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Atomic Energy and American Foreign Policy

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ATOMIC ENERGY AND AMERICAN FOREIGN POLICY

By Caryl P. Haskins

ONE reason the political problem raised by the discovery of the means to release atomic energy is so vast is that it contains inherently contradictory elements. Only by international action can we reap the potential benefits of atomic energy, which are so great for all mankind; only by international action can we find any security against the bomb, which has destructive possibilities that are so appalling. But if the bomb is thus the sharpest spur to internationalism, it is also the sharpest reminder that American foreign policy must not forget that American security is endangered as never before. The bomb provides the greatest temptation to aggression ever offered an ambitious people or an unscrupulous leader, and against it the traditional modes of national defense are clearly inadequate. New strategies are called for, alike in the military and the political fields.

An attempt to encompass the problem must begin with a review of the scientific factors conditioning the release of atomic energy and the technical circumstances in which the bomb was developed. There is no short-cut to an understanding of the political and social problems involved; and no simple "yes" or "no" answer can be given to the various proposals made for dealing with them. The present paper aims merely to summarize and place in juxtaposition the facts about atomic energy which have special significance in the formulation of foreign policy, and to see how they apply in the case of the United States.

II. FUNDAMENTAL SCIENTIFIC DISCOVERIES

The discovery of uranium is not recent. It was recognized as a metallic constituent of pitchblende in Germany at least as early as the middle eighteenth century. Until 1789 it was generally thought to be tungsten, but in that year W. H. Klaproth proved it to be a new element and named it after the planet Uranus, then newly discovered in the heavens. It was rather inert in its chemical properties, and until 1938 was considered to have only minor commercial importance as an alloying metal (for which in general it was too expensive) and in the tinting of glass and ceramics. So little interest had it excited that previous to 1938 its chemical and physical properties remained imperfectly known.

Uranium had attracted brief world-wide attention on two occasions, however. The first was in 1896 when Becquerel, noticing that uranium ores caused a blackening of photographic plates in the dark, discovered the now-famous "Becquerel" rays and ushered in the study of natural radioactivity. The second was when the Curies used the uranium pitchblende ores of Joachimsthal as their principal raw material in the discovery and separation of radium. The discoveries of Becquerel and the Curies were dramatic in several respects. Not only were uranium and radium unique in exhibiting a spontaneous emission of radiations, the rate of which could not be influenced by any treatment that could be given them, but they were the only elements then known which could undergo transmutation, yielding ultimately, in both cases, a form of lead. All other elements were thought to be so stable that transmutation was reckoned as remote as the discovery of the Philosopher's Stone. Then, in 1919, Lord Rutherford showed that such a change could in sober reality be artificially effected. By bombarding nitrogen with a stream of charged elemental particles ("alpha" particles, the nuclei of helium atoms) at rather high velocities, he succeeded in producing some oxygen, with another form of electrically charged particle as a by-product. This by-product was shown to be equivalent in charge to the nucleus of a hydrogen atom, and was called the "proton." Rutherford found that, as soon as he ceased bombarding his nitrogen, both the transformation to oxygen and the generation of protons ceased.

For 20 years after Rutherford's work, bombardment experiments of this kind were pushed forward with great vigor. Many elements were used as targets, and many transformations were found to be possible, with the production of several kinds of elemental "particles" as by-product. The electron and the proton were already known, and in 1932 the "positron" and the "deuteron" were discovered and named. But the most important discovery from the standpoint of atomistics was that of the "neutron," the existence of which was demonstrated, likewise in 1932, by Sir James Chadwick. The neutron is a particle of neutral electrical charge, exceedingly hard to detect and with extraordinary penetrating power.

One more basic scientific discovery of outstanding importance to the development of techniques of large-scale atomic fission remained to be made. Irene Curie, daughter of Madame Curie, and her husband Frederic Joliot, showed in 1934 that certain light elements such as boron, magnesium or aluminum not only underwent transformation when bombarded with alpha particles, with the emission of energy (in the form of positrons), but that these positrons continued to be emitted for some time after the initial bombardment had been cut off. An intermediate radioactive element had been produced which then "decayed" further, as uranium or radium had long been known to do naturally. Artificial radioactivity had been discovered.

