# Global Regulation: Controlling and Accepting Radioactivity Risks

Soraya Boudia

**RÉFÉRENCE**

Soraya Boudia, « Global Regulation: Controlling and Accepting Radioactivity Risks », *History and Technology*, 23, 4, 2007, p. 389-406

# GLOBAL REGULATION: CONTROLLING AND ACCEPTING RADIOACTIVITY RISKS

Soraya Boudia
IRIST, Université Louis Pasteur

**Abstract**

This paper aims to examine the determining role of nuclear hazards in the emergence of a new category of risks, 'global risks' and to retrace how an international structure for expertise and regulation of these risks was constructed as result of American foreign policy, international relations in the context of the Cold War, public mobilization against nuclear weapons, criticism and demands for "social precautions" as well as scientific research interests and professional legitimatization. By focusing on the role of scientists in this process, this paper aims to discuss the political and social role of these regulation activities.

Key words: Atomic Fallout, Health and Environmental Radioactivity effects, Radiation and Nuclear Risks Scientific Expertise, Global Regulation.

## *INTRODUCTION*

Nuclear fallout emerged in public debate in the 1950s as the first global health and environmental risk. Radioisotope contamination from fallout later became a focus point for pollution, notably in Rachel Carson's bestseller, *Silent Spring*. The word *global* was taken up in many discussions to mark a change in the spatial and temporal scale of the threats to which human health would subsequently be exposed, either directly or from environmental pollution. The emergence of a category of problems brought about by human activity, their scale and their irreversibility appeared then to be a new situation, demanding action on an international scale. Among the most publicly visible solutions was the creation of international institutions to regulate these new problems.

Structures for discussing and regulating problems at international level began to develop in the 19th century; it was not, however, until after World War II that the number of international institutions increased significantly. Today, the activities of a whole series of intergovernmental agencies and organizations, such as the International Agency for Atomic Energy (IAEA), via the Iraq war, or the World Health Organization (WHO), with the worldwide alert over bird flu, show the public and media importance of this type of structure. In this article, I will examine the determining role of nuclear hazards in the emergence of a new category of risks: 'global risks'. I will retrace how an international structure for expertise and regulation of these risks was constructed by the convergence and overlapping of several different committees. This international system is simultaneously the result of American foreign policy, international relations in the context of the Cold War, public mobilization against nuclear weapons, criticism and demands for "social precautions" as well as scientific research interests and the desire for disciplinary and professional legitimatization. The major task, therefore, is to untangle the jumbled threads.

Regulatory activities are highly political, especially when they deal with something as strategic as nuclear matters. First, these activities play an important role in international affairs. The system of regulating health and environmental risks described in this article is an example of the planetary extension after 1945 of research methods and risk management models, first created and used in the United States, and then, to a lesser extent, in Great Britain. The American project was based on a certain concept of world order, a stable political world, pacified, and removed from Soviet influence[1]. The United Nations (UN) was the instrument of *pax americana* after the Second World War. Regulatory activities were developed to impose order on the world and to ensure its smooth functioning. However, the international regulatory system which took shape at the end of the 1950's was not simply a linear extension of American organizational models. The geopolitical division of the world between the West and the Soviet Union and its allies, communist groups who actively campaigned for disarmament and peace, the decolonization movement and the position of Third World countries such as India in favor of non-alignment, and the actions of scientists seeking to maintain a certain professional autonomy - all these factors resulted in negotiations and trade-offs and helped to create the international system of expertise and regulation.

Regulation was also an instrument of social management. The establishment of an international system for regulating radioactivity risks was a response to controversies and mobilizations regarding nuclear technology. By creating committees of experts, political authorities aimed to end a real public crisis. Often scientists were expected to rebuild public trust, thus leading to the demobilization, albeit only partial, of some of the protagonists who were able to air their concerns. The locus of confrontation was thus moved from public arenas towards an institutional framework. Confining a problem to an institutional framework can significantly deflect criticism and decrease levels of tension, thus offering a possible way out even as a crisis comes to a head.

The role of regulation as a form of social and political technology raises an important issue for historians of science: the place of science and scientists in this process. After 1945, scientists acquired unprecedented social importance through their mobilization in the construction of politico-scientific-administrative authorities, their contribution to devising and providing the tools for managing and governing things and men.[2] In other words, science became a key tool in building and reinforcing a new social order on a worldwide scale. Scientists regularly appeared ahead of the game, serving as the go-betweens for nuclear institutions or decision-making political authorities. It was often these scientists who defended the development of civil nuclear technology when nuclear industries were beginning to take off. However, as we will see, they had to adapt to external military, industrial and political demands. They had to learn how to come to terms with constraints and to act within a framework, which they defined only very partially, and to constantly renew their contribution in order to maintain their presence on the institutional and political scene. Because scientists had a significant asset, i.e., the favorable public image of scientific research, their participation in regulatory activities was a resource in the construction of social, political and economic consensus.

## *RADIATION HAZARDS: THE BEGINNING OF INTERNATIONAL REGULATION*

The first visible signs of the health effects of X-rays and radium were typically fatigue, along with skin burns, which appeared as red blotches and oedemas, followed by blisters and ulcers. With the significant increase in the use of radiology during World War I, these symptoms became more and more common and visible outside medical circles.[3] Indeed, they were the subject of cinematographic news broadcasts such as those by Gaumont in France, which showed the fate and the sacrifices of several physicians and researchers using radiology. , Some lost arms and fingers, others died. The pathological effects of radioactivity were less spectacular after WWI. This was partly due to the scarcity of radium, the basic radioelement for all research on radioactivity and its applications. The situation changed with the development of the radium industry, first in the United States and then in Belgium with the Union Minière in Katanga.[4]

The first serious health warning was issued just before World War I by the Radium Institute of London, specialized in medical applications. Several members of this institute died and it informed other bodies working in the same field. In France, in 1925, several scientists raised the alarm after the excruciatingly painful deaths of two former Curie Laboratory researchers who had both worked in the radium industry. In the United States a dentist made the link between the abnormally high incidence of jaw cancer among female workers in a Pittsburg factory and their professional activity of painting clock-faces with luminescent paint containing radium, during which they constantly dipped the brushes into their mouths![5]

It was within the professional community using radiation – among doctors and scientists - that the first partial synthesis of the knowledge of the pathogenic effects of ionizing radiation, and a definition of the rules for its use, were made during the inter-war period. At the beginning of the 1920s, recommendations for radiation protection were drawn up in several countries.[6] One of the major questions at the heart of the debate was that of dose quantification and measurement units. The first International Congress of Radiology held in London in 1925 established the International Commission on Radiation Units and Measurements (ICRU). Three years later, during the second congress in Stockholm, the International X-Ray and Radium Protection Committee (ICXRP) was also created, composed of the Swedish physician Rolf Sievert, the British physicist G.W.C Kaye, the French physicist and physician Elser Solomon, the British physician Stanley Melville, the German physicist Gustav Grossman, the Italian physician Guilio Ceresole and the American physicist Lauriston Taylor.[7] The committee's task was to bring together all the scientific data on the effects of radiation and dosage techniques in order to work out recommendations for protecting health. Its activity, however, remained relatively limited and the committee's only meetings were held at the international congresses of radiology: in Paris in 1930, Zurich in 1934, and in Chicago in 1937.

