalty units or to a term of imprisonment of not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

(8) A person who uses or makes a threat to use,

(a) radioactive material or device unlawfully; or

(b) nuclear material or device unlawfully

to compel another person, a State or an international organisation to do or refrain from doing any act, commits an offence and is liable on summary conviction to a fine of ten thousand penalty units or to a term of imprisonment of not less than ten years or to both the fine and the term of imprisonment.

(9) A person commits an offence if that person

- (a) damages a nuclear facility by interfering with the operation of that facility with the knowledge that the damage is likely to cause death or bodily injury, or substantial damage to property or the environment; or
- (b) does an act directed at a nuclear facility and in a manner that
 - (i) results in the release of radioactive material; or
 - (ii) risks the release of radioactive material
 with the intent that the act will cause death or bodily injury, or substantial damage to property or the environment.

(10) A person who contravenes subclause (1) is liable on summary conviction to a fine of not less than five thousand penalty units and not more than seven thousand five hundred penalty units or a term of imprisonment not less than ten years and not more than fifteen years or to both the fine and the term of imprisonment.

(11) A person who demands access to a nuclear facility,

- (a) by use of threat;
- (b) by use of force; or
- (c) by any other form of intimidation under circumstances which indicate the credibility of the threat

commits an offence and is liable on summary conviction to a fine of not less than five thousand penalty units or to a term of imprisonment of not less than three years or to both the fine and the term of imprisonment.

(12) A person who engages in an act to sabotage a facility which uses

- (a) radioactive material or device; or
- (b) nuclear material or device,

commits an offence and is liable on summary conviction to a fine of five thousand penalty units or to term of imprisonment not more than five years or to both the fine and the term of imprisonment.

C.6. MODEL PROVISIONS ON APPEALS OF REGULATORY DECISIONS

Regulation ##. General Provisions on Appeals

(1) Any applicant, authorized person or other person substantially impacted by a decision of the Authority shall have the right to file an appeal against this decision.

(2) Any appeal shall be filed with the [Board or High Court depending on the case] within [specify time period] of the issuance of the decision and shall state the factual, legal and procedural grounds on which it is based.

(3) Any such appeal shall not have the effect of suspending the decision by the Authority.

(4) Upon a finding by the Board that the decision of the Authority does not comply with the applicable law or is based on an erroneous determination of fact, the Board may grant such relief as it judges appropriate, including remanding the matter to the Authority for a further decision consistent with the decision of the Board.

(5) Consistent with the relevant laws and procedures of Ghana, the appellant in an administrative proceeding and the Authority may appeal decisions of the Board to the High Court within [specify time period] after issuance of a decision by the Board.

Regulation ##. Decision of inspector or analyst subject to appeal

- (1) A person aggrieved by a decision or measure taken by an inspector in a report submitted to the Authority under section 82(2) of the Act may appeal to the Board.
- (2) A pending appeal against a decision or a measure taken by an inspector or analyst shall, until the appeal is disposed of, not operate as a stay of that decision or measure.

Regulation ###. Complaints procedure

- (1) A person aggrieved by a decision or action of an inspector, analyst or other employee other than the Executive Director of the Authority may, submit a complaint in writing to the Executive Director of the Authority.
- (2) The complaint shall be submitted to the Board within thirty days from the date the complainant becomes aware of the decision or action to which the complaint relates.
- (3) The complaint shall
 - (a) contain the issues objected to; and
 - (b) have attached to it, a copy of the decision objected to and any relevant document for consideration and determination of the complaint;

Regulation ##. Appointment of Complaints Panel

- (1) The Board shall within fourteen days of receipt of a complaint appoint a panel consisting of
 - (a) one representative each of the following:
 - (i) the Ministry responsible for the affairs of the Authority not below the rank of a Director;
 - (ii) the Attorney-General's Department not below the rank of a Senior State Attorney;
 - (iii) the Ministry with responsibility for the undertaking not below the rank of a director; and
 - (b) two persons with specialisation in the complainant's field of operation or industry.
- (2) Each panel member shall submit a written statement of disclosure of interest or otherwise in activities related to the nuclear materials or substances.