In succeeding years, innumerable experiments of this sort were carried forward, and by the time of the war some 500 radioactive "species" of elements had been artificially produced and the properties of many of them described. Of particular interest was some work of Fermi, who studied the bombardment by neutrons of heavy elements of high atomic number. Fermi reasoned that the neutron, because of its neutral charge, should penetrate such an atomic nucleus much more readily than a charged particle. He found that such bombarding neutrons might in fact be "captured" by the nuclei, and a new, unstable, radioactive form of the element produced; this then decayed to a stable form, with the emission of additional energy. It only required that such energy be also in the form of neutrons of suitable velocity, and that their number be greater than that of the particles of the original bombardment, for there to be initiated a "chain" reaction which would make large-scale, self-maintaining atomic fission possible. The extraordinary potentialities of such a process were long recognized by nuclear physicists, but realization of them did not seem to be practicable.

Such had been the lines of experiment, and such was the knowledge, which pointed to the techniques used in producing the atomic bomb.

III. THE IMMEDIATE BACKGROUND OF THE BOMB

Fermi and his colleagues had studied the bombardment of uranium by neutrons in 1934. But it was five years later that O. R. Frisch and L. Meitner, both refugees from Germany working in the laboratory of Niels Bohr in Copenhagen, suggested that the absorption of neutrons by uranium caused the uranium atom to split into lighter, nearly equal fragments, with an enormous emission of energy in the process. This idea was based on an important finding published in Germany early in 1939, by O. Hahn and F. Strassman, that a species of barium could be found among the reaction products of uranium under neutron bombardment. Bohr visited the United States in January of 1939 and communicated his idea. Before the end of February, four American laboratories and Bohr's laboratory in Copenhagen had confirmed the reaction.

By the middle of 1940 the fact that three elements, uranium, thorium and protactinium (the last exceedingly rare), could undergo fission under neutron bombardment had been widely published. It was further known that the bombarding neutrons must have very high velocities to accomplish fission in protactinium or thorium, but that in the case of uranium slow neutrons could achieve the effect. The fast neutrons were captured primarily by the uranium isotope[1] 238, and might lead to the formation of a higher isotope, U-239, which could finally decay to a new element, unknown in nature, which was christened "plutonium." It was guessed at that time that plutonium might be itself fissionable if bombarded by slow neutrons, and this later proved to be both true and critically important. The slow neutrons could also be captured by the rarer uranium isotope U-235, with explosive fission and the production of additional neutrons.

The possibilities of initiating a "chain" reaction, such as would be required to produce an atomic bomb, either through the use of U-235 or through plutonium or both, were instantly realized in this country. The sobering danger of the knowledge was foreseen, first by a small group of foreign-born physicists, to whom the concept of harnessing scientific knowledge in the service of national armament was more familiar than to our own people. There followed conferences with President Roosevelt, his appointment of an initial Advisory Committee on Uranium late in 1939, and the transfer of $6,000 from the Army and Navy to defray its expenses. The total ultimate expenditure of the uranium project was to be in the neighborhood of two billion dollars. The next steps were the reconstitution of the Uranium Committee as a subcommittee of the newly organized National Defense Research Committee in 1940; the formal arrangements for full exchange of information with the British in the same year;

[1] Isotopes are species of a single element which have the same nuclear charge, but differ in atomic weight. They may be virtually indistinguishable in chemical properties.

and the formation of a Top Policy Group including the Vice-President, the Secretary of War, the Chief of Staff of the Army, the Director of the Office of Scientific Research and Development, and the Chairman of the National Defense Research Committee. There followed in 1942 the formation of the Manhattan District in the Army Corps of Engineers and the transfer of the uranium work to the District under the directorship of Major-General Groves. Likewise there followed the initiation of immense research projects at Columbia University, the University of Chicago, the University of California and elsewhere, and the construction of the gigantic installations at Oak Ridge and Hanford and in New Mexico and other places. Finally came the bombs at Los Alamos and Hiroshima and Nagasaki.

IV. BASIC FACTORS IN THE USE AND CONTROL OF ATOMIC ENERGY

We can now summarize the basic technical information affecting the international aspects of atomic energy.

First of all, it has been established beyond reasonable scientific doubt that only two elements, uranium and thorium, need to be reckoned as raw materials for atomic bombs or atomic power plants. Furthermore, only one of these, uranium, is capable of supporting a chain reaction.

