**NUCLEAR ENERGY PROLIFERATION: LESSONS FOR THE THIRD WORLD NATIONS, 1945-2006**

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***Abstract***

The proliferation of nuclear energy is a phenomenon of the 21stcentury and apparently, the most pernicious issue in modern international relations. As nations jostle for atomic devices, the international system is threatened by the fear of nuclear holocaust. Therefore, the need to underscore the relationship between the “nuclear haves” and the “nuclear have nots”, becomes imperative. Moreover, the nuclear proliferation saga is overblown and the general public is ill-informed of the intricacies of nuclear politics as well as the games nations play in this regard. This study is poised to unravel and highlight these issues in consonance with the realities of the international system in the 21st century and draw attention to the implications of this phenomenon to the Third World countries of the world.

****CHAPTER ONE****

****INTRODUCTION****

****1.1       Background to the Study****

Besides the many discoveries of Science and technology in the 20th Century, nuclear energy seems to be one of the few inventions which have more direct impact on people’s lives and the society at large. The innovation is profitable in several civilian uses. It is the safest, cleanest, cheapest and most efficient energy source, but the danger lies in its use for the manufacture of bombs and other destructive weapons. Ironically, some nations acquire nuclear energy for military advantage in an uncertain international system. Thus, as governments seek to survive as viable entities in the conflict prone International system, the desperate bid for nuclear energy becomes inevitable. However, the military, as one of the major determinants of national power, is only a reflection of other components of a state’s existence(Alfred ,2001). In spite of measures taken by the international community to forestall the development and the diffusion of weapons of mass destruction, nuclear energy proliferation has become the hallmark of global discourse since the end of Second World War. It is widely accepted that the United States bombardment of the Japanese cities of Hiroshima and Nagasaki in August, 1945, ushered in the most destructive epoch in the development of nuclear technology in the globe.(Alfred,2001) However, the ideological rift between the United States and the Union of Soviet 10 Socialist Republics (U.S.S.R.) exacerbated the proliferation of nuclear devices. Five powers, namely, the United States, Russia, Britain, France and China are considered to be the major “nuclear haves’. Nonetheless, the new generation of nuclear powers, known as the “Phantom Proliferators”, adds a new phase to the spread of nuclear energy around the world. The “phantom proliferators” include India, Pakistan, North Korea, Iran and to a lesser degree, Argentina and Brazil. In all, over 31 nations have acquired nuclear reactors in the world. The dynamics of global politics has left the international system in a dilemma, arising from the antics of the “nuclear haves” and the “nuclear have nots”. Traditionally, the most advanced nations are referred to as the “nuclear haves”, while the Third World nations represent the “nuclear have nots”. The nuclear tests by India, Pakistan and North Korea are strong indications that some Third World nations have already acquired the capacity for Uranium enrichment and could be close to having a bomb in the basement.

**1.2     Statement of Problem**

No comparison is intended between energy resources, and thus no conclusion is reached as to which option is more preferable or best. Indeed, it would not be prudent to exclude any one of them. Accordingly, the point of singling nuclear energy out is just to underline the current drive of states for nuclear energy, and why this is the case. Drastic increases in the energy needs of states force decision-makers to choose an economically viable and sustainable resource option, which brings huge output and also is cost-effective. Authorities, unlike other citizens, perceive that they are under the pressure of time in making decisions owing to the estimated short, medium, and long-term economic status of their countries.5 That said, options are mainly the renewable energy resources, carbon sequestration, increased energy efficiency, and nuclear energy.

**1.3     Purpose of Study**

The purpose of the study is as follows

1. To evaluate the non-proliferation measures and the ideas behind them.
2. To examine the importance of nuclear energy proliferation.
3. To examine the development and expansion of commercial nuclear energy.

**1.4     Significance of Study**

This study will examine nuclear energy proliferation: lessons for the third world nations,hence the study will be significant to the Nigerian government as it will be exposed to the need of developing nuclear energy.

The study will be of benefit to the academic community as it will contribute to the existing literature.

**1.5     Scope and Limitations of Study**

The study will evaluate the non-proliferation measures and the ideas behind them. The study will also examine the importance of nuclear energy proliferation. Lastly the study will examine the development and expansion of commercial nuclear energy. The study is delimited to Nigeria.

for the researcher.This study was constrained by a number of factors which are as follows:

 just like any other research, ranging from unavailability of needed accurate materials on the topic under study, inability to get data

Financial constraint , was faced by the researcher ,in getting relevant materials and in printing and collation of questionnaires

Time factor: time factor pose another constraint since having to shuttle between writing of the research and also engaging in other academic work making it uneasy

**1.6     Method, Sources and Organization of Study**

To achieve the purpose of this research. The study is divided into five inter-connected chapters, ranging from chapter one to five.

In this chapter one the researcher has been able to give an introduction to the work, state the problem that necessitate this study, outline the questions this work seek to answer as well as the objectives it hopes to achieve. The scope and limitations of this study were outlined as well as the methodology that was used for the study. Chapter two deals with Modern Nuclear Technology,  Early Trait of Nuclear Technology, The Uses of Nuclear Energy etc. Chapter three discuss the The Nuclear Powers and Nuclear Energy Proliferation,  Military Imbalance between the Developed and the Developing Nations etc. Chapter four delves into the International Atomic Energy Agency (I.A.E.A) ,  The Politics of Nuclear Non-Proliferation Treaty (NPT, etc. ,while chapter five deals with the summary, recommendations and conclusion.

**1.7     Theoretical Framework.**

**Kinetic Molecular Theory**

Kinetic energy is energy that an object has because of its motion. The Kinetic Molecular Theory explains the forces between molecules and the energy that they possess. This theory is based on three theories about matter.

• Matter is composed of small particles (atoms, molecules, and ions).

• The space the molecules occupy (volume) depends on the space between the molecules and not the space the molecules occupy themselves.

• The molecules are in constant motion. This motion is different for each of the three states of matter. They are colliding with each other and the walls of their container. When the molecules collide with each other, or with the walls of a container, there is no significant loss of energy.

Absolute zero is the temperature used to describe when all movement is as slow as it can possibly be.

Temperature is the term used to explain how hot or cold an object is. Temperature is the average kinetic energy of particles in the substance. Water molecules at 0º C. lave lower kinetic energy

than water at 100º C.

**Mass, Volume, and Density**

Mass is the measure of the heaviness of a substance, usually is weighed in grams. The characteristics of atoms in the material determine the mass. The more tightly packed they are, the greater the mass; and the larger the atomic number, or the atomic mass, the greater the mass of the substance. Hydrogen, number 2 on the periodic chart, has an atomic mass of 4, because it has 2 protons and 2 neutrons in its nucleus. Gold has an atomic mass of 197, so each atom is much heavier. Mass is often referred to as weight. To distinguish between mass and weight, think of a lump of gold both here and on the moon. It would have the same mass in both places, but would weigh less on the moon because its gravity is about 1/6 of Earth’s. The volume of a substance is the three-dimensional space it occupies. It is measured in cubic centimeters or millimeters. One cubic centimeter equals 1 millimeter. When scientists set up the metric system, they set those quantities up that way to make science easier. Density is the ratio of mass to volume. To determine the density of a substance, divide its mass by its volume. Water has a density of about 1, and objects that sink in water, such as steel, have a higher density. In contrast, steel’s density is about 8 (Carson,1993).

**1.8     Literature Review**

The spread of weapons to potential adversaries has long been a concern of states, and measures have been taken to prevent this. The news as we speak is full of the word “proliferation” and war is impending between the United States and Iraq over the acquisition of “weapons of mass destruction” – WMD – by Iraq in contravention of the UN Security Council resolutions dating from the 1991 Gulf War. Iraq was found to possess chemical and biological weapons and to have an aggressive and widespread program for the acquisition of nuclear weapons. All of these were forbidden to Iraq by the UN Security Council. “WMD” is a misnomer, since chemical weapons in general are far less effective, per kilogram, than BW or nuclear weapons. But we seem to be stuck with the term. The consequences of use by terrorist groups of BW or nuclear weapons are detailed in a number of current publications; including some of my own posted at www.fas.org/rlg. Some of these are also available in print form, as in the September 2002 article “The Technology of Megaterror.”(Alfred,2001) In particular, the detonation of a nuclear explosive of yield 10,000 tons of TNT (10 kt) in a densely occupied part of Manhattan during the working day could kill 200,000 to a million people. Even a 1 kt weapon would subject almost one-quarter of the area to the same lethal over pressure, and be an unparalleled catastrophe. BW can be simply infectious as is in large part the case with anthrax, or contagious, as with measles or smallpox. A contagious BW agent such as smallpox has the potential of killing tens of millions or more, and it is fortunate that in this case there happens to be a sufficient number of doses of smallpox vaccine available to protect most Americans. Yet the epidemic would surely spread to the rest of the world, and must be prevented there too. Our current topic is the proliferation of nuclear weapons, and that in particular is advanced by the Bush Administration as the primary reason for war with Iraq, although the purpose is sometimes cast as “regime change” in order to avoid the possession of WMD by Iraq. The Bush Administration also objects to the sale by Russia to Iran of one to five nuclear reactors, despite the arguments by Russian officials that Iran would in any case acquire nuclear reactors, and the Russian supplied power plants would use fuel which would be returned to Russia after being used in the reactor to produce electrical energy.

