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Development of a national Human Reliability Program (HRP) model for an emerging nuclear country: Nigerian case study

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To the Graduate Council:

I am submitting herewith a thesis written by Stephen Olumuyiwa Ariyo Dahunsi entitled "Development of a national Human Reliability Program (HRP) model for an emerging nuclear country: Nigerian case study." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nuclear Engineering.

Howard L. Hall, Major Professor

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Development of a national Human Reliability Program (HRP) model for an emerging nuclear country: Nigerian case study

A Thesis Presented for the
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Stephen Olumuyiwa Ariyo Dahunsi
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DEDICATION

Dedicated to God Almighty, from whom all blessings flow.

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ABSTRACT

The current demand for electricity and concern of the climate change in emerging countries has led to the rise in the number of nations adopting nuclear technology options. Besides this, the global rise in terrorism and the existence of credible threats in Nigeria and other emerging countries embarking on nuclear program for peaceful application may pose a critical challenge in implementation of this technology. Furthermore, the dual threat issue of providing electricity, while inadvertently producing weapon and radiological material that could similarly undermine international security must be mitigated. In order to achieve the mitigation target, it is highly important to know the elements human factors, reliability and security culture could play through the life cycle of such scheme as it traverses from cradle to grave. Additionally, the knowledge of these factors will help anticipate and correct the deficiencies that might arise from the degradation of designed procedures in the face of this emerging threats and the catastrophe that any failure could bring about. This knowledge will also provide critical guidance to Nigeria and other nuclear emerging countries that could in turn bring about significant long-term improvements in how facilities and materials are secured and managed. Establishment of a virile Human Reliability Program (HRP) is one of the requirements that is relied upon to promote such assurances of mitigation, safe, secure and uninterrupted application of nuclear technology. The outcome of this research recognizes and establishes; the acceptance and existence of credible nuclear and radiological threats, the role that HRP could play in detection and mitigation of aberrant behaviors. And most importantly, the need to establish and develop a national HRP policy for Nigeria and by extension to other emerging countries implementing nuclear power program for peaceful application. Additionally, a strategy for national threat assessment and evaluation is suggested as this is the first step that precedes the development of an HRP plan. However, this is must take into

consideration the dynamics of threat spread over the country and the cost of sustaining the planning and implementation.

Key words: Security, HRP, threat, mitigation

PREFACE

All of the work presented in this research are original and conducted by Stephen Dahunsi with the support of faculty, subject matter experts and everyone who anonymously participated in the survey leading to the conclusion and recommendation. The survey and results published met the requirements of the Institution Review Board of the University of Tennessee.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

ABU	Ahmadu Bello University
ANS	America Nuclear Society
CERD	Center for Energy Research and Development
CERT	Center for Energy Research and Training
CNES	Center for Nuclear Energy Studies
CNERT	Center for Nuclear Energy Research and Training
CNEST	Center for Nuclear Energy Studies and Training
CoE	Centers of Excellence
CRP	Coordinated Research Project
DBT	Design Basis Threat
DSS	Department of State Security
EFCC	Economic and Financial Crime Commission
FMoJ	Federal Ministry of Justice
GIF	Gamma Irradiation Facility
HEU	Highly Enriched Uranium
HRP	Human Reliability Program
IAEA	International Atomic Energy Agency
IMS	Integrated Management System
INS	Institute for Nuclear Security
INMM	Institute of Nuclear Materials Management
IRB	Institution Review Board
LEU	Low Enriched Uranium
MBA	Material Balance Area

MEND	Movement for the Emancipation of Niger Delta
MNSR	Miniature Neutron Source Reactor
NCC	National Coordinating Committee
NEC	National Executive Committee
NHRC	National Human Right Commission
NPP	Nuclear Power Program
NSC	Nuclear Security Culture
NSCDC	National Security and Civil Defence Corps
NSSC	Nuclear Security Support Centres
NSSS	Nuclear Safety, Security and Safeguards
NTA & E	National Threat Assessment & Evaluation
NTC	Nuclear Technology Center
OIT	Office of Information Technology
ORNL	Oak Ridge National Laboratory
PNS	Partnership for Nuclear Security
RPMS	Radiation Portal Monitoring System
SPSS	Statistical Package for Social Science
TOR	Term of Reference
UNCC	United Nations Convention against Corruption
USDoS	United States Department of State
UT	University of Tennessee

CHAPTER 1

INTRODUCTION

Nigeria is among several countries seeking to develop nuclear power program for peaceful applications in order to meet several national developmental obligations. This and many other reasons have driven the Federal government of Nigeria to embark on a comprehensive long-term electricity generation/distribution strategy to make up for the shortfall in national capacity and to help meet future demands. However, safety and security of nuclear materials and operation has become an area of concern. Regionally, Nigeria is faced with the rising trend in tribal and religious extremism. Boko Haram one of the regional terrorist group have pledged allegiance to the Islamic State (ISIS) group [1] known to be seeking nuclear materials for increased terrorist activities. This trend will further increase the difficulties in developing and implementing the Nigerian nuclear program. For Nigeria to contribute to global security and earn international confidence in their nuclear power program there is the urgent need to adequately prove that the country will be able to secure nuclear and/or radiological materials and facilities against an insider acting alone or receiving support externally. A well thought-out human reliability program (HRP) must adequately be put in place to mitigate any unwarranted risk to this implementation and eventual operations. This research will propose measures that compares the present knowledge of HRP in Nigeria as a newcomer country against that of the United States that has many years of successful operating experience.

The result of this comparison will help identify the present gaps in the understanding of HRP in Nigeria (a nuclear newcomer country) to implement best practices. In addition, the analysis of results will facilitate a model for employer/employee engagement in Nigeria. In addition, the

research will consider attributes of policies and procedures for security culture sustainability in a way that accounts for pattern of observable behavior, attitudes and shared beliefs.

The benefits and the secondary effects that arise with the implementation of this program will help the Nigeria develop a suitable power industry conducive to better economic advancement. However, the success of this energy portfolio will draw strength from a strong nuclear security practice, coupled with a competent HRP. The HRP program is contingent upon having a good understanding of a Nigeria's ethnic and cultural identities, cultural values, beliefs, and practices that characterize the country. By understanding national and regional beliefs and values, an environment for stronger nuclear security culture will be cultivated. This could constitute the platform with which a structure of trustworthiness is built and extended to other critical infrastructures of high security concern in the country. In addition, the establishment of good relationships and strong trust between employers, employees, stakeholders, and partnering organizations will advance the benefits of a successful nuclear power program.

Humans are responsible for significant aspect of safe and secure operation of nuclear plants and such other infrastructure of high security consequence. [2] With the increased activities of elicitation, sabotage, and threats of terrorism, the ability to secure nuclear material and related technology is more difficult. Nuclear security requires a holistic approach with all layers of operation from the activities outside of the facility to the innermost part of operations, including information and infrastructure.

Based on this, cultural values in Nigeria's nuclear security plan became significantly important. A complete HRP will help to uncover and seek to understand the latent intention of any malicious insider, as it relates to a cultural trend. This understanding will allow for realistic input to the existing country Threat Assessment (TA) document for the nuclear power program.

Additionally, this knowledge will further contribute the development of comprehensive methods that provide physical protection, control and accounting for nuclear and radiological materials in Nigeria. It is expected that efficient nuclear security culture (NSC) and HRP will be established such that employees develops confidence to alert the employer as to safety and security concerns with regard to the existing policies and procedures.

NSC is essential to ensuring the security of nuclear plants and other facilities that makes use of nuclear materials. This research hopes to combine social, technical, human reliability and organizational culture and practice [3] to achieve best practice in the implementation of the Nigerian peaceful applications of nuclear technology.

Nigerian people and culture

Figure l.0. Map of Nigeria

Nigeria is located on the coast of West Africa (Figure. 1) with an estimated population of 183.2 million (2013 estimate). [4] The history of Nigeria dates back to approximately 2000 years

ago and today the country is comprised of over 250 ethnic groups with an estimated 521 local languages. [5] Out of this estimated Figure, approximately 510 of these languages are still spoken by native speakers. Two (2) of the remaining languages are spoken only as second languages without any recognized native speakers, and the remaining nine (9) languages died out naturally. [5] Due to high number of spoken languages in Nigeria, most ethnic groups in the rural area prefer to communicate in local languages. However, the official language remained English in order to stimulate a continuous cultural, linguistic harmony, education, business transactions, and official gatherings.

Research Objectives

The objective of this research is to perform a gap analysis. In order to achieve this, a structured HRP in an established nuclear power country (United States) and a newcomer country (Nigeria) will guide in the implementation of a nuclear security culture. The outcome of this proposed work will set precedence for continuous review model that could further strengthen the comprehensive procedure to identify personnel or prospective employees with probable malicious character that could be of reasonable threat to the facility or country's security.

Relevance and Justification

Nigeria, as of February 2013, has a total installed electricity capacity of 6,000 MWe of which only about 4,500 Mwe (<1% of national power production) is available at any time. The electrical grid capacity is built around hydro (31%), natural gas (37%) , and oil (32%), and is grossly inadequate

for the nation's current and future energy demand. At the current level, the centralized per capita electricity generation in the country is less than 30We, which is grossly inadequate for an emerging economy. Additionally, it is not likely that the country will be able to meet national electricity demand and stable power by all conventional sources combined. It has also been estimated that to increase natural gas to a maximum would only add 36,000 MWe to the to the existing 6,000 MWe. This implies that the contribution of natural gas to future generations has an upper limit, which will have to be derived from other sources of energy.

In order to meet this national energy demand projection, more reliable and high power density sources, such as nuclear power, must be included into the national energy mix. In response to this need, the government of Nigeria in August 2006 reactivated the Nigeria Atomic Energy Commission (NAEC) as the focal agency of government established under Act 46 of 1976. The goal of the NAEC is to promote and develop peaceful applications of nuclear technology to ensure that Nigeria increases its energy supply mix, while increasing the electricity base load. [6] The increase in electrical power would improve the standard of living of its citizens, would allow Nigeria to support the Kyoto protocol on climate change, and would allow for industrialization of the country. The NAEC is engaged in the development of a framework and technical pathways to explore, exploit and harness atomic energy for peaceful applications for the socio-economic development of Nigeria. [7] However, the existing national culture leads to the need for an improved NSC and the development of a HRP. A robust NSC and HRP would lend itself to aid in the development of a platform to resolve the challenges that comes with the planning, implementation, operation, and decommissioning of the plant and the spent fuel from its operation. A good HRP is the one that ensures highest standard, reliability and mental stability from individuals who occupies positions that requires their access to materials, facilities and programs.

This program must equally establish a distinct management structure and a uniform, comprehensive, and concise set of requirements that continually protects national security against individuals who may harbor reliability, safety and security concern [8]

The projection for the planned nuclear power project was that the installed grid capacity would increase to at least 10,000 MWe by the end of year 2010. However, even with this projected increased capacity, the country still faces an imminent energy crisis as demand continuously outstrips supply due to the estimated population growth rate.

Nigeria operates three (3) fully established functional and four (4) new research institutes under the aegis of NAEC. Namely;

Fully established Center of Excellence:

1. The Centre for Energy Research and Training (CERT), Ahmadu Bello University (ABU), Zaria – The center operates a 30KW MNSR research and test reactor, HEU as the fuel type. Nigeria in 2006 joined the IAEA's Coordinated Research Project (CRP) conversion studies to Low Enriched Uranium (LEU)
2. Center for Energy Research and Development (CERD), Obafemi Owolowo University, Ile-Ife - 1.7 MeV Tandem Accelerator.
3. Gamma Irradiation Facility (GIF), at the Sheda Science and Technology Complex, Abuja, Nigeria.

Newly established Center of Excellence:

4. Center for Nuclear Energy Studies (CNES) at the University of Port Harcourt, Rivers State
5. Center for Nuclear Energy Research and Development (CNERD), University of Maiduguri, Borno State, Nigeria
6. Center for Nuclear Energy Studies and Training (CNEST), Federal University of Technology, Owerri

7. Federal Government of Nigeria - International Atomic Energy Agency Field Monitoring Station & Laboratory Facility, Koluama, Bayelsa State, Nigeria.

In addition to the above facilities, there are several high and low radioactive sources for medical applications and for oil and gas exploration. All of the above-mentioned facilities and their operations are under a strong national regulatory regime and IAEA safeguards inspection. The importance of HRP and Nuclear Security program is inevitable and cannot be compromised based on the Nigerian culture.

There is also a grave global concern about non-state actors and terrorist group looking for nuclear weapons and materials to produce weapons of mass destruction. [9] As part of the national security portfolio, Boko Haram is among the top four terrorist group that is dominate in the Nigerian region. [9] Nigeria also has the ongoing Movement for the Emancipation of Niger Delta (MEND). Upon this premise, the Nigeria national security threat is a consequent of increased menace of these regional actors.

Based on the internal security issues, it is important to consider aspects of the Nigerian culture that have led to the present security challenges as highlighted below:

- Poverty and poor remuneration
- Weak institutions that reduce the administration of justice
- Supplanting of government laws by informal rules (“settling”)
- Criminal acts and corrupt behavior
- Nature of the economy (rent seeking i.e, overdependence on crude oil for national revenue)
- Past security incidents that show vulnerability in planning and sustenance of critical facilities.

These aspects of the Nigerian culture has led to the division of the country on political and social issues. It is important to develop a program that puts less emphasis on tribal and political affiliation for employment, but rather selects individuals who can be trusted with the access to and responsibilities for nuclear and/or radiological facilities.

Based on the above enumerated facilities and factors that could impact on best practice, it is hoped that Nigeria will put in place, adequate ability for decision making and judgment required to establish good human reliability program

Scope of study

It is highly important to know the role that human factors, reliability and security culture will play contribute to the life cycle of a nuclear power program. This knowledge will help anticipate and correct the deficiencies that might arise from malicious insider or a potential employee. The preliminary stage of the proposed work will investigate aspects of the Nigerian culture that have the potential to compromise the ethics of fundamental application of best practice and nuclear security culture. The second part of the project will also collect a survey of the present understanding of the existing Nigerian HRP and that of a developed nuclear operating country (United States). The result will further outline the gaps and challenges that could generally affect the full implementation of best practice in NSC and HRP as Nigeria moves forward in the efforts to implement a nuclear program. Furthermore, the outcome of this proposed work will explore the different procedures and the contribution of Management System as it affects cultural ideology in the safe and secure delivery of this technology. The findings will also highlight factors and

management practices that could potentially switch personnel to an inside after passing through a qualitative human reliability and personnel engagement procedures.

Nigeria and cultural challenge on nuclear security culture

Nigeria is a culturally rich country with longstanding traditions, even though Western values have gained momentum within the wider Nigerian society. Every Nigerian strives to enhance the quality of livelihood from one generation to another. It is the general belief in Nigeria that cultural identity, political affiliation and personal relationships will help improve livelihood. [10] Nigerians also consider national leadership to be the primary instrument in promoting change. [11] The Nigerian constitutional provisions outlaw nepotism, but cultural values promote preferential treatments in hiring and promotions for friends and relatives. There are also situations where trusted personnel is required for certain positions, rather than advertising these positions, close family friends, political associates and/or traditional rulers are allowed to make recommendations to fill the vacancy. This practice is aimed at sustaining family business or political bonds within an organization or community. [12] As an emerging country, it is important to consider the existing socio-cultural environment that may inadvertently have a negative impact on acceptable norms and best practices in NSC as Nigeria implements a nuclear power program:

Political and Ethnic Conflict – At Nigeria's independence (from Britain) in 1960, the various ethnic groups struggled for power to gain prominence and leadership advantage over one another. This resulted in intertribal wars and ethnic cleansing which started by the killing of the Yoruba and Hausa leaders by their Igbo counterpart. The cleansing created a deep political difference

between the geopolitical zones and further led to reprisal attack and eventual killing of the leaders and prominent citizens from the Igbo region. The numerous attacks marked the beginning of ethnic tensions and political distrust in Nigeria that also led to power struggle and suspicion against one another. These sentiments, more than corruption, tend to divide Nigeria into sections. [13] This tension continues to exist after 100 years of amalgamation, and there is still continuous outcry for separation. Rather than teamwork, ethnic sentiments have superseded merit in the affairs of the country's work force and has led to the degradation of Nigerian vision, value system and the ability to get things right. [14] There still exists elements of tribal and political sentiments in policy and administrative processes in governance that can compromise organizational allegiance, arguably slowing down innovation and sustainable development. [15]

Recruitment process and Workforce Management - Before the arrival of the British colonialists to Nigeria, the employment system practiced in Nigeria was that of "paternalistic employment relations" [16] that placed the traditional family head as owner of the enterprise and leader while his workers were members of his household. This cultural system brings together people of the same age bracket to cultivate farmlands and be remunerated cooperatively on a rotational exchange basis between families in a particular locality. This later evolved to a more coordinated process that led to the establishment of several agencies that recognize federal character for the promotion of equal opportunity in employment, promotion, and advancement known "as quota system" in all government owned enterprises. Privately owned institutions are allowed to design their individual reward and promotion system that suits their organizational values. In both instances, employees have the opportunity to appeal the decision through the industrial arbitrations court. Yet, traces of the former system are still readily observed in employment and rewards systems. Lastly, tribalism

and nepotism constitute a cultural impact that in some cases has led to industrial action and civil unrest, which sometimes makes the Nigerian environment unfavorable and deters investment in new, indigenous technologies.

Corruption – According to the Transparency International, Nigeria ranked 136 out of the 175 on the corruption perception index. [17] Corruption has become endemic, and it constitutes a national challenge for infrastructural development. [18] This has drastically increased in per unit cost of infrastructural development. Public funds are stolen with impunity and are flaunted to the masses without remorse to public feelings. [19] Furthermore, tolerance of continuous stealing and corruption in various forms continues to impact on the cultural norm and professional standard within organizations. Even though there are ongoing efforts to tackle corruption in Nigeria with the enactment of the Economic and Financial Crime Commission (EFCC) Act 2004. Corrupt officials still get away with "plea bargaining" or remain totally unpunished and yet celebrated. However, with the renewed collaboration in bi-lateral and multilateral agreements, international frameworks and strategies for prevention of corruption in concert with the assistance of the United Nations Convention against Corruption (UNCC), Nigeria is now receiving the necessary assistance to tackle corruption.