Thorium is relatively abundant in nature, occurring in large deposits in India and fairly extensively in Brazil, the Malay Archipelago, Australia and the United States, largely in the form of monazite sands. It can be used to supplement uranium supplies in the manufacture of fissionable materials, but cannot be used without uranium.

Uranium is not a rare element. It occurs in minute but detectable amounts in most granite and sedimentary rocks, and comprises about eight parts in 100,000 of the earth's crust. It thus stands next to copper in abundance, is more abundant than zinc, and is about four times as plentiful as lead. Deposits from which it can be obtained in reasonable yield probably occur in at least 15 nations, in at least 10 of which — the United States, Canada, the Belgian Congo, Czechoslovakia, England, Portugal, Australia, Norway, Sweden and Russia — commercial amounts are known to have been recovered. However, the outstanding deposits are more narrowly distributed, being confined to the United States, Canada, the Belgian Congo, Czechoslovakia and possibly Russia.

Uranium occurs in the form of three isotopes, U-234, U-235, and U-238. The first is rare and of no immediate practical importance. U-235 is the isotope which undergoes explosive fission with slow neutrons; it composes about one part in 140 of naturally occurring uranium. U-238 is by far the most abundant isotope. It is not fissionable by slow neutrons, but is the source of plutonium. Fissionable materials, therefore, can be manufactured from a mixture of the isotopes of uranium, and in this process not only are raw materials for atomic bombs produced, but large quantities of power are incidentally generated also. Thus the production of power and the production of fissionable materials for bombs are technically inextricably linked; the same "pile," using the same raw materials, might serve as a power plant or as a source of bomb loadings, or even in both capacities simultaneously, if suitable arrangements were made. Further, these same "piles" can also be used to produce the radiations and to manufacture the artificially radioactive "tracer" materials which are of such immense value for scientific and medical research and therapy. However, although the generation of power or the production of bomb loadings requires a large plant, a very small plant, one so small, indeed, that it would be of little practical use in turning out explosives, could serve the scientists and medical men of an entire nation.

These facts suggest several conclusions bearing on our foreign policy:

(1) Since uranium and thorium alone can be used as raw materials for the production of either power or bombs, and since uranium is indispensable, the problem of controlling atomic energy, even though vast and complex, is nevertheless subject to delimitation in a way which would be out of the question if fissionable materials could be made, for example, from clay. The fact that the richest deposits of uranium ore occur in a fairly limited number of places might make international control feasible; but it also foreshadows violent competitive struggles for ownership of the richest deposits (the struggle for oil greatly intensified).

A plant producing materials of scientific or medical interest can be distinguished fairly easily from one designed to produce power or to turn out explosives, on the simple basis of size. However, without facilities for very thorough inspection it would be extraordinarily difficult to distinguish between a plant producing power for peaceful purposes and one which was turning out fissionable materials for war.

(2) All the scientific information essential to an understanding of the processes of fission was well known to the scientists of the world, either just before the beginning of the war in Europe or just before our entry into the war. This knowledge was based mainly upon original discoveries made in England, France, Denmark and Germany. Only the technology necessary to the actual fabrication of the bomb was kept secret in the hands of the United States, Great Britain and Canada. This technology, to be sure, is highly important because it involves intricate processes, vast installations and, particularly, large resources of technically trained manpower. Nevertheless, we may fairly estimate that Great Britain, if she chose, could in a minimum of two years achieve the degree of efficiency in bomb manufacture attained by this country, and that Russia might attain that position in a minimum of five, after which her rate of progress might well exceed our own.

We therefore cannot count on maintaining our security through a monopoly of fundamental knowledge in the atomic field — indeed, we narrowly escaped having that knowledge concentrated in the hands of Germany, where much of it originated. Further, our monopoly of technical information and facilities is limited and is diminishing. At present we do have a monopoly of stockpiles of raw materials and finished atomic bombs, and we are equipped with gigantic plants for producing these materials. Within something like ten years, however, our monopoly in technology may have disappeared completely, whatever the policy we now adopt with respect to international action.