End Notes

 R.L. GARWIN and G. CHARPAK, Megawatts and Megatons: A Turning Point in the Nuclear Age? 1-14,

Alfred A. Knopf, Publisher, New York, (2001). This will appear as a paperback in December 2002, Megawatts

and Megatons: The Future of Nuclear Power and Nuclear Weapons, The University of Chicago Press.

www.aaknopf.com/authors/garwin).

 J. CARSON MARK “Explosive Properties of Reactor-Grade Plutonium,” Science & Global Security, 4, p.

111, (1993).

 W.K.H. PANOFSKY, Chair, “Management and Disposition of Excess Weapons Plutonium,” Report of the

National Academy of Sciences, Committee on International Security and Arms Control, 1-7. National Academy

Press, Washington, DC, (1994).

 W.K.H. PANOFSKY, Chair, “Reactor-Grade and Weapons-Grade Plutonium in Nuclear Explosives” of

“Management and Disposition of Excess Weapons Plutonium,” Report of the National Academy of Sciences,

Committee on International Security and Arms Control, Chp. 1, pp. 32-33, National Academy Press,

Washington, DC, (1994).

Final Report of the U.S.-Russian Independent Scientific Commission on Disposition of Excess Weapons

Plutonium”, J.P. HOLDREN (Co-Chair), J. AHEARNE, R.L. GARWIN, W.K.H. PANOFSKY, J.J. TAYLOR,

and E.P. VELIKHOV (Co-Chair), A.A. MAKAROV, F.M. MITENKOV, N.N. PONOMAREV-STEPNOI,

F.G. RESHETNIKOV, (1997).

**CHAPTER TWO**

**REVIEW OF LITERATURE**

**INTRODUCTION**

Our focus in this chapter is to critically examine relevant literature that would assist in explaining the research problem and furthermore recognize the efforts of scholars who had previously contributed immensely to similar research. The chapter intends to deepen the understanding of the study and close the perceived gaps.

**2.1     MODERN NUCLEAR TECHNOLOGY.**

The gradual growth of national nuclear frameworks and of the industry are described as a result of a combination of exogenous and endogenous factors originating with the military spill-over effects. These factors evolved during the subsequent phases of the technology development, following the transfer of technological know-how from military establishments to civilian atomic agencies (occurring first in the US in 1946, and later in France and the UK in 1954), and the creation of an independent private industry(Auer,2016).The key development stages of military and civilian applications will be analyzed chronologically. Te primary concern will be the US, British and French experiences, due to their early start and close military ties. In addition to technology development, we briefly describe the agreements, policies and regulations of the US government and the International Atomic Energy Agency (IAEA) which affected the domestic and international marketing of nuclear power plants. Looking at the international framework will allow us to consider the role of the international organizations fostering the development of nuclear power such as the IAEA, the European Atomic Energy Community (Euratom) and the schemes that acted as vehicles for the international sale of nuclear power plants. Afterwards, we look briefly at two national frameworks. Britain receives more attention because initially it was the only country competing with the US in size and government backing in the international market. Te discussion of early military and civilian deployment of nuclear energy will be roughly subdivided into the following stages(COM,2015):

1. Initial military applications characterized by US leadership of the allies who took part in the Manhattan project leading to the A-bomb (Britain, Canada, France and the US), roughly corresponding to 1940–47;
2. Co-existence between military and civilian applications preceding commercial development, characterized by the creation of a national public civilian Atomic Agency. Knowledge accumulated under the military was transferred to the Atomic Agency, but tight military control was maintained in the choice, implementation, and deployment of the technology. During this stage, basic and applied research leading to reactor prototypes was conducted and several different technologies were concurrently tested with the primary goal of obtaining plutonium for military purposes;

3. Exclusively civilian applications. Here the focus is on the evolution of a specific industrial autonomy and the establishment of the market duopoly by Westinghouse and General Electric (GE). Their marketing policy was articulated through pre-existing and newly established licensing agreements with European countries and Japan.In analyzing the success of Light Water Reactor (LWR) the American technology par excellence and its establishment in the world market, we argue that the success of LWR can be explained by examining the interplay of various factors at work in the US market, along with certain exogenous influences in both domestic and export arenas. Te early technological and economic success of LWR technology can be attributed to a rather heterogeneous set of interdependent factors. In this analysis, however, we find it useful to separate these factors and determine which had the greatest impact at any given time. Some of them, like the military spill-over effect, can be considered exogenous to the industry or as a socialization of its costs. Others, like the industrialization nurtured under the US Atomic Energy Commission (AEC), can be viewed as the result of a dynamic interrelation between organizational, industrial and institutional factors. Although at these stages, the industry’s role was limited to receiving government contracts and procurements and/or working under strict military control, this period marks the beginning of a close interdependence between the military establishment (and later the atomic agencies) and industry that enhanced growth of internal capabilities and nurtured what can be called the military-industrial complex (Haas,2014).

**2.2     EARLY TRAIT OF NUCLEAR TECHNOLOGY**

The first nuclear reactor was only the beginning. Most early atomic research focused on developing an effective weapon for use in World War II. The work was done under the code name Manhattan Project.Early in 1942, a group of scientists led by Fermi gathered at the University of Chicago to develop their theories. By November 1942, they were ready for construction to begin on the world’s first nuclear reactor, which became known as Chicago Pile-(Cantelon,1980). The pile was erected on the floor of a squash court beneath the University of Chicago’s athletic stadium. In addition to uranium and graphite, it contained control rods made of cadmium. Cadmium is a metallic element that absorbs neutrons. When the rods were in the pile, there were fewer neutrons to fission uranium atoms. This slowed the chain reaction. When the rods were pulled out, more neutrons were available to split atoms. The chain reaction sped up.However, some scientists worked on making breeder reactors, which would produce fissionable material in the chain reaction ( Edelson,1994). Therefore, they would create more fissionable material than they would use.After the war, the United States government encouraged the development of nuclear energy for peaceful civilian purposes. Congress created the Atomic Energy Commission (AEC) in 1946. The AEC authorized the construction of Experimental Breeder Reactor I at a site in Idaho. The reactor generated the first electricity from nuclear energy on December 20, 1951. Enrico Fermi led a group of scientists in initiating the first self sustaining nuclear chain reaction. The historic event, which occurred on December 2, 1942, in Chicago, is recreated in this painting. A major goal of nuclear research in the mid-1950s was to show that nuclear energy could produce electricity for commercial use. The first commercial electricity-generating plant powered by nuclear energy was located in Shipping port, Pennsylvania. It reached its full design power in 1957. Light-water reactors like Shipping port use ordinary water to cool the reactor core during the chain reaction. They were the best design then available for nuclear power plants. Private industry became more and more involved in developing light-water reactors after Shipping port became operational. Federal nuclear energy programs shifted their focus to developing other reactor technologies. The nuclear power industry in the U.S. grew rapidly in the 1960s. Utility companies saw this new form of electricity production as economical, environmentally clean, and safe. In the 1970s and 1980s, however, growth slowed. Demand for electricity decreased and concern grew over nuclear issues, such as reactor safety, waste disposal, and other environmental considerations. Still, the U.S. had twice as many operating nuclear power plants as any other country in 1991. This was more than one-fourth of the world’s operating plants. Nuclear energy supplied almost 22 percent of the electricity produced in the U.S(Groves,1975).

**2.3     THE USES OF NUCLEAR ENERGY.**

To enhance the role of nuclear energy systems in future it is necessary to create innovative nuclear systems at present known as Generation IV [Murty,2008]. This system comprise the nuclear reactor and its energy conversion systems, as well as the necessary facilities for the entire fuel cycle from ore extraction to final waste disposal. To achieve the aims of Generation IV system, four areas must be developed, sustainability, safety and reliability ,proliferation resistance and physical protection and economics. Sustainability includes the extracting the nuclear fuel supply by recycling used fuel, with reduction of residual radioactive waste at the accept impact on the environment. Safety and reliability must be transparent, understood also by non-experts and enhance public confidence of safety of nuclear energy. Proliferation resistance and physical protection will be achieved by improved design features with an aim to be unattractive for diversion .Generation IV systems will have a clear life cycle financial risk comparable to other energy sources and the financial risk will be comparable to other energy projects. The limiting factor facing an essential role for nuclear energy with the once-through cycle is the availability of repository space and in longer term also availability of uranium resources. Closed fuel cycles permit partitioning the nuclear waste and management of each fraction with the best strategy .Advanced waste management strategies include the transmutation technologies, cost effective decay-heat management and flexible waste storage .Motivation for selection of Generation IV systems was to identify systems that make significant advances toward the technology goals and ensure that the important missions. of electricity. generation, hydrogen and heat production and actinide management. .Six designs have been selected [1]for further research and development, and subsequent deployment. Gas-cooled fast reactor (GFR) , Lead-cooled reactor (LFR), Molten salt reactor (MSR), Sodium- cooled fast reactor (SFR), Very high temperature reactor (VHTR) ,Super critical water-cooled reactor (SCWR)[IAEA,2007].