Meeting and Greeting Protocol – The Nigerian culture reserves and lays emphasis on addressing people at first by their academic, professional, or honorific titles and surnames. [5] This they believe set the tone for a friendly atmosphere that is expected to precede any form of business meeting or contractual obligation. As Nigeria explore and move forward in her quest for nuclear,

it is important that the country identify and strengthen the cross-cultural value system and cultural diplomacy that strengthens cooperation with the international technical partners and stakeholders.

Hierarchy and Control – Traditional Nigerian culture believes that age and hierarchy bestow knowledge on individuals. [13] As such, older people or senior fellows must not be questioned, and must be the anchor of any decision. This is reflected in the culture of "the eldest in the society or group must be in charge of affairs irrespective of experience or knowledge of subject matter" [13]. Besides this, in the northern and southwestern part of Nigeria, cultural norms do not allow the younger ones to contribute to issues when any elderly person is present except otherwise required to do so by the eldest in the gathering, as such, older personnel might feel offended by correction or reprimanding from younger personnel. Thirdly, the northern and southeastern parts of Nigeria, it is culturally believed that male children are more valuable than their female counterparts, intrinsically, this are norms that would not allow best practice to thrive in HRP and general nuclear This has influenced the political participation of women in the past. Furthermore, the implication of this practice is that best female candidate cannot preside over or be part of decision making in HRP as they are considered to play a second fiddle to their male counterpart. Nevertheless, this discrimination has arguably contributed to the slow pace in technical and infrastructural development witnessed in Nigeria.

Social Practices and Family Values – The strength of character of the social system in Nigeria is the extended family system embedded in recognition of hierarchy and seniority. [5] Individuals turn to members of the extended family for financial aid and guidance. The norm requires any successful member of a family to provide welfare for other members of the family. This

expectation may however, turn up financial pressure on an employee in charge of nuclear materials or information. The banking sector in Nigeria has recorded a high number of this type occurrence. Unlike the United states, where HRP requires a good credit history check as an integral part of the security clearance to work in a nuclear facility or infrastructure of high security concern. [20]. Presently in Nigeria, there is no national law, regulatory or legal framework to put this in place. If such remains at status quo, it will always be a challenge to implement a viable HRP program.

Religion – Religious freedom is a part of the Nigerian constitution. Islam, Christianity, and traditional religions are practice in Nigeria. Religious practice and belief in the Nigerian context may bring about disproportional rule application. Christians observe Sunday as a holiday to attend church services and Islamic religious practice requires observing "Jumat prayers" on Fridays. Nonetheless, HRP permits that security and safety process must be in place to ensure highest standards of reliability and stability. As such, the concern of the operator to fulfill religious obligation without hindrance may impair operational and security judgement in the development and implementation of a new nuclear program.

CHAPTER 2

LITERATURE REVIEW

The number of developing countries indicating interest for the inclusion of nuclear power in their energy mix is on the increase with the hope that the inclusion will solve their energy challenges. This is due to the fact that, nuclear energy is cost effective, has no controlled air pollutant, a very high yield energy per fuel. [21] However, policies and processes must be in place to build the requisite human resource base that will provide the needed critical infrastructure and create the necessary enabling environment for operating the infrastructure. Furthermore, these policies must consider attributes of national culture, organizational culture and practice. Organizational design, operations feedback to the system and management systems must be adequate and put in proper perspective in order to demonstrate and measure the implementation of best practices that establish comprehensive international standards.

Aim of research

The aim of this proposed work is to conduct a survey that collects and collates the statistics of baseline unserstanding of HRP in Nigeria and compare with that collected from a developed (United States) operating country's HRP. The result will help to identify gaps that could negatively affect the implementation of a peaceful application of nuclear power program. The result will also support the identification and design of training and eduactional needs of the nuclear program.

Definition of terms

Nuclear Security

The IAEA defines nuclear security as "the prevention of, and response to, criminal or international unauthorized acts involving or directed at nuclear material, other radioactive material, associated facilities, or associated activities" [22]

In order to achieve excellence in the implementation of a peaceful Nigerian nuclear power program and lessons drawn from past nuclear or radiological incidents used to justify the program need. The planning, implementation and operation of nuclear or radiological programs create a higher likelihood of the insider threat against the facility and country due to the advantage they hold in having access to the facility. [23] To this end, securing nuclear materials has become a priority around the world today, unfortunately, there are no international or a comprehensive rule that articulates the level or extent of security needed to secure such nuclear materials. [24] Furthermore, in order to facilitate a global effort to tackle threats posed by insiders acting alone or collaborating with an external adversary, the nuclear community must develop and share best practice and challenges, including the analysis of incidents and lessons learned. Besides this, allocation of adequate human and material resources including broad and pragmatic performance test on equipment and facility must considered. This will afford all stakeholders the clear comprehension of threat and security errors and resolutions to past incidents and best way to mitigate similar occurrences.

Human Reliability Program (HRP)

HRP is an important component that supports a well-developed NSC. It is designed as an assurance program that certifies individuals, who take up responsibilities and have access to facilities or handle nuclear materials, must exhibits peak values with high-level reliability, trustworthiness and are physically and mentally suitable to perform or carry out given tasks.

The call for increased global capacity in the allocation of proportionate human and materials resources for sustainable nuclear security culture and human reliability program cannot be overemphasized.[23] The recent occurrences relating to theft of nuclear materials, elicitation, espionage and sabotage of nuclear facilities is an indicator to the fact that credible threats exist. [9] The Doel 4 nuclear plant sabotage of August 2014 in Belgium that led to loss of millions of dollars, is an evidence of the damage that an insider could inflict on plant operations. [25] It is therefore evident that the development of a HRP must involve the application of engineering, psychology and realistic assessment based on the contemporary threshold and perceived need. [2] The implementation of HRP takes different structure from component and system reliability in an organization or society. If adequately implemented in Nigeria, the program will help identify dishonest, disloyal and unreliable personnel including the mitigation of potential employees that may inadvertently become a threat to facility or the Nigerian nuclear power program. [26]

Nuclear Security Culture

The International Atomic Energy Agency defines NSC as the assembly of characteristics, attitudes and behavior of individuals, organization and institutions, which serves as a means to support and enhance nuclear security. [27] As the number of countries planning to include nuclear

technology for peaceful application increases, the ratio of threat to use this technology maliciously will equally be on the rise. It is therefore sufficient to develop a structure and culture that mitigates the rise in the threat ratio from the planning, implementation, operational and decommissioning stages of the program. [28] Beliefs, principles and organization values are three major factors that could affect NSC. Security implementation is a task that is important to every organization but it is been faced with contending demands for resources and attention by safety, staff welfare, infrastructure development and other operational improvement factors which tends to bring the compliance to less than the optimal requirements in terms of financial availability and in turn, best practice. It is expected that deficiency in any form may lead to security program delays, cancelled or compromised. [29] Furthermore, developing the culture of security must take into account the environment, personnel understanding, and the impacts of such policy implementation on the overall performance on the organization. [29] A good organizational security culture is developed from planned and well taught out corporate culture, security policy, education and personnel awareness training with management support. [30] Attitudes, beliefs, perception and patterns of behavior within such organization must also be well understood. [31] The implementation of organizational security culture is based on the requirements of nuclear security culture. Nuclear Security Culture is defined as the assembly of characteristics, attitudes and behavior of individuals, organization and institution that serves as a means to support and enhance nuclear security [32]

Management system

Management system (MS) process implements complete, well-coordinated tasks and activities that integrates values, policy, process, and structure, that make the best possible

contribution for the attainment of organizational objectives as defined by documented legal and regulatory need. [33] It is important to test the knowledge of the senior management personnel involved in the implementation of the Nigerian nuclear power program on HRP. This understanding will be useful in the creation and development of a methodology that is consistent with the cultural values and systems in Nigeria.

Integrated Management System for HRP and Nuclear Security Culture (IMS-HRP/NSC)

The introduction of Integrated Management System (IMS) to this work is developed from the need for continuous improvement of the overall quality of human reliability and nuclear security culture. Integration of HRP and NSC will also contribute to cost reduction in terms of accident and insider threat mitigation. To implement this, the IMS for the Nigeria nuclear power must identify process, sequence, interaction of policy, criteria, resources, methods for effective operations and control feedbacks that considers the importance of human factors and culture in nuclear security. HRP and NSC must be integrated into management system polices and procedure and must take into consideration the requirements and understanding of all stakeholders. The integration must be developed alongside quality control (QC) and quality assurance (QA) process to complement one another with the view of continuous suitability of operational policy for the Nigerian nuclear program.

Recommendations from this research will be proposed to the Nigerian government based on identified gaps for inputs in upgrading existing understanding of HRP and NSC.

Interrelationship between HRP, NSC and Management system.

HRP, NSC and MS implemented in the Nigerian program will seek to achieve operational excellence through safety, security and the mitigation of risk associated with the inside threat. All the three elements take into account performance shaping factors that could affect personnel's judgment in operation. They all contribute to the development of risk assessment model for nuclear security.

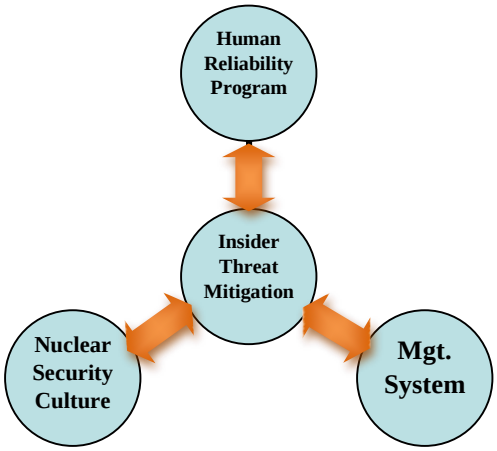

Figure 2. Relationship between HRP, NSC and Management system

Framework for HRP and nuclear security culture in Nigeria

The Nigerian government considers the grave effects that a security breach in her national nuclear program could cause to the rest of the world. The understanding of this fact has redirected the attention and strengths of the country towards the development and implementation of a robust legal framework for human reliability and NSC to fulfill its national and international obligations.

Nigeria is collaborating with international organizations through professional participations in professional meetings, exchange programs and workshop organizations. With increased commitment on the part of the government to further, build capacity. The United States Department of State (USDoS) Partnership for Nuclear Security (PNS) is sponsoring efforts towards developing site specific HRP that would in turn be replicated in other critical infrastructure facilities with the view that the combinational efforts will culminate into a national program for the peaceful and secure nuclear power applications. However, in the area of HRP, there has been little achievement due to the unofficial culture of nepotism. The efforts and support from the US DoS is beginning to yield results in the recognition that it is very important component of any country's nuclear program. The Institute for Nuclear Security (INS) at the University of Tennessee (UT) has contributed to the development of the Nigeria Research Reactor – 1 (NIRR-1) facility specific HRP and leading efforts to support the Nigerian government in the area of collaborative work and educational exchange program. On the other strength of the understanding of NSC, the government is taking the following steps and commitments to further strengthen nuclear security at its facilities and ensure that nuclear/radiological materials are under control:

1. Implementation of Legal and Regulatory Framework
    - Review of Nuclear Safety, Security and Safeguards Bill (NSSS) bill
    - Review of the Nigerian Safety and Security of Radioactive Sources Regulations, 2006
    - Development of draft Regulations on Physical Protection of Nuclear Materials and Nuclear Facilities
2. Import-Export Control of Radioactive Material
3. Border monitoring and prevention of illicit trafficking

- Radiation Monitoring Equipment (RPMS)

4. Participation and sharing of information on illicit trafficking in nuclear and radioactive materials
5. Search and Secure of orphan and legacy Radiactive sources
6. Nuclear Security Support Centre
7. Development of Design Basis Threat (DBT) for nuclear and radiological materials in Nigeria (HRP not inclusive the moment)
8. Conversion of HEU to LEU for NIRR-1
9. Continuous Regulatory inspections of nuclear and Radiological facilities
10. Nuclear Material and Accounting
11. IAEA Safeguards inspection of NIRR-1, CERT, Zaria
12. Nigeria has acceded to the IAEA additional protocol on non-proliferation of nuclear weapons
13. Studies on creation of Additional Material Balanced Area (MBA) was completed.
14. The approval for the establishment of Nuclear Security Support Centres (NSSC)
15. Collaboration with the University of Tennessee on curriculum development in nuclear security education
16. Development of a Comprehensive National Radioactive Waste Management System and Disposal Facility, among others.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

Objectives of research design

This research employs a data-driven strategy that aggregates experiences of subject matter experts to develop Human Reliability Program (HRP) for Nigeria as an emerging country. It attempts to gather information about the understanding and application of HRP in both the developed and emerging nuclear states. The resultant data is expected to assist in the planning and implementation of the program in emerging countries while also suggesting further ways and ideas to strengthen the program in countries with developed program. The research considered best practices that could support or hinder the implementation of a reliable program. In order to achieve these set objectives, the responses from the online survey conducted was used as the basis for predicting program needs using research case studies.

A set of initial questions was designed that advocated the need for HRP and the strategies that could be employed to eliminate insider threat. The overall intention of this research is to explore and activate the technical versus policy intersection with the view of generating a protective assessment of acceptable HRP norms that will strengthen operations in nuclear power plants and other facilities of high security consequence in emerging countries. [35]

Nigeria is one of the emerging countries that have started implementing a new nuclear program for peaceful applications. It is expected that the knowledge gap inferred by the outcome of the survey could be a guide and a starting point for the development of a workable HRP that facilitates best practice in the recruitment and retention of trusted personnel. Additionally, the survey is expected to develop a good understanding of the intricate methods in the use of

qualitative results and analysis of past experiences to shape the future needs of trusted employee engagements.

Research questions

Present and future improvements in nuclear technology have relied on data and tools made available by researchers to approximate requirements for the foundation of probabilistic analysis of events. [36] The research questions were structured into two sections; the first section was built upon open source experience and summary of interactions with subject matter experts, while the second section (survey question) was developed to elicit supplementary data from researchers, personnel in HRP positions and subject matter experts. This action was also intended to gather synopsis on elements that reinforces the program in developed countries. Additionally, this will help to develop more understanding on the factors that encourage proportional risks associated with increased interest in the technology. It is important for the process to be globally consistent and standardized to reduce the risk associated with insider threats. [35]

Consequent upon setting the above agenda, the question set in paragraph 3.3 were arrived at on the importance of a virile HRP plan for emerging countries while increasing the capacity in developed countries. A further detailed question (Appendix B) were generated to have more detailed insight into the understanding of policies and procedures between the two countries used as case study (United States as developed and Nigeria as emerging). It is believed that HRP plan in place in the developed countries may be adequate for the present status of their programs. However, the program can be improved upon with continuous and recommended supervisory reviews while the need for establishing a strong HRP is proposed.

Nonetheless, the operational accidents are being drastically reduced through the application of reliable technology, safety developments, and protection through the creation of operational redundancies. The gain still runs short of expectations in view of the increased rate of insider threat, personnel elicitation, espionage actions and the new wave of terrorism that reflects on the quest for nuclear materials to wage war on innocent civilians. [37]

Accidents does not just occur, it is either caused by deliberate human error, organizational failure or combination of both. [38] A model (Figure 3.1) was developed in order to interconnect the overall ideas generated on the basis of analytics of the survey outcome

The research will conclude by further establishing the correlation between the impact of Human Reliability, Management System and cultural anthropology on nuclear system. Besides this, the model was used to recommend ideas by outlining the impact and influence that failure or success of nuclear security will have on both the developed and emerging countries.

Research needs

The following principles are factors considered that necessitated the research needs:

i. Explicit human reliability needs for emerging nuclear states that clearly address cultural synchronization with global best practice.
ii. Projected increase in the number of reactors world-wide, mostly in developed countries and the need to replace retiring professionals with trusted employee.
iii. Nuclear security and global terrorism.

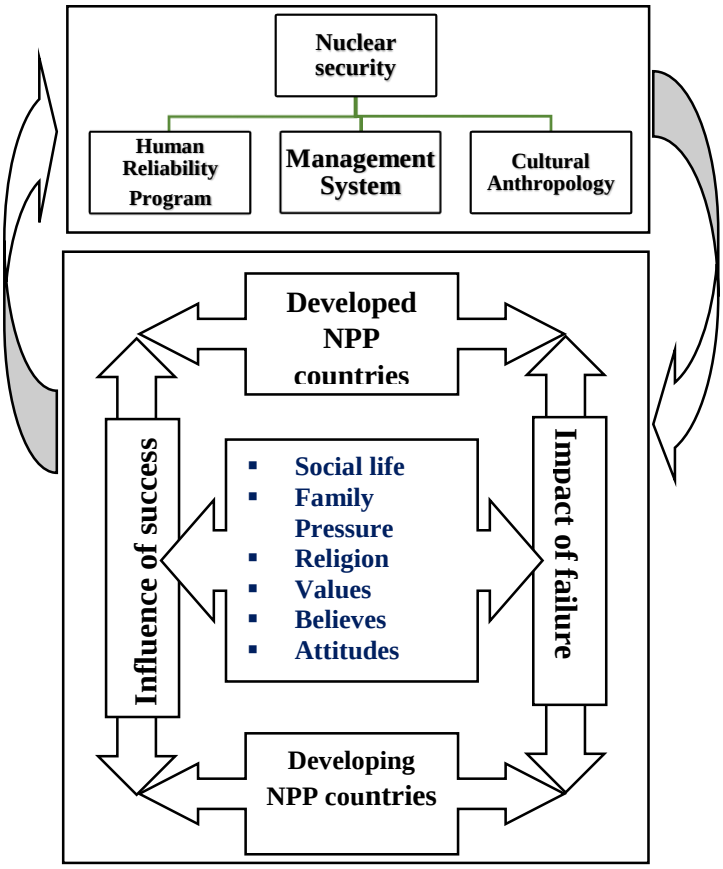

Figure 3.1. NSC – HRP analysis model

The following are question raised by subject matter experts in order to establish research needs:

i. What are the elements of HRP that has supported the peaceful and unhindered operation of power plants and other critical infrastructure facilities in countries with advanced nuclear program?

ii. What are the policies and procedures that work for or against implementation of HRP in power plants and other critical infrastructure facilities in countries with advanced nuclear program?

iii. What are the factors that inhibit best practice in HRP in nuclear power plant operations?

iv. What role will cultural anthropology; political, sociological, economical, technological adaptations and values play in the planning, application and accomplishment of HRP for emerging countries?

v. How does management system affect HRP in the smooth take-off and running of the program in emerging countries?

vi. What are the knowledge needed to support the integration and coordination of facility/stakeholder HRP into a national plan in order to sustain a nuclear new build?