(3) The bomb is detonated by an explosively rapid "chain" reaction (the explosion of the atoms in any one "generation" being initiated by the neutrons produced by the previous "generation" of atom explosions). Hence there is a critical size below which the bomb will not explode. It is made to explode, in fact, by an almost instantaneous assemblage of parts of subcritical size to a mass of larger than critical dimensions, whereupon the reaction starts immediately. Limitations to the size of the bomb on the small side, however, are not such that it could not be transported by the larger rocket carriers and by piloted or pilotless bombers. Long-range rockets of the V-1 or V-2 type, or improvements on these, carrying atomic explosives, will therefore defi-

nitely have to be reckoned with in another war. These will possess such speed and manœuvrability that the possibility of developing direct technical defenses against them becomes exceedingly remote. Virtually the only defenses which can be visualized at present are indirect, such as the concealment of vital installations (at least 500 feet underground) or the extensive dispersion of urban populations and facilities. Neither solution is wholly practical.

We must conclude, then, not only that we do not possess more than temporary security based on a scientific or technological monopoly in the field of atomic explosives, but that we cannot count on security based on direct technical defense.

(4) These considerations may tempt us to fall back on the sort of territorial defenses considered useful in the past — a system of insular bases around the world and a "security zone" of loyal neighboring nations. Territorial defenses will undoubtedly remain exceedingly important in our strategy, but their usefulness must necessarily be reduced. Small islands would almost certainly be untenable under atomic attack, and the range of future carriers of atomic bombs would diminish their value in any case. The defection of even a small nation within our zone might have most serious consequences if that nation could arm itself with atomic bombs. We thus might be obliged to adopt a much less passive attitude toward the internal affairs of countries within our security belt. Finally, the range and speed of atomic weapons will certainly reduce the protective value of such geographic features as the Atlantic and Pacific Oceans and the northern Canadian wilderness.

(5) The bomb is the ideal weapon for an aggressor. It is effective over a wide area and it is much cheaper than any existing instrument of destruction. The Los Alamos explosion blew the roof off a farmhouse two miles from the site. At Nagasaki, twisted steel beams were found three miles away. At Hiroshima everything within an area of four square miles was virtually demolished. It has been conservatively estimated that 10,000 bombs might eliminate all the urban areas of a great nation. The cost of that number of bombs would be about 10 billion dollars — and the figure is likely to decrease. An atomic bomb's great radius of destruction will make long-range rockets efficient even when far less precisely aimed than those sent by the Germans against London. Conversely, greater ranges could be attained with equal skill of aim. In short, the atomic bomb offers a means of destruc-

tion which is from ten to possibly one hundred times cheaper for the aggressor, in proportion to damage done, than any weapon hitherto available. Leaving aside some factors which might nevertheless be of importance (such as fear of retaliation), we can see many reasons why a nation which had determined on war would launch its aggression by using atomic weapons.

(6) Two additional facts worth pointing out refer not to atomic explosives but to atomic power and follow directly from the condition that any plant, whether designed primarily to produce radiations or power or supplies of fissionable materials, actually produces all three. One fact, technical in nature, is of military significance. A uranium power plant sends out radiations of great potential danger to its human operators unless it can be adequately shielded; and adequate shielding is so heavy that the power plant becomes unsuitable for installation in light carriers, though it might well be used in a surface vessel. The second fact is economic. Recent calculations indicate that while atomic power cannot at present compete economically with coal in a country having adequate coal reserves, it might nevertheless be of great importance to a nation lacking such resources. The implications for the "have-not" nations are obvious.

V. STEPS TOWARD INTERNATIONAL CONTROL

Such facts have convinced most people that some sort of international regulation of atomic energy is absolutely necessary. The first reaction was that the atomic bomb must be "outlawed," a thoroughly unrealistic solution, of course, until war itself is successfully outlawed. A second proposal was that the development of atomic energy should be renounced altogether, by prohibiting the mining or processing or possession of fissionable materials for any purpose. But such a policy would deny the world the potential benefits inherent in the peaceful development of atomic energy, and never in human history has progress been prevented by fiat. These two courses having been dismissed, what alternatives remain?

The general objectives, evidently, are, first, that there should be no production, manufacture or stockpiling of potentially explosive fissionable materials except under effective international supervision and control; and, second, that there should be full realization of the scientific and industrial potentialities of atomic fission for peaceful purposes. The double paradox is that no nation will relinquish its private (and secret) activities until the first condition is fulfilled, while the second cannot be achieved unless the world's leading minds in the field of atomistics, wherever they may happen to be, are able to exchange information freely in the best scientific tradition. The reconciliation of these two apparently contradictory objectives presents a towering challenge.