**2.4     THE SPREAD OF NUCLEAR ENERGY**

Nuclear energy programs do increase countries’ technical ability to develop nuclear weapons, including by providing them with a source of plutonium and improving their general nuclear know-how. This technical advantage is counterbalanced, however, by the political obstacles to proliferation that nuclear energy programs generate. Specifically, nuclear energy programs facilitate U.S. and international nonproliferation intelligence efforts and make potential proliferators more vulnerable to nonproliferation sanctions. Countries that seek to proliferate under the cover of a nuclear energy program are more vulnerable to U.S. and international intelligence efforts for at least four reasons. First, nuclear energy programs are public endeavors that are likely to invite scrutiny from foreign intelligence agencies, particularly if the country developing nuclear energy is in an unstable security environment, lacks a compelling economic justification for a nuclear energy program, or announces that it intends to build enrichment or reprocessing facilities. Second, nuclear energy programs involve regular acquisitions of material and technology from foreign firms, providing more opportunities for intelligence agencies to collect information on the program and allowing the program to be infiltrated. Third, such programs offer clear targets—for example, reactors, research centers, and nuclear scientists—on which intelligence agencies can focus their efforts. Fourth, they generally come with International Atomic Energy Agency safeguards on relevant facilities, either because of the recipient country’s membership in the Nonproliferation Treaty (NPT) or because of supplier requirements.Declassified U.S. intelligence assessments show that proliferators with nuclear energy programs are detected in a more timely fashion compared to proliferators without such programs. Specifically, for the reasons stated above, the United States has been less likely to underestimate the progress of proliferators using an energy program as a cover. Moreover, these proliferators have been more likely to face U.S. nonproliferation sanctions than countries that pursued nuclear weapons without energy programs, suggesting that timely intelligence translates into international pressure. States with nuclear energy programs also face higher costs than those without them from nonproliferation sanctions, which generally involve a cutoff of nuclear supplies. For countries that rely on nuclear energy to fuel their economies, a cutoff can be prohibitively expensive. Nuclear energy programs are especially vulnerable to sanctions because the nuclear industry is highly regulated and globalized (Murty,2008). A relatively small number of countries build power reactors abroad, and all are members of the Nuclear Suppliers Group (NSG), which requires exporters to secure safeguards and other nonproliferation commitments. Moreover, light water power reactors—by far the most common type of reactor in use—rely on enriched uranium fuel, which is usually imported from one of a few major suppliers. Thus, although proliferators may hope that a nuclear energy program will aid their acquisition of nuclear weapons, they may discover instead that it renders them extremely vulnerable to international nonproliferation pressures. The United States, in particular, has long used its nuclear supply relationships as a source of leverage for enforcing nonproliferation. The threat of damaging U.S. sanctions against their nuclear energy programs is an important reason why countries such as Japan, South Korea, Sweden, and Taiwan do not have nuclear weapons today, despite facing serious security threats(IAEA,2008).

****CHAPTER THREE:****

****NUCLEAR ENERGY AND ITS PROLIFERATION****

**3.1 THE NUCLEAR POWERS AND NUCLEAR ENERGY PROLIFERATION.**

The spread of weapons to potential adversaries has long been a concern of states, and measures have been taken to prevent this. The news as we speak is full of the word “proliferation” and war is impending between the United States and Iraq over the acquisition of “weapons of mass destruction” – WMD – by Iraq in contravention of the UN Security Council resolutions dating from the 1991 Gulf War. Iraq was found to possess chemical and biological weapons and to have an aggressive and widespread program for the acquisition of nuclear weapons. All of these were forbidden to Iraq by the UN Security Council. “WMD” is a misnomer, since chemical weapons in general are far less effective, per kilogram, than BW or nuclear weapons. But we seem to be stuck with the term. The consequences of use by terrorist groups of BW or nuclear weapons are detailed in a number of current publications; including some of my own posted at www.fas.org/rlg. Some of these are also available in print form, as in the September 2002 article “The Technology of Megaterror.”1 In particular, the detonation of a nuclear explosive of yield 10,000 tons of TNT (10 kt) in a densely occupied part of Manhattan during the working day could kill 200,000 to a million people. Even a 1 kt weapon would subject almost one-quarter of the area to the same lethal over pressure, and be an unparalleled catastrophe. BW can be simply infectious as is in large part the case with anthrax, or contagious, as with measles or smallpox. A contagious BW agent such as smallpox has the potential of killing tens of millions or more, and it is fortunate that in this case there happens to be a sufficient number of doses of smallpox vaccine available to protect most Americans. Yet the epidemic would surely spread to the rest of the world, and must be prevented there too. Our current topic is the proliferation of nuclear weapons, and that in particular is advanced by the Bush Administration as the primary reason for war with Iraq, although the purpose is sometimes cast as “regime change” in order to avoid the possession of WMD by Iraq. The Bush Administration also objects to the sale by Russia to Iran of one to five nuclear reactors, despite the arguments by Russian officials that Iran would in any case acquire nuclear reactors, and the Russian supplied power plants would use fuel which would be returned to Russia after being used in the reactor to produce electrical energy. In order to discuss proliferation to states or to terrorist groups, it is a good idea to understand the nature of nuclear weapons. We will be discussing the degree to which proliferation: • Depends on nuclear power • Is eased by nuclear power • Might be hindered by nuclear power The weapons in the inventories of the nuclear weapon states (in order of acquisition of nuclear weapons: United States, Russia (as the Soviet Union), Great Britain, France, and China) are composed of highly enriched uranium (typically 90% U-235 or more) or weapon-grade plutonium (typically 93% Pu-239 or more). The “fissile material” can undergo fission in the presence of a neutron, liberating on the order of 150 MeV of energy as the fission fragments fly apart and come to a halt in the material. Nuclear fission was recognized early in 1939, after having been produced quite abundantly beginning in 1934 – especially in experiments by Enrico Fermi and his group in Rome. But the phenomenon was so bizarre to those knowledgeable about nuclear physics, that it lay almost totally unsuspected for more than four years. Fission is a collective phenomenon of the neutrons and protons composing a heavy nucleus. The nucleus is stable against small vibrations, but if provoked by the energy associated with capturing a slow neutron or a fast neutron, the nucleus can be set into vibration of sufficient amplitude that in a long time (on nuclear scales) the two large portions of the nucleus can pinch off much in the way a liquid drop fragments into two. The repulsive electrostatic energy (Coulomb energy) between these separating portions of the nucleus drives them apart, with a kinetic energy which is a large portion of the 150 MeV. In addition, the two fission fragments are left in highly excited states, and these decay by the emission of prompt gamma rays. Further excitation is removed by so-called beta decay – the emission of negative electrons so that a fission fragment becomes in the course of time the nucleus of an atom with nuclear charge one greater than the primary fission fragment. Symmetric fission is rare; much more common is for fission to take place producing a heavy nucleus such as barium and a light nucleus such as krypton. From the point of view of the nuclear power engineer, the energy release in fission provides the heat which drives the plant. The energy release in gamma rays and particularly later beta rays and decay gamma rays is a nuisance, requiring heavy shielding for the plant itself and care for hundreds of thousands or millions of years for the waste from the power plant. The power plant design is dominated by nuclear physics considerations in keeping the reaction going in a stable fashion, and by thermal considerations, so that the fuel can be cooled to prevent excursions to damaging temperatures. Thus a nuclear power plant is of substantial size, and the fuel is substantially diluted in space and in many cases in quality (typically 4-5% U-235 in U-238 for the fuel of a light-water reactor). In contrast, a nuclear explosive needs no cooling. It can be very small, although there are lower and upper limits to the size of a fission explosive. In energy terms, the complete fission of 1 kg of U-235 or Pu-239 (or for that matter, of U-238) yields the equivalent of 17,000 tons of TNT. A gram of high explosive is typically taken to yield 4.2 kilojoules (4.2 kJ) of energy, so that one ton of high explosive provides 4.2 GJ of energy. The characteristic energy (PxV) in the atmosphere corresponds to 0.1 MJ per cubic meter, so that 1 kt of energy would double the energy density in 4x107 cubic meters of air – the volume of a hemisphere 270 m in radius or 540 m diameter. In any case, nuclear explosions are bad news for cities and if detonated close enough, even for missile silos or other very robust structures. To achieve a nuclear explosive requires that of the 2.5 neutrons from a U-235 fission (3.5 from a Pu-239 fission) more than one remain within the initial mass in order to cause a divergent chain reaction. In a nuclear reactor, precisely one neutron per fission goes on to cause a succeeding fission – in a time on the order of 0.01 microseconds for a fast-neutron reactor, and closer to a millisecond for a thermal reactor. In the fissile metal of a nuclear explosive, a neutron travels only on the order of 7 cm before causing a fission, so the generation time is on the order of 10-8 seconds. This is important because if the generation time is very long, a divergent fission reaction only gradually increases the energy density in the material, which will gently disassemble rather than explode. But with achievable generation times in fissile metal, the energy density rises in a time short compared with the sound transit time across the material, so that it disassembles at speeds in a time comparable with the generation time, but at an exceedingly high energy density. The efficiency of the plutonium bomb which destroyed Nagasaki in August 1945 was on the order of 20%. It contained about 6 kg of Pu, and yielded almost 20 kt of energy. The uranium bomb which destroyed Hiroshima three days earlier had an energy release of some 13 kt but contained about 60 kg of uranium. Its efficiency was thus on the order of 2%. Although other fissile isotopes can in principle be used to make nuclear explosives (in particular, U-233 and Np-237), such materials are not widely available. So proliferation has usually been taken as concerning the availability of highly enriched uranium or plutonium. One of the early cooperative measures against proliferation of nuclear weapons was the first Atoms for Peace Conference in Geneva, Switzerland, in 1955. President Eisenhower and his advisors felt that by cooperating with other nations on the peaceful uses of atomic energy, one could reduce the force of the argument that a state needed to acquire nuclear weapons or nuclear reactors in order to obtain the peaceful benefits of nuclear energy – the industrial and medical uses of radioisotopes, and the like. This began an intensive cooperation between the United States and others in education in nuclear energy, and in active collaboration. The commitment to cooperation and peaceful uses was formalized in the Non-Proliferation Treaty (NPT) which entered into force March 5, 1970. The NPT distinguished between nuclear weapon states (NWS) and non-nuclear weapons states (non-NWS), defining a nuclear weapon state as one which had tested a nuclear weapon or other nuclear explosive device prior to January 1, 1967. The NPT was open for signature by any state and entered into force after a sufficient number had adhered, so that each state could sign up as an NWS (only 5 admitted) or a non-NWS. Under the Treaty, the NWS committed themselves not to transfer nuclear weapons or nuclear weapon technologies to a non-NWS, and the non-NWS committed not to acquire or accept nuclear weapons. You will note that other nations now have tested nuclear weapons – namely, India and Pakistan – and South Africa joined the NPT only after revealing that it had made six Hiroshima-type bombs, which had been disassembled and the HEU diluted so that it was no longer directly usable in weapons. Israel is also widely regarded as having a substantial number of nuclear weapons. But these states cannot enter the NPT in either NWS or non-NWS category, and that is a problem which needs to be overcome if their nuclear weapons are to be made as controllable as possible and safeguarded as well as they might be. The NPT gave rise to the Viennabased International Atomic Energy Agency (IAEA) which operates a system of safeguards by which each nonNWS demonstrates that whatever nuclear facilities it has are not in violation of the commitment not to acquire nuclear weapons. The IAEA has from the beginning defined a significant quantity (SQ) of plutonium as 8 kg; the SQ for HEU is 25 kg. These numbers are somewhat obsolete, in that the Nagasaki bomb contained only 6 kg of Pu, and it is widely discussed that some 20 kg of U-235 would suffice to make a powerful nuclear weapon if it were used in an implosion device rather a “gun” type nuclear explosive.