Survey design and research methodology

Survey/Questionnaire

A set of questions were developed and administered online to professionals in the research and nuclear plant-operating environment in order to understand and gain more knowledge of their

level of awareness of human reliability process and policies in both Nigeria and the United States. This survey provided a straightforward baseline data collection expressed by anonymous respondents on their understanding of HRP. The results generated from the questions analyzed and comparative deductions made to further identify the social actions and gaps that consciously and unconsciously may affect the implementation of the Nigerian Nuclear power program. Statistical analytical software, Statistical Package for Social Science (SPSS) was deployed in order to analyze the output from the questionnaire, the software was deployed due to its ability to execute cross tabulation and descriptive ratios in the identification of group data.

Focal agencies involved in the implementation of the Nigerian nuclear power program were considered, the survey design exploited the detail contribution and understanding of operational and existing Centers of Excellence for facility based opinion data on the status of HRP.

The survey design exploited the use of relevant Centers of Excellence (CoE) and focal organizations for nuclear implementation in Nigeria (Figure 3.2) as the simulation platform. Furthermore, analyzing the needs in each of the organ was opined will develop better ideas that helps communicate the requirements that could eventually translate to a national plan.

The analysis of the data also exploited the use of four demography index in table 3.1; ***facility, country, culture and management system*** to highlight gaps between the two case studies. One each from the four (4) index group was analyzed to as a representation of the group to establish their roles in the development of a viable HRP plan. This four groups are the suggestive shaping factors that must be considered in any country of implementation.

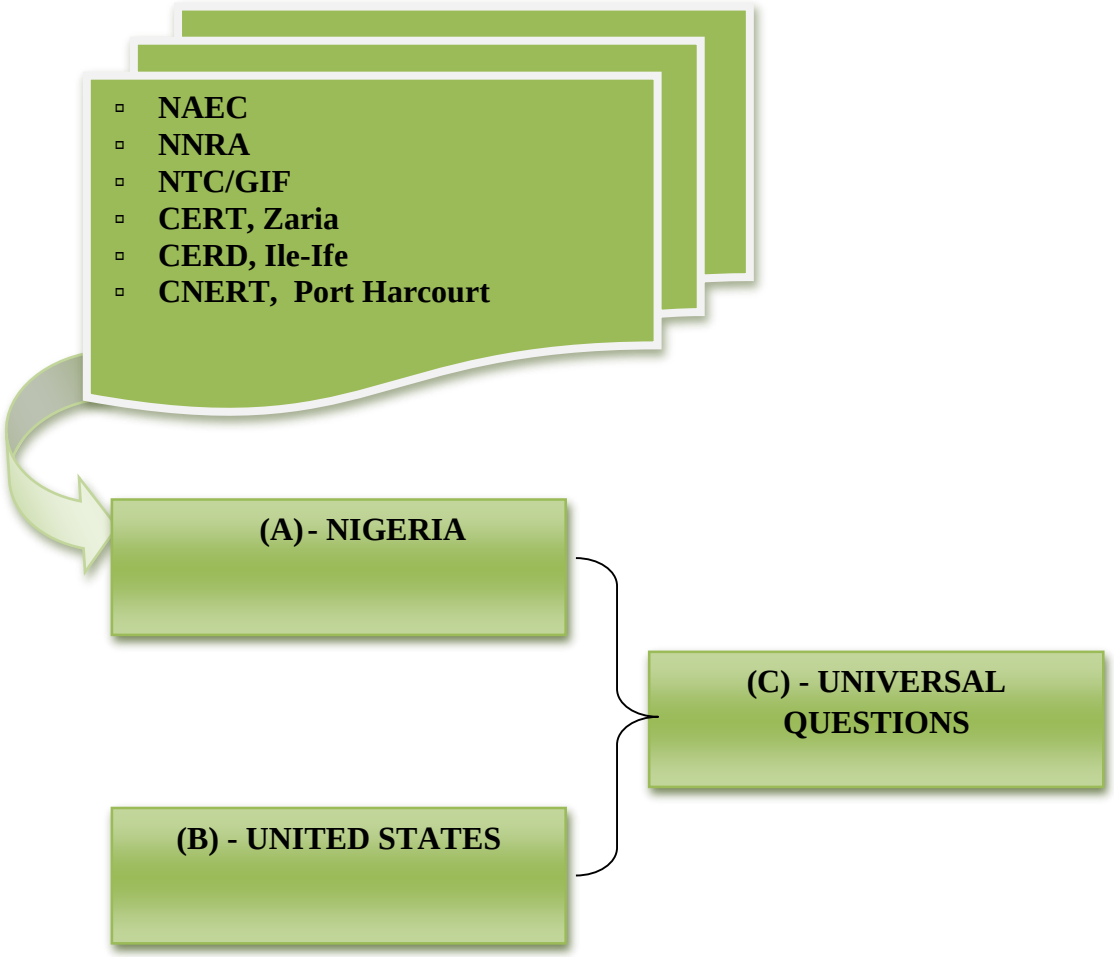

Figure 3.2 Survey design model

Additionally, the group analytics will enable the research establish the role that each group could play in the implementation and sustenance of HRP. Two (2) of the survey question are termed general questions as it deals with the acceptance or otherwise that credible threats exist in the operation of nuclear and radiological services.

Procedure for data collection and instrumentation

The survey was designed on an electronic platform using the Qualtrics research suite as recommended by the university of Tennessee office of information technology. Qualtrics account was created and the page populated with the designed survey questions after rounds of inputs from UT faculties and subject matter experts from the Oak Ridge National Laboratory (ORNL).
Email notifications were distributed in meetings and sent to heads of establishments, research groups, subject matter experts and personnel involved in HRP.

Figure 3.3 below shows the design and progression of activities; Data collection, inspection, transformation, modelling and analysis.

Data Analysis

The SPSS software was employed in the analysis of the survey result. Significance T – Test was conducted to analyze the data. Histogram and error bars of selected results were plotted. Additionally, the result of the data analysis are highlighted in chapter four (4) of this report

Table 3.1 Demographic factors that affect HRP

Facility	Country
▪ Policies and procedures for HRP are in place within your facility ▪ A legal framework for policies and procedures for HRP are in place in your facility ▪ HRP plan in place at your facility is effective ▪ The requirements and means of evaluation for HRP are well understood and clear to all employees ▪ Your organization's HRP plan is very effective and efficient for the present status of your nuclear power program ▪ There are sufficient internal control for your facility's HRP plan ▪ There are systems in place for continuous feedback from subject matter experts on the effectiveness of your facility ▪ There are perceived or suggestive weaknesses in your facility HRP implementation plan	▪ Policies and procedures for HRP are in place within your country ▪ A legal framework for policies and procedures for HRP are in place in your ▪ There is an acceptable national control plan for your country's HRP plan. ▪ Stakeholders are well informed of their responsibilities in the national HRP plan. ▪ The overall assessment of your country HRP is satisfactory
Culture (Performance shaping factors)	**Management System**
▪ The overarching principles of HRP account for local/national culture. ▪ Do you believe that aberrant behavior like; unusual character, elicitation, alcoholic indiscipline, Financial indiscipline, drug addiction, criminal records, arrest records, work history verification, e.t.c, could be detected with implementation of a good HRP ▪ There is an acceptable national control plan for your country's HRP plan	▪ Management System decisions contribute/account for the effectiveness of HRP ▪ There are sufficient internal control for your facility's HRP plan ▪ There are systems in place for continuous feedback from subject matter experts on the effectiveness of both the facility and country plan? ▪ Stakeholders are well informed of their responsibilities in the national HRP plan ▪ Facility HRP plan takes into account personnel competencies needed for job functions ▪ Resources for personnel job proficiency training are available

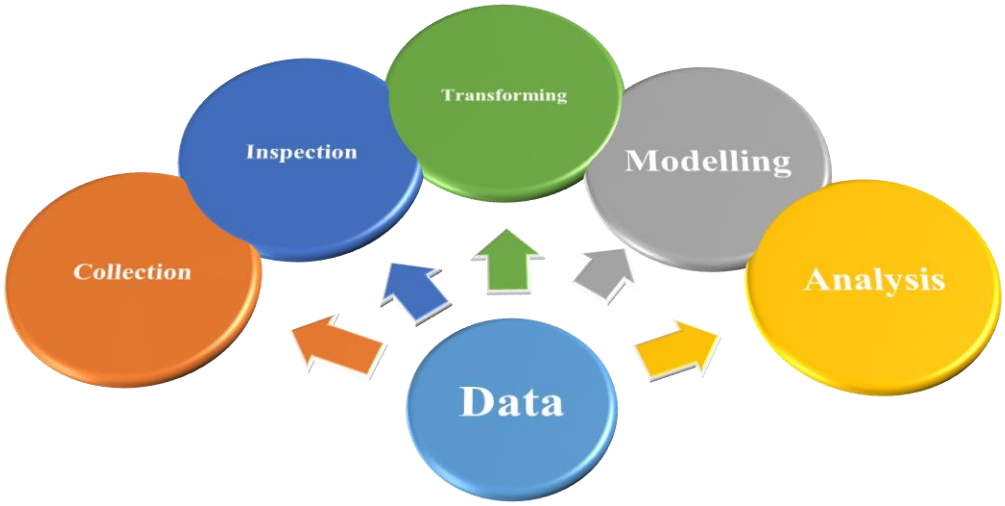

Figure 3.3. Data structure and process

CHAPTER 4

RESULTS AND ANALYSIS

This chapter provides the result and description of statistical analysis derived from the data collected. The analysis of result considered all assumptions used in the determination of the research conclusion and recommendations. The consistency of the result in the survey questions was determined by the use of other platform like Excel to generate camparable results.

Response Demography

It is assumed that the data collected for this research and analysis are sample size of a larger data set of professionals in HRP certification, HRP supervising official. The data suffice to be statistically significant enough to present a valid argument and therefore enough to be satisfactorily used as a model for the initiative of this research. From the survey result, 40% of the respondents were from the United States while the remaining 60% were from Nigeria (Figure. 4.1). A statistical significance test, the (Significance T-Test) was further administered in order to establish the objectives of this research.

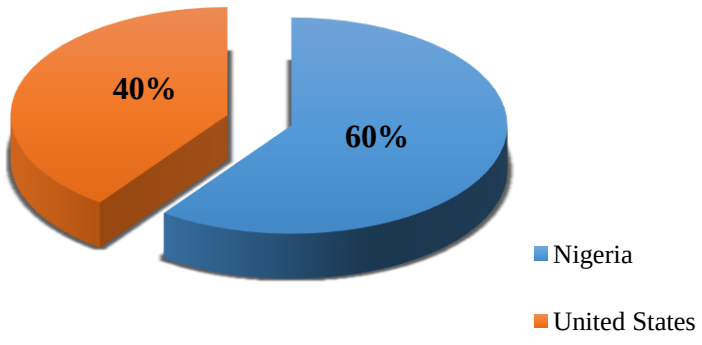

Figure 4.1. Survey response by country

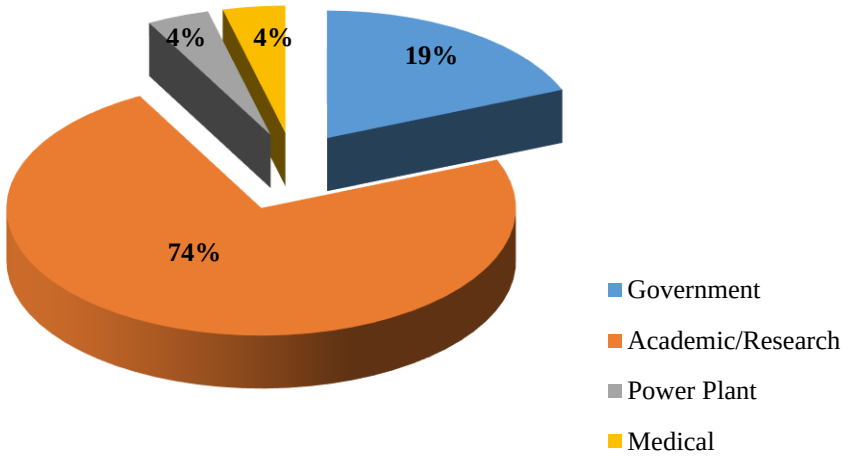

Figure 4.2. Survey response by US affiliation

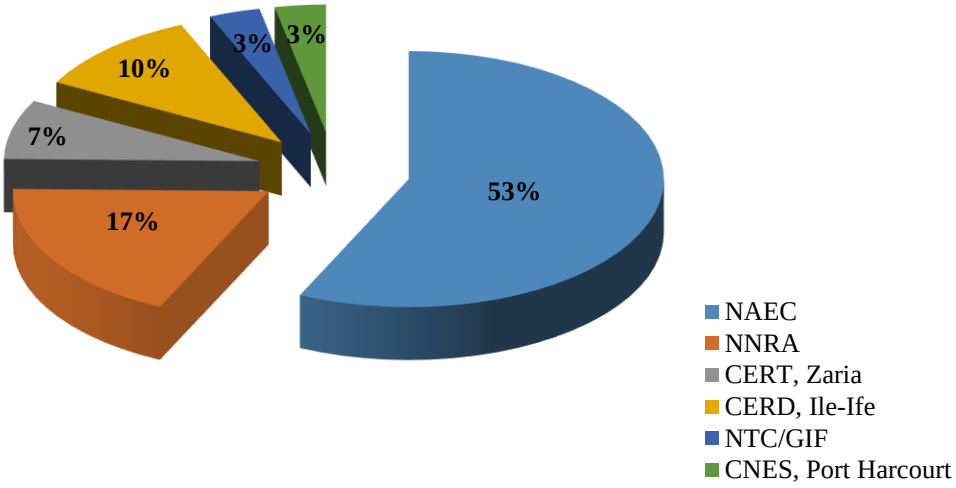

Figure 4.3 survey response by Nigeria affiliation

The test is a measure of the mean difference between two groups and it estimated the difference between the samples mean (US) and the population mean (Nigeria). The research made use of the data output to extrapolate the gaps by plotting histograms and comparing the distribution and skewness value. This helped to visualize the difference between the program understandings in the United States against that of Nigeria. The data evaluation will qualify the existence of statistical significance between the two case studies.

Threat and mitigation strategies

Three (3) out of the survey questions were dedicated to the understanding of the existence of credible threat and the instrument/strategy to mitigate the likelihood of the percieved threat. The 3 questions were dedicated to accepting that credible nuclear and radiological threat exist, the likeliness that the credible threat exist and the method or intrument to mitigate such threat

i. Do you agree that credible nuclear and radiological threat exists?
ii. How likely is this credible threat?
iii. Do you believe that aberrant behavior like; unusual character, elicitation, alcoholic indiscipline, Financial indicipline, drug addiction, criminal records, arrest records, work history verification, e.t.c could be detected with the implementation of a good HRP?

The data Figure 4.4 – Figure 4.11, further analysis were carried out and Figure A.1.1 – A.2.2 were obtained respectfully for each of the questions above. The information obtained from the analysis included following; histogram of the response, the frequency distribution and other statistical data that clearly distinguished the result obtained between both countries. Notably, the difference was used as a need based evidence for the development of an HRP model for Ngeria.