After World War II nuclear weapons, the emerging nuclear industry, and the political stakes related to the atom, all changed the nature and the scale of radiation problems. In the initial post-war years, radiation hazards continued to be a subject of concern and recommendations in professional *milieux*. Radiation protection changed drastically in the United-States with the creation of the first effective protective structures within the framework of the Manhattan Project, and later in large laboratories like Oak Ridge. Taylor reorganized the US Advisory Committee on X-rays and Radium Protection in 1946, calling it the National Committee of Radiation Protection (NCRP)[8], and brought together scientists, industrialists and various institutional representatives. The Atomic Energy Company Ltd., in Canada and the British Medical Research Council also established structures devoted to radiation protection. In 1949, the American Atomic Energy Commission (AEC) invited experts from the USA, the UK and Canada to meet at the first Tri-Partite Conference at Chalk River in Canada to discuss various health and safety aspects of the atomic energy program.[9]

In parallel, the first post-war international congress on radiology, planned for London in 1950, provided an opportunity to revive the international structures that had existed before the war. Dr Arthur Christie, the President of the International Congress of Radiology in Chicago in 1937 was asked to provide a survey report for the meeting. He found that Taylor and Sievert were the only surviving members of the ICXRP, whereupon he advised Ralston Paterson, the President of the forthcoming congress in London, to ask Taylor to reestablish both the ICXRP and the ICRU. At Paterson's request asked Taylor and William Mayneord, the Chairman of the Radiation Protection Committee established by the Medical Research Council in the UK,prepared an organization plan for both the ICXRP and the ICRU. Their first meeting took place in London over one day; its emphatic conclusion was that "Developments in nuclear physics and their practical application since the last international congress have greatly increased the number and the scope of potential hazards."[10]

To deal with this new hazard, the ICXRP was renamed the International Commission on Radiological Protection (ICRP) It comprised a main commission bringing together twelve members and six sub-committees, each sub-committee dealing with a specialized aspect of radiological protection. The organization was clearly modeled on the American NCRP, but, unlike the latter, the various committees were composed exclusively of scientists. The similarity in the structures was such that two chairman held corresponding positions in both the ICRP and the NCRP: Gioacchino Failla chaired the sub-committees working on the limits of external exposure and Karl Morgan those working on internal exposure. Sir Ernest Rock Carling was nominated President of the Commission and Walter Binks, Director of the Radiological Protection Service at Downs Nursery Hospital (UK) , was it's Secretary. The work begun by the NCRP and the Tripartite Conference was used as a basis for the work of the ICRP. After the creation of the ICRP, two other tripartite conferences were held, the first at Harwell after the ICRP meeting in London, and the second in New York in 1953. At the meeting of 1950, Taylor emphasized that "It was unusual but useful step in combining the interests of these governments with an international non-governmental organization. Since that time, a close but strictly unofficial collaboration had continued between them as well as other governments added later."[11]

In the year following the London meeting, Binks, Taylor and Mayneord sought members for the various sub-committees. The first rule of the ICRP specified that such members should "be chosen on the basis of their recognized activity in the fields of radiology, radiation protection, physics, biology, genetics, biochemistry, biophysics, without regard to nationality". In practice this amounted to American and British experts nominating their peers. This "domination" reflected the advance of research in these two countries into various radiation-related issues in physics, medicine and biology, and Binks, Meyneord and Taylor tried to expand the representation of other western countries on the different sub-committees. By the following International Congress of Radiology, planned for Copenhagen in 1953, the overall structure of the ICRP was finally in place. However, major changes in public awareness of the dangers of radioactivity were underway. Heated international debates over the consequences of nuclear testing moved the goalposts and led to important developments in the how protection was organized internationally.

## *GLOBAL FALLOUT: NEW GEOPOLITICS OF RADIOACTIVITY RISK*

The atomic bomb, by virtue of the investments it entailed and the fears it aroused, was emblematic of the atomic age and synonymous with the Cold War. Its emergence sparked international pacifist movements which denounced the prospect of a nuclear war liable to destroy all life on Earth. Several scientists were key figures in these pacifist movements which adopted hybrid strategies including the use of scientists' reputations, and lobbying or public mobilization in the form of meetings, articles and petitions.[12] Undeterred, the nuclear powers continued testing bombs in the atmosphere or the ocean, or underground. On March 1, 1954, the displacement of the radioactive cloud generated by the test of an H-bomb 700 times more powerful than that dropped on Hiroshima contaminated a territory of several thousand square kilometers and affected several Japanese fishermen who were outside the nominal danger zone, 160 km from the testing site.[13] The event provoked strong reactions and clearly showed that, despite the claims of the advocates of atomic tests, scientists were still a long way from managers the dangers. The AEC's position did much to fuel these controversies. Its attempts to minimize and even to deny the risks led some American scientists to publicly voice their dissent. Several expressed their indignation with their colleagues in the AEC and published opposing data in specialist journals and in the media generally.

Knowledge of the pathogenic effects of radiation came initially from laboratory studies on flies and mice.[14] Concerning human health, the principal source was the American Bomb Casualty Commission, created to scientifically monitor the long-term condition of survivors of Hiroshima and Nagasaki.[15] Genetic effects - changes induced by radiation and its consequences - emerged as one of the central themes of these controversies. Genetic risks in particular caught the attention of the various protagonists as they had both an immediate effect, and one spread over several generations. The idea that radiation could thus induce an irreversible deterioration in human beings conjured up visions of the species' decay and the potential production of "monsters". The risk of radiation cancer was also a broad subject of research and debate. Attention was focused in particular on leukemia caused by the environmental dissemination of radioisotopes resulting from nuclear explosions, in particular Strontium 90 and Cesium 137.