There are two principal difficulties. In the first place, international supervision of stockpiles and plants and processing methods involves a considerable delegation of national sovereignty; and an almost equally deep faith in internationalism is required if a nation is to share freely the information which it has gathered. Faith of this sort cannot be engendered to order and at once.

The second difficulty is to devise a workable system of inspection that will reveal whether atomic energy is being developed for peaceful or warlike purposes. (The same plant, remember, can make both bombs and power.) Inspection of mines, or of raw materials at or near the source, would certainly be easier than inspection later in the manufacturing process. Prospecting of mines by an international authority would be easier than supervision of factories. However, if a nation were hostile to the international authority, the technical difficulties in the way of any sort of inspection would be very great, perhaps insurmountable.

The Anglo-American-Canadian Declaration on Atomic Energy of November 15, 1945, marked the first step in the development of an international atomic policy. Its fundamental proposal was that international coöperation and coördination in the whole field should be advanced as adequate safeguards were developed. It was proposed that these developments proceed by stages. The three nations themselves undertook to initiate the first stage — the exchange of basic scientific information. The second was described as the exchange of knowledge in the field of industrial use. The third was the "elimination from national armaments of atomic weapons and of all other major weapons adapted to mass destruction."[2] Adequate safeguards (inspection and other means) were to be devised for preventing evasions and violations of the spirit of the pact. Finally, the Declaration proposed that an Atomic Energy Commission be set up within the United Nations.

At the Moscow Conference of the Foreign Ministers of the "Big Three," late in 1945, it was specifically suggested that an

[2]Note the breadth of this statement.

Atomic Energy Commission be established by the General Assembly of the United Nations, to act in an advisory capacity to the Security Council. The Commission was to consist of one representative from each of the states on the Security Council, plus Canada in the event that she did not become a member. Its terms of reference were to inquire into all phases of the problems arising from the discovery of atomic fission, with the specific responsibility of formulating proposals for extending the exchange of information between nations so as to attain the four objectives outlined in the Anglo-American-Canadian Declaration. Its reports to the Council would be made public unless security reasons dictated otherwise. This proposal was considered by the Political and Security Committee of the United Nations in London and was adopted by the General Assembly on January 24, 1946. All the most difficult portions of the gigantic task, evidently, lie ahead. Whether they will be dealt with successfully will depend largely upon the suggestions for concrete action which the United States Delegate brings to the Commission's first meeting.

Two recent developments, among others, will influence these proposals. The first is the unanimous adoption by the Special Senate Committee on Atomic Energy of the revised McMahon Bill, officially designated the Atomic Energy Act of 1946. The domestic atomic energy commission of five members created by this bill would assume control of the Manhattan District Project and would probably continue research and development with a budget of approximately $500,000,000 a year. There obviously had to be legislation for the domestic control of atomic energy before this country could participate in a system of international control. It remains to be seen how workable the structure it sets up may be.

A second important development has been the State Department's issuance of a report prepared by a special committee, of which Under Secretary of State Acheson was chairman, and by an advisory panel of experts under the chairmanship of David E. Lilienthal.[3] This much-discussed report forms perhaps the most original single contribution so far made to the thinking on the problem of international control. While it raises certain difficulties in its own right, it indicates possible paths around a number of major obstructions which had seemed well-nigh insuperable.

[3] "A Report on the International Control of Atomic Energy," Department of State Publication 2498.

VI. THE STATE DEPARTMENT REPORT

The proposals in the State Department report are based on two technical premises of great importance, the first of which we have already considered, namely that only uranimum and thorium can serve as raw materials for atomic bombs. The second premise is novel and extremely interesting. It is that existing stocks of purified U-235 and plutonium may be "denatured" under certain conditions in such a way as to impair them at least temporarily for military purposes while not decreasing their utility either for scientific or for industrial ends. This result is achieved by adding to the potentially explosive fissionable material a non-explosive isotope of closely similar chemical properties. Repurification of the denatured material remains a possibility; but the process will be cumbersome, calling for installations similar to those at Oak Ridge (though not of comparable size), demanding scientific and engineering skill of a rather high order, and probably requiring at least a year. The operation, then, could hardly be undertaken secretly on a large scale.