Regulation ##. Hearing by the complaints panel

- (1) The Board shall refer the complaint to the panel, which shall give a fair hearing to the parties concerned.
- (2) The proceedings of the panel shall be recorded and documented.
- (3) The panel shall make a recommendation after hearing the parties and submit the recommendation to the Board stating the reasons for the recommendation.
- (4) The panel shall submit the recommendation referred to in subsection (3) to the Board within sixty days from the date the complaint is referred to the panel.

- (5) The Board may accept the recommendation of the panel or proceed to take its own decision in the interest of the nation, and shall give reasons for either accepting the recommendation or taking its own decision.
- (6) The recommendation of the panel shall be recorded and documented.
- (7) The panel shall cause copies of the record of proceedings and recommendations to be sent to the Board.

Regulation ##. Judicial appeal

- (1) A person aggrieved by a decision of the Board may appeal to the High Court.
- (2) The Court shall on receipt of the appeal call for the record of proceedings and a copy of the decision of the Board with its reasons.
- (3) The Court may invite relevant and neutral international experts to give evidence on the subject before the Court.
- (4) The proceedings at the Court shall be in camera.

Regulation ##. Foreign Judgments

The High Court shall recognise and enforce the final judgment by a foreign court awarding compensation for nuclear damage as if it were a judgment of the High Court, except where

- (a) the judgment was obtained by fraud;
- (b) the party against whom the judgment was pronounced was not given a fair opportunity to present the case of the party; or
- (c) the judgment is contrary to the public policy of Ghana or is not in accord with fundamental standards of justice.

C.7. MODEL PROVISIONS ON RADIATION PROTECTION

Regulation ##. Fundamental Principles of Radiation Protection

The following fundamental principles of radiation protection shall apply to all activities and practices conducted in Ghana:

- (a) *Justification.* No activity or practice shall be authorized unless it produces sufficient benefit to exposed persons or to society in a manner that offsets the radiation harm that it may cause, taking into account social, economic and other relevant factors.
- (b) *Optimization.* In relation to radiation exposures from any particular activity or practice, radiation protection measures should ensure that doses, the number of persons exposed and the likelihood of incurring exposure are at all times kept as low as reasonably achievable, taking into account social and economic factors.
- (c) *Dose limitation.* Activities and practices should be conducted in a manner that ensures that the total dose that a person may experience does not exceed the dose limit established by the Authority, so that no person is subject to an unacceptable risk attributable to radiation exposure.

Regulation ##. Regulatory Control of Radiation Safety

- (1) The Authority shall adopt requirements for the protection of persons from injury due to exposure to ionizing radiation.

(2) The Authority shall establish dose limits for persons that may not be exceeded in conducting activities under regulatory control. Such dose limits will take into account the recommendations of recognized international bodies, including the International Atomic Energy Agency.

(3) The Authority shall identify sources or practices to be exempted from regulatory control based on the following criteria:

- (a) That the radiation risk for persons is sufficiently low to be of no regulatory concern;
- (b) That the collective radiological impact is sufficiently low that regulatory control is not warranted;
- (c) That the source or practice is considered to be inherently safe, with no likelihood of creating situations that could result in a failure to meet the criteria in (a) or (b).

(4) The Authority shall establish clearance levels (or values), as set out in Schedule III, below which radioactive material or radioactive objects within authorized activities and practices can be released from regulatory control.

Regulation ##. Radiation Protection Requirements for Authorizations (Licences)

The Authority shall adopt requirements for radiation protection that must be met before any activity or practice can be authorized (licensed). These requirements shall include, inter alia, the following:

- (a) That the authorized person (licensee) possesses an adequate understanding of the fundamental principles of radiation protection;
- (b) That the authorized person (licensee) will take all steps necessary for the protection and safety of workers and the public by keeping doses below the relevant threshold and ensuring that all reasonable steps are taken to minimize adverse effects on the population, at present and in the future;
- (c) That the authorized person (licensee) will plan and implement the technical and organizational measures necessary to ensure adequate safety, including effective defences against radiological hazards;
- (d) That the authorized person (licensee) will prepare and implement an appropriate emergency plan;
- (e) That the authorized person (licensee) will ensure compliance with the dose limits established by the Authority as set out Schedule IV and will monitor the radiation exposure of workers;
- (f) That the authorized person (licensee) possesses adequate human and financial resources to conduct the proposed activity or practice in a manner that ensures safety and security;
- (g) That the authorized person (licensee) has made adequate financial arrangements for waste disposal, decommissioning and potential liability for radiological or nuclear damage;
- (h) That the authorized person (licensee) will provide access by inspectors of the Authority to locations necessary for the performance of their duties;
- (i) That the authorized person (licensee) will not modify its conduct of any authorized activity or practice in a manner that could affect the protection of workers, the public or the environment without seeking the approval of the Authority;
- (j) That the authorized person (licensee) will provide, upon request or pursuant to the requirements in these regulations, the Act, and relevant applicable regulations, all information considered to be necessary by the Authority.