From 1955 onwards, several scientists, including those from the California Institute of Technology, affirmed that radioactive fallout was having major medical repercussions at that very moment, on the American population. When the Nobel Prize-winning biochemist Linus Pauling estimated the number of present and future deaths from atomic-testing induced leukemia in the thousands, his claims were covered in many newspapers. The biologist E. B. Lewis[16], by looking at a variety of studies, presented for the first time a synthesis of the available data and began to assert the existence of a direct causal relationship between leukemia and the amount of irradiation. Lewis confirmed the findings of the studies conducted on radiologists exposed to X-rays at the very start of the century, as well as on the Japanese population irradiated in 1945, which showed that, even below the thresholds of deterministic effects, random effects, particularly cancers, could affect certain people. In the following months, several publications disputed the assumption of the linearity in dose-effect relationships: certain scientists claimed there was a threshold below which radiation seemed to be devoid of pathogenic effects, while others considered a curvi-linear dose-effect relation as being more probable. John Bughes, the director of the AEC's Division of Biology and Medicine, argued that the figures put forward and the supposed risks were based on an extrapolation of observations made on higher doses and, usually, on laboratory experiments conducted on animals.[17]

Public controversies opened windows of opportunity for certain groups of researchers who obtained financing to study the effects of radioactivity and the mechanisms of contamination. Research fields such as radiobiology and genetics experienced unprecedented development. At the environmental level, the first big studies were conducted on the impact of pollutants and the consequences they could have for human health.[18] Because it was possible to follow radioactivity through the atmosphere, the oceans, the soil and food chains, radioisotopes resulting from the explosion of bombs were the first pollutants to be taken into account on a global scale. Fields of research indirectly related to the study of nuclear risks, such as oceanography,[19] climatology and earth sciences[20] also benefited financially from this development.

The public controversies and growing scientific interest in fallout effects, as well as the disputes over the findings, were key factors in the public's changing awareness of the nature and scale of the dangers to which humanity was exposed by the atomic bomb The possibility of an apocalyptic nuclear war was one source of concern, but so too was this invisible, insidious radioactivity that atomic tests spread throughout the globe and which infiltrated everything - the air, water, soil, food, plants and human bones.[21] This was clearly a new type of danger, and on a planetary scale. The frequency of expressions such as "one world or none" or "global fallout" in press articles and scientific reports reflected this change of perspective: the risk had became global.

*OBJECTIVIZING AND DEPOLITICIZING: SCIENTIFIC REPORTS ON THE EFFECTS OF FALLOUT*

Groups of scientists belonging to or financed by organizations involved in nuclear activities conducted classified research and acquired data relating to the health and environmental effects of radioactivity. In response to public demand many policy makers released at least some of their findings, though their credibility was tarnished by their source. The enrolment of more neutral scientific entities therefore appeared to be a more effective way to calm fears and resolve disputes. In 1955, two institutions, the Medical Research Council (MRC) in Great Britain and the National Academy of Science (NAS) in the United States took on this role. The British Prime Minister asked the MRC to appoint an independent committee to report on the medical aspects of nuclear radiation. Under the guidance of Sir Harold Himsworth, a committee was created to draft a report which brought together geneticists such as Lionel Penrose, the head of the Galton Laboratory, and William Richard Brown, the head of the MRC Group for Research into the General Effects of Radiation based at the Western General Hospital in Edinburgh. Bradfort Hill, a famous epidemiologist, and the medical radiologist Joseph Mitchell were also on the panel.[22] In the United States, Detlev Bronk, the president of the NAS, coordinated the study.[23] He brought together about 100 of the most distinguished people in their fields, including those who had publicly criticized the AEC, to conduct an ongoing study of the biological effects of atomic radiation in relation to genetics, pathology, meteorology, oceanography and fisheries, agriculture and food supplies, and the disposal of radioactive waste. Six committees were established to study the Biological Effects of Atomic Radiation (BEAR). The Rockefeller Foundation financed the study and Douglas M. Whitaker, Vice-President of the Rockefeller Institute, provided coordination and liaison among the study committees, who were assisted in their work by many authorities in private and government organizations, especially the AEC and the Department of Defense.[24]

The British and American reports were published at the same time and came to rather similar conclusions. This point has often been put forward to support the validity of the findings of the two studies, which were undertaken independently of one another and conducted by institutions with solid scientific reputations. However, neither the simultaneous publication, nor the convergence of the results was entirely coincidental. In April 1955, while the two studies were still in progress, it was decided that the British and the American committees should hold regular exchanges without their content being made public: as one British diplomats put it, "we feel that it is desirable and should be very helpful, to establish informal, and private, relations with the American Committee, but we feel it undesirable to make any public announcement that this is being done."[25] The two studies, made public in June 1956,[26] concluded that radioactivity from fallout was negligible compared to natural radioactivity and insisted on the importance of keeping this radioactivity at a low level and on the need to develop major studies on the effects of radiation on man and his environment.