The revelation that fissionable materials can be denatured enables us for the first time to drive a distinguishing wedge between potentially peaceful and potentially destructive uses of atomic power, thereby opening the way to at least a partial solution of one of the most baffling features of the whole problem. The State Department report proposes to utilize this advantage to classify all activities concerned with any phase of the handling of fissionable materials into "dangerous" and "safe" categories.

The "dangerous" category of activities would include any which offers a solution "either in the actual fact of its physical installation, or by subtle alterations thereof, to one of the three major problems of making atomic weapons: I. The provision of raw materials; II. The production in suitable quality and quantity of the fissionable materials plutonium and U-235; and III. The use of these materials for the making of atomic weapons."[4] Thus any activities concerned with the prospecting, mining or refining of uranium, or to a lesser degree of thorium, the enrichment of U-235 by any methods at present known, the operation of "piles" for the production of plutonium and of separation plants for its extraction, and all research and development in atomic explosives, would be counted "dangerous." The "safe"

[4] *Ibid*, p. 26.

category of activities would include the use of radioactive materials as tracers, the use of small piles as radiation sources or for the manufacture of radioactive materials (especially those which decay rapidly), and the operation of large reactors for the production of power, in the range of 100,000 to 1,000,000 kilowatts. The inclusion of this last activity in the "safe" category constitutes one of the report's most important contributions. Such reactors cannot produce fissionable materials (in the absence of further uranium or thorium) and they will actually "burn up" their initial "fuel;" hence they will require recharging from time to time.

The report proposes the establishment of an international agency, which might be organized as a Commission of the United Nations or in some other way, termed for purposes of discussion the Atomic Development Authority. This Authority would have the right to own and lease property anywhere in the world and to carry on mining, manufacturing and research in the atomic energy field, and to conduct such transactions as licensing, selling and inspection. It is proposed that the Authority have title and access (through ownership or lease) to all uranium and thorium deposits, and alone conduct all mining operations in this field, taking possession of all material mined. All denatured fissionable material would remain in its permanent possession. Denatured materials and non-explosive by-products of the mines (such as vanadium or radium) would be made available to nations or to private individuals through sale or lease. The Authority would construct and own, and alone would have the right to operate, all separation plants for fissionable materials and all "piles" which use undenatured material. It alone would conduct all research in the general fields relating to atomic explosives, and one supposes that it would build up powerful and advanced research staffs for that purpose. One of the major responsibilities of these research units would be continually to reexamine the line dividing "dangerous" from "safe" activities, which might well shift as knowledge advanced. In short, the Authority would have a monopoly of the operation of all intrinsically "dangerous" activities in the nuclear field. In addition, it would exercise the right of inspection in all nations, particularly in the raw materials field, presumably through a staff recruited and maintained on a truly international basis.

"Safe" activities in connection with atomic energy could rest in governmental or private hands. Thus individual nations or their citizens would be free to conduct, under license and with a minimum of inspection, the generation of power for peaceful purposes in privately owned piles operating with denatured substances, and to produce materials for scientific and medical research. Since the "charges" in such piles would be expendable, they would be renewed from time to time by the Authority from its stocks of denatured material. Private research and development would be encouraged in the "safe" fields, and it is anticipated that close collaboration would be maintained between such private research groups and the more widely informed research and development groups of the Authority.

Finally, it is emphasized that the mining facilities and the processing plants of the Authority should be distributed among several nations. Such plants would be under the military guard of the Authority; but in the event that a recalcitrant nation seized the plants within its territory, the remaining plants throughout the world would be able to take appropriate measures for defense. Since any nation seizing such plants would require approximately a year to produce bombs on a large scale, there would be time to take the necessary protective measures. Thus no nation could readily achieve a monopoly of atomic weapons.

Before the publication of the State Department report, almost all the thinking about the international control of atomic energy assumed that ultimate ownership and control of all mines and of all mining, refining and manufacturing processes connected with fissionable materials (in both the "dangerous" and the "safe" categories) would rest with individual nations. The hope was to subject these national operations to international law and the "policing" of an international inspection force. The State Department plan reverses this thesis, placing all the intrinsically "dangerous" activities in public hands and under international ownership and control from the start.