C.8. MODEL PROVISIONS ON RADIATION SOURCES

Regulation ##. National register of radiation sources

- (1) The Authority shall establish and maintain a national register of radiation sources.
- (2) The categorisation of radiation sources in the national register shall take account of their potential to cause injury to humans and the environment.
- (3) The Authority shall adopt measures to protect information contained in the national register to ensure that the safety and security of a registered radiation source is not compromised.

Regulation ##. National register of export, import, trans-shipment and transport of radioactive sources

- (1) The Authority shall determine and publish in the *Gazette* any radioactive or nuclear material, equipment or technology that is subject to control as a national policy and in the interest of the security of Ghana.
- (2) A person shall not export, import, trans-ship or transport a controlled item without a permit from the Authority.
- (3) A person who intends to export, import, trans-ship or transport a controlled item shall apply to the Authority in writing, for a permit.
- (4) The application shall be addressed to the Executive Director and submitted with the prescribed fee and information prescribed by Regulations for purposes of the permit sought.
- (5) On receipt of an application, the Authority shall acknowledge receipt of the application not later than five days.
- (6) The Authority shall after consultation with institutions the Authority considers appropriate, consider the application and may grant or refuse the permit not later than twenty-five days after acknowledging receipt of the application.
- (7) The Authority shall inform the applicant of its decision not later than ten days after taking the decision, and where the decision is to refuse the application, state the reasons for the refusal.
- (8) A person dissatisfied with the decision of the Authority under subclause (6) may appeal to the High Court.

Regulation ##. Export and import of controlled items

The Authority shall

- (a) before granting a permit to an applicant to export an item which is subject to control by the Authority, consider the following:
 - (i) that the receiving State has made a binding commitment to use the item being exported and information in respect of that item for a peaceful purpose only;
 - (ii) any International Atomic Energy Agency safeguards requirement applicable to the item to be exported;

- (iii) whether the receiving State has placed its nuclear material and nuclear facilities under International Atomic Energy Agency safeguards;
 - (iv) whether approval of the Authority has been given for the transfer to a third State, of an item or technology previously transferred into the country;
 - (v) whether the requirements in the Convention on the Physical Protection of Nuclear Material for the transport of the material to be exported has been met; and
 - (vi) any information provided by the applicant in respect of the end use and end user of the nuclear material, equipment or information to be transferred that confirms the legitimate peaceful use of the nuclear material, equipment or information; and
- (b) before granting a permit to an applicant to import an item which is subject to control by the Authority, consider the following:
- (i) whether the material, equipment or technology to be imported is not prohibited by any law or regulatory provision in the country;
 - (ii) whether the designated recipient of the imported item is subject to a licensing requirement under another enactment and the licence has been granted;
 - (iii) whether the end user of the imported item has the technical and administrative capability and resources to use the imported item in a safe and secured manner.

Regulation ##. Recovery of orphan sources

(1) A licensee issued a permit under section 34(6) or who has lost control of a radioactive source shall, promptly report the loss or any other incident that could pose a significant risk to the safety or security of persons and the environment, to the Authority.

(2) The Authority shall collaborate with the Ministry responsible for National Security and the National Disaster Management Organisation, to develop a national strategy for the prompt recovery and control over an orphan source in respect of which control is lost.

(6) The Authority shall manage any orphan source to ensure its security and safety.

C.9. MODEL PROVISIONS ON EMERGENCY PLANNING AND RESPONSE

Regulation ##. Emergency plans

(1) A person shall not be licensed unless that person has in place an appropriate emergency preparedness and response plan approved by the Authority for the

- (a) operation of that person's facility or a source the person possesses or uses; and
- (b) activity or practice for which the licence is sought.