During this time, several scientists gave their backing to demands that a study be carried out on an international scale by scientists unaffiliated with nuclear weapons countries In May 1955, Robert Maurice Alers Hankey, the British ambassador in Stockholm informed the Foreign Office that the Swedish Government was considering putting forward a proposal that the United Nations investigate the effects on the human body of nuclear explosions, insisting that “only an international enquiry could set at rest the fears of world opinion and the matter could not be postponed beyond the next General Assembly.”[27] The Indian government envisaged a similar step at the UN. The request for an international study carried out under the auspices of the UN appeared to both the pro- and anti-nuclear lobby as a means of bringing atomic tests out into the open in order to ban them. The American State Department as well as the AEC opposed such a study, believing that it would be used to attack the United States and as platform for pacifist propaganda. This was not the opinion of Ambassador Lodge, the American representative to the UN. He felt, on the contrary, that his country should support such a request in order to keep a measure of control over its work which could be largely inspired by the NAS’s report. Herbert Loper, Assistant to the Secretary of Defense for Atomic Energy, conceded that Lodge’s proposal was very interesting from a public relations standpoint.[28] Finally, at the September 1955 session of the General Assembly of the United Nations in San Francisco, the United States formulated a request to form an international commission of scientists to study the potential dangers of nuclear fallout. The initial US proposal was for a panel placed under the authority of the UN Disarmament Commission with the explicit idea that the activities of this commission, in which the USSR was a minority and India not even represented, were "under control" so that any outburst could be contained. Although the British shared the same concerns, they preferred to place the new working group under the authority of the Secretary-General in order to dissociate any proposed action from disarmament issues.[29] The British delegation clearly formulated its project of an ad hoc committee of scientists from a limited number of states: the United States, Great Britain, the USSR, France and Canada. The United States and Great Britain anticipated the request of India and Sweden to become members of such a committee as these two countries had previously proposed the idea of a UN committee to undertake a study on radioactive fallout. The United States proposed to add Czechoslovakia to the group in order to deal in advance with any request emanating from the USSR.[30] At the announcement of the composition of the committee, the Latin American states argued for a Hispanic member - preferably Mexico, which had suffered from tests in neighboring Nevada.[31] India also supported the inclusion of Mexico and Egypt and "any other reasonable candidates" on the grounds that “the committee should not be an autocratic club dominated by the powers possessing hydrogen bombs.”[32] In the end, fifteen states were represented in the Committee: the four nuclear powers, France, the UK, the USA, and the USSR, along with Argentina, Australia, Belgium, Brazil, Canada, Czechoslovakia, India, Japan, Mexico, Sweden and Egypt. On December 3, 1955, the founding resolution 913X was adopted by the UN General

Assembly which officially created the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR).[33] The resolution recognized the importance of, and the widespread attention being given to problems relating to the effects of ionizing radiation upon mankind and its environment, and asked that all available scientific data on the short- and long-term effects upon mankind and his environment of ionizing radiation, including radiation levels and radioactive "fallout" should be circulated as widely as possible.[34] This committee started its work in 1956 and produced a major report two years later.[35] The Secretary-General, the Swede Dag Hammerskjöld, who was closely involved in nuclear questions, decided to give the committee permanent status[36].

In two years, three major scientific reports were produced for an international audience. All three were prepared in collaboration with the authorities of the various countries engaged in nuclear programs. Those who drafted these reports felt that they had displayed objectivity, made a specific point as to the state of knowledge, and emphasized the lack of data relating to the health effects of radioactivity, in particular that of low doses. These scientists constantly stressed the importance of not increasing the number of atomic tests, but they sought to disassociate their work from any political maneuvering over nuclear weapons. However, this was the issue at the very heart of what they were endeavoring to do. Many of the scientists involved in expert panels were convinced that their role was to provide technical answers likely to convince political and military leaders to limit, perhaps even to stop nuclear tests. However, several of them assumed that these reports were also intended - and even primarily intended - to alleviate public concerns over nuclear technology.

*STRUCTURING THE INTERNATIONAL SYSTEM OF REGULATION*

Before World War II and in the years which followed, the regulation of ionizing radiation risks was a national affair, even if it was based on international recommendations made by the ICRP. Up until the middle of the 1950s, the ICRP was a simple scientific committee whose only resources were provided by the International Congress of Radiology or the parent bodies of its members. In the context of the increase in the number of expert committees on the hazards of radioactivity, the ICRP redefined its position. The first concern, shared by the principal leaders of the ICRP, was to create a more effective organization, with a permanent secretariat and resources to enable more regular activities than those carried on by the commission.

The Swedish biophysicist Sievert actively developed connections with institutions able to finance ICPR activities. At the first conference on the Peaceful Use of Atomic Energy in Geneva in August 1955, Dr. R. G. Gustavson, President and Executive Director of "Resources for the Future", an organization linked to the Ford Foundation, expressed his great interest in radioprotection and encouraged the ICRP to provide him with data that would enable him to draw up a report for the purpose of obtaining funding from the Ford Foundation.[37] The same steps were taken at the Rockefeller Foundation whose Director of Natural Sciences Division, Warren Weaver, was particularly interested in radiation effects. In 1956, the ICRP officially acquired the status of a non-governmental organization at the WHO. The WHO also promised to help with translating its recommendations into various languages, as well as with their publication and dissemination to various governments.

Other organizations concerned with radiation protection also entered the arena The International Atomic Energy Agency (IAEA)[38], established within the framework of the *Atoms for Peace* program, promoted the peaceful applications of nuclear energy, in particular the use of radioisotopes and the construction of reactors. The European Atomic Energy Community (Euratom), established in 1958, included among it goals the definition, enactment, and harmonization of national legislations.

Against the backdrop of the growing number of institutions involved in radiation protection, Sievert suggested establishing an International Radiation Protection Organization, an umbrella organization for the various international structures for radiation protection, including UNSCEAR, the WHO, UNESCO and the International Labour Organization. He argued that "the situation as to the importance of radiation protection activities has changed very rapidly even during the past year, and indicates that protection against radiation is today an urgent international problem, and that its treatment in worldwide co-operation is therefore also an indispensable aim."[39] Siervert stressed that there was a patent lack of fundamental knowledge of radiation protection. Thus, "it seems essential to try as soon as possible to collect the best specialists in all relevant fields into one powerful international organization and to make it possible for them to work on a broad basis to stimulate and support research work and to settle recommendations for the guidance of national bodies."[40]

Sievert's project gave rise to many debates within the ICRP. Bink and Taylor were very skeptical about it, believing it was not realistic to aim to develop an independent scientific body, which would escape from political pressure while simultaneously being linked to the UN. Moreover, Taylor believed that there was already enough confusion with the existing array of organizations concerned with radiation and dependent on the UN. Creating a new organization that would then have to carve out a role for itself "*would seem to me merely extend the already enormous confusion that exists between the various members of the UN family ; Here we already have the UNSC, WHO, UNESCO , and the AIEA, all struggling for priority in the field of radiation protection. I do not believe that the establishement of another organization would do anything to simplify this*"[41]. Rock-Carling also noted that: "*Now Euratom, the Agency, OEEC, ILO, Western European Union and other bodies are manoeuvring for leadership*."[42]