**3.2     Military Imbalance between the Developed and the Developing Nations**

Military Power can be defined as “the ability of human agency to exercise control over its social and physical environment”i . Power imbalances exist in a social setting, that is, when there are asymmetrical relations of power among persons, institutions or states. A power imbalance exists when A has more control or influence over B’s behaviour than vice versa. Control may be exercised by the use of superior force, or by economic means, or by control over knowledge and information. Each of these is present when considering power imbalances in North-South relations. In the sphere of force, imbalances are manifested in the overwhelming preponderance of the military power of the North, headed by a super-power with a global military capability. The willingness and ability to use this power, under conditions that are unilaterally or plurilaterally determined, sets perceived limits on the allowable behaviour of lesser states. It establishes a kind of framework of customary action for the conduct of international relations. Furthermore, the fact that these limits can be arbitrarily redefined by dominant powers acts as a disincentive to engage in “risky” state behaviour. Military alliances also render many Southern states dependent on the North for their security, with spin-offs in other areas of their external relations. Power imbalances in the economy are embedded in the operation of global markets and in the ownership and governance of international institutions. Hence, the institutions of international development become sites of interaction of North-South relations in certain matters concerning trade, finance and technology. Here power imbalances are manifested, mediated and sometimes renegotiated. But these interactions always take place within a wider system of power that conditions the possibilities, limits and consequences of change. Power imbalances in knowledge are expressed in Northern dominance in knowledge construction, reproduction and dissemination. We are using “knowledge” here to mean the constructs, assumptions, and beliefs by which people understand and interpret the world around them. In systems of domination, knowledge serves the function of justifying hierarchical relations. It is codified as ideology, as economic or social theory, or as religious doctrine; or it may take the form of “cultural hegemony” in the Gramscian sense. Historically knowledge domination has been an integral part of North-South relations. Religious and racial doctrines were used to justify conquest and enslavement. Later notions of “civilizing mission” were used to justify colonialism. Today neo-liberal theory is used to justify market-led and corporate-dominated globalization (Bendana 2006). Domination of higher education and of the global media is the means by which a particular view of history and world affairs is reproduced and disseminated. Knowledge renovation serves to interpret contradictions and changing realities, responding to challenges to the hegemonic discourse in ways that maintain existing hierarchies of power. The devices used include linguistic co-optation, conceptual/theoretical innovation and revision of policy agendasiii. In the real world the military, economic and epistemic dimensions of power imbalances overlap. But which is the most significant? Clearly the use of force most directly impacts on physical behaviour, constraining some actions and compelling others. Economic dependence is also a powerful means of control. The enslaved person is dependent on the master, the worker on the capitalist, the colonial economy on the metropolitan economy. But knowledge may be the most powerful, in its ability to condition routine behaviour without resort to physical force or material sanction. Knowledge operates at the level of internalized assumptions. People behave according to the understanding that they have of their own existential reality. It conditions what they believe to be necessary, desirable, possible and acceptable. The same holds for states. This is why imperial conquest was followed by religious conversion and colonial education. In the words of Steve Biko, “The most powerful weapon in the hands of the oppressor is the mind of the oppressed.” The military dimension of power imbalances is not, of course, within the scope of this paper. Economic power imbalances can be addressed through South-South economic cooperation and Southern solidarity in global negotiations to reform the international development architecture. Our approach points to addressing imbalances in the sphere of development knowledge as one important objective of reform. This is not necessarily a simple matter since it involves challenging existing paradigms and ideologies.

**3.3     THREAT OF NUCLEAR PROLIFERATION TO WORLD PEACE.**

Nuclear weapons proliferation is at the top of the news these days. Most recent reports have focused on the nuclear efforts of Iran and North Korea, but they also typically warn that those two acute diplomatic headaches may merely be the harbingers of a much darker future(GARWIN,2001). Indeed, foreign policy sages often claim that what worries them most is not the small arsenals that Tehran and Pyongyang could build for themselves, but rather the potential that their reckless behavior could catalyze a process of runaway nuclear proliferation, international disorder, and, ultimately, nuclear war. The United States is right to be vigilant against the threat of nuclear proliferation. But such vigilance can all too easily lend itself to exaggeration and overreaction, as the invasion of Iraq painfully demonstrates. In this essay, I critique two intellectual assumptions that have contributed mightily to Washington’s puffed-up perceptions of the proliferation threat. I then spell out the policy implications of a more appropriate analysis of that threat. The first standard assumption under girding the anticipation of rampant proliferation is that states that abstain from nuclear weapons are resisting the dictates of their narrow self-interest—and that while this may be a laudable policy, it is also an unsustainable one. According to this line of thinking, sooner or later some external shock, such as an Iranian dash for the bomb, can be expected to jolt many states out of their nuclear self-restraint.This assumption is highly questionable. There have been many supposedly destabilizing shocks to the global nonproliferation norm over the years. These include the Indian nuclear test of, the revelation of Israel’s secret nuclear arsenal in, the Indian and Pakistani nuclear tests of, and the North Korean nuclear tests of, and , to mention just a few. Yet, despite these provocations, today fewer states are engaged in suspicious nuclear activities than ever before. The nonproliferation norm is much more solidly entrenched than most observers believe. The historical resilience of the nonproliferation norm becomes much less surprising when we realize that abstention from nuclear weapons is not a bizarre departure from states’ normal pursuit of national security and international standing. The effects of nuclear weapons are huge, indiscriminate, and long-lasting. Most thinkers have focused on the offense these monstrous characteristics give to the human conscience. But it is equally important to note that these same characteristics also render the bomb useless for almost all military purposes. Therefore, states that try to build new nuclear weapons arsenals have increasingly been seen not as prudent and pragmatic, but instead as paranoid and power-mad. This essentially limits the bomb’s appeal to those few state leaders who really are paranoid and power-mad. The second—and even more fundamental—assumption under girding the anticipation of rampant proliferation is that more than forty states now have the latent capacity to build the bomb within just a few years, if they wished to do so.Former CIA Director George Tenet offers an even darker assessment: “In the current marketplace, if you have a hundred million dollars, you can be your own nuclear power(CARSON,1993).” In other words, getting the bomb today is merely a matter of money—and not even all that much money. If Tenet is right, then a mere trickle of new nuclear weapon states could rapidly turn into an unmanageable cascade. This assumption of ubiquitous latent nuclear capacity, however, is just as questionable as the assumption of ubiquitous latent nuclear intentions. It is true that some of the obstacles to building the bomb are lower than they used to be. For instance, most of the scientific secrets of the original nuclear weapons projects have long since been revealed, and many highly sensitive technologies are now available on the international black market. But the actual experiences of recent nuclear weapons projects contradict the conventional wisdom that the bomb is now easily within the reach of all but the most hapless members of the international state system. The fact is that recent nuclear weapons projects have not fared much better than their predecessors did; instead, they have fared much worse. This puzzling global trend demands careful examination. The above chart summarizes the history of all the dedicated nuclear weapons projects since the start of the nuclear age. By “dedicated” projects, I mean projects that were the result of a clear commitment at the highest political levels to produce the bomb, and not just tentative explorations or diplomatic feints. There is a rough consensus among international security scholars that seventeen dedicated nuclear weapons projects have been launched since the beginning of the nuclear age(CARSON,1993). The seventeen cases are lined up along the X-axis according to their start date. The black bars in the chart represent the number of years the successful projects took to produce their first big explosion or, in the cases of Israel and Pakistan, to allegedly produce untested but operational nuclear weapons. The white bars represent the number of years the unsuccessful projects lasted until they were shut down. Finally, there is a striped bar for the case of Iran, because its ultimate outcome is uncertain. One may quibble with the interpretation of this or that country case, but the general patterns I will be discussing here persist even if we apply alternative coding. If technological difficulty were the key factor driving proliferation outcomes, then early nuclear weapons projects should have taken many years to complete and should have experienced a high failure rate, whereas more recent projects should have taken much less time and should have experienced a much lower failure rate. But as the above chart clearly demonstrates, precisely the opposite has happened. All of the dedicated nuclear weapons projects that were launched before succeeded, and their average time to the first nuclear test (or to the direct induction of operational weapons without a test) was about seven years. By contrast, only three of the ten dedicated nuclear weapons projects that were launched since have succeeded, and they needed an average of about seventeen years to do so. As for Iran, Israeli intelligence recently pushed back its estimated earliest potential date for a first Iranian bomb to and this for a nuclear program that was launched way back in the mids. Whatever Iran’s ultimate nuclear intentions may be, the country’s extremely slow technical progress to date is clearly consistent with the general proliferation slowdown.