(2) The plan shall consist of both on-site and off-site emergency plans.

(3) An applicant shall in preparing an emergency plan, take into account

- (a) an assessment of the nature, likelihood and potential magnitude of resulting damage, including the population and area potentially at risk from an accident, malicious act or incident;
 - (b) the results of any accident analysis and lessons learned from that accident or incidents that have occurred in connection with similar activities or practices.
- (4) An emergency plan shall
- (a) identify the conditions that could create a need for emergency intervention;
 - (b) require the applicant to immediately notify the Authority and other government agencies determined by the Authority, of any situation or incident that poses a risk of radiological injury and requires emergency intervention;
 - (c) allocate responsibilities for
 - (i) initiating intervention; and
 - (ii) notifying relevant emergency intervention and response organisations;
 - (d) specify procedures, including communications arrangements, for contacting and obtaining assistance from emergency intervention organisations;
 - (e) specify intervention levels for protective actions and the scope of their application, taking into account the possible severity of emergencies that could occur;
 - (k) describe the methods and instruments necessary for assessing an emergency situation and its consequences;
 - (l) specify the procedure for terminating each emergency response or action;
 - (m) specify the training required of emergency responders and for conducting appropriate practice exercises to test the adequacy of the plan and to ensure that persons who may be involved in the emergency interventions are adequately informed and prepared for possible emergencies;
 - (n) ensure persons likely to be affected by an emergency are well educated and informed about the potential risks of that emergency; and
 - (o) be prepared in consultation with relevant emergency intervention or emergency responders, including the traditional authority, the local authority, and district, regional and national administrative authorities.

(7) An emergency plan shall be reviewed annually and updated.

(8) In the event of a nuclear or radiological emergency, the licensee shall implement the emergency plan as approved by the Authority.

Regulation ##. National plan for nuclear or radiological emergencies

(1) The Authority shall in collaboration with the National Disaster Management, Organisation develop and maintain a national emergency plan for responding to potential nuclear or radiological emergencies.

(2) The Minister responsible for Science and the Minister responsible for Interior shall be approve the plan.

(3) The national emergency plan for nuclear or radiological emergencies will take into account existing emergency response plans or programmes.

- (4) The national emergency plan for nuclear or radiological emergencies shall detail an allocation of responsibilities and actions among relevant governmental and non-governmental bodies, including arrangements for communications and public information.
- (5) The Authority shall in collaboration with the National Disaster Management Organisation review and update the plan every two years.
- (6) The updated plan shall be approved in accordance with subclause (2).

Regulation ##. Trans-boundary emergencies

- (1) In the event of a nuclear or radiological emergency that poses a risk of radioactive contamination spreading beyond the boundaries of Ghana, the Authority shall immediately notify the International Atomic Energy Agency and the relevant authorities of any State that could be affected by the release.
- (2) The Authority shall, in collaboration with the organisations responsible for disaster management, serve as the point of contact for providing any information or assistance regarding nuclear or radiological emergencies under the terms of relevant international instruments, including the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

C.10. MODEL PROVISIONS ON NUCLEAR POWER INSTALLATIONS

Regulation ##. Construction and operation of nuclear installations

- (1) A person shall not construct or operate a nuclear installation and conduct a related activity unless the person is licensed by the Authority under section 26 of the Act.
- (2) A person who intends to undertake maintenance, expansion, or an alteration or any activity related to the site or structure of a licensed facility shall notify the Authority and obtain a permit before the commencement of the activity.

Regulation ##. National site evaluation process for nuclear installations

- (1) The Authority shall establish a process consistent with procedures contained in the national nuclear development plan for the evaluation of proposed sites for nuclear installations in the country.
- (2) The Authority shall approve the proposed location for the development of a nuclear installation and associated facilities before the detailed evaluation of that site and preconstruction review and assessment of the proposed facility are commenced.
- (3) The process for site evaluation shall include an assessment of the following:
 - (a) the effects of external events occurring in the region, either of natural origin or human induced;
 - (b) the characteristics of the site and its environment that could influence the transfer to persons and the environment of radioactive material that has been released;
 - (c) the population density and population distribution and other characteristics of the external zone in so far as they may affect the possibility of implementing emergency measures and the need to evaluate the risks to individuals and the population.