Sievert, Taylor and the other members of the ICRP, asserted their status as members of a longstanding scientific organization, independent of any state, whose neutrality and essential objectivity on matters in which the political stakes were high could be counted on. They would be able to "maintain their position, even if this should be unpopular because of national or industrial considerations."[43] However the "objectivity" that the scientists of the ICPR claimed as their own could only really be brought to bear if their project was accepted by the political authorities. This proved difficult. Their proposal for an international radiation Protection Organization was, rejected out of hand by American and the British nuclear authorities. Next, several of the scientists, some of them internationally renowned, discovered that the IAEA had become a force to be reckoned with. In 1958, the IAEA announced its wish to cover all fields relating to civil nuclear power, including that of protection. In 1959, the Agency invited the ICRP and the ICRU to send observers to its general conference. The Frenchman Henri Jammet (a member of the French CEA and representing the ICRP) and Taylor attended. They learned that the IAEA was going to begin drawing up its own recommendations in the field of health and safety; these recommendations would be closely based on those of the ICRP. When informed of this, the majority of the ICRP's members considered this decision as an encroachment into their field of action and could not understand why the IAEA did not simply adopt the recommendations worked out through consensus among the experts. During the initial discussions, they realized that the IAEA would not change its position, and that the ICRP, like the ICRU, would have to deal with this new situation. The ICRP had to find a compromise with the IAEA, which intended to develop its own code of protection come what may. Taylor - who knew the general manager, Sterling Cole – was given responsibility for discussing the type of links which could be established between the two commissions and the Agency. He was told at one point "in so many words that this relationship with the Commissions was essential to the Agency to enable it to develop 'a place in the sun' for itself."[44] "I am not particularly sympathetic to the way the Agency is going about its activities," Taylor wrote "but I do recognize that it does have certain responsibilities and is obviously anxious to work as closely with the ICRU/ICRP as possible." In the event a division of labor was established in which "the Agency will make codes and the ICPR will develop fundamental philosophy."[45] The ICRP's efforts to assert a scientific position clearly limited its intervention in the operational aspects of radiation protection. As a result of these negotiations, in the early 1960s, the ICRP established official relations with the IAEA and the WHO and was recognized by UNSCEAR, with whom regular collaboration took place. The ICRP succeeded in setting up a permanent structure with five-year financing plans. The first funds came from the Ford Foundation ($50,000/year), the Rockefeller Foundation ($25,000/year), the WHO ($9,000/year), and the International Society of Radiology ($1,000/year)[46].

We see then that an international space for the expertise and regulation of the health and environmental risks of radioactivity was constructed out of the convergence and the tangle of activities of various committees in which experts of different countries could meet one another and circulate between committees. Between 1950 and 1960, doctrines and recommendations were developed on radiation protection within a complex process involving several international authorities. In the process, the ICRP worked out recommendations for standards on the basis of work carried out and data collected by UNSCEAR, national science academies or medicine (primarily NAS and BEIR), as well as radioprotection professional structures which later came together in the International Association for Radioprotection. On the basis of these recommendations, the IAEA at international level, and Euratom at European level, defined the reference texts which were subsequently transposed into national regulations. These texts related not only to workers exposed to ionizing radiation, but also to the entire world population.

## *CONCLUSION: ON THE POLITICAL ROLE OF A " SMALL WORLD"*

The international system for regulating radioactivity risks which is still largely in operation today, was not the result of a global project, conceived in various phases. It was constructed through successive actions and the creation of different organizations, each trying to carve out a role for itself. The result was multi-layered structures with overlapping missions, and even territorial conflicts. Organization of international regulations after 1950 took the form of a subtle game between various bodies, each one constantly having to redefine its role and its scope of action in relation to other institutions and prevailing conditions.

In spite of the tensions and crises, such as that which followed Chernobyl, international regulatory activity was characterized by a relative consensus built up through the production of reports circulating among the various members. Each report could take years to develop, so that the result would integrate a range of remarks and criticisms. Thus, the final product was a collective effort which deflected all public criticism from experts. In addition, the circulation of experts among different international committees was a determining element in building a consensus within the system. In 1957, Sweden's Bo Lindell succeeded Binks as Secretary of the Commission and also worked as a member of the UNSCEAR secretariat in New York. So that, for one year, the ICRP and the UNSCEAR had the same address. In 1958, Sievert, after the end of his mandate as President of the ICRP, became President of UNSCEAR. In this close-knit environment "'consanguinity' favors harmonization and coherence,"[47] noted one member of the French delegation to UNSCEAR. Indeed several people in charge of nuclear power recognized that the harmonization of the system of regulation resided in the fact that "the international scientific radioprotection community formed a 'small world' and were (or are) members of one or more of the above-mentioned organizations, including groups of experts set up by different competent intergovernmental organizations in the field of radioprotection."[48]

In the creation and structuring of this international system, scientists played an important role. They created the ICRP, they participated in expert committees such as the BEIR of the American NAS, they occupied a central position in UNSCEAR and some of them were experts within the IAEA. The majority of the scientists involved in regulation sincerely believed in their mission and their ability to affect policy. This feeling was bolstered by the fact that their work met with suspicion in nuclear organizations, and sometimes they became involved in significant disputes when working out rules and standards and having them applied. The energy that they expended in making these rules and standards effective accentuated the feeling that they were playing an important role - even a determining one - in occupational and public health. Comparing their own field to other fields of activity, many people in charge of protection were convinced that the nuclear industry was a model of risk management, and one of the domains where the monitoring of workers was most systematic. In addition to this "exemplary" nature, risk management in nuclear power served as a model for management methods in other sectors, in particular through the generalization of risk assessment in the 1980s, originally conceived in the field of nuclear power.

However, the enormous and visible presence of scientists in the regulation of nuclear activities could barely mask the adjustments that scientists made regularly in order to meet political demands so as to continue to hold a place in the structures created by them or by political authorities. They justified their ongoing enrolment in various ways: to obtain resources for research, to acquire public and political recognition for their activities, or to try and play a role in political decisions, particularly those which related to scientific and technological issues. All the same their idealized quest for objectivity regularly came into conflict with political and economic interests. Their attitudes accordingly evolved over time. Some clearly became spokesmen for nuclear authorities while others moved out of regulation activity altogether. A small minority publicly denounced the attitude of the nuclear "establishment" with respect to radiation protection

These scientists were also exposed to another source of tension. They worked in international organizations in a dual capacity. They were specialists in a research field and members of a scientific community who wanted to be seen as universal and self-policing. They were also representatives of their national governments and were therefore supposed to defend the interests and priorities of their domestic administrations. This dual role created some tense situations. These scientists liked to think of themselves as independent and able to manage these tensions and possible conflicts of interest. To do so, their main tool was the technical nature of their work which was supposed to shelter them from politics. This position was tolerable on a day-to-day basis but became less so in periods of crisis. It was at such moments that regulation acquired all its relevance.