This arrangement makes possible the formulation of an international code which is clear-cut and enforceable. For if the mere possession of undenatured fissionable material, or the operation of mines or plants producing or using such material, constitutes a violation of the law, evidence of guilt can be quite readily established. As already noted, detection of the illegal use of facilities which were nevertheless legally owned would be very difficult at best. Under the new plan, only mining operations might require large-scale and continuous policing by the international authority. A nation which sought to evade its obligations could produce bombs in appreciable quantity only by carrying through many illegal steps, from mine to final processing plant, using undenatured fissionable materials at every step of the way. To do this undetected on a large scale would probably be difficult even with a fairly limited system of inspection.

If, as suggested, the Atomic Authority maintained extensive research facilities in atomic explosives and related fields, the functions of research and inspection might be combined, with the result that the Authority would always remain master of the world situation by virtue of technological superiority as well as by legal right. The proposal to keep "safe" activities in private hands tends in the same direction. Since "safe" materials are expendable and can be produced and supplied only by the Authority, it will naturally exercise control over such activities while at the same time encouraging the full development of private initiative and giving to the relations between the public agency and private individuals the positive character of an aid to research and development.

Finally, the plan does not ignore security phases of the problem in the event that the whole system of world order should suddenly collapse. Plants and facilities can be distributed among nations in such a way that in the event of collapse no one state will have a preponderance of atomic weapons — at any rate no advantage as great as it might well have secured by subterfuge under conditions of national ownership. During the basically insecure period of transition, the United States, Great Britain and Canada will be in the most secure positions, as they are today. Their sharing of information and facilities may somewhat accelerate the impairment of that security. But, as we have seen, security based on monopoly is in any case doomed.

The difficulty of gaining general acceptance of this sytem is evident. Any practicable system of international control will require every nation to delegate some of its national authority, and this is sure to be resisted by sections of public opinion. The area of national sovereignty to be delegated under this plan admittedly would be very considerable. Other objections, both broad and detailed, can be brought against the plan. They all will have to be taken into account. In considering them, however, we must recognize that they apply to any plan of international control, and we must set off against them the disadvantages of systems which propose primary national controls, subject to international jurisdiction.

VII. CONCLUSIONS

Certain conclusions may be drawn from the foregoing analysis:

(1) International control of atomic energy is the surpassingly important objective of this nation's foreign policy. It must be, indeed, the chief present goal of every nation that wants peace. If the development of atomic energy continues to rest entirely in the hands of separate nations, if there is no provision for the international exchange of information, for international coöperation and eventually international control, an international atomic arms race seems inevitable. The dangers of this cannot be exaggerated. The advantage that the atomic bomb would give an aggressor, the localization of the richer deposits of uranium ore in certain areas, and the inherent differences in technological capabilities between nations would breed national rivalries, ambitions and fears. The tension might become unbearable as the military potentials of rival nations became more and more unequal.

A further argument for the international approach is found in the fact that the possibilities for the constructive use of atomic energy in peacetime can be adequately developed only through world-wide coöperation. These potentialities for good, in the fields of industry, scientific research and medicine, are very great. Mankind cannot be asked to forego such benefits.

Many in this country will object that the present American monopoly of atomic weapons constitutes a protection not only for ourselves but for the world as a whole, since the United States cannot, as they believe, be suspected of ever planning to start a war. The conclusion of their argument is that our continued monopoly ought not to be put in jeopardy by efforts toward international coöperation. The answer is that our monopoly will be short-lived in any case. Our security cannot be based on a continued monopoly of the raw materials, facilities or manpower for making atomic bombs, or on a monopoly of the necessary basic knowledge. There is no adequate direct defense against atomic weapons. And our former security based on our geographical position has greatly diminished. International coöperation and eventual international control, then, seem plainly designated as the objectives of a realistic foreign policy.

(2) To be at all effective, any system of international control requires some delegation of national sovereignty by every participating nation. This will be hard to achieve, especially if the actual power of a central authority were less, at any rate at the start, than that of individual nations or some coalition of them. The processes of education, negotiation and then of actually putting the system agreed upon into operation will take time. Success can be achieved only if the participating nations realize that the safety of each one of them, quite apart from the welfare of the world as a whole, depends upon the efforts they put forth. Meanwhile, as things stand, the development of atomic weapons will inexorably proceed faster and faster. No time must therefore be lost in setting out on the long and laborious road toward the goal of effective international control.