Regulation ##. Site evaluation for nuclear installations

An applicant for a licence to construct and operate a nuclear installations shall, prepare a site evaluation report for assessment and review by the Authority, and the report shall include,

- (a) the frequency and severity of external natural and human induced events and the phenomena that could affect the safety of the facility;
- (b) the foreseeable evolution of natural and man - made factors in the proposed area that may have a bearing on safety during the projected life span of the facility;
- (c) the hazards associated with external events that are to be considered in the design of the facility, including the potential combined effects of these hazards with ambient conditions including hydrological, hydro-geological and meteorological conditions;
- (d) additional matters relating to safety, including the storage and transport of nuclear and other radioactive materials, fresh and spent fuel and radioactive waste;
- (e) the possible non-radiological impact of the facility due to chemical or thermal releases, and the potential for explosion and the dispersion of chemical products;
- (f) the potential for interactions between nuclear and non-nuclear effluents;
- (g) the potential radiological impact in operational state and its conditions on persons within the area, including impacts outside of Ghana; and
- (h) in so far as possible, the total nuclear capacity to be installed on the site, with provision for re-evaluation of the site if the installed capacity is to be significantly increased beyond the level assessed in a previous site evaluation.

Regulation ##. Preconstruction review and assessment of nuclear installations

The Authority shall before permitting the construction of a nuclear installation review and assess

- (a) the competence and capability of the applicant to meet relevant permit or licence requirements;
- (b) the site evaluation report prepared under section 44 to confirm its acceptability and related information needed for the design of the proposed facility;
- (c) the potential environmental impact of the proposed facility;
- (d) the basic design of the proposed facility, to confirm that it can meet relevant safety, security and physical protection requirements;
- (e) the quality assurance organisation and programme of the applicant or operator and vendors;
- (f) research results and development plans related to demonstration of the acceptability of the design; and
- (g) arrangements for the management of radioactive waste and decommissioning.

Regulation ##. Construction review and assessment of nuclear installations

The Authority shall review and assess the following during the construction of a nuclear installation:

- (a) the development of the facility design through documentation submitted by the operator to determine its continued acceptability; and
- (b) the progress of research and development activities in connection with demonstrating the acceptability of the design

Regulation ##. Pre-commissioning review & assessment before commissioning a nuclear installation

The Authority shall before commissioning a nuclear installation, review and assess the

- (a) commissioning programme of the nuclear installation and if necessary establish a schedule for further review and assessment;
- (b) as-built design of the installation;
- (c) limits and conditions for radiation protection;
- (d) provisions for radiation protection;
- (e) adequacy of operating instructions and procedures, especially the main administrative procedures, general operating procedures and emergency operating procedures;
- (f) recording and reporting systems;
- (g) arrangements for training and qualification of personnel for the installation, including staffing levels and fitness for duty requirements;
- (h) quality assurance organisation and programme for operation;
- (i) emergency preparedness programme;
- (j) accounting measures for nuclear and radioactive materials; and
- (k) adequacy of physical protection measures.

Regulation ##. Review and assessment before commissioning of a nuclear power installation

The Authority shall before permitting the loading of nuclear fuel or initial criticality, complete the review and assessment of the following:

- (a) the results of non-nuclear commissioning tests;
- (b) arrangements for periodic testing, maintenance, inspection, and control of modifications and surveillance.

Regulation ##. Review and assessment during operation of nuclear installations

The Authority may during the operation of a nuclear installation,

- (a) review, assess and approve any changes in operational limits and conditions or significant safety-related modifications; and
- (b) make periodic reviews of the operator's compliance with relevant terms and conditions related to the safety and security of the installation.

Regulation ##. Responsibility of the operator

An operator is responsible for ensuring the safe and secure conduct of any activity or practice associated with that operator's facility.

Regulation ##. Annual levies of licensed persons

The Authority may, implement the graded levying system set out Schedule V for

- (a) minimum compensation for nuclear damage arising from a licensed activity or practice; and
- (b) management and permanent disposal of radioactive waste.

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