During times of crisis triggered by public conflict in the field of science and technology, scientists and the objectivity which they stood for provided political leaders with a powerful tool for restoring and strengthening public trust. Evaluation and regulation provided one of the main instruments for carrying out this political work. This idea was formulated in particular by leading nuclear scientists, like Bertrand Goldschmidt, who stressed that "only effective safety measures can give confidence to an increasingly sensitive public whose fears grow in proportion to the extension of programs that create new research projects and industrial centers."[49] Certain people in charge of radioprotection were fully aware that part of their job was to bolster public trust. Some fully embraced this role, such as the director of the French Central Service of Radiation Protection (SCPRI), Pierre Pellerin, who declared on many occasions that, "far from constituting an obstacle to the development of nuclear energy, organizations responsible for public health are an invaluable asset by playing the role of arbiter."[50] If those in charge of radioprotection no longer carried out the role that was assigned to them, or that they had assigned to themselves, and suddenly conducted a critical assessment of their activity, they generally lost all credibility with their colleagues. Such was the case of Karl Morgan, a figure in international regulation for about fifteen years, the first president of the internal dose committee of the NCRP and the ICRP, and the founder and first president of the International Radiation Protection Association. When, at the beginning of the 1970s, he publicly criticized a new generation of nuclear reactors, he found himself rapidly cold-shouldered. He had overstepped a tacitly-agreed limit not to publicly criticize nuclear risks as an expert on such risks. Reflecting on his role, Morgan sadly commented

> "For nearly three decades I had served as the leading spokesperson for the advancement of health physics. Now I knew the sad truth: protecting employees and members of the public from the harmful effects of exposure to ionizing radiation constituted only a secondary objective of the nuclear-industrial complex. In exchange for the generous economic support given to our profession, we were expected to present a favorable testimony in court and congressional hearings. It was assumed that we would depreciate radiation injury. We became obligated to serve as convincing expert witnesses to prevent employees and members of the public who suffered radiation injury from receiving just compensation".[51]

Regulation consists in organizing a framework for a given activity. It is an important mechanism in maintaining a balanced system and ensuring its proper operation. The history of the development of an international system for regulating radioactivity risks clearly reveals it to be a response to public mobilization against nuclear tests and the development of nuclear weapons. Major overhauls of this system in the mid-1970s or after Chernobyl took place against a backdrop of public debate and dissent. The regulatory system has thus served as a mechanism for increasing the social acceptability of controversial technologies. The introduction of a system for evaluating and regulating risks and the research efforts made regarding the medical effects of radiation appear to provide proof that governments and the nuclear industry have a real concern for public health. The resulting scientific evaluation and regulation helped increase the institutional and political acceptability of problems that arose, rendering them more "acceptable" within the existing framework. This channeling and framing of problems served as a tool for politically managing conflict and as a process for tackling some of the criticisms emanating from society, as well as a vehicle for integrating these within an institutional framework. Thus, regulation became an "adjustable parameter" when criticism became too harsh. The remaining issues - the construction of reactors, nuclear power plants, and weapons and their international marketing - were seldom included in the debate. Indeed they became less visible as attention focused on the risks and potential dangers. Building this support was not only a rhetorical process. By developing integrated committee structures with overlapping memberships that implicitly defined the problem of radiation protection as one of downplaying and managing risk to calm 'non-rational' public anxieties, the foundations of nuclear programs were solidified. The system's power lay in the number of allies it had and the fact that it involved important technological, industrial, political and ideological components: challenges were difficult and costly..

---

[1] Krige, American Hegemony.
[2] See for example: Kevles, The Physicists; Leslie, The Cold War and American Science; Dahan and Pestre, Les sciences pour la guerre.
[3] Kevles, Naked to the Bone; Pallardy, Pallardy and Wackenheim, Histoire illustrée; Bordry and Boudia, Les rayons de la vie, 132.
[4] On history of radium industry see: Boudia, Marie Curie et son laboratoire; Boudia, 'L'industrie des radioéléments,' 102.
[5] Clark, Radium Girls.
[6] Wintz, Protective Measures; Lindell, 'The History of Radiation Protection.'
[7] Taylor, Organization for Radiation Protection, 1979; Kaye, 'International Recommendations for X-rays and Radium Protection' 358.
[8] Taylor, Organization for Radiation Protection.
[9] Taylor, The Tripartite Conferences.
[10] ICRP, 'International Recommendations on Radiological Hazards,' 7-210.
[11] Taylor, The Tripartite Conferences, 6.
[12] Boyer, By the Bomb 's Early Light; Hacker, Elements of Controversy; Wittner, The Struggle Against the Bomb; Schubert and Lapp, Radiation; Lapp, The Voyage of Lucky Dragon.
[13] Kopp, 'The Origins of the American Scientific Debate over Fallout Hazards,' 403; Hacker, Elements of Controversy; Hughes, 'The Strath Report: Britain Confronts the H-Bomb, 1954-1955', 257; Boudia; 'Naissance, extinction et rebonds d'une controverse scientifique: les dangers de la radioactivité pendant la guerre froide', 157.
[14] Carlson, Genes, Radiation, and Society.
[15] Beatty, 'Genetics in the Atomic Age'; Lindee, Suffering Made Real.
[16] Lewis, 'Leukemia and ionizing radiation', 965.
[17] Kopp, 'The Origins of the American Scientific Debate over Fallout Hazards,' 403.
[18] Weart, 'Global Warming, Cold War, and the Evolution of Research Plans', 319; Bruno, 'The Bequest of the Nuclear Battlefield: Science, Nature, and the Atom During the First Decade of the Cold War,' 237.
[19] Rainger, ''A Wonderful Oceanographic Tool': The Atomic Bomb, Radioactivity and the Development of American Oceanography,' 93; Hamblin, Oceanographers and the Cold War.
[20] Doel, 'Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945', 635.
[21] Lacassagne, 'Exposé introductive,' 1, 2-3.
[22] The other official committee members were: E. Rock-Carling, J. D. Cockcroft, A. Haddow, J. F. Loutit, K. Mather, W. V. Mayneord, P. B. Medawar, E. J. Salisbury, F. G. Spear, J. R. Squire, C. M. Waddington, L. Whitby and B. W. Windeyer.
[23] Hamblin, ''A Dispassionate and Objective Effort:' Negotiating the First Study on the Biological Effects of Atomic Radiation', 1.
[24] US National Academy of Science, The Biological Effects of Atomic Radiation; Strauss, 'Statement before the Joint Committe on Atomic Energy', April 15 1955, AB16/1656, 260819, The National Archives, London.
[25] Letter from Sir Harold Caccia to Quirk, 25th April 1955, AB16/1656, 260819, The National Archives, London.
[26] US National Academy of Science, The Biological Effects of Atomic Radiation; UK Medical Research Council, The Hazard to Man of Nuclear and Allied Radiations.