Table 4.1a. T-Test output for the group statistics (US and Nigeria)

Group Statistics					
	Country?	N	Mean	Std. Deviation	Std. Error Mean
sumtotalmng	Nigeria	31	12.5484	2.56695	.46104
	United States	21	13.5238	2.65742	.57990

Table 4.1b. T-Test output for equality of means

Independent Samples Test									
	Levene's Test for Equality of Variances t-test for Equality of Means								
	F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.645	.426	-1.32	50	.191	-.97542	.73582	-2.4533	.50252
Equal variances not assumed			-1.31	42.069	.195	-.97542	.74084	-2.4704	.51957

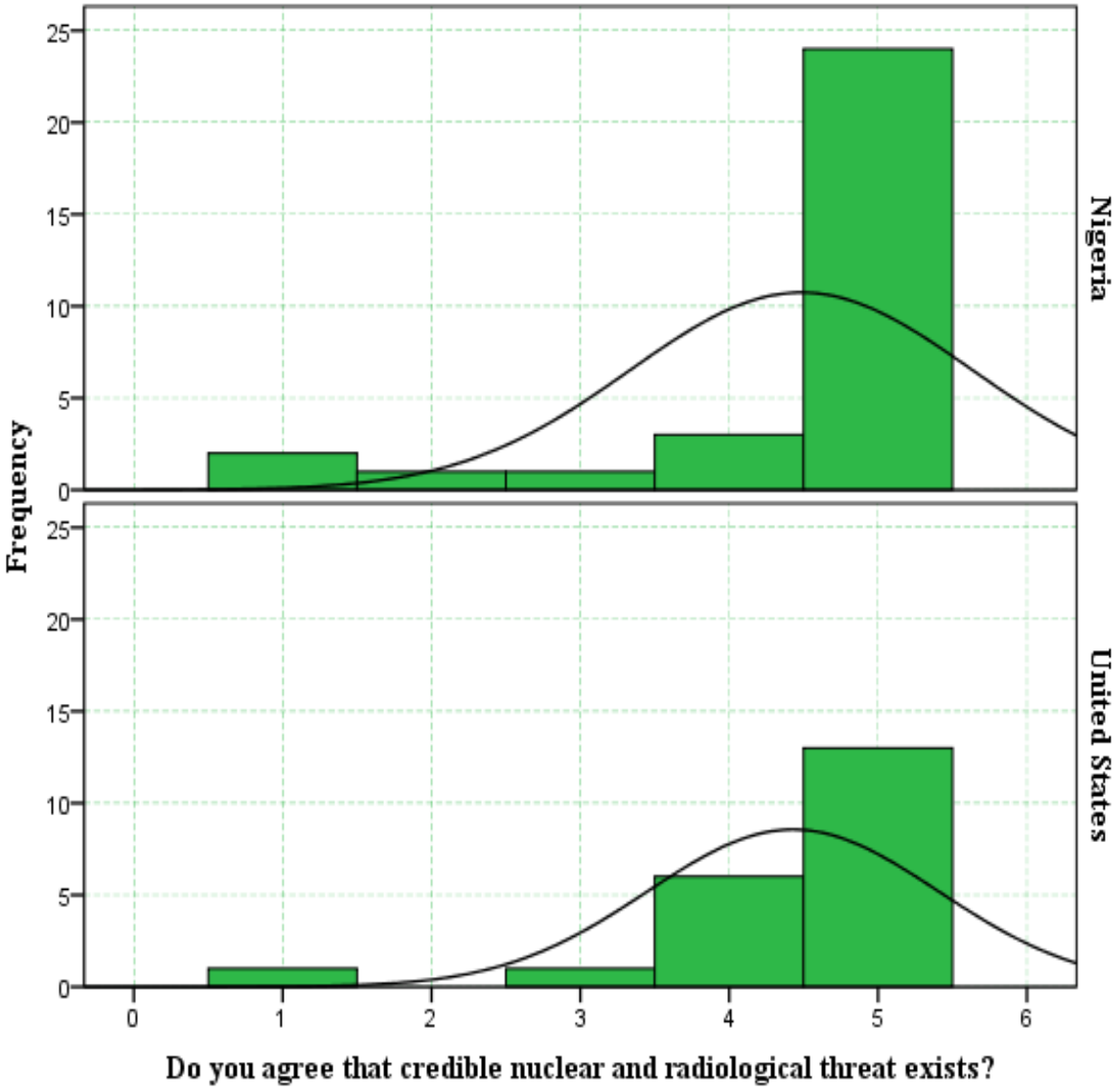

Figure 4.4. Credible nuclear and radiological threat exist

The model plan is attached in Appendix C of this report. The procedure could also be used to develop same program for other emerging countries alike. Additionally, based on the result, recommendations were made. For the analysis of this survey results, the x-axis represent the frequency while the y-axis represents the range of values for the number of occurrence. 1 =strogly disagree, 2 = somewhat disagree, 3 = Neither disagree nor agree, 4 = somewhat agree, 5 = strongly agree and 6 = Not Applicable.

In Figure. 4.4 above, the result shows the comparism between the acceptance of the existence of credible nuclear and radiological threat by both groups used as case studies. In the output, Nigeria has a higher value of those who strongly disgraee as well as those who strongly agree to the existence of the credible threat to nuclear and radiological. Further observation of the statistics from Nigeria reveals that those who strongly disagree about the existence of credible nuclear threat are from facilities situated away from the region where insurgency has their foot print. The result strongly demostrates the better understanding of HRP and the factors put in place to secure nuclear and radiological facilities including places of high security concequence. This is indicates that credible threat mitigation factors, understanding and awarenes are in place in the United States.

A descriptive test was carried out to itterate the spread and the skewness of the data for the purpose of analysing the difference between the results from both countries in Table 4.2a (Nigeria) and 4.2b (United States)

Table 4.2a. Descriptive Statistics (Nigeria)

Descriptive Statistics (Nigeria)								
	N	Min.	Max.	Mean		Std. Dev.	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Do you agree that credible nuclear and radiological threat exists?	31	1	5	4.48	.207	1.151	-2.342	.421

Table 4.2b. Descriptive Statistics (United State)

Descriptive Statistics (United States)								
	N	Min.	Max.	Mean		Std. Dev.	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Do you agree that credible nuclear and radiological threat exists?	21	1	5	4.43	.213	.978	-2.435	.501

Table 4.2c. Descriptive Statistics (Nigeria and United States)

	N	Min.	Max.	Mean		Std. Dev.	Skewness	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
Do you agree that credible nuclear and radiological threat exists?	52	1	5	4.46	.149	1.075	-2.310	.330

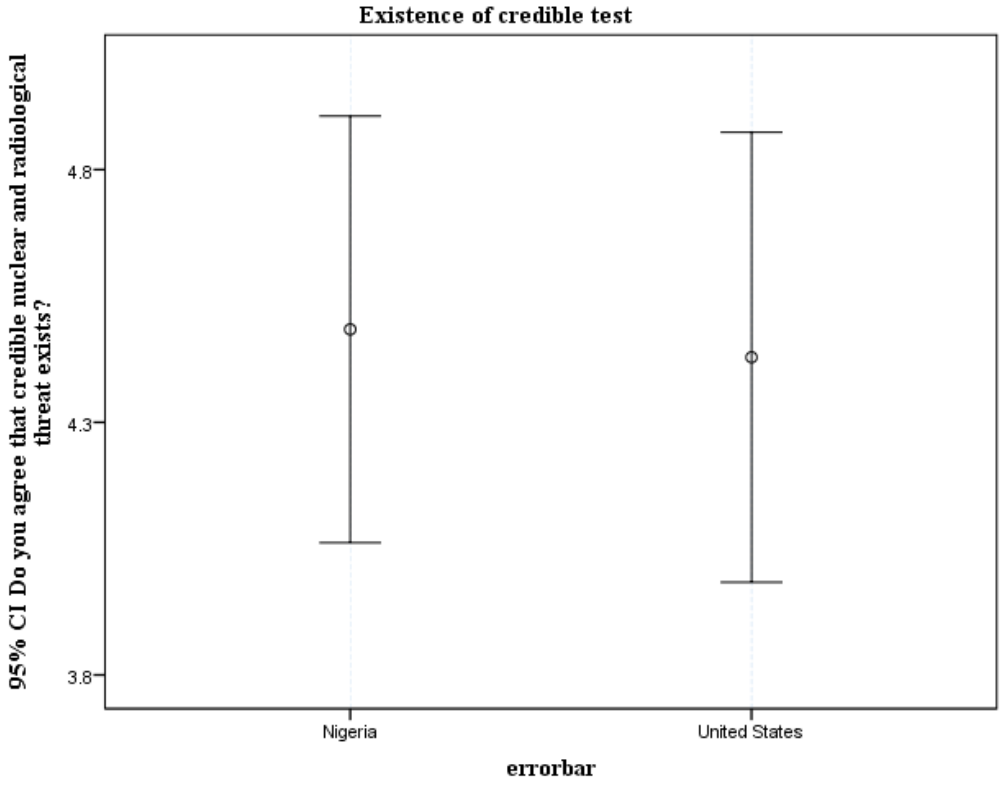

Figure 4.5. Errorbar for existence of credible threat (Nigeria & United State)

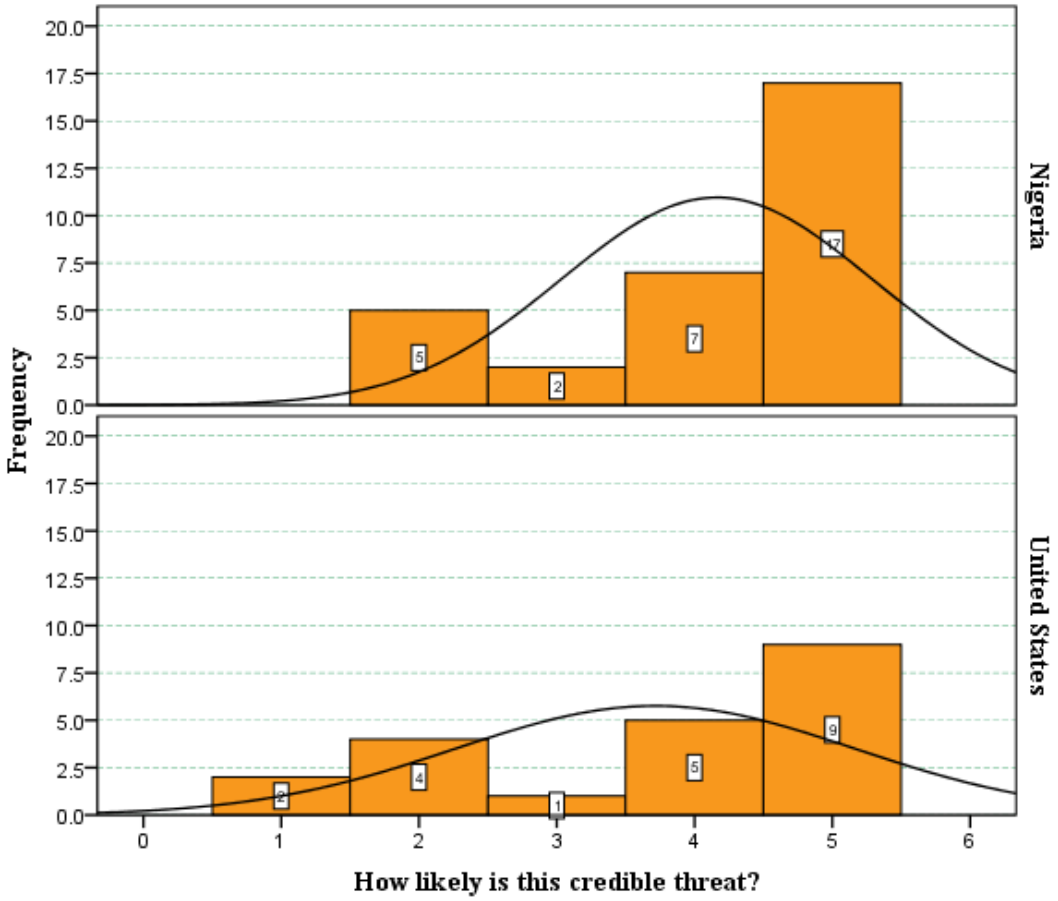

Figure 4.6. Likelihood of credible threat

Table 4.2d.Percentage response (How likely is this threat?)

	How likely is this credible threat? (%)				
	Strongly Unlikely	Somewhat Unlikely	Undecided	Some what Likely	Strongly Likely
Nigeria	0.0	16.1	6.5	22.6	54.8
United States	9.5	19.0	4.8	23.8	42.9
Total % (Nigeria – United States)	3.8	17.3	5.8	23.1	50.0

The result from the above tables were obtained for the plot on Figure. 4.4. Additionally, the table a combined plot comfirmed the agreement on the existence of credible threat. The negative results obtained in Tables 4.2a, 4.2b and 4.2c for the skewness on the table clearly justifies the visual display on the histogram. Table 4.2c further describes that the combined standard deviation (σ) of the distribution obtained from the plot in Figure.4.4 is 1.075 with a mean value of 4.46 with a standard error of 0.149.

Likewise, the error bar on Figure 4.5 advance justifies the fact that in both Nigeria and the United States, the level of believe in the existence of the threat is real and high. Figure 4.5 shows explains that most respondants spread across both countries believed the existence of the threat. The high value result outcome on both the histogram and the error bar, validates the acceptance of this credible threat. Obviously, since Nigeria is implementing a new nuclear program. The need for a viable HRP plan can never be over emphasized.

Also from the Figure 4.6 above, is the histogram of the likelihood of the credible threat discussed earlier, Nigeria has the higher value of those who believed in the likelihood of a credible threat. The fact that the HRP implementation is well undertsood is a factor, this is based on additional interview of some of the respondants at meetings during the elecitaion of data from subject matter experts. Furthermore, the values obtained for strogly unlikely result in Figure 4.6 (US) is a suggestive of a strong HRP in the United State. Table 4.3 below is the highlights of the data obtained the graph in Figure 4.6.

The errobar in Figure 4.7 shows Nigeria has a higher value of the likelikelihood of the existence of a nuclear and radiological threat than the United States. From the Figure, the lowest value were 3.7 for Nigeria and 3.1 for the US. This is an indication that the threat level in Nigeria is higher than in the US.

Table 4.3. Descriptive statistics (Nigeria/US) Likelihood of a credible threat.

Descriptive Statistics (Nigeria and United States)						
	N	Min.	Max.	Mean		Std. Dev.
How likely is this credible threat?	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
	52	1	5	3.98	.177	1.276
Nigerian Affiliation	52	1	9	5.17	.507	3.655
United States Affiliation	52	1	6	3.88	.291	2.102

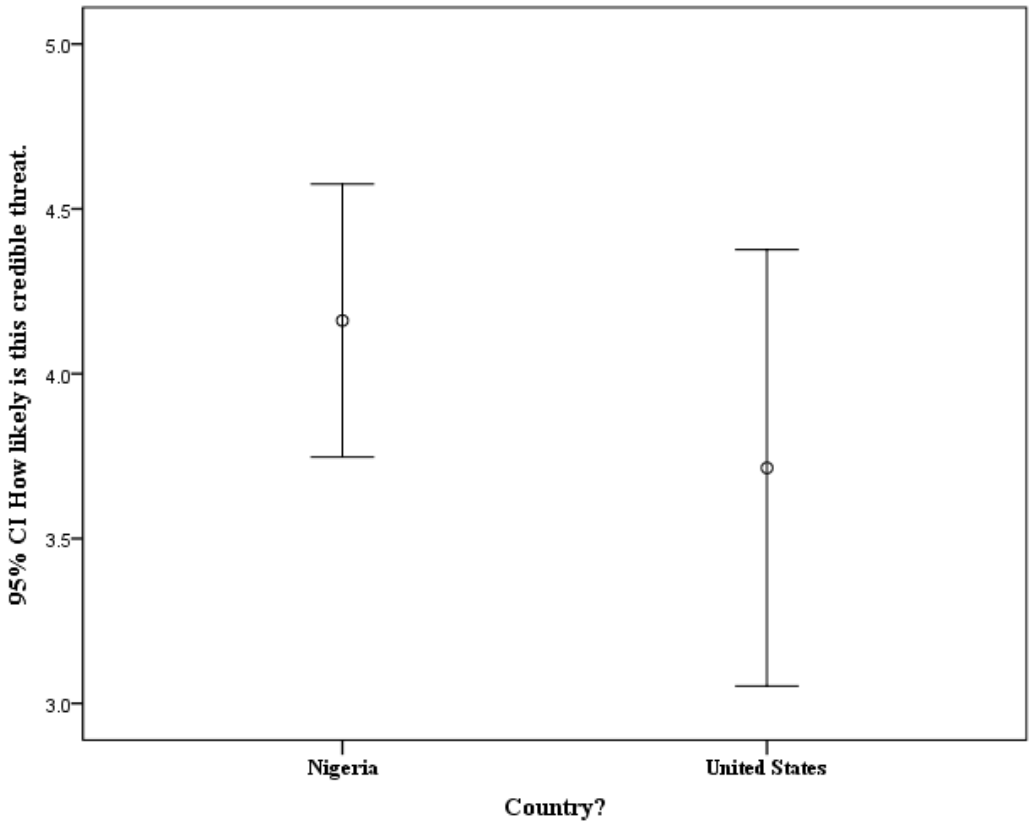

Figure 4.7. Errorbar likelihood of credible threat

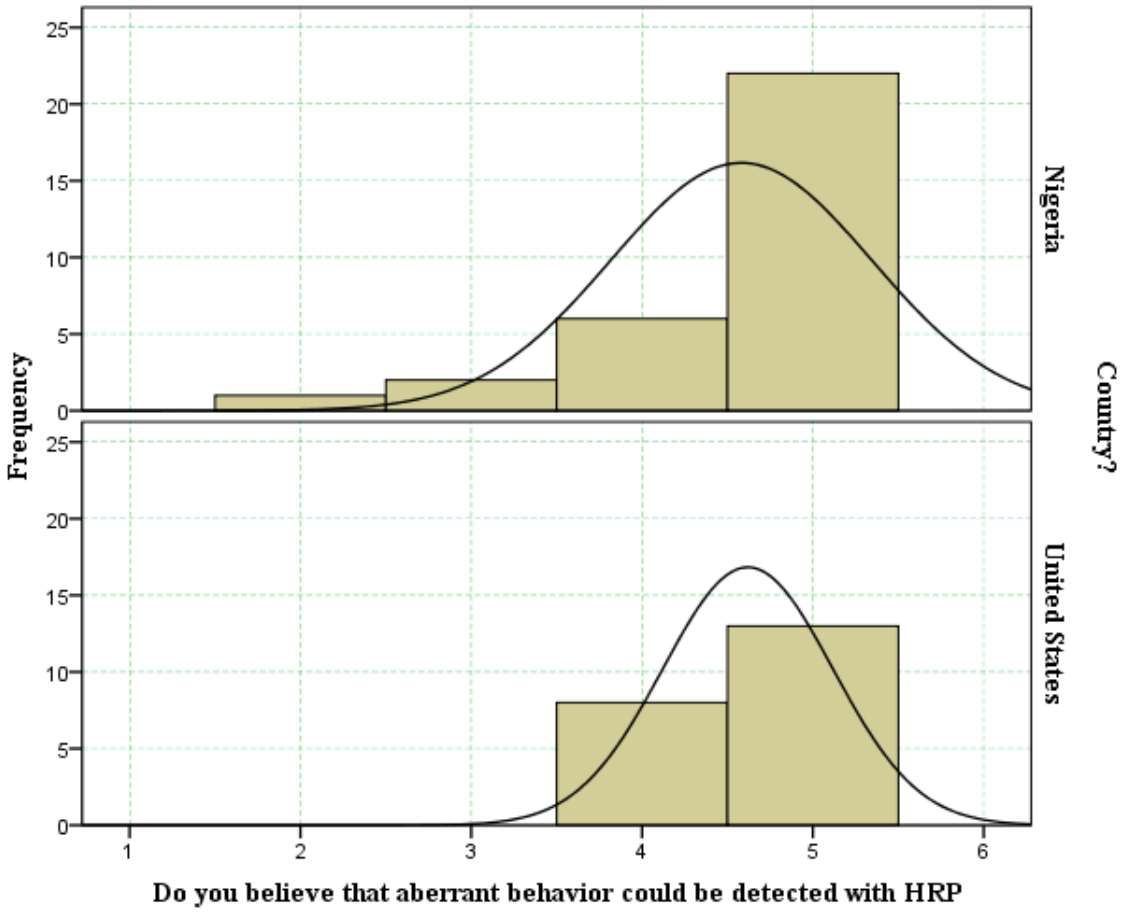

Figure 4.8. Aberrant behaviors detection with HRP

Table 4.4 Descriptive Statistics (Aberrant behaviors detection with HRP)

Descriptive Statistics							
Do you believe that aberrant behavior could be detected with HRP	Min	Max	Mean		Std. Dev.	Skewness	
	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Std. Error
	2	5	4.60	.092	.664	-1.827	.330
Nigerian	1	9	5.17	.507	3.655	-.029	.330
United States	1	6	3.88	.291	2.102	-.039	.330

Conversely, the upper limit of the error bars further shows that the US value (4.4) is lower than that of Nigeria at 4.6. It can be deducted from the Figure. 4.7 that both countries strongly believed in the esistence of credible threat, the lower value obtained for United States is an indication of a better program in place in the US. This is an indicating of a better HRP and the expectation that plan in place is adequate to mitigate the existence of the threat.