****CHAPTER FOUR:****

****NUCLEAR CONTROL.****

**4.1 The International Atomic Energy Agency (I.A.E.A)**

 The International Atomic Energy Agency (IAEA) was established as an organ of the

United Nations on July 29, 1957. It is headquartered in Vienna, Austria, and reports to the United Nations General Assembly and the United Nations Security Council. The agency is structured into three constituent bodies. The Board of Governors formulates most of the policies of the IAEA, meeting five times a year to make recommendations to the General Conference, which includes representatives from all member states of the IAEA. The General Conference meets annually to approve policy and budget recommendations passed on by the Board of Governors and to debate current issues within the agency’s jurisdiction. The Secretariat is the bureaucratic arm of the IAEA, divided into six departments – nuclear energy, nuclear safety and security, nuclear sciences and applications, safeguards, technical cooperation, and management – which oversee and execute the policies approved by

the General Conference. The IAEA plays an important role in the global nuclear nonproliferation regime, with the Nuclear Non-Proliferation Treaty (NPT) enshrined at its core. The NPT represents a bargain between the existing nuclear weapons powers and non-nuclear weapons states in which the nuclear powers promised to cap

and reduce their own nuclear weapons arsenals and assist non-nuclear weapons states

with peaceful nuclear energy programs, in exchange for a pledge from the non-nuclear weapons states to refrain from nuclear weapons development. The IAEA is crucial to the NPT, overseeing the control and protection of nuclear materials amongst its signatory states through strict monitoring and careful accounting of nuclear material passing in and out of declared nuclear facilities. The IAEA supports the regulatory authorities of member states at all stages from design to construction, operation, and decommissioning of nuclear facilities. After the fall of the Soviet Union, the IAEA was involved in accounting for nuclear weapons and fissile materials from installations in Russia and the former Soviet republics. The agency has been a key player in international proliferation-related disputes involving Iraq, North Korea, and Iran. The impact of high-profile international terrorist attacks has also led to an increased emphasis on preventing the transfer of nuclear materials and technologies to non-state actors such as terrorist organizations. There are several major challenges facing the IAEA moving forward. The attainment of nuclear weapons status by countries outside the nonproliferation regime directly challenges the NPT and confidence in the IAEA’s oversight role. In making little progress toward eliminating their nuclear arsenals, nuclear weapons states have themselves undermined the NPT and thereby demonstrated the continuing geopolitical utility of

nuclear weapons proliferation. Yet the greatest proliferation risk lies with countries outside the nonproliferation regime, whose nuclear operations are not subject to IAEA oversight. There is also a danger that some states may develop technologies associated with the nuclear fuel cycle under IAEA safeguards then opt out of the NPT, leaving them free to further develop their nuclear capabilities free from IAEA auditing. Finally, nuclear energy is increasingly seen as a clean energy source that can aid greenhouse gas mitigation. This may increase the number of states pursuing nuclear energy programs, adding to the volume of nuclear technology and material

traffic internationally.

**4.2 THE POLITICS OF NUCLEAR NON-PROLIFERATION TREATY (NPT)**

The Nuclear Non-proliferation Treaty (NPT) is generally regarded as the key pillar