[27] Robin Hankey to P.H. Dean, Foreign Office, Stockholm, May 31, 1955, p 2, AB16/1656, 260819, The National Archives, London.
[28] Hewlett and Holl, Atoms for Peace and War.
[29] Letter from Foreign office to United Kingdom Delegation to United Nations, August 10, 1955, AB16/1656, 260819, The National Archives, London.
[30] United Kingdom Delegation to the United-States to Foreign Office, November 2, 1955, AB16/1656, 260819, The National Archives, London.
[31] United Kingdom Delegation to the United-States to Foreign Office, November 4 and 5, 1955, AB16/1656, 260819, The National Archives, London.
[32] United Kingdom Delegation to the United-States to Foreign Office, November 4 and 5, 1955, AB16/1656, 260819, The National Archives, London.
[33] Text available from http://www.unscear.org.
[34] In 1973, Germany, Indonesia, Poland, Peru, Sudan and in 1986 China joined UNSCEAR.
[35] 1956 and 1958. Report of the UNSCEAR, New York, United-Nations, n°16 A/5216, 1962.
[36] International cooperation took also place on nuclear waste, see: Hamblin, 'Hallowed Lords of the Sea: Scientific Authority and Radioactive Waste in the United States, Britain, and France', 209.
[37] Letter (August or September 1955) from Bink to the Main Commission members, reproduced in Taylor (1979), 8-270/8-271.
[38] Fisher, History of the International Atomic Energy Agency; Scheinman, The International Atomic Energy Agency and World Nuclear Order; Hecht, 'Negotiating Global Nuclearities', 25.
[39] Sievert, 'Proposal for an international radiation protection research Organization', April 24, 1956, Gray Box 5, p 1. Underlined by Sievert.
[40] Idem p 2.
[41] Taylor to Sievert, April 24, 1958 reproduced in Taylor, Organization of Radiation Protection, 8-464/8-466, 8-465
[42] Letter from Rock-Carling to Sievert, 27th May 1958, reproduced in Taylor, Organization of Radiation Protection, 8-468/8-469, 8-468.
[43] Idem p 7.
[44] Letter from Taylor to Gray, November 8, 1960. Gray Box 6.
[45] Letter from Taylor to Gray, December 5, 1960. Gray Box 6.
[46] Letter from Sievert to Pearson, Stockholm, May 4, 1960, reproduced in Taylor, Organization of Radiation Protection, 9-300/9-301.
[47] Flüry-Herard, 'UNESCEAR: les connaissances de bases,' 51, 55.
[48] Bourguignon et Mercier, 'Vers une harmonisation internationale de la radioprotection: le point de vue de l'ASN,' », 40, 42. *Contrôle* is the Autorité de sûreté nucléaire française journal.
[49] Goldschmidt, L'aventure atomique, 247
[50] Pellerin, 'Les problèmes de santé posés par le développement de l'énergie nucléaire,' 533, 539.
[51] Morgan and Paterson, The Angry Genie, 116.

*REFERENCES*

Beatty, John. 'Genetics in the Atomic Age: the Atomic Bomb Casualty Commission, 1947-1956.' In *The Expansion of American Biology*, edited by B. R. Keith, J. Maienschein and R. Rainger. New Brunswick: Rutgers University Press, 1991, 284-324.

Bordry, Monique and Boudia, Soraya (eds.). *Les rayons de la vie, une histoire des applications médicales des rayons X et de la radioactivité en France*. Paris: Institut Curie, 1998.
Boudia, Soraya. 'L'industrie des radioéléments.' In *Les rayons de la vie, une histoire des applications médicales des rayons X et de la radioactivité en France* edited by M. Bordry et S. Boudia, Paris: Institut Curie, 1998, 102-112.
Boudia, Soraya. *Marie Curie et son laboratoire, science et industrie des radioéléments en France*. Paris: Éditions des archives contemporaines, 2001.
Boudia, Soraya. 'Naissance, extinction et rebonds d'une controverse scientifique : les dangers de la radioactivité pendant la guerre froide.' *Mil neuf cent. Revue d'histoire intellectuelle* (25) (2007): 157-170.
Bourguignon, Michel and Mercier, Jean-Pierre. 'Vers une harmonisation internationale de la radioprotection : le point de vue de l'ASN.' *Contrôle* (167) (2005): 40-44.
Boyer, Paul. *By the Bomb 's Early Light: American Thought and Culture at the Dawn of the Atomic Age*. Chapel Hill (N.C.): The University of North Carolina Press, 1994.
Bruno, Laura A. 'The Bequest of the Nuclear Battlefield: Science, Nature, and the Atom During the First Decade of the Cold War.' *HSPS* 33(2) (2003): 237-260.
Carlson, Elof Axel. *Genes, Radiation, and Society: The Life and Work of H. J. Muller*. Ithaca: Cornell University Press, 1981.
Carson, Rachel. *The Silent Spring*. Greenwich: A Fawcett Crest Book, 1962.
Clark, Claudia. *Radium Girls: Women and Industrial Health Reform, 1910-1935*. University of North Carolina Press, 1997.
Dahan, Amy and Pestre, Dominique (eds). *Les sciences pour la guerre, 1940-1960*. Paris: Presses de l'EHESS, 2004.
Doel Ronald E. 'Constituting the Postwar Earth Sciences: The Military's Influence on the Environmental Sciences in the USA after 1945.' *Social Studies of Science* 33(5) (2003): 635-666.
Eisenbud Merrill and Gesell Thomas. *Environmental Radioactivity: From natural, industrial and military sources*. San Diego, 1997.
Fisher, David. *History of the International Atomic Energy Agency: The First Forty Years*. Vienna: IAEA, 1997.
Flüry-Herard, Anny. 'UNESCEAR: les connaissances de bases.' *Contrôles*, (167) (2005): 51-55.
Forland, Astrid. 'Negotiating Supranational Rules: The Genesis of the International Atomic Energy Agency Safeguards System.' PhD. Diss, University of Bergen, 1997.
Goldschmidt, Bertrand. *L'aventure atomique – ses aspects politiques et techniques*. Paris, Fayard, 1962.
Hacker, Barton. *Elements of Controversy: the Atomic Energy Commission and Radiation Safety in Nuclear Weapons Testing, 1947-1974*. Berkeley: University of California Press, 1994.
Hamblin, Jacob. ''A Dispassionate and Objective Effort:' Negotiating the First Study on the Biological Effects of Atomic Radiation.' *Journal of the History of Biology Journal of the History of Biology* (40) (2007): 147-177.
Hamblin, Jacob. *Oceanographers and the Cold War: Disciples of Marine Science*. Seattle: University of Washington Press, 2005.
Hamblin, Jacob. 'Hallowed Lords of the Sea: Scientific Authority and Radioactive Waste in the United States, Britain, and France.' In *Global Power Knowledge. Science, Technology and International Affairs*, edited by J. Krige and K. H. Barth. Osiris, 21 (2006): 209–228.