In Figure 4.8 above, the output data, displays visual and statistical values for the response to the survey question on the use of HRP to mitigate against aberrant behaviors. The data obtained in Figure. 4.8 above shows a wider spread of opinion of respondents from somewhat disagree to the highest on the histogram in Nigeria, while the data obtained from the United States indicates a coherent and firm response between somewhat agree and strongly agree. However, the data output from Nigeria displayed that a higher number of respondents strongly believed that HRP could be used to detect aberrant behaviors.

The value indicated a fairly large difference in standard deviation between Nigeria (3.655) and the United States (2.102). The standard error of the skew indicate values to the left, pointing to the fact that United States have more confidence and belief in the HRP procedures. The Nigerian data set is symmetrical, having a wider spread among all the range of response.

The error bar output further emphasizes on the data spread in Nigeria. The mean of the error value is lower in Nigeria than the United States. There is a very strong approval for the use of HRP for the mitigation of aberrant behaviors in Nigeria, this plus several other reasons like national security, the dare need for a stable society and support nuclear security and the detection of threats.

Tables 4.5, 4.6, 4.7, 4.8 and 4.9 below are the statistical values obtain from running the data on SPSS to analyze the policy and procedure awareness between Nigeria and the United States. Values obtained were, standard deviation, standard error, error mean and the variance.

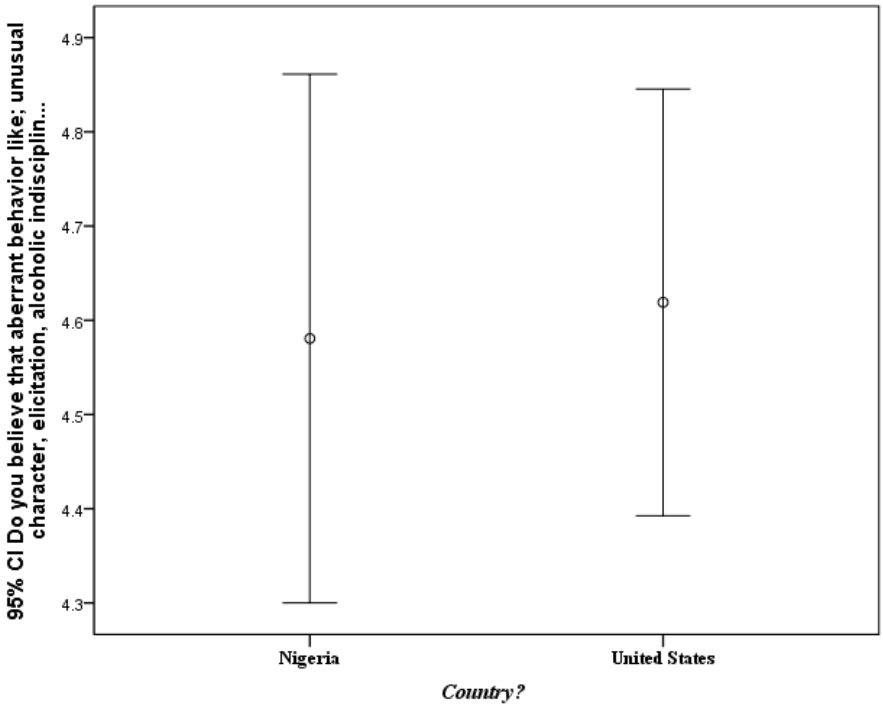

Figure 4.9. errorbar - aberrant behaviors detection with HRP

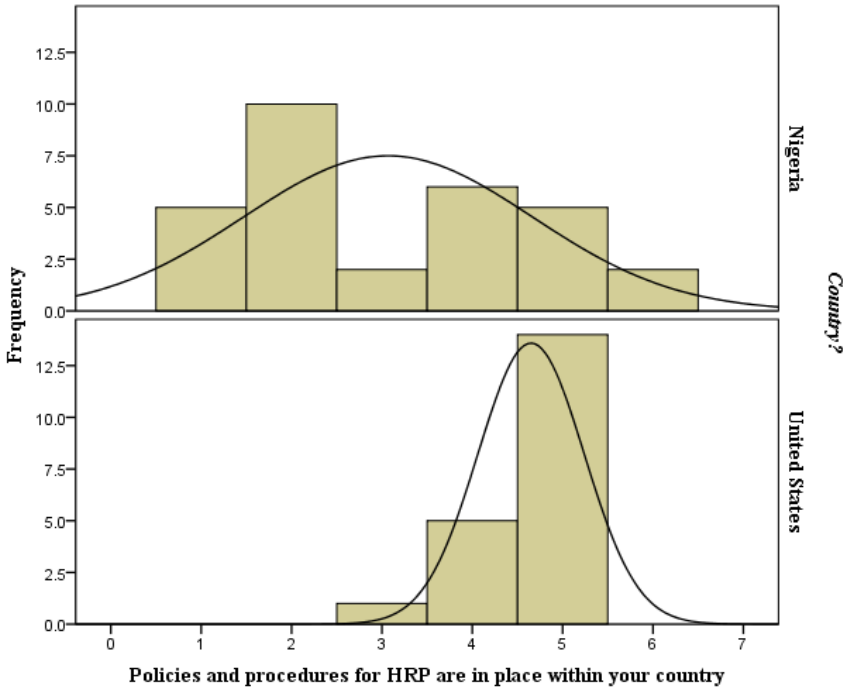

Figure 4.10. Policy and procedure for HRP

Policies and procedures for HRP

An effective HRP plan must identify good policies, procedures and effective actions that is acceptable to all stakeholders.Establishment of policies and procedures for Nigeria and other emerging nuclear states is an intergral portion of this research. In Figure 4.10 above, the output shows a well spread distribtion on the response for Nigeria, however, on the same Figure 4.10, the output values for the United States strong showing is well defined on the result. It clearly points to the fact that there is an urgent need to consider an HRP plan for Nigeria alongside the present implementation phase. Figure 4.11 clearly displays the difference between the awareness of HRP policy in Nigeria and the United States. The error distribution for the Nigerian response lies between 2.5 and 3.5 error value which indicates a very low level of awareness of HRP policy in Nigeria. However, the response from the United States indicates a high level of awareness of the program and policy. For the United States responders, the range of error distribution and value lies between 4.4 and 4.9. This clearly supports the preciseness of measurement and the true value of the HRP program in the case studies.

The result of figure A.1.1, A.1.2, A.2.1 and A.2.2 in Appendix AA strongly shows that there are weaknesses in the present HRP plans in facilities in Nigeria. Additionally, the HRP in Nigeria is not satisfactory for the present status of the NPP as indicated by respondents. This is further verified with the result on the Figure A.1.1 is suggestive of the weakness and the unsatisfactory level of HRP in Nigeria. The Figure A.1.2 shows that Nigeria and the US has 4.6 and 4.3 respectfully on the error mean. This is a call for more action and revision of programs in both Nigeria and the US. Furthermore, Figure A.2.1 shows that the present status of HRP in Nigeria is not satisfactory from the response. While on Figure A.2.2, the result obtained from Nigeria 3.6 and that of the US at 4.5 is a clear difference in satisfaction of HRP programs in both countries.

Table 4.5 Statistics (Nigerian policy & procedure awareness)

Statistics (Nigerian Policy)			
		Policies and procedures for HRP are in place within your:-Country	Nigerian Affiliation
N	Valid	30	31
	Missing	1	0
Mean		3.07	2.58
Std. Error of Mean		.291	.422
Median		2.50	1.00
Mode		2	1
Std. Deviation		1.596	2.349
Skewness		.320	1.599
Std. Error of Skewness		.427	.421
Range		5	8
Percentiles	25	2.00	1.00
	50	2.50	1.00
	75	4.25	4.00

Table 4.6 Frequency distribution response (Nigerian policy & procedure awareness)

Policies and procedures for HRP are in place within your:-Country				
	Frequency	Percent	Valid Percent	Cumulative Percent
Strongly Disagree	5	16.1	16.7	16.7
Somewhat Disagree	10	32.3	33.3	50.0
Neither agree nor Disagree	2	6.5	6.7	56.7
Somewhat Agree	6	19.4	20.0	76.7
Strongly Agree	5	16.1	16.7	93.3
Not Applicable	2	6.5	6.7	100.0
Total	30	96.8	100.0	
System	1	3.2		
Total	31	100.0		

Table 4.7 Nigerian affiliation respondents (Nigerian policy & procedure awareness)

Nigerian Affiliation (%)			
		Frequency	Percent
Valid	Nig. Atomic Energy Commission (NAEC)	16	51.6
	Nig. Nuc. Regulatory Authority (NNRA)	5	16.1
	CERT, ABU, Zaria	2	6.5
	CERD, OAU, Ile-Ife	3	9.7
	NTC/GIF, Abuja	1	3.2
	CNES, UniPort	1	3.2
	Others	2	6.5
	Not Applicable	1	3.2
	Total	31	100.0

Table 4.8 Statistics (US policy & procedure awareness)

Statistics (United States)			
		Policies and procedures for HRP are in place within your:-Country	United States Affiliation
N	Valid	20	21
	Missing	1	0
Mean		4.65	2.14
Std. Error of Mean		0.131	0.210
Median		5.00	2.00
Std. Deviation		0.587	0.964
Variance		0.345	0.929
Skewness		-1.521	3.396
Std. Error of Skewness		0.512	0.501
Range		2	5
Percentiles	25	4.00	2.00
	50	5.00	2.00
	75	5.00	2.00

Table 4.9 Frequency distribution (US policy & procedure awareness)

Policies and procedures for HRP are in place within your:-Country					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Neither agree nor Disagree	1	4.8	5.0	5.0
	Somewhat Agree	5	23.8	25.0	30.0
	Strongly Agree	14	66.7	70.0	100.0
	Total	20	95.2	100.0	
Missing	System	1	4.8		
Total		21	100.0		

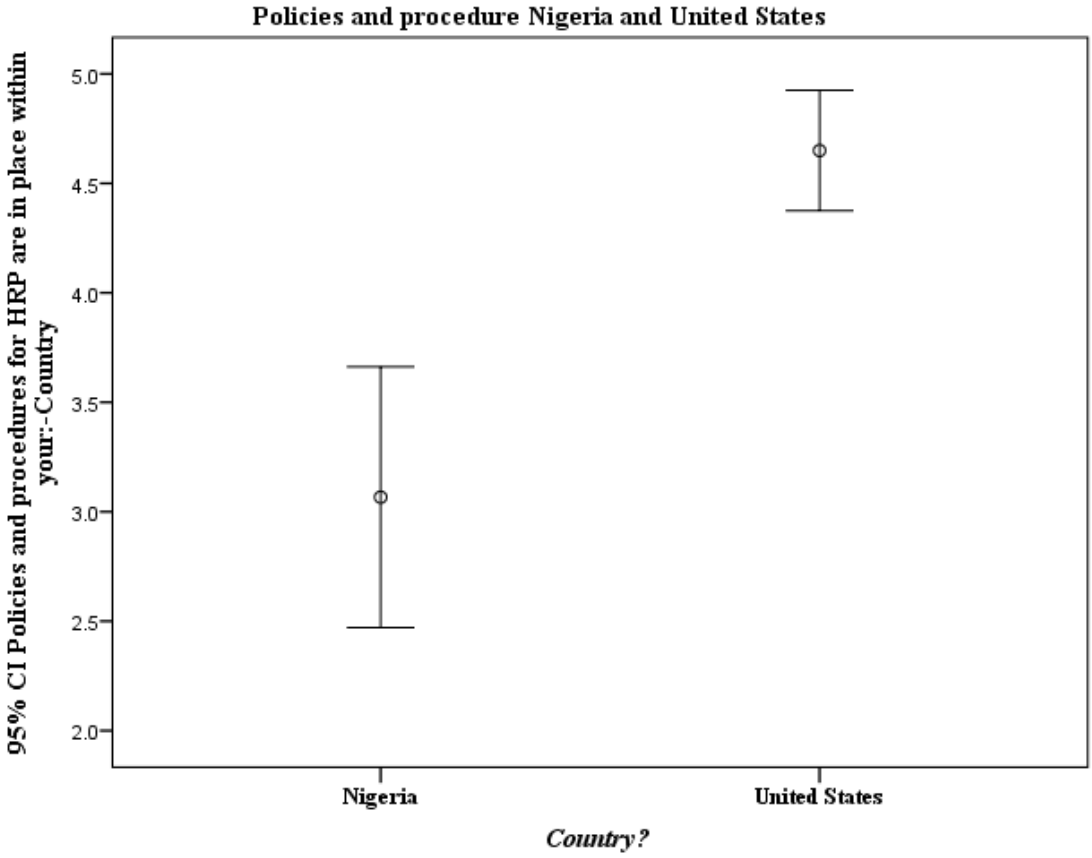

Figure 4.11. Policy and procedure (Nigeria and United States)

CHAPTER 5

CONCLUSION AND RECOMMENDATION

Conclusions

The conclusion of this research highlighted the precarious need to create a critical mass of trustworthy personal with an enabling environment for safe and secure nuclear power program. HRP encompasses accurate, timely, and detailed process for the analysis of human behavior. Which is instilled through policies and practices of an organization. This is put in place to ensure operational and security reliability. For a nuclear security program to be successful, there are several factors to be considered and put in place. The designed model in Figure. 3.1 serves as a good and exemplary procedure to analyze the importance of HRP in nuclear security. It helps in the understanding of best practice by outlining the impact of any program failure and the influence of a successful program.

The gaps subject to the survey result and the analysis that follows, includes:

i. Cultural difference in believes, values and the conceptual waiving of rights by personnel at the point of entry for employees that requires HRP certification between Nigeria and the United States. In Nigeria waiving of rights and privacy of personnel is not considered and are not common feature of employee agreement, while in the United States employees' rights waiver are vital part of the acceptance to work in high security facilities. For best practice it is expected that Nigeria will find a place for screening based on credit check, drug verification and general background check.
ii. The ideology of security contributes to the confidence building in support of safe and secure implementation of nuclear technology in the United States. It is important for Nigeria to clearly develop same ideology to improve on the confidence building

iii. Figure 4.11 shows that policies and procedures for HRP is the bedrock for the sustenance of peaceful application of nuclear technology in the United States, meanwhile, lack of policy and operational procedure still permeate operations in Nigeria. This must be clearly address to chat a way forward for the Nigeria nuclear power program.

iv. Figure A.2.1, established the big difference between the overall assessment of HRP in Nigeria versus the United States. From the output, over 50% of participants from Nigeria strongly or somewhat disagreed that the overall assessment of the country's HRP plan is adequate or satisfactory for the present status of the nuclear program in Nigeria. Figure A.2.2 further buttress this gap between the two counties with the highest value in Nigeria standing at 3.6 while that of the United States was obtained as 4.9. This is a clear indication that the level of satisfaction is higher in the United States than Nigeria. Therefore, it is suggested that HRP should be given an accelerated consideration alongside all other plans in the implementation of the country's nuclear power program

This research established and evaluated a baseline data on the knowledge and understanding of participants in human reliability in nuclear systems. The data was collected through the administration of an online survey of professionals and subject matter experts. The method employed, appraised the awareness of participants using Nigeria and the United States as case studies. The data collected from both case studies were statistically compared and gaps were established in the analysis of response distributions and measurements grouped by the established and documented knowledge and understanding of the program in both countries.

Figure 4.4 has most responses from both case studies in support of the existence of credible threat. The visual display indicated a higher ratio in those who believed that it does not exist in Nigeria. However, this is not an indication that the program thus far is not well matched with the

level of insecurity in Nigeria. Looking at the response demography, the responders from the northern part of Nigeria alluded to the existence of credible threat while those from the southern part responded otherwise. This suggested that the level of insecurity is greater in the north than the south.

Most importantly in the outcome of this research analysis is the result in Figure 4.10 on the availability of policy and procedure for HRP in the case studies. Figure 4.10 evidently shows that above average number of responses agreed that there are no policies and procedures in place for the program. This is also corroborated by the error bar output in Figure 4.11 that returned the least value for Nigeria at 2.4 and the least for United States as 4.4. This is a strong indication that there is a dare and urgent need for HRP development for Nigeria.

The outcome of this research establishes; the acceptance and existence of credible nuclear and radiological threats, the role that HRP could play in detection and mitigation of aberrant behaviors. And most importantly the need to establish and develop a national HRP policy for Nigeria and by extension to other emerging countries implementing nuclear power program for peaceful application.