of the world nuclear order Walker [Walker ,2012]. With its 188 parties, it is the most universal arms control treaty in world history. Its basic philosophy is that nuclear war is a global calamity that must be avoided and that nuclear war becomes all the more likely the more states possess nuclear weapons and the more dyads of nuclear armed states watch each other with distrust and fear weary that the opponent may try to attack with surprise to disarm the victim’s deterrent. In such a world, every single political crisis would open the specter of a nuclear holocaust. The NPT was meant to prevent this world from emerging by stopping the number of nuclear weapon states at five, the number existing officially when the negotiations for this Treaty started earnestly in 1968.(Walker ,2012)The NPT constitutes a historical anomaly. In the political history of mankind, political units from nomadic hordes to territorial states always strove for the most powerful weapon of their time within the boundaries of their own resources. Through membership in the NPT, in contrast, most states renounce most powerful weapon of their time, while a small minority is permitted to possess them temporarily, and a few more states have acquired them as non-members of the NPT. In other words, the Treaty constitutes an unequal world—at least for the time being. Such inequality creates the inevitable impulse to get back to a level playing field. This impulse is not uniform and simultaneous for all countries at all times, but occurs with considerable regularity: one or the other government considers, embarks on, and sometimes brings to end, a program of activities geared towards the acquisition of nuclear bombs. In the nuclear age, no less than 37 cases of such consideration, embarking, or completion have become known. The value of the NPT can be deduced from the fact that the overwhelming number of these cases started before the Treaty entered into force, and the overwhelming number of renunciations occurred when he was in force. Obviously, the NPT provides a framework in which renouncing these weapons is supported by the dominant normative and legal framework Müller and Schmidt. Catching up with the nuclear Joneses by the many, however, is not the only way to create equality. Disarmament by the few is the obvious alternative, and this path is prescribed in Article VI of the NPT which obliges all parties to the NPT to terminate the nuclear arms race and to embark in good faith negotiations towards nuclear disarmament. The International Court of Justice (IGJ) has clarified in an Advisory Opinion in 1996 that good faith requires that negotiations are pursued in a way that they are brought to a successful end. It is for this reason that I have mentioned above that the NPT’s inequality is “temporary” “for the time being”. The said inequality has three dimensions. First, there is the unequal distribution of rights and duties of the parties to the NPT; this dimension distinguishes the NWS from the NNWS. NWS, as mentioned, are permitted for the time being to possess nuclear weapons, NNWS are prohibited from acquiring and possessing them. Thus, the NPT distributes military power unequally among its membership. The second dimension concerns the precision by which duties are defined. The prohibition for the NNWS is relatively clear (even though what “development” and what “nuclear weapon” means is not defined). In addition, this prohibition is to be verified by the International Atomic Agency (IAEA), and what verification entails is detailed in two lengthy documents, the Comprehensive Safeguards Agreement which is obligatory for all NPT NNWS, and the Additional Protocol with even farther reaching and more intrusive rights for the inspectors which is yet voluntary. In contrast, the disarmament obligation in Art. VI is vague. Neither the time frame is prescribed, nor are the steps that are obligatory clearly stated. The third dimension concerns the procedures for addressing non-compliance disputes and enforcement decisions. These procedures empower the NPT NWS through their UNSC permanent seats, since the UNSC, reading the NPT, the Comprehensive Safeguards Agreement, and the IAEA statute in their mutual relationship, is put in the role of the ultimate arbiter in non-compliance cases under international law. This situation has been described sarcastically as the alcoholics empowered to ensure abstinence. There is a fourth type of inequality which must be noted, an inequality of a regional kind: The inequality in the conflict-ridden region of the Middle East, where Israel is the single nuclear weapons possessor, even though the Israeli government has never officially claimed to be in this position. This regional inequality triggered the same impulse for catching up, and led no less than four regional states to make attempts to do so: Libya, Syria, Iraq and Iran. Like at the global level, there is a regional approach to create equality by disarmament and regional diplomacy. This is the motivation for the regional project of a Nuclear Weapon (or Weapons of Mass Destruction) free zone in the Middle East Müller and Müller [Mülle,2015]. These inequalities and the feelings of injustice they are inducing are at the roots of three crises Becker et al. [Becker ,2015] which characterize the present relationships within the Treaty regime: a crisis of compliance, a crisis of confidence, and a crisis of leadership. Currently, the NPT is facing two serious compliance problems concerning the core of the NNWS undertakings. The first concerns the Democratic People’s Republic of Korea (DPRK), the second one the Islamic Republic of Iran. North Korea left the NPT in 2004 after having cheated on its undertakings by running a nuclear weapons program while the country was still a party to the Treaty. In response, the international community, led by the United Nations Security Council (UNSC) pursued a double strategy of sanctions and diplomacy. The strategy was compromised by the opposite geopolitical interests of China and the US in East Asia. The fact that the DPRK is an ally of China in the struggle for regional and global leadership dissuaded Beijing from imposing pressure that could lead to regime collapse. Apart from the fear of regional destabilization, the prospect of Korean re-unification under South Korean leadership implied the nightmare of US armed forces in immediate neighborhood of Chinese Borders. China agreed to sanctions, but insisted on limitations. The stubborn pursuit of nuclear weapons by the DPRK and nowadays the brandishing of these arms and utterance of wild threats not only against the United States, but also against South Korea and Japan, two NPT NNWS, constitute the most blatant case of defiant proliferation against the spirit and letter of the NPT so far. Iran—the second serious non-compliance case, failed to comply with its obligations under its safeguards agreement with the IAEA for more than a decade, after it had re-started its nuclear program in the mid-eighties after the experience that Iraq’s use of chemical weapons did not provoke any international response while, to the contrary, East and West continued to prop up Iraq’s military power, including supplies which were used in Saddam Hussein’s weapons of mass destruction programs. (Perkovich,,2002), it became known through the revelations by an Iranian resistance group that the country had started a clandestine program for uranium enrichment. In the following dispute Teheran was first ready to cooperate, but after the election of President Ahmadinejad defied a series of UNSC resolutions and refused to fully cooperate with the IAEA in order to resolve open questions concerning its nuclear activities, particularly its potential weapons aspects. Significant and increasing pressure and the need to overcome growing sanction costs that threatened to cripple the Iranian economy moved Teheran to seek cooperation. Under the new President Rouhani and a more accommodating US Administration under President Obama, a diplomatic solution became possible. The eventual agreement (JCPoA) presented a triumph of diplomacy and reason by accepting basic requests of either side. It treated Iran with respect and accepted implicitly its right to develop civilian nuclear energy, including enrichment. Iran, on its side, accepted an extra burden to restore lost confidence through extraordinary concessions concerning constraints on its civilian program and unprecedentedly intrusive verification measures. The agreement thus stopped Iran’s creep towards the bomb for an extended period of time. The JCPoA includes the most intrusive and comprehensive verification system ever installed Perkovich et al. [ Perkovich,2015]. Yet, the agreement is threatened by Pres. Trump’s hostility and the stubborn opposition of right-wing Republicans. It is unlikely that Pres. Trump has read a single line of the JCPoA, and if so, has understood a single word. Yet he refused to certify that this agreement is in the US interest and opened the opportunity for Congress to kill it. The two cases of the crisis of compliance are a heavy burden for the existence of the NPT, yet they have not, so far, destroyed the Treaty. It is likely that the North Korean case might be contained as a regional problem and that the combined efforts of China and the USA might eventually halt the further progress of Kim Jon-un’s arsenal. It might also happen that President Trump wants to use the remaining, brief window of opportunity before the DPRK can field indeed an operational intercontinental capability to destroy cities at the US West Coast by a devastating (hopefully conventional) strike against North Korea’s nuclear (and probably chemical and some conventional) assets, creating havoc on the Peninsula. Or things will just fall apart with North Korea enlarging arsenal and capabilities and the US and China deeply divided and hostile against each other. The Middle East situation may have even more repercussions. Iran has indicated that a withdrawal of Washington from the JCPoA might not be the end of things if the other parties—China, Russia, France, Germany, the UK and the EU stick to the agreement and help to compensate for losses incurred by Iran for US defection. What this would mean for the Western Alliance, however, remains to be seen. For the NPT and future compliance crises, the experience that US legal commitments to agreements destined to terminate a crisis may have long-term negative consequences. 47 years after the NPT entered into force, there are much less nuclear weapons in the world, between 14 000 and 15 000 instead of over 60 000. Yet, the remaining nuclear weapons are still integral part of national security strategies of NWS and their allies. This situation created seep dissatisfaction among non-allied NNWS which undermines the unity of the Treaty community and threatens to de-legitimize the NPT. The NWS refusal to disarm is justified b three arguments which look right at the surface but become unconvincing if scrutinized carefully: First, Nuclear abolition needs specific political requirements. On the surface, this argument seems to have something to it: Since nuclear weapons are presumably held to respond to certain perceived security problems, the solution of these problems would help to eliminate the missions for nuclear weapons. But this argument is largely invalid in reality since the political facts which prevent the NWS from disarming are largely the consequences of their own policies: The doctrine of superiority of the US armed forces and Washington’s (and NATO’s) claim to employ force for “higher objectives” even when there is neither a case for self-defense nor legalization of such military action by a UNSC Resolution under Chap. 7 of the UN Charter. The second argument maintains that nuclear weapons as deterrent in the hands of rational, “civilized” governments are risk less and, moreover, useful for international security. But this argument is unconvincing in the light of leaders who brandish nuclear weapons like Putin or Trump. The third argument states that nuclear disarmament can progress only in steps, not in jumps. In principle, an incremental strategy promises the most realistic path of disarmament, because each single step lays the groundwork for the next and enhances mutual confidence which is the condition for more daring progress. But this argument is empty in the light of history because of the present undeniable stagnation in nuclear disarmament. Even worse, the NWS refuse to take steps they have already agreed to. Analyses like the annual Hiroshima report document that compliance with agreed disarmament steps are below 50% Hiroshima Prefecture [Hiroshima,2017]. We have to look at the facts: There has been no new nuclear disarmament treaty since 2010, the ABM Treaty which prohibited complete national missile defense system, granting the integrity of deterrence arsenals even at very low number has been scrapped by the George W. Bush administration, the plutonium disposition agreement of 2010 has been suspended by Moscow, the CTBT is not in force 21 years after its negotiations were concluded, because states like the US, China, India, Pakistan, India, Israel and North Korea have not become parties. The US and Russia accuse each other of violating the INF Treaty; this pillar of nuclear disarmament might fall by the wayside in the next few years. Rather than a process nuclear disarmament, we are watching a five-polar nuclear arms competition which involves the US, Russia, China, India, and Pakistan. Not everybody is arming against everybody else, but we have a chain of mutually distrusting nuclear armed dyads so that armament steps of any of these actors engender ripple effects everywhere else. All the while, the NWS improve the quality of their arsenals. China, India and Pakistan increase the number of their nuclear warheads. Russia has announced that it envisages a strategy of nuclear de-escalation; this means the employment of nuclear weapons in wars that go badly for Russia with a view to dissuade the enemy from continuing fighting because of the risk of further escalation. In NATO, nuclear deterrence gains new traction, because the Eastern members are highly nervous about Russian exercises, illegal overflights by Russian military aircraft and nuclear saber-rattling, notably after what happened in Ukraine. As a consequence of these developments many NNWS have lost confidence in the sincerity of NWS commitment to nuclear disarmament. Frustrated by perceived neglect of the NWS’central NPT duty, repelled by the condescending attitude of the NWS, most NNWS, supported by NGOs, chose a new path: negotiating a Nuclear Ban Treaty (NBT). A movement, initially driven by a few leading governments (e.g. Austria, Switzerland, Ireland, Mexico, South Africa, Costa Rica) started with a focus on humanitarian consequences of NW—as highlighted in the NPT’s preamble. Three consecutive conferences in Norway, Mexico and Austria reached the conclusion that nuclear arms are inhumane, incompatible with international humanitarian law and must be prohibited like biological or chemical weapons. From there emerged the demand for a legal ban against nuclear weapons (NBT) (]Kmentt,2015). The NBT movement proceeded against the opposition of the NWS and allies and without their participation. In 2016, the majority of the UN General Assembly established a negotiation forum for ending the lack of an effective legal instrument against nuclear weapons. During the negotiations in 2017, only the Netherlands joined among US allies the negotiating crowd of 124 states, because the Dutch parliament, driven by a public referendum, ordered the executive to take part in the talks. The NWS and their other allies abstained. Eventually, the NL voted against the ban Potter, Mukhatzhanova [ Mukhatzhanova,2017]. The NBT that was adopted by the vast majority constitutes an impressive signal by the majority and a new element into NPT debates whose impact remains to be seen. Given the history since indefinite extension of the NPT, notably the disappointment by broken promises, it was inevitable and justifiable that the majority would seek self-empowerment to break deadlock. Unfortunately, the NBT is not a very good treaty: it fails to fill NPT gaps concerning prohibition scope by not mentioning nuclear weapons research research, transfer of arms parts, materials and technology in addition to nuclear weapons of which to dispose the NBT members are not permitted anyway, it lacks any clause on export controls beyond the transfer of full weapons, is silent on non-compliance/ enforcement but contains only a toothless dispute settlement imperative, lacks institutional. Clarity, because the IAEA and a mysterious “Authority” with competences in verifying nuclear disarmament share authority without clearly distinct

mandates. Nevertheless, the NBT is there and will most likely enter into force in the

coming years. Opponents will have to learn to live with it. Fundamental opposition

will thus prove futile and counterproductive. NWS and their allies appear painfully