(3) The nations which first produced the bomb and which still have a monopoly in the field — the United States, Great Britain and Canada — have taken the lead in acting on the thesis set forth in the preceding paragraph. The Anglo-American-Canadian Declaration, the Moscow Communiqué and the establishment of the Atomic Energy Commission show that they understand the salient features of the problem — the need for an immediate beginning, the need for maintaining a balance between national security and international action, the need for a long-term approach, and the need for enlarging the field of action to embrace all weapons capable of mass destruction. But these are generalities. The next step will be to present concrete and detailed suggestions as to how a beginning may be made in action. Here again the nations now possessing a monopoly of atomic weapons have the responsibility for taking the lead. This is especially true of the United States. The challenge to our leadership — moral, intellectual and political — will come during the first meetings of the Atomic Energy Commission, scheduled to begin about the time these lines appear in print.

(4) With the control and ownership of raw materials, processing plants and manufacturing facilities in each nation primarily in the hands of the individual governments, the determination of whether a given atomic energy plant were legitimately engaged in producing power or were nefariously manufacturing atomic bombs would be a formidable undertaking, particularly

since the rules to be enforced would relate to the *manner of use* of facilities legally owned by states rather than to the illegal possession of materials or the illegal conduct of processes.

A further drawback to a control system based on national ownership is that if it suddenly fails — and this must be counted a possibility — the first nation defaulting may be in the advantageous position of having all its own plants intact, a personnel already expert in the production of bombs (which might have been made illegally for some time before being detected), and perhaps a stockpile of bombs and raw materials.

(5) The State Department plan for international control is built on a more hopeful set of premises. It assumes that the ownership and operation of all atomic facilities of military potentiality shall rest initially with an international Atomic Energy Authority. Utilizing the fact that fissionable materials can be denatured, it draws a tentative line of distinction between "dangerous" and "safe" materials and activities. It proposes that the former remain within the sole province of the Authority, but that "safe" activities may be conducted by nations or by private individuals, who will obtain the necessary "safe" materials from the Authority. It further proposes that the Authority shall conduct all research within the "dangerous" areas, through a corps of the ablest researchers in atomic energy, whose secondary task will be to act as inspectors to ensure the proper conduct of the "safe" activities by nations and individuals.

Among the advantages of the plan are the identification of ownership with responsibility for the conduct of operations in a way impossible under schemes built on national ownership. This permits drawing up a much simpler rule of law, making illegal the mere possession of certain materials or the mere conduct of certain processes. It also offers more security in the event the system breaks down, for a judicious distribution of plants among many nations at the start can assure that a monopoly of knowledge and facilities would not be concentrated, even under the very worst circumstances, in the hands of any one national group. Most important of all, it makes inspection a positive function and ensures that the inspectors shall be research men of the highest caliber who will have the knowledge and interest required to detect evasions and ensure enforcement.

The scheme's principal handicap, perhaps, is that it calls for so large a grant of national sovereignty to the international authority. We cannot gauge as yet the political obstacles which this fact may create. But any form of international control will encounter political objections; and if there is to be international control of atomic energy in any form these political objections will have to be squarely met.

At length the country is face to face with the real issue. The American policy has on the whole been sound. The Anglo-American-Canadian Declaration gave statesmanlike evidence that we recognize the scope of the problem no less than its critical nature. But we have been slow to act, and that slowness has been costly. A great psychological opportunity to enlist public opinion in favor of the necessary grant of sovereignty was lost at the very beginning; and every step that has been taken, down to the publication of the State Department report, has lost force by being delayed. The essential fact of the question of the control of atomic energy is that a delegation of sovereignty such as the State Department plan proposes will inexorably be a part of any plan which promises to be effective, and that the public mind must be prepared for this through an understanding both of the logic of the situation and of the calamitous nature of the alternative policy of national control and national competition. The necessary faith in international control cannot be called into being by the touch of a wand. It must be built link by link, and gather power as it proceeds. But there is not a moment to lose; the chain reaction that can blow civilization apart is under way also. Once again — and more truly than ever before — the race is between education and disaster.