Hecht, Gabrielle, 'Negotiating Global Nuclearities: Apartheid, Decolonization, and the Cold War in the Making of the IAEA.' In *Global Power Knowledge. Science, Technology and International Affairs*, edited by J. Krige and K. H. Barth. Osiris, (21) (2006): 25-48.
Hewlett, Richard G., and Holl, Jack M.. *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission.* Berkeley: University of California Press, 1989.
Kaye, G.W.C. 'International Recommandations for X-rays and Radium Protection: The Second International Congress of Radiology.' *British Journal of Radiology* (1928): 358-365.
Hughes, Jeff. 'The Strath Report: Britain Confronts the H-Bomb, 1954-1955', *History and Technology*, 19(3) (2003): 257-275
Kevles, Bettyann. *Naked to the bone: Medical Imaging in the 20th Century*. New Brunswick: N.J., Rutgers University Press, 1997.
Kevles, Daniel. *The Physicists: the History of a Scientific Community in Modern America*. Cambridge (Mass.): Harvard University Press, 1987.
Krige, John. *American Hegemony and the Postwar Reconstruction of Science in Europe*. The MIT Press, 2006.
Krige, John. 'Atoms for Peace, Scientific Internationalism, and Scientific Intelligence.' In *Global Power Knowledge. Science, Technology and International Affairs*, edited by J. Krige and K. H. Barth. Osiris, 21 (2006): 161-181.
Kopp, Carolyn. 'The Origins of the American Scientific Debate over Fallout Hazards.' *Social Studies of Science*, 9 (4) (1979): 403-422.
Lacassagne, Antoine. 'Exposé introductive.' In *L'énergie atomique dans ses répercussions sur la vie et la santé*. Paris. L'expansion Editeur, 1955: 1-5.
Lapp, Ralph E. *The voyage of Lucky Dragon*. New York : Harper and Brothers, 1958.
Leslie, Stuart W. *The Cold War and American Science: the Military-Industrial-Academic Complex at MIT and Stanford*. Columbia University Press, 1993.
Lewis, E. B. 'Leukemia and Ionizing Radiation.' *Science* (125) (1957): 965-972.
Lindee, Mary Susan. *Suffering Made Real: American Science and the Survivors at Hiroshima*. Chicago: University of Chicago Press, 1994.
Lindell, Bo. 'The history of radiation protection.' *Radiation Protection Dosimetry* (68) (1996): 83-95.
Morgan, Karl and Peterson, Ken. *The Angry Genie: One Man's Walk Through the Nuclear Age*. University of Oklahoma Press, 1999.
Pallardy, Guy, Pallardy, Mari-José and Wackenheim, Auguste. *Histoire illustrée de la radiologie*. Paris: Roger Dascosta, 1989.
Pellerin, Pierre. 'Les problèmes de santé posés par le développement de l'énergie nucléaire.' *Energie nucléaire* 6(8) (1964): 533-553.
Rainger, Ronald. ''A Wonderful Oceanographic Tool': The Atomic Bomb, Radioactivity and the Development of American Oceanography." In *The Machine in Neptune's Garden: Historical Perspectives on Technology and the Marine Environment*, edited by H. M. Rozwadowski, D. K. Van Keuren, Sagamore Beach, Mass.: Science History Publications, 2004: 93-131.
Scheinman, Lawrence. *The International Atomic Energy Agency and World Nuclear Order*, Baltimore: Johns Hopkins University Press, 1987.
Schubert, Jack and Lapp, Ralph E. *Radiation: What It Is and How It Affects You*. New York: Viking Press, 1957.
Stannard, J. Nevell. *Radioactivity and Health: A History*. Pacific Northwest Laboratory and U.S. Department of Energy, 1988.
Sturtevant, Alfred Henry. 'The Genetic Effects of High Energy Irradiation of Human Populations.' *Engineering and Science* 18(1) (1955): 9-12.

Taylor, Lauriston. *Organization for Radiation Protection: the Operation of ICPR and NCRP, 1928-1974*. Washington DC: US Department of Energy, 1979.
Taylor, Lauriston. *The Tripartite Conferences on Radiation Protection, Canada, United Kingdom, United States (1949-1953).* US Department of Energy, 1984.
Walker, Samuel. *Permissible Dose: A History of Radiation Protection in the Twentieth Century*. Berkeley: University of California Press, 2000.
Weart, Spencer. *Nuclear Fear: a History of Images*. Cambridge (Mass.). London: Harvard University Press. 1988.
Weart, Spencer. 'Global Warming, Cold War, and the Evolution of Research Plans.' *HSPS* 27(2) (1997): 319-356.
Wintz, Herman. *Protective Measures Against Dangers Resulting from the Use of Radium, Roentgen and Ultra-Violet Rays*. Geneva: Health Organization of the League of Nations, Report 1054, 1931.
Wittner, Lawrence. *The Struggle Against the Bomb*. Volume 1. *One World or None: a History of the World Nuclear Disarmament Movement through 1953*. Stanford: Stanford University Press, 1993.
Wittner, Lawrence. *The Struggle Against the Bomb*. Volume 2. *Resisting the Bomb: a History of the World Nuclear Disarmament Movement, 1954-1970.* Stanford: Stanford University Press, 1997.
Ziegler, Charles and Jacobson, David. *Spying Without Spies: Origins of America's Secret Nuclear Surveillance System*. Westport: Praeger, 1995.