unprepared to face the facts. In the current situation, there is no leadership visible on any side in the disputes which would open a new path, cut the Gordian knot, or build bridges between the opposite camps. The US suffers worst domestic political cleavage inside since the Civil War and is led by an incapable, psychically if not mentally defect president without any knowledge of the world who is not, and will never be, up to his job. Many Republicans in Congress are fanatics and ideologues of Bolshevik dimensions and known as little about the world as their president. Russia is led by a nationalist, corrupt and resentful elites, led by a president socialized as a mediocre intelligence officer of the Soviet Union with the behavior of a strong boy in puberty with minority complexes. Ensuring geopolitical gains, showing military muscles, and taking revenge against the US for perceived past slights take priority over rational, compromising external policy. China is busy with preserving internal rule by the Communist party, pursuing territorial claims against no less than 8 neighbors, and standing up and getting equal with the US. An ego-orientated president tries to enhance his personal power and extend his personal rule by enlarging the international power of China. In this project, territorial claims against altogether eight neighbors on land and on sea are an apparently non-negotiable part. The EU is internally divided between NWS/allies and disarmers (Austria, Ireland, and Sweden). Germany as the leading economic power in the EU is compromised in the eyes of many NPT members by its nuclear NATO role. France is, besides Russia, the most uncompromising NWS. It is obvious that in the field of nuclear disarmament, the EU is incapable to function as an unified actor. In the NAM, South Africa suffers from a weak, corrupt president. Brazil focusses on preserving its Navy‘s plans for nuclear powered submarines. Iran is still busy to stand up to the US, enhance its regional power status, and pacify internal divisions by propping up national pride. Egypt has developed an almost manic concentration on the Middle East theme. That Egypt did not take to offer of Israel, extracted by intense US diplomacy, to address the nuclear subject in a conference on a Middle East Zone Free of Weapons of Mass Destruction under the condition that it will be embedded in the overall regional security situation still strikes me as incomprehensible. As long as this stubbornness persists, Egypt is not up to the task as a NAM leader. Some states, e.g. Mexico, Costa Rica, Indonesia show occasional, but not perpetual leadership qualities. Iran’s failure as NAM chair, despite best efforts to rally NAM consensus around positions during the 2015 RevCon and during the 2016 UNGA debate concerning NBT negotiations documents the lack of NAM leadership, and possible the structural impossibility to establish one. The next phase in the future of the NPT will be, of course, the review cycle which has already begun. Frontlines between the majority of the NWS and their allies, on the one hand, and the vast majority of the NNWS are as sharp and deep as never before. The NWS resent the NBT and allege that it is hurting the NPT. They try to keep discipline among their allies, which is easier with some (the Easternmost NATO members) than with others (“old” NNWS Europe and the Southern part). They attempt to arms-twist smaller states not to sign and ratify the NBT, because they still maintain the hope that they might be able to prevent the NBT from entering into force because of the quorum: fifty ratifications are needed for the NBT to enter into force. The NWS continue to regard nuclear deterrence, decisions on the nuclear posture, arms control and disarmament as their exclusive turf with no role for NNWS. Because the NBT intrudes this chasse guardee, they take it as offense, as a slight in their face xxx dealt them by countries of minor importance. As far as disarmament is concerned, NWS want moves, if at all, as single small steps, to become obligatory only with their agreement, and to be implemented after such agreement only at their will and with due regard to the national security requirements—as they see them—of the moment.

The majority of NNWS refuses, in retaliation for lacking disarmament, to accept any further improvement of the non-proliferation toolbox (verification, export control, procedures for withdrawal and non-compliance cases, obligatory multilateralisation of fuel guarantees and fuel cycle activities). The weaknesses in the NBT prove this attitude: even for saving the credibility of their commitment to lay the foundations of a nuclear weapons free world, they were not ready to take upon themselves the necessary undertakings beyond present ones. This attitude puts an air of lack of seriousness over the NBT. It is also possible that at least the NAM members are ready to shelter peer NAM states who temper with NPT compliance by their solidarity, as long as the cleavage continues, even though this would remove the realization of a nuclear weapons free world even farther into the future. If world politics were the realm of reason, both NWS and NNWS would do their best to strengthen the NPT as their common good, given what is at stake. The NWS would agree to take steps towards disarmament, notably those which would enhance safety against nuclear war, accident, or non-state actor attack. The NWS and their allies would accept the NBT as fait accompli. They would agree to take note of the NBT, recognize that it is designed to serve the objectives of the NPT’s preamble and Art. VI, that it is compatible with the NPT, and that a large number of NPT parties support it. NNWS would accept that agreed disarmament steps, although not leading to nuclear weapons abolition in the short term, serve the common goal and are thus worth supporting. They would agree to improve new non-proliferation measures and to help bring non-compliant states back to good standing, NWS and NNWS would both effectively implement the agreed steps. On the Middle East, the formula which the US extracted from Israel in 2015—address nuclear issue, but in the context of regional security—would be embraced by all regional states. But international politics is not the realm of reason Bleiker and Hutchinson [Bleiker,2014 ]. NWS are jealously guarding their privileges and pursue their competitive geopolitics which stand in the way of disarmament. NNWS feel offended and humiliated by the NWS’ disregard for their cherished positions and thus block measures that would be in their own best interest. In the past, wise bridge-builders were repeatedly capable to work as catalysts for consensus. Xxx But with the lack of capable leadership in our age of populist emotions, can reason prevail? Hence, unfortunately, my answer to the question about the future of the NPT ends itself with a question mark.

**4.3 THE POSITION OF THIRD WORLD NATIONS.**

Nuclear energy now contributes more than 12% to total electricity generation in industrialized countries, including those in Europe which have centrally-planned economies [1]. However, it still plays a minor role as an energy source in developing countries. As shown in Figure 1, at the end of 1983 only six developing countries which are Member States of the IAEA (Argentina, Brazil, India, the Republic of Korea, Pakistan, and Yugoslavia) had nuclear power plants in operation — a total of 13, with a combined capacity of around 5100 MWe, accounting for less than 2% of developing countries' total electricity production. In addition, 18 plants with a total capacity of about 11 000 MWe were under construction, in these six countries and in Cuba, Mexico, and the Philippines. In at least four other countries (People's Republic of China, Egypt, Libyan Arab Jamahiriya and Turkey) plants are in the final planning stage. In the year 2000, the total nuclear capacity in developing countries might be 50 GWe, providing about 7% of their total electrical energy. The corresponding figures for industrialized countries are expected to be between 500 and 700 GWe, supplying about 30% of their total electrical energy. However, if prevailing constraints can be overcome, up to ten additional developing countries have the potential to start construction of nuclear power plants before the end of the century. Given that the lead time for plant construction in most countries is 10 to 15 years, those intending to launch programmes must take early decisions. Such decisions need to be based on careful assessment of future energy supply and demand, economic and financial implications, and requirements for infrastructure and technology transfer. Experience indicates clearly that most developing countries actively planning and implementing a nuclear power programme require broad-scope assistance if their use of nuclear technology is to be safe, economic, and reliable. This is normally assured by bilateral co-operation, the most important channel for the transfer of nuclear technology. Argentina and Brazil are good examples of countries which have received assistance through successful bilateral co-operation, and have developed the necessary industrial infrastructure. However, other sources of assistance are needed in the preparatory phase of a nuclear power programme, before bilateral agreements can function. Assistance is also needed to establish the necessary support and surveillance structures. The Agency's assistance is therefore directed both to general planning, and to the development of supporting structures; and is based on an assessment of needs which cannot be satisfied by other means. The Agency's Division of Nuclear Power has the technical background and tools to support a comprehensive programme of assistance in nuclear power assessment, planning, and implementation. Assistance can be provided on request either as a complete package, or as selected components.

**4.4      LESSONS OF NUCLEAR ENERGY PROLIFERATION FOR THE THIRD WORLD COUNTRIES.**

One common objective in the strengthening of these structures is to assure a level of quality that will guarantee a high level of safety and reliability in all phases of a project and plant operation. Qualified manpower. Nuclear technology is usually acquired from a more advanced country. For technology transfer to be successful, the recipient country must be capable of absorbing the technology, and the key to this is the availability of qualified manpower. In many developing countries the need for nuclear scientists and research-oriented personnel has often been over-estimated, while the need for highly qualified and experienced practically-oriented engineers, technicians and craftsmen has been very much under-estimated. In most cases the major staffing problems have concerned engineers and technicians at all levels with practical experience for project execution and operation. The Agency's assistance usually begins with an assessment of the need for a manpower development programme. This reviews the staffing experience of the existing organizations, and national educational institutions at all levels, and takes into account the number of graduates, their disciplines, and the levels of qualification attained. IAEA missions for assessment of manpower availability and required manpower development programmes have been performed in Egypt, the Republic of Korea, the Libyan Arab Jamahiriya, Mexico, the Philippines, and Yugoslavia. Following such assessments, comprehensive manpower development programmes have been established with Agency assistance in the Republic of Korea and the Philippines, and in specific sectors of education in Argentina, Brazil, and Egypt. In addition, significant United Nations Development Programme (UNDP) projects (shown in Table 1) have been or are being executed in Argentina, Brazil, the Philippines and Yugoslavia. In the latter case a major project valued at more than US$ 3 million over five years helped to establish manpower qualification and a simulator training centre. It is certainly desirable that manpower development programmes take the form of multi-year technical cooperation (Yugoslavia) or UNDP projects, as they require continuity and more funds than are normally available under the Agency's regular Technical Co-operation programme. Technician education and training for nuclear power remains a difficult problem. It is not, however, one of education and training only; it is also one of social tradition and of recognition of the technician level.

**CHAPTER FIVE**

**SUMMARY, CONCLUSION AND RECOMMENDATION**

**5.1 SUMMARY**

In this study, our focus was to examine the nuclear energy proliferation: lessons for the third world nations, 1945-2006 **.** The study specifically was aimed at highlighting the non-proliferation measures and the ideas behind them. The study also, examine the importance of nuclear energy proliferation. Lastly, the study examine the development and expansion of commercial nuclear energy.

**5.2 CONCLUSION**

Based on the finding of this study, the following conclusions were made:

A careful review of the historical evidence suggests that the links between nuclear energy and nuclear weapons proliferation are overstated. Although nuclear energy programs make it technically easier for states to develop nuclear weapons, they make it substantially more difficult politically, as proliferators with energy programs are more vulnerable to intelligence collection efforts and nonproliferation pressures. This suggests that the spread of nuclear energy can be managed and will not inevitably lead to greater proliferation of nuclear weapons. Nevertheless, because these political obstacles are largely the result of effective policy countermeasures, officials in the United States and elsewhere should remain vigilant and committed to nonproliferation if they hope for these trends to persist.