Recommendations

- A strategy for national threat assessment and evaluation is most important and must precede the development of an HRP plan. This must take into consideration the dynamics of threat spread over the country. Above all, the strategic program should include cost for sustaining the planning and implementation process.

- The HRP program implementation team must ensure that roles and responsibilities are identified and are in place from the planning phase of the program and responsibilities shared accordingly.
- The development of a national HRP plan must proceed from the facility/stakeholder level in order to get more detailed cultural influence that may impair the implementation. Figure 5.0 below is a model recommended for the stepwise action towards the development. The facility model is recommended to be synchronized into the national plan. A proposed national HRP plan in the model is elaborated in Appendix C
- The reward and discipline system must be clear and open to every personnel in HRP
- The program development for HRP must consider a revolving cost platform to be associated with training equivalent of job task with respect to evaluation and certification of personnel.
- Legal and Regulatory framework must be put in place and a structure of record keeping must identify type of records and those who are authorized to have access to such records.

Future work

The future of this research is aimed at extending the research model to other emerging countries considering the inclusion of nuclear energy for peaceful purposes. The process adopted in the design could help develop a viable threat assessment that could be a useful tool in the development of national HRP plan and strengthen national security.

This research is developed and expected to contribute to the development of a succinct process flow for the building of the infrastructure for the establishment of a viable human reliability program. Besides this, this research has helped to develop a proposed HRP plan for use in the implementation of the Nigeria nuclear power program. The outcome of this research is anticipated to set a precedence for continuous review of the model and the program that could further strengthen the comprehensive procedure to identify personnel or prospective employees with probable malicious character that could be of reasonable threat to the facility or national security. Additionally, the outcome of this research is applicable as a model to support the planning and implementation of HRP in other nuclear emerging countries.

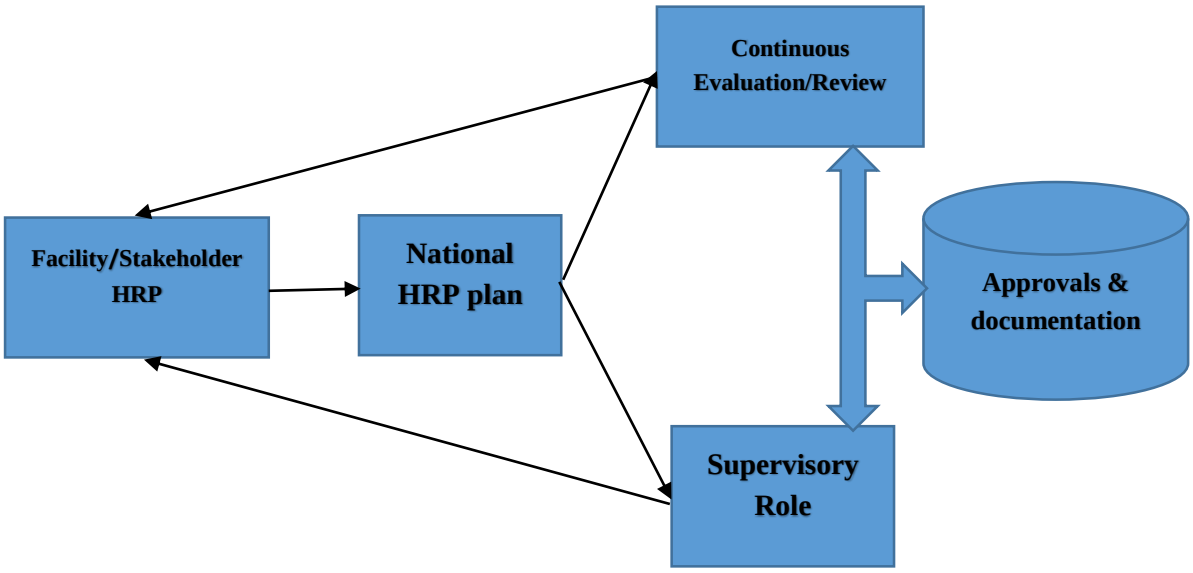

Figure 5.1. Integration strategy for HRP plan

LIST OF REFERENCES

[1] http://www.nytimes.com/interactive/2015/06/11/world/africa/boko-haram-isis-propaganda-video-nigeria.html?_r=0

[2] Moieni P., Spurgin A. J., and Singh A. (1993), "Advances in human reliability analysis methodology"

[3] Giustino Manna (2007) "Human and Organizational factors in nuclear installations: Analysis of available models and identification of R & D issues"

[4] http://www.worldometers.info/world-population/nigeria-population/

[5] http://www.kwintessential.co.uk/resources/global-etiquette/nigeria.html

[6] Osaisai, F. E. (2011), "Nuclear Power Introduction in Nigeria: Organization and Way Forward", Paper Presented at the IAEA 2nd Regional Conference on Energy in Africa. May 30 – 31, 2011, Cape Town South Africa.

[7] Osaisai, F. E. (2008), "Atomic Power Essential for Nigeria's Energy Source [8] Diversification Program". Available at http://www.nigatom.org.ng/index.html

[8] http://energy.gov/ehss/human-reliability-program-handbook (DOE HRP Program)

[9] Reshmi Kazi, (2015), "Nuclear Security in Asia: Problems & Challenges", Strategic Analysis

[10] Okechukwu O. (2014), "Partition or Perish: Restoring Social Equilibrium in Nigeria through ReconFigureuration"

[11] Emmanuel O. and Lloyd C. H (2000), "Leadership style, organizational culture and performance: empirical evidence from UK" International Journal of Human Resources Management.

[12] Centre for Intercultural Learning http://www.intercultures.ca/cil-cai/ci-ic-eng.asp?iso=ng#cn-9

[13] Mofope A. (2013), "The Applicability of Management Theories in Nigeria: Exploring the Cultural Challenge", International Journal of Business and Social Science Vol. 4 No. 10 [Special Issue – August 2013]

[14] Akinsola Akinwowo, (1972), "Tribalism & Nation-Building in Nigeria".

[15] Olatona Olabode (2012), "Tribalism, Nepotism, Cronyism and General Poverty" assessed at http://dailypost.ng/2012/07/18/tribalism-nepotism-cronyism-general-poverty/

[16] Fola Daniel Adelesi (2014): "National Interests First & Tribal Sentiments Behind" http://www.bellanaija.com/2014/10/02/fola-daniel-adelesi-national-interests-first-tribal-sentiments-behind/

[17] https://www.transparency.org/cpi2014/results

[18] Okolo, P., & Raymond, A. (2014). "Corruption in Nigeria: The Possible Way Out". Global Journal of Human-Social Science: F Political Science, Volume 14 Issue 7 Version 1.0 (2249-460x), Pg.31-38. Available at https://globaljournals.org/GJHSS_Volume14/4-Corruption-in-Nigeria-The-Possible.pdf

[19] Enakhimion Imonitie Lucky, (2011), "Corruption in Nigeria", Lund University, School of Economics and Management

[20] UT-Battelle, Oak Ridge National Laboratory (2014), US Department of State Partnership for Nuclear Security "Roadmap to a sustainable Human Reliability Program"

[21] Elizabeth K. Ervin, assessed at http://home.olemiss.edu/~cmchengs/Global%20Warming/Session%2017%20Nuclear%20Energy%20-%20Statistics/Nuclear%20Energy.pdf

[22] International Atomic Energy Agency (IAEA), (2014) "Nuclear security series Glossary" Version 1.1

[23] International Atomic Energy Agency (IAEA), (2008), Nuclear Security Series No. 8, "Implementing Guide: Preventive and Protective Measures against Insider Threats".

[24] Matthew Bunn, Martin B. Malin, Nicholas Roth and William H. Tobey, (2014) "Advancing Nuclear Security: Evaluating Progress and setting New Goals"

[25] Power Engineering International, (Online edition), (2004) http://www.powerengineeringint.com/articles/2014/08/electrabel-confirms-doel-4-nuclear-power-plant-sabotage.html

[26] http://www.osti.gov/scitech/biblio/5053959

[27] International Atomic Energy Agency (IAEA) (2014), "Nuclear Safety Review"

[28] Stephen Dahunsi, Hannah Hale, Yakubu Viva Ibrahim, Rosalind I. J. Hackett, Howard Hall, Joseph Stainback IV (2015) "Cultural influence on nuclear security: A Nigerian perspective"

[29] Nicholas Gaunt, (2000) "Practical approaches to creating a security culture"

[30] Chia P. A., Ruighaver A. B., and Maynard S. B. (2014) "Understanding organizational security culture"

[31] Khripunov et al (2007), "Nuclear Security Culture: From National Best Practices to International Standards"

[32] International Atomic Energy Agency (IAEA), (2008), "Nuclear Security Series No. 7, "Implementing Guide: Nuclear Security Culture".

[33] Thomas Schobe, (2012) "Management Requirements: Identification, Recognition and Application"

[34] Dhillon B. S., (2014), "Human Reliability Error, and Human Factors in Power Generation", Springer.

[35] Kenneth N. Luongo and Sarah Williams., (2014), “Integrating Nuclear Security Policy & Technology: Asian Centers of Excellence” Center for Strategic and International studies”,

[36] Laura D’iaz Anad’ion, Gregory Nemet and Elena Verdolini., (2013) “The future cost of nuclear power using multiple elicitations: Effects of RD & D and elicitation design”, (IOP Science) stacks.iop.org/ERL/8/034020.

[37] International Atomic Energy Agency (IAEA) (2013), “Nuclear Security Series implementation guide No 21”, Vienna, Austria.

[38] Nancy Leveson, Nicholas Dulac, Karen Marais and John Carroll., (2004), “Moving beyond Normal Accidents and High Reliability Organization: A system approach to safety in complex systems”, MIT.

[39] https://oit.utk.edu/research/Pages/exit.aspx

APPENDIX

APPENDIX AA

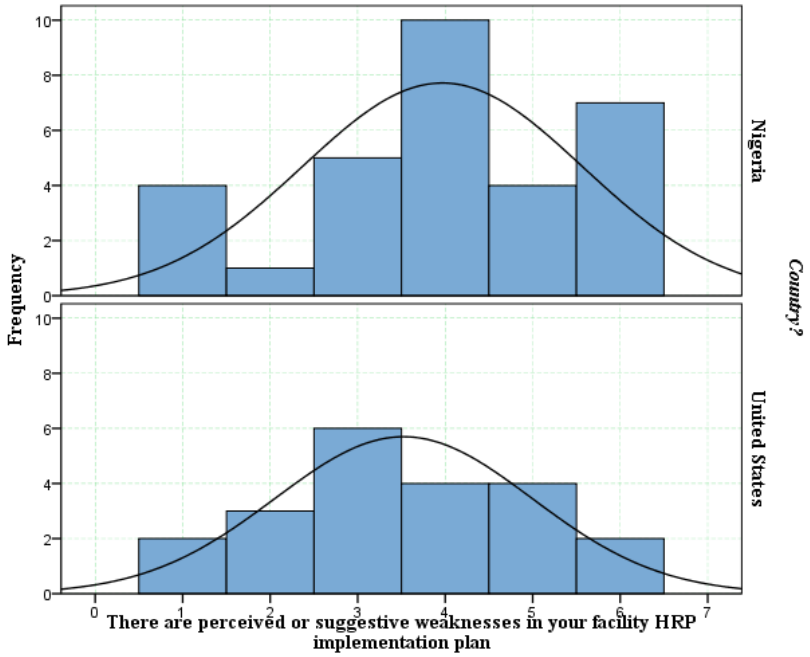

Figure A.1.1. Perceived facility weakness

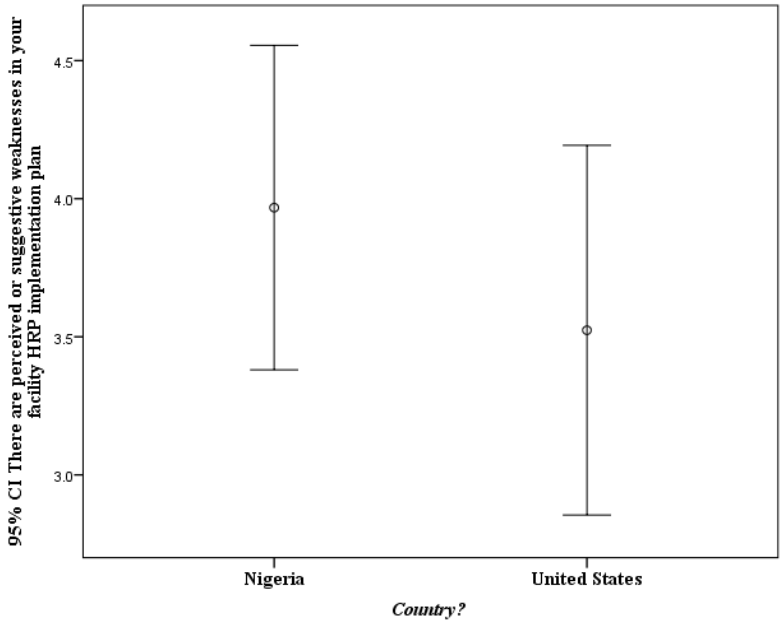

Figure A.1.2 Error bar perceived facility weakness

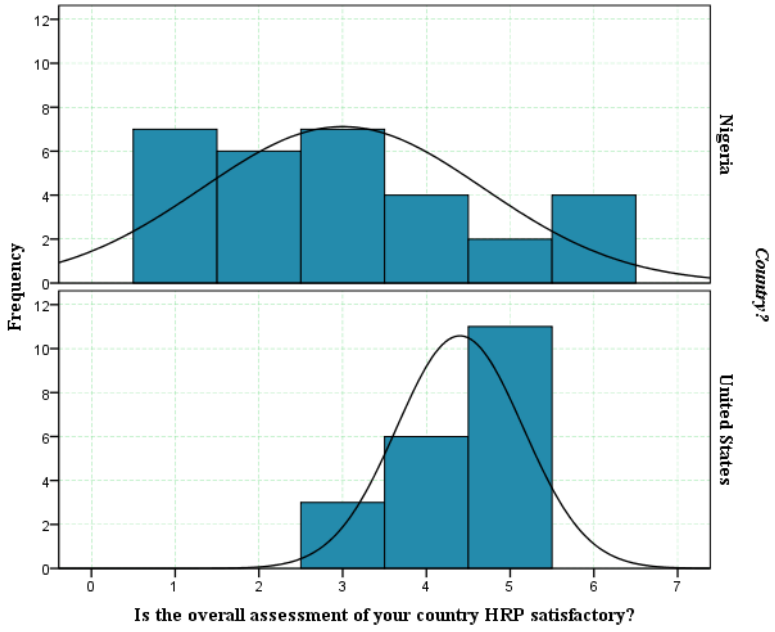

Figure A.2.1 Overall assessment of country HRP

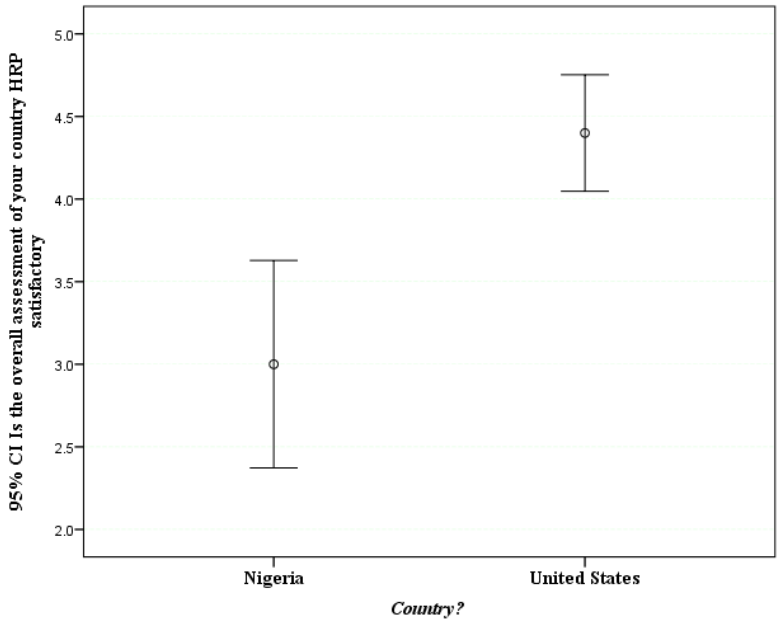

Figure A.2.2 Error bar overall assessment of country HRP

APPENDIX A1

THE UNIVERSITY of TENNESSEE
KNOXVILLE
Office of Research & Engagement
INSTITUTIONAL REVIEW BOARD (IRB)

1534 White Ave.
Knoxville, TN 37996-1529
865-974-7697
fax 865-974-7400

February 10, 2016

Stephen Olumuyiwa Ariyo Dahunsi, Ms
UTK - Nuclear Engineering

Re: UTK IRB-15-02598-XM
Study Title: Human Reliability Program Gap Analysis

Dear Stephen Olumuyiwa Ariyo Dahunsi:

The Administrative Section of the UTK Institutional Review Board (IRB) reviewed your application for the above referenced project. The IRB determined that your application is eligible for **exempt** review under 45 CFR 46 Category 2. In accord with 45 CFR 46.116(d), informed consent may be altered, with the cover statement used in lieu of an informed consent interview. The requirement to secure a signed consent form is waived under 45 CFR 46.117(c)(2). Willingness of the subject to participate will constitute adequate documentation of consent. Your application has been determined to comply with proper consideration for the rights and welfare of human subjects and the regulatory requirements for the protection of human subjects.

This letter constitutes full approval of your application (version 1.1, including supplemental Recruitment Plan version 1.0), recruitment email (version 1.0), Sign up sheet for organizations (version 1.0), INS Survey IRB Application (version 1.1), and the consent cover statement (version 3.2) stamped approved by the IRB on 02/10/2016 for the above referenced study.

In the event that volunteers are to be recruited using solicitation materials, such as brochures, posters, web-based advertisements, etc., these materials must receive prior approval of the IRB.