**5.3 RECOMMENDATION**

1. It is recommended that the Agency's advice on nuclear energy proliferation will be sought increasingly..
2. That if a country is to introduce nuclear power, Competence in the construction and erection industries and in operational and maintenance capabilities is a basic requirement.

**REFERENCES**

 A Technology Roadmap for Generation IV Nuclear Energy Systems ,Issued by the US DOE Nuclear Energy Research Advisory Committee and Generation IV International Forum, GIF-002-00,2002

Akyuz, Yilmaz (2004). “The Rational for Multilateral Lending: A Critical Assessment”

Akyuz, Yilmaz (2005). “Reforming the IMF: Back to the Drawing Board”. UNCTAD

Alfred A. Knopf, Publisher, New York, (2001). This will appear as a paperback in December 2002, Megawatts and Megatons: The Future of Nuclear Power and Nuclear Weapons, The University of Chicago Press. www.aaknopf.com/authors/garwin).

Banerjee, Abhijit; Angus Deaton; Nora Lustig; and Ken Rogoff (with Edward Hsu) (2006). An Evaluation of World Bank Research, 1998 – 2005. Available on-line at

Barja, Gover (2007). Country Case Study Bolivia. Paper prepared for the Project on the Reform of the International Development Architecture. (May).

Bendana, Alejandro (2006). “Development Assistance and its Discontents: A Perspective from the South”. Excerpts from paper presented at the Forum “The White Man’s Burden: Civil Society and Market Fundamentalism” Oslo, June

Berthelot, Yves (2004). “Unity and Diversity of Development: The Regional Commissions’ Experience”, in Yves Berthelot (ed.) Unity and Diversity in Development Ideas: Perspectives from the UN Regional Commissions. Indiana University Press.

Blix, H. (2004) Disarming Iraq. Pantheon Books, New York.

Buira Ariel (2005). “The Bretton Woods Institutions: Governance Without Legitimacy?” http://www.g24.org/govwtleg.pdf. Sourced July 19, 2007.

Buira, Ariel, (2000). “Governance of the International Monetary Fund”, G24 Research Paper, online, http://www.g24.org/imfgover.pdf. Sourced September 27, 2006

Buira, Ariel, (2003a). “An Analysis of IMF Conditionality”, G24 Research Paper, online, http://www.g24.org/buiratgm.pdf

Buira, Ariel, (2003b). “The Governance of the IMF in a Global Economy”, G24 Research Paper, online at http://www.g24.org/buiragva.pdf. Sourced September 28, 2006

Callan, Eoin (2006),“World Bank 'uses doubtful evidence to push policies'”. Financial

Cantelon, Philip, and Robert C. Williams. Crisis Contained: The Department of

Challenges, New Approaches, edited by Fereidoon P. Sioshansi. (Amsterdam: Academic Press, Elsevier, 2013). ISBN: 978–0-12-397891- Lovins A., Sof Energy, 1978.

Cohen, Bernard L. Before It’s Too Late, A Scientist’s Case for Nuclear Energy. New York: Plenum Press, 1983. This 1981 recipient of the American Physical Society Bonner Prize for basic research in nuclear physics explains nuclear energy to the layman.

D. Van Nostrand Company, 3rd ed., 1979. An encyclopedic compilation of useful atomic energy information. Groves, Leslie R. Now It Can Be Told, The Story of the

Doyle, J.E. (ed.) (2008) Nuclear Safeguards, Security, and Nonproliferation: Achieving Security with Tech nology and Policy. Butterworth-Heinemann, Oxford.

Draft for Discussion. 5 July. http://www.new-rules.org/docs/ffdconsultdocs/akyuz04.pdf.

Edelson, Edward The Journalist's Guide to Nuclear Energy. Nuclear Energy Institute, 1994. Glasstone, Samuel. Sourcebook on Atomic Energy . Princeton:

electricity markets in Europe fundamentally”, Energy 57, 2013, 38–53.

Energy at Three Mile Island: A History . Washington, D.C.: U.S. Department of

Energy, 1980.

G. Perkovich, M. Hibbs, A. James, T. Dalton, Parsing the Iran deal, in An Analysis of the Irandeal from a Nonproliferation Perspective (Carnegie Endowment for International Peace, Washington DC, 2015), <http://carnegieendowment.org/2015/08/06/parsing-iran-deal/iec5?mkt_>tok=3RkMMJWWfF9wsRoguKjPZKXonjHpfsX56OwpXaKg38431UFwdcjKPmjr1YU BTMN0aPyQAgobGp5I5FEIQ7XYTLB2t60MWA%3D%3D

G24 Discussion Paper Series, No. 38. November. Available at http://cdi.mecon.gov.ar/biblio/docelec/unctad/g24/38.pdf. Last sourced 19 July 2007.

H. Müller, A. Schmidt, The little-known story of deproliferation: why states give up nuclear weapons activities, in Forecasting Nuclear Proliferation in the 21st Century, vol. I, The Role of Theory, ed. by W.C. Potter, G. Mukhathhanova (Stanford University Press, Stanford, 2010), pp. 124–158

H. Müller, D. Müller, WMD Arms Control in the Middle East: Prospects, Obstacles and Options (Ashgate, Farnham (UK)/Burlington VT, 2015)

Haas R, Auer H, Resch G., Lettner G. Te growing impact of renewable energy in European electricity markets in: Evolution of Global Electricity Markets—New Paradigms, New

Haas R, Lettner G, Auer J, Duic N. Te looming revolution: How Photovoltaics will change

Haas R., On the future design of electricity markets: Capacity payments or smart solutions? In: C. Brebbia et al “Energy Quest” Wessex, 2014.

Harper, 1975. The history of the Manhattan Engineering District's wartime project by

IAEA: Advanced Application of Water Cooled Nuclear Power Plants, IAEA, Vienna, 2008.

IAEA: Non-electric Applications of Nuclear Power, Proc.Int.Conf., Oarai, Japan,2007

 J. CARSON MARK “Explosive Properties of Reactor-Grade Plutonium,” Science & Global Security, 4, p. 111, (1993).

London, 2012)

Lund H. Renewable energy systems. 2nd edition, ISBN: 9780124104235, Academic Press (2014)

Lund PD, Lindgren J, Mikkola J, Salpakari J: Review of energy system fexibility measures to enable high levels of variable renewable electricity. Renewable and sustainable Energy Reviews, 45, 785–807, (2015),Nicolosi M. Wind power integration and power system fexibility – an empirical analysis of extreme events in Germany under the new negative price regime. Energy Policy 2010;38:725-768.

Manhattan Project. New York:

Murty K.L., Charit I.,(2008) Structural materials for Gen-IV nuclear reactors: Challenges and opportunities :Journal of Nuclear Materials, Vol.383, 189-

Nicolosi M. Wind power integration and power system fexibility – an empirical analysis of extreme events in Germany under the new negative price regime. Energy Policy 2010;38:725-768.

Nielsen S, Sorknæs P, Østergaard PA. Electricity market auction settings in a future Danish electricity system with a high penetration of renewable energy sources e a comparison of marginal pricing and pay-as-bid. Energy 2011; 36: 4434–44.

Plutonium”, J.P. HOLDREN (Co-Chair), J. AHEARNE, R.L. GARWIN, W.K.H. PANOFSKY, J.J. TAYLOR, and E.P. VELIKHOV (Co-Chair), A.A. MAKAROV, F.M. MITENKOV, N.N. PONOMAREV-STEPNOI, F.G. RESHETNIKOV, (1997).

Praktiknjo A. Sicherheit der Elektrizitätsversorgung im Spannungsfeld der energiepolitischen Ziele Wirtschaflichkeit und Umweltverträglichkeit, PhD thesis, Berlin, 2013.

1. L. GARWIN and G. CHARPAK, Megawatts and Megatons: A Turning Point in the Nuclear Age? 1-14, Sourced 25/09/06 the man who directed it.

Times, London (December 22) reproduced in Heterodox Economics Newsletter, No. 38, January 26,2007; “Report on World Bank’s Research Activities” by Peter Bakvis. Online at http://l.web.umkc.edu/leefs/htn38.htm. Sourced 23/02/07.

U. Becker, H. Müller, T. Seidler-Dieckmann, Regime conflicts and norm dynamics: nuclear, biological and chemical weapons, in Norm Dynamics in Multilateral Arms Control: Interests, Conflicts, and Justice, ed. by H. Müller, C. Wunderlich (University of Georgia Press, Athens, Georgia and London, 2013), pp. 51–81

W. Walker, A Perpetual Menace: Nuclear Weapons and International Order (Routledge,

 W.K.H. PANOFSKY, Chair, “Management and Disposition of Excess Weapons Plutonium,” Report of the National Academy of Sciences, Committee on International Security and Arms Control, 1-7. National Academy Press, Washington, DC, (1994).

 W.K.H. PANOFSKY, Chair, “Reactor-Grade and Weapons-Grade Plutonium in Nuclear Explosives” of “Management and Disposition of Excess Weapons Plutonium,” Report of the National Academy of Sciences, Committee on International Security and Arms Control, Chp. 1, pp. 32-33, National Academy Press, Washington, DC, (1994).

www.worldbank.org\data&research\evaluationofbankresearch\htm).