Any alterations (revisions) in the protocol must be promptly submitted to and approved by the UTK Institutional Review Board prior to implementation of these revisions. You have individual responsibility for reporting to the Board in the event of unanticipated or serious adverse events and subject deaths.

Sincerely,

Colleen P. Gilrane

Colleen P. Gilrane, Ph.D.
Chair

APPENDIX A2

Consent

You are invited to participate in the research below. The research is aimed at establishing a baseline data on Human Reliability Program. The outcome of the study will be used to develop a gap analysis for Human Reliability program in Nigeria.

Participation in the study is voluntary and please refer further question(s) concerning the survey to the following:

(i) The University of Tennessee - IRB research compliance officer on +1 865 974 3466 http://irb.utdev4.wpengine.com/wp-content/uploads/sites/29/2013/05/informed_consent_basic.pdf

(ii) Stephen Dahunsi on +1 865 232 5009, sdahunsi@vols.utk.edu

(iii) Prof. Joseph Stainback IV +1 865 719 8923, jstainback@utk.edu

This is a scholarly research study conducted by Stephen Ariyo Dahunsi, a graduate student in the Department of Nuclear Engineering at the University of Tennessee and the Institute for Nuclear Security at the Baker Center for Public Policy. The purpose this study is to establish baseline data on the participant's knowledge of Human Reliability Programs (HRP). In this case a Human Reliability Program refers to the policies and practices of an organization to ensure both operational and security reliability. This research involves the completion of an online set of questions that will take approximately 15 minutes of the participant's time. Participation in this study is voluntary and the responses will remain anonymous and confidential. Anyone contacted to participate in this survey may refuse to participate and may stop participating in this survey at any time. No identifying information such as name, email, or IP address will be asked for nor should it be provided by the participants. All information provided will be kept in a password

secured location. The data gathered from this survey will be analyzed, and used to develop a baseline gap analysis of the Human Reliability Program (HRP) in Nigeria. The methodology will evaluate the present understanding and knowledge of the program in Nigeria through the administration of these questions. The same set of questions will be administered in the United States and the results gathered from both surveys will be compared for identification of gaps, further refinement or development, and training and education purposes in Nigeria. The future of this work is to continuously improve the methodology for application of HRP in emerging nuclear states. This method will take into account the present and future plans for security of nuclear and radioactive source usage/services, as well as implementation and cultural factors that work for or against HRP best practice. [Each question has a box for each participant to rate 1 to 5 with 1 (Strongly Disagree), 2 (Somewhat Disagree), 3 (Neither agree nor Disagree), 4 (Somewhat Agree), 5 (Strongly Agree). The 6th box is for questions or answers that are Not Applicable (N/A).]

The University of Tennessee requires all participants to be aware of procedures and policies in order to consent to participation any survey, as such, the itemized statements below addresses the elements of such informed consent for participants to review in order to guide their participation or otherwise in the survey. Please review statements 1 – 13 below and select (a) or (b) to either continue or discontinue with the survey:

1. This study involves research regarding the collection of anonymous survey data to identify any knowledge gaps both in the United States and Nigeria regarding Human Reliability Programs.
2. The selection of participants and data gathered therein will remain protected and anonymous.
3. Participation in this survey is voluntary and should take no more than 3 minutes.

4. The procedure entails participants responding to a series of questions regarding their knowledge of any applicable HRP policies and programs they are a part of.
5. There are no discernable risks or discomforts to the participants.
6. There are no benefits (i.e. rewards or compensation) to the participants or others outside of what the research data will reveal regarding overall knowledge of HRP policies and programs.
7. There are no other alternative procedures considered for this research.
8. All data will be password protected and accessed on a need-to-know basis.
9. There are no foreseeable injuries associated with this research and thus no compensation is planned.
10. The survey administrator (Stephen Ariyo Dahunsi) will be available by his email as declared above.
11. Anyone contacted to participate in this survey may refuse to participate and may stop participating in this survey at any time.
12. The rights, privacy and welfare of all the participants will be adequately protected during and after the survey.
13. The findings from this survey will significantly be used to further develop a viable Human Reliability Program for Nigeria.

❍ I agree to participate (a)

❍ I disagree (b)

APPENDIX A3

Recruitments for survey:

- Colleagues from Nigeria who had previously participated in Human Reliability and related program in the United States have been identified and will be contacted for the distribution of the online survey. Besides this, further sharing among professional colleagues in the nuclear industry in Nigeria will be encouraged and pointed out in the information calling for participation in the online survey. (See attached – Appendix B)
- Emailing list in form of "signup sheet" will be generated with the help of the student chapters of the American Nuclear Society (ANS) and Institute of Nuclear Materials Management (INMM) during the ANS and INMM professional conference/meetings and the link (https://utk.co1.qualtrics.com/jfe/form/SV_d50qfzPOFLezOD3) to the survey will be mailed to each person who voluntarily signed up on the sheet. However, no name will be required on this signup sheet except email addresses. (See attached – Appendix A)
- Sharing of the survey link will also be carried out within Faculties and Personnel involved in educational and curriculum development on HRP within the academia with the help of Prof. Howard Hall, Prof. Joseph Stainback IV and Dr. John Auxier whom are Co-PI on the study.
- Further identification of subject matter experts involved in the design and administration of HRP.

APPENDIX B

HPR Questionnaire

Consent

You are invited to participate in the research below. The research is aimed at establishing a baseline data on Human Reliability Program. The outcome of the study will be used to develop a gap analysis for Human Reliability program in Nigeria. Participation in the study is voluntary and please refer further question(s) concerning the survey to the following: (i) The University of Tennessee - IRB research compliance officer on +1 865 974 3466 http://irb.utdev4.wpengine.com/wp-content/uploads/sites/29/2013/05/informed_consent_basic.pdf (ii) Stephen Dahunsi on +1 865 232 5009, sdahunsi@vols.utk.edu (iii) Prof. Joseph Stainback IV +1 865 719 8923, jstainback@utk.edu

- ❍ I agree to participate (1)
- ❍ I disagree (2)

This is a scholarly research study conducted by Stephen Ariyo Dahunsi, a graduate student in the Department of Nuclear Engineering at the University of Tennessee and the Institute for Nuclear Security at the Baker Center for Public Policy. The purpose this study is to establish baseline data on the participant's knowledge of Human Reliability Programs (HRP). In this case a Human Reliability Program refers to the policies and practices of an organization to ensure both operational and security reliability. This research involves the completion of an online set of questions that will take approximately 15 minutes of the participant's time. Participation in this study is voluntary and the responses will remain anonymous and confidential. Anyone contacted to participate in this survey may refuse to participate and may stop participating in this survey at any time. No identifying information such as name, email, or IP address will be asked for nor should it be provided by the participants. All information provided will be kept in a password secured location. The data gathered from this survey will be analyzed, and used to develop a baseline gap analysis of the Human Reliability Program (HRP) in Nigeria. The methodology will evaluate the present understanding and knowledge of the program in Nigeria through the administration of these questions. The same set of questions will be administered in the United States and the results gathered from both surveys will be compared for identification of gaps, further refinement or development, and training and education purposes in Nigeria. The future of this work is to continuously improve the methodology for application of HRP in emerging nuclear states. This method will take into account the present and future plans for security of nuclear and radioactive source usage/services, as well as implementation and cultural factors that work for or against HRP best practice. [Each question has a box for each participant to rate 1 to 5 with 1 (Strongly Disagree), 2 (Somewhat Disagree), 3 (Neither agree nor Disagree), 4 (Somewhat Agree), 5 (Strongly Agree). The 6th box is for questions or answer that are Not Applicable (N/A).]

Q1 Do you agree that credible nuclear and radiological threat exists?

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q2 How likely is this credible threat.

- ❍ Strongly Unlikely (1)
- ❍ Somewhat Unlikely (2)
- ❍ Undecided (3)
- ❍ Somewhat Likely (4)
- ❍ Strongly Likely (5)
- ❍ Not Applicable (6)

Q3 Policies and procedures for HRP are in place within your:

	Strongly Disagree (1)	Somewhat Disagree (2)	Neither agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)	Not Applicable (6)
Facility (1)	❍	❍	❍	❍	❍	❍
Country (2)	❍	❍	❍	❍	❍	❍

Q5 A legal framework for policies and procedures for HRP are in place in your:

	Strongly Disagree (1)	Somewhat Disagree (2)	Neither agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)	Not Applicable (6)
Facility (1)	❍	❍	❍	❍	❍	❍
Country (2)	❍	❍	❍	❍	❍	❍

Q7 HRP plan in place at your facility is effective

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q8 The requirements and means of evaluation for HRP are well understood and clear to all employees

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q9 The overarching principles of HRP account for local/national culture.

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q10 Management System decisions contribute/account for the effectiveness of HRP?

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q11 Your organization's HRP plan is very effective and efficient for the present status of your nuclear power program

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q12 Do you believe that aberrant behavior like; unusual character, elicitation, alcoholic indiscipline, Financial indiscipline, drug addiction, criminal records, arrest records, work history verification, e.t.c, could be detected with implementation of a good HRP?

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q13 My organization's HRP plan can be easily integrated into the national HRP procedures?

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q14 There are sufficient internal control for your facility's HRP plan

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q15 There are systems in place for continuous feedback from subject matter experts on the effectiveness of your:

	Strongly Disagree (1)	Somewhat Disagree (2)	Neither agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)	Not Applicable (6)
Facility HRP plan (1)	❍	❍	❍	❍	❍	❍
Country HRP plan (2)	❍	❍	❍	❍	❍	❍

Q17 There is an acceptable national control plan for your country's HRP plan.

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q18 Stakeholders are well informed of their responsibilities in the national HRP plan.

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q19 Facility HRP plan takes into account personnel competencies needed for job functions.

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q20 Resources for personnel job proficiency training are available

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q21 There are perceived or suggestive weaknesses in your facility HRP implementation plan

- ❍ Strongly Disagree (1)
- ❍ Somewhat Disagree (2)
- ❍ Neither agree nor Disagree (3)
- ❍ Somewhat Agree (4)
- ❍ Strongly Agree (5)
- ❍ Not Applicable (6)

Q22 The overall assessment of your country/facility HRP is satisfactory

	Strongly Disagree (1)	Somewhat Disagree (2)	Neither agree nor Disagree (3)	Somewhat Agree (4)	Strongly Agree (5)	Not Applicable (6)
Facility (1)	❍	❍	❍	❍	❍	❍
Country (2)	❍	❍	❍	❍	❍	❍

Q24 Country?

- ❍ Nigeria (1)
- ❍ United States (2)

Q25 Nigerian Affiliation

- ❍ Nig. Atomic Energy Commission (NAEC) (1)
- ❍ Nig. Nuc. Regulatory Authority (NNRA) (2)
- ❍ CERT, ABU, Zaria (3)
- ❍ CERD, OAU, Ile-Ife (4)
- ❍ NTC/GIF, Abuja (5)
- ❍ CNES, UniPort (6)
- ❍ Nuclear Medicine facility (7)
- ❍ Others (8)
- ❍ Not Applicable (9)

Q26 United States Affiliation

- ❍ Government (1)
- ❍ Academic/Research (2)
- ❍ Power plant (3)
- ❍ Medical (4)
- ❍ Others (5)
- ❍ Not Applicable (6)

APPENDIX C

RECOMMENDED HUMAN RELIABILITY PROGRAM TEMPLATE FOR NIGERIA

In preparation for plans to establish a national Human Reliability Program (HRP), this research recommendation proposed to have in place an established National Threat Assessment and Evaluation (NTA & E) in order to identify the vulnerabilities. Besides, areas with possible adjustment that could accommodate global best practice from lessons learned out of case studies must be identified. The importance of this assessment and evaluation is realized in the national security guarantee for establishing a nuclear program.

It is significant that, only after this assessment is concluded and in place that the recommendations be followed by development of strategies to have the best employee in place for the mitigation of identified threats. The objectives this appendix is a follow up to the recommendation of the research result, it is intended that this document will further support and guide in developing a program for selecting individuals who can be trusted with the access to, and responsibilities for nuclear and/or radiological facilities and have the right attitudes and values appropriate to work with the best qualifications in the implementation of the Nigeria nuclear power program for peaceful applications. Additionally, it is expected that the program development will contribute to global security and earn Nigeria international confidence in her program implementation.

Furthermore, based on the research outcome and recommendations as derived from the case study used in the main body of this report, a working document that represent an HRP model for selecting trusted employees that presently work or those that will be engaged to work in the future at any nuclear or radiological facilities and other government agencies of national security concern in Nigeria and by extension, other emerging nations.

The proposed plan is also recommended to be reviewed and updated on a regular basis or at a convenient time interval to be determined according to the national need based on the outcome of threat evaluation.

Procedure for a national HRP plan (Nigeria)

The Nigerian nuclear power implementation infrastructure presently places all the six (6) existing nuclear Centers of Excellence under the purview of the Nigeria Atomic Energy Commission. The national law gives the Commission the power to supervise over the activities of all the centers placed under it. Besides this, the enabling Act of the Commission gives it direct control over all matters relating to atomic energy in Nigeria. Based upon this Act, the establishment of a national HRP infrastructure is suggested to be supervised by the Commission. However, for operational excellence, it is also suggested that the establishment of a national plan for HRP should integrate and coordinate under one umbrella, facilities and services in the field of nuclear and radiological practice in Nigeria. Another important organization indented and also empowered by law is the Nigeria Nuclear Regulatory Authority (NNRA). The NNRA role as agency of government is the responsibility of regulating all practices relating to nuclear and radiological services. Consequence upon this, it is suggested that the two focal agencies of government should take the lead in the implementation of a national HRP plan.

The introduction and integration of national HRP plan starts with critical human capital development through the transfer of knowledge and best practice from subject matter experts in all areas of need. This is justified by the national evaluation database. It must take into account national; culture, believes, values, environment and the political climate, but in conformity with

international best practice. This is expected to pave the way for the development of a technical, regulatory and legal framework as the basis on which the program implementation will run on. The development of this frameworks must consider facilities and stakeholders involved in the implementation of the national nuclear program. Based on the result of survey, the better option for program development is to have a bottom-top approach, this allows the integration of local plan that stems from the facilities and stakeholder to a national plan. This in turn will further strengthen and give better direction, standards and criteria, reporting requirements, interagency cooperation, material accounting, emergency response procedures, and disciplinary actions to erring personnel.

The implementation of the planned program shall commence with a stepwise approach starting from the establishment or inauguration of pre-screened and high profile representatives who have previously participated in training programs or have the knowledge of HRP from facilities and stakeholder organizations involved with the national nuclear power program as National Executive Committee (NEC). They shall be saddled with the responsibilities of overseeing the smooth implementation/and or application of HRP as an integral part of the national nuclear power program. Besides this, the NEC shall be responsible for the development of the Term of Reference (TOR). The TOR document shall ascertain components and program needs that synchronizes national culture, values and believes with international best practice into the Nigerian program needs. Additionally, the identification of the components and program needs shall lay foundation for the establishment of a virile legal and regulatory framework infrastructure. Once this is established, it gives the desirable regulatory and legal instruments that guides the operation. The Figure. C.1 Below shows the flow chat of procedure recommended for the program implementation starting from national threat assessment and evaluation.

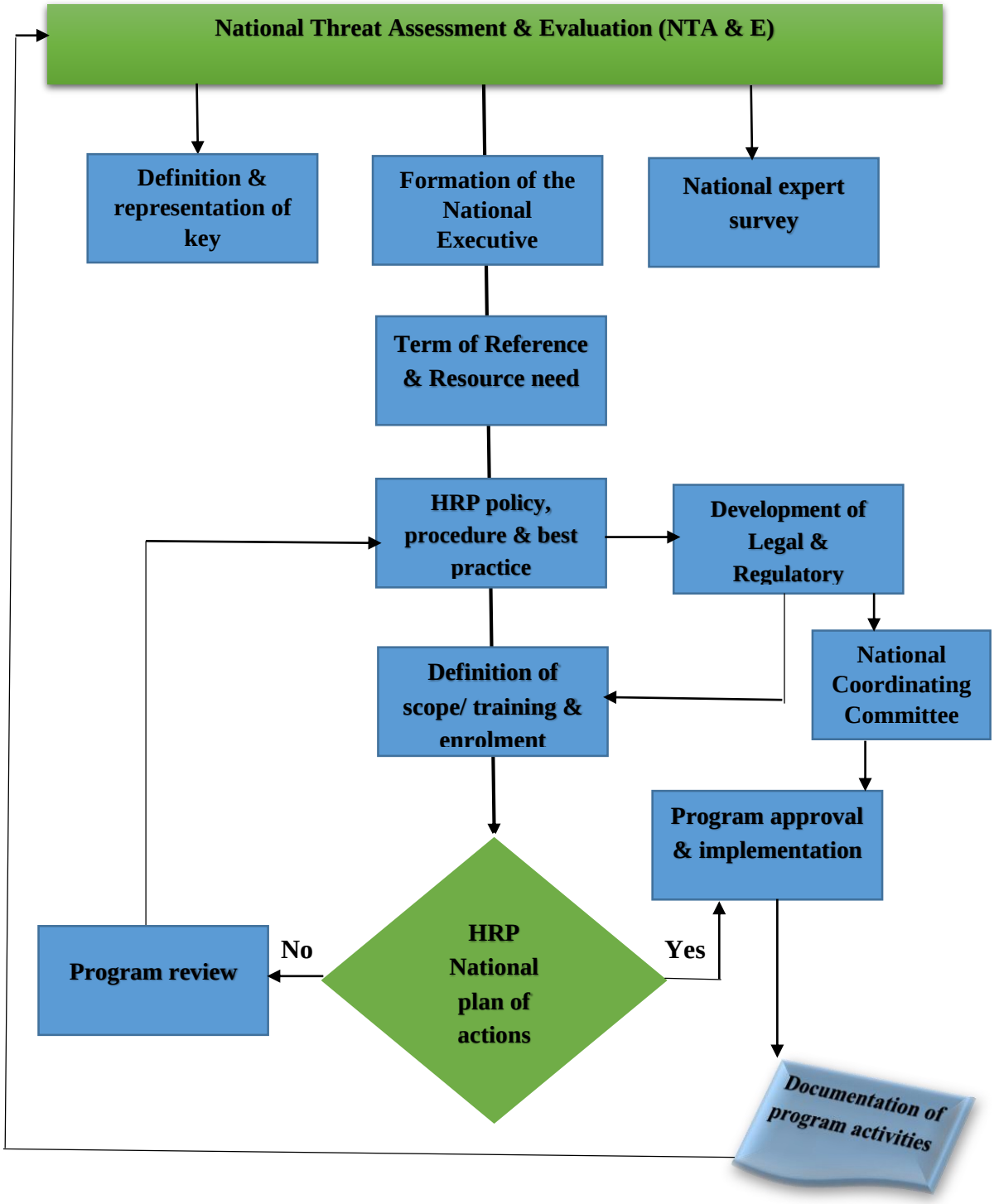

Figure C. 1 Recommended organizational structure for the implementation of HRP in Nigeria

Establishment of Policies and procedures

The establishment of policies and procedures for the program will consolidate and guarantee a coherent and comprehensive program appraisal structure that certifies suitability of personnel in HRP position. The policies and procedure will create an enabling environment of trust on individuals who can recognize, report, and mitigate risks associated with unreliable employees in sensitive positions. Besides this, the policy is expected to provide protection of individual rights as well as the national security. Additionally, the policies and procedures will ensure and mitigate safety concerns of personnel who present security concerns due to physical, mental/personality disorders, substance abuse, or other life circumstances. A comprehensive policy shall be in place for the following procedures

i. HRP positions and designation
ii. Requirements for HRP certification
iii. HRP implementation and documentation
iv. Supervisory review
v. Medical assessment
vi. Management evaluation
vii. Security review
viii. Training requirements
ix. Removal from HRP
x. Review of certification hearing
xi. Request for re-certification after successful hearing

National Threat Assessment & Evaluation

The objective of the NTA & E is to gather information and identify trends on the existing threat to national security as it would affect the smooth operation of the planned program. Knowing specifically whom assets are been protected against is the foundation of a good threat assessment. This process reduces cost because it is a threat informed assessment. The design should identify factors that could potentially make or switch employees against the facility or program. The goal of national threat and evaluation is to study and evaluate potential security risk to nuclear power program through a multifaceted survey approach, in order to determine and mitigate the challenges that the risk could bring upon people, environment and equipment. The assessment and evaluation should be carried out in collaboration of all stakeholder and agencies charged with the responsibility of protection of national asset. The procedure must recognize all activities, communications and precise or suspected undertakings that is directed to or could jeopardize national security. Furthermore, the assessment will evaluate frequency of specific hazard and the potential harm. The assessment should conclude with the evaluation and documented outline of potential mitigation for all the factors discovered. The assessment shall be a continuous development in terms of competencies and evaluation.

Legal and Regulatory framework

Legal and Regulatory frameworks are essential aspect of a successful HRP plan and implementation. Both frameworks shall be developed to guide the national HRP plan using best practice guide from established nuclear operating states and the IAEA. The formulation of the frameworks shall comprise of professionals and experts from participating facilities and

stakeholder organizations. They are expected to develop and synchronize a comprehensive legislation, instruments and procedures that will recognize and classify all legal and regulatory requirements for all personnel involved and those to be engaged in HRP positions. The legislation is expected to strengthen deterrent and enhance the safety of operations in all the facility and organs involved in the program implementation.

Scope

The scope of the national HRP plan is to implement a structured program that guarantees a process for initial and timely certification of personnel that holds critical position in the national nuclear energy program which in turn could inadvertently impact on national security.

Certification requirements for HRP.

The following procedures highlights the processes for certification of personnel in HRP positions:

i. Pre-employment background check.
ii. Authorization access
iii. Periodic review.
iv. Signed releases, acknowledgements and waivers.
v. Supervisory review of; medical assessment and management evaluation.
vi. Psychological assessment.
vii. Initial and random test for narcotics and illegal drug.

viii. Initial and random alcohol test.

ix. Random polygraph test.

The equipment, interval and system of evaluation must be determined and documented by the NEC for the purpose of fairness and equity. However, randomness will apply in reported cases verified and justified to warrant such actions.

Responsible organization

The establishing Act of the Nigeria Atomic Energy Commission (NAEC) (Act 46 of 1976) empowers the commission to be the focal/lead agency of government for the advancement and development of technical framework on peaceful uses of nuclear technology. This national law also placed all the existing CoEs under the purview of NAEC. Based on this, NAEC shall be the lead agency and equally the responsible organization. The commission shall institute a ***national coordinating committee (NCC)*** for HRP. The committee shall coordinate the joint activities of all other stakeholders to perform the following functions through the nationally designated HRP management official:

- Certify
- Recertify
- Temporary removal and
- Review of cases with proportionate actions on outcomes.
- Manage database of HRP personnel

HRP Administrative Responsibility

For a new nuclear build, centralization of operation is highly desirable for unity of focus and purpose. The NCC shall coordinate all national efforts and maintain a national database and records of HRP activities on certifications, recertification, supervisory review and medical assessment emanating from facilities and stakeholder organizations. The national program shall

Facility HRP plan

The facility HRP plan in place shall be strengthened and elements that could conflict with the national plan of actions shall be continuously ratified and documented. Above all, the facility HRP supervisor must make sure that every personnel involved in the program is satisfied with the procedure, guidelines, working condition, training, general rewards system and disciplinary actions proposed for erring personnel. Each facility and stakeholder organization shall maintain a structure and documentation that is easily integrated into the national plan. There shall be an HRP certifying official at every facility and stakeholder organizations. They shall be designated as the representative of the facility to the NCC board. No access shall be granted to any visitor during HRP activities. However, in the situation that a visitor must be allowed, the facility HRP certifying officer must provide an HRP certified escort to such visitor(s)

The HRP certifying official must ensure that an HRP certified personnel that is transferred to another site or facility meets the following requirements:

i. Validate the status of the transferred personnel
ii. Appoint a temporary observing supervisor
iii. Authenticate if HRP is applicable to the new position the personnel is occupying

iv. Confirm the last certification of the personnel and document due date for the next certification. However, only the certifying official at the personnel's permanent facility can approve recertification on return to permanent facility. Only temporary certification shall be granted at the new facility.

v. Confirm the level and elements of HRP contained in the requirements for the recertification and also determine the access level to be granted.

vi. Administer job specific training requirements for the new position

Designation of HRP positions

Positions designation shall be determined based on the weight of expected risk according to records obtained from the national threat assessment and evaluation database. The designation shall take into cognizance, positions that consequences of its failure or attack could warrant grave damage to any of the facility, service or national security. This designation shall be updated with respect to threat definition and as the need arises. Furthermore, the designation shall take into cognizance, level of access, critical operations, information and equipment.

There shall be an annual program review to appraise the effectiveness and accomplishments of HRP. Participating facilities and organizations shall submit a facility level report to the NCC. The NCC shall analyze the report and assign commensurate actions points to all matters arising from the report. Appropriate actions shall be taken to strengthen the program as determined by the NCC.

Obligations of eligible and certified personnel.

All eligible and certified HRP personnel shall:

i. Execute HRP releases, acknowledgements and waivers

ii. Report all medical and psychological conditions warranting medical attention.

iii. Report all matters of safety and security concerns

iv. Report drug and alcohol abuse

v. Persistent failure to comply with lawful directive or instruction.

vi. Persistent and unexplainable personnel error.

vii. Perceptible financial recklessness

Obligations of supervisors

The personnel HRP supervisors shall be empowered to identify and communicate:

i. The objectives, scope and HRP requirements.

ii. Prompt recognition of personnel character traits that could impair his/her trustworthiness and reasoning.

iii. Significance of promptly reporting all HRP concern to the HRP management official.

HRP supervisors shall perform the following and any other necessary actions that sustains HRP. They shall:

- Conduct and report annual review for each HRP personnel
- Document the outcome of sequential observations on all HRP personnel during execution of job schedule. (Recommended observation time is 30 calendar days).

- Removal of HRP personnel who demonstrate any safety or security concern.
- Removal of HRP personnel who is unsuccessful during recertification.
- Removal of HRP personnel with breath alcohol result above prescribed normal for an initial 24 hours period after due consultation with the HRP management official and the facility medical representative. (United States prescribed limit of 0.02% is recommended).
- Reassigning HRP position after temporary or permanent removal or restriction.
- Circulate notifications to the management official, security unit and concern officials of removal and remedial actions after removal.
- Liaise with the security unit to conduct an annual security review.

Obligations of facility medical representative

The facility medical representative shall be empowered to observe identify and communicate the following evaluation about all HRP personnel seeking certification or recertification:

i. Physical or medical disability that may affect judgment and job performance
ii. Suspected or noticeable use of illegal or misuse of legal drugs.
iii. Suicidal tendencies.
iv. Mental or personality disorders that may impair job performance or delivery

The medical representative shall also conduct the following appraisal on all HRP personnel seeking certification or recertification.

- Psychological appraisal for HRP personnel seeking certification and continuous re- appraisal for HRP personnel seeking recertification
- Psychological reappraisal for HRP personnel that has been on leave for prescribed number of days and returning back to work. (The NEC shall have powers to stipulate time of leave that will warrant reappraisal from time to time. This shall be made known to all personnel in HRP).
- Escalate recommendations to the HRP supervising official for temporary or permanent removal of personnel from HRP position after due medical examination.
- Prescribe medication, treat and keep medical records of HRP personnel
- Determine when removal on medical grounds shall be applicable to any HRP personnel.

Management Appraisal

Management appraisal procedure must take place in order for an HRP personnel to be considered for HRP certification or recertification. The personnel must provide a documented management appraisal and endorsement of supervisory review officer's form for medical, drug, alcohol and security clearance. This must be duly submitted to the NEC through the HRP certifying official for final approval.

Additionally, all facilities and stakeholder organization that constitutes the NEC must put in place, a record and documentation of processes and outcome of all reviews, certification, recertification, medical evaluation, test, removal, disciplinary actions and suspension.

Likewise, the management appraisal shall include the type and form of training granted to personnel in HRP positions before certification. Such appraisal shall contain the required job task analysis if the process is for an initial certification.

TERMS OF REFERENCE

A. Objective

The objective of the Terms of Reference is to provide a guideline and strategic direction for the National Committee. This Term of Reference is suggested to present a common front by unifying the management structure for HRP from all the Centers of Excellence with the view that individuals who occupy positions affording access to certain materials, facilities, and programs meet the highest standards of reliability, physical and mental suitability requirements for his/her schedule.

The NEC will determine those that must be certified prior to and the duration of employment. Those to be certified will include personnel in critical position needing HRP status as defined by the HRP implementation team and approved by the NEC. They may comprise of:

- Employees that have access to/or those expected to have access to special nuclear materials
- Personnel involved in or that is expected to transport or protect nuclear materials
- Personnel that have access to information on critical aspect of operation within and outside the nuclear facilities.
- Personnel that have access to nuclear devices or components.

The NEC shall define critical positions based on the inputs and the representations from facilities and stakeholder organizations.

Pre-employment evaluation of an individual is also suggested for HRP certification, this is intended to determine and identify any latent employment risk that could advertently affect or disrupt operation. This may include but not limited to the following:

- Background check, including references
- Initial substance test
- Criminal arrest records
- Financial evaluation and appraisal
- Education records verification
- Previous employment verification

In addition to the above, any personnel engaged under the HRP should further be placed under further:

- Supervisory review
- Medical and psychological evaluation
- Management appraisal based on supervisory review and all other previous evaluation results

B. Term

This effective date of this proposal shall be subject to scrutiny and approval by the Nigeria Atomic Energy Commission (NAEC), therein referred to as the focal agency for atomic energy matters in Nigeria. Under the authority of NAEC, the National Executive Committee shall decide and document all the procedures including commencement and termination of rules for HRP

submissions including the effective date for any rule. They shall be empowered to adjudicate and interpret on all matters of the HRP.

C. Membership

Membership of the committee shall comprise of designated representative of the CoEs and stakeholder organizations involved in the implementation of the national nuclear power program.

- Nigeria Atomic Energy Commission (NAEC)
- Nigeria nuclear Regulatory Authority (NNRA)
- Federal Ministry of Health (Medical Director/designee)
- Center for Energy Research and Training, (CERT), Zaria
- Center for Energy Research and Development (CERD), Ile-Ife
- Gamma Irradiation Facility/Nuclear Technology Center (GIF/NTC), Abuja.
- Center for Nuclear Energy Studies (CNES), Port-Harcourt
- Center for Nuclear Energy Research and Training (CNERT), University of Maiduguri
- Center for Nuclear Energy Studies and Training (CNEST), Federal University of Technology, Owerri, Nigeria
- Department of State Security (DSS)
- Nigeria Security and Civil Defense Corps (NSCDC)
- Nigerian Police Force (NPF)
- National Human Right Commission (NHRC)
- Federal Ministry of Justice (FMoJ)

D. Leadership

The committee shall have powers to elect and appoint the leadership of the committee for smooth unhindered functions. The election of officers may be due to;

(a) Expiration of service term

(b) Termination of any committee member after due consideration.

(c) Retirement

(d) Vacancy due to:

i. Retirement

ii. Withdrawal (with written notification/acceptance).

iii. And, ill health that constitute incapacitation, unsound mind. (This shall be subjected to medical confirmation)

E. Roles and Responsibilities

The HRP implementation team shall commit to:

- Transparency in all matters and rulings of the committee.
- Perform functions that guarantees highest level of fairness and equity.
- Commit to punctuality during meetings and hearings of the committee.
- Share relevant communications and information with all HRP committee.
- Make timely and collective decisions.
- Recommend appropriate policies that are unbiased and guarantees equality.

E. Meetings

All meetings will be chaired by (insert individual's name and organization). Decisions will be made by consensus (i.e., members are satisfied with the decision even though it may not be their first choice). If consensus is not possible, the chair makes the final decision. Meeting agendas and minutes will be provided by (*name and organization*), who is responsible for preparing

F. Rulemaking and amendments.

Adopted rules for amendment may be considered provided that;

(a) Quorum is formed at any of such meeting

(b) After prior notice and copies of such amendments circulated to all concern members and due consultations

(c) It is supported by two third majority of the committee membership

(d) The amendment is not in conflict with any legal or regulatory provisions

Specimen forms used in HRP implementation

AUTHORIZATION AND CONSENT TO RELEASE HUMAN RELIABILITY PROGRAM (HRP) RECORDS IN CONNECTION WITH HRP

1. I, _____, (print applicant's/employee's full name) am a candidate for occupying or continuing to occupy an HRP-identified position.

2. I understand that the HRP certification process will generate medical and non-medical records (hereinafter HRP records) relevant to my eligibility to occupy an HRP position. I recognize that these HRP records are protected by the privacy regulations.

3. For purposes of this consent, my HRP records include, but are not limited to, any records generated by a pre-employment check performed by either medical records, including but not limited to, medical histories, results of medical examinations, results of psychological examinations and/or tests; results of urine tests taken to determine the presence of illegal drugs in my body; and the results of an alcohol breathalyzer test.

4. I hereby consent that any of the HRP records within the coverage of paragraph 3 may be disclosed to the appropriate management officials who have a legitimate need for the records in the performance of their duties and responsibilities in the HRP review and approval process.

5. I acknowledge that such disclosure in connection with the HRP is an approved disclosure in accordance with applicable regulations. I further agree that this document will serve as written consent to the disclosure of the HRP records to the appropriate management officials within the meaning of privacy regulations.

6. I further waive any rights and release any and all HRP management officials including medical department personnel, from liability under applicable federal or state statutes, any applicable physician-patient privilege, and common law claims of any nature whatsoever, for disclosure of my HRP records to management officials with a legitimate need for the records in the performance of their responsibilities in the HRP review and certification process.

7. My signature below acknowledges that I have read and understand the foregoing authorization and consent agreement.

_____ _____

Date Employee (Signature)

_____ _____

Date HRP Management Official (Print Name and Signature)

Source: (US Department of State Partnership for Nuclear Security)

Specimen forms used in HRP implementation

ACKNOWLEDGMENT AND AGREEMENT TO PARTICIPATE IN THE HUMAN RELIABILITY PROGRAM (HRP)

I, _____, (name of individual), acknowledge that I am seeking to occupy or retain an HRP position.

I recognize that the _____ (facility/organization name) has the highest of national security, safety, and public health interests in assuring that individuals occupying HRP positions meet the highest standards of human reliability.

I acknowledge that I have been advised of the requirements for occupying, or continuing to occupy, an HRP position. I have also been advised of my responsibilities under the program. The HRP components, including supervisory review, medical assessment, psychological examination, testing for the use of illegal drugs, random alcohol testing, management recommendation, and the security review and clearance determination, have been fully explained to me.

I hereby consent and agree to submit to all components under the HRP and further consent and agree to cooperate fully with assessment of my eligibility or certification to an HRP position.

_____	_____
Date	Employee (Signature)
_____	_____
Date	HRP Management Official (Print Name and Signature)

Source: (US Department of State Partnership for Nuclear Security

VITA

Stephen Olumuyiwa Ariyo Dahunsi was born in Lagos, Nigeria. He attended Birch Freeman High School, Lagos and obtained his Senior Secondary Certificate of Education in 1994, He attended the Abubarkar Tafawa Balewa University, Bauchi Nigeria and graduated with a Bachelor of Engineering (B.Eng) degree in Electrical/Electronic Engineering in 2004. Upon graduating, he joined the SocketWorks limited, Lagos as a Project manager. He later joined the Nigeria Atomic Energy Commission in 2007 as a Scientific Officer and in 2012 he was awarded the International Atomic Energy Agency's fellowship to the University of Ghana where he obtained a Post-Graduate diploma in Radiation protection. He was admitted to the University of Tennessee, Knoxville in 2014 in pursuit of his M.S. in Nuclear Engineering. The publication of this thesis in May of 2016 is in partial fulfillment for the award of M.S. in Nuclear Engineering.