Secret

CANADIAN MISSION TO THE INTERNATIONAL ATOMIC ENERGY AGENCY

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SECRET

September 24, 1958

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Dear Mr. McKinney:

As you know tri-partite discussions have been going on between the United States, United Kingdom and Canada for some time on the question of what sort of a safeguard system is necessary to ensure that nuclear materials supplied for peaceful purposes to other countries are not diverted to military purposes.

In accordance with the understanding reached some time ago that each of the three countries would parpare a paper outlining its views on the nature of such a safeguard system the Canadian authorities have prepared the attached document, entitled "The Application of Safeguards to Nuclear Exports". This paper has already been given by Mr. Watson of Atomic Energy of Canada Limited, to Mr. Schaetzel of the State Department and to Mr. Michaels in Geneva. However, I thought you might like to have a copy of the document here in Vienna for your information.

Yours sincerely,

M.H. Wershof

Safeguards

Mr. Robert M. McKinney,
American Delegate to
I.A.E.A. Conference,
VIII, Schmidgasse 14,
VIENNA.

Secret

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The Application of Safeguards to Nuclear Exports

PART I - General Considerations

It is the policy of the Canadian Government that safeguards against diversion to military use should be applied to nuclear materials exported from Canada for peaceful use. A similar policy is pursued by the United States and United Kingdom Governments in respect of such exports from their countries and the bilateral agreements of all three countries with other countries or regional organizations provide for the application of safeguards.

2. The standard Safeguards article ~~or~~ Canadian bilaterals, which is reproduced as Appendix B of this report, provides for the application of safeguards to identified material only (i.e. as defined in our Agreements, this means, broadly speaking, uranium and thorium and derived substances). Other nuclear materials, such as heavy water, reactors, etc., serve an essential role in the production processes by which nuclear source materials are converted into fissile materials usable for military purposes. These items must therefore be controlled in any comprehensive safeguards system. However, since it will be several years before Canada is in a position to export such items, we will have neither the right nor opportunity to exercise safeguards over them during this period. The remainder of this paper will therefore address itself to the problem of applying safeguards to nuclear source and fissile materials. It must, however, be recognized that nuclear plant is as essential to the production of fissile material as are nuclear source materials, that safeguards during the process of production of fissile materials must be applied in the nuclear plant itself and that it would be inequitable to expect the producers of source materials alone to bear both the burden and possible commercial disadvantage of applying a safeguards system.

Objectives of a Safeguards System

3. While nuclear energy has a variety of military applications, including propulsion, power supply and materials' irradiation, the essential object of a safeguards system from Canada's point of view is to prevent the diversion of uranium supplied for peaceful uses to the manufacture of atomic weapons. Natural uranium cannot be used directly for this purpose but fissile materials, notably the isotope U235 and plutonium, can be derived from it respectively by passage through an isotope separation plant and by the treatment of irradiated natural uranium in a chemical processing plant.

4. Since isotope separation plants are extremely expensive to build and operate, it is doubtful whether any country other than the USA, UK and USSR (which at present have such plants) and France (which is considering building a plant) would contemplate their construction in the near future and it is even more doubtful whether, if they should decide to do so, the construction and operation of such a plant could be kept secret. This is not, however, true of a chemical processing plant which would be substantially cheaper and might be clandestinely constructed and operated.

5. In view of the foregoing, it is considered that for the next few years the main problem facing Canada will be to apply safeguards against the diversion of natural uranium to the manufacture of atomic weapons via the plutonium cycle. Natural uranium might be diverted with a view to its irradiation and processing in clandestine plants or the plutonium might be diverted either before or after chemical processing. It is therefore necessary to contemplate the application of safeguards to natural uranium in all of the forms in which it may be supplied by this country and at all stages in its processing and use abroad: during refining, during fabrication into metal and fuel elements, during irradiation and subsequent storage, during chemical processing and, finally, safeguards will also be required over the plutonium produced and over the further uses of this plutonium.

Some Limitations of the Safeguards Concept

6. For both technical and practical reasons, no safeguards system can completely prevent wilful diversion of uranium and plutonium. Except for uranium metal it is not possible, even for those responsible for operating nuclear plants, to make completely accurate inventory reports of these items. For example, plutonium formation in a given quantity of uranium irradiated at a known power output level for a given time in a reactor of known characteristics, can often not be predicted within 5%. There is thus a margin of error in all such reports and, in addition, operating staff could wilfully falsify records, instruments, etc. to provide a much larger margin for diversion. A safeguards system can limit the amount of diversion possible but the narrower these limits are to be, the more elaborate, costly and onerous the system required. It has been suggested that a simple audit of operating records might detect 25% diversion from a reactor complex, while the best figures which can be achieved by a full time resident staff of inspectors in such a complex might be about 2%.

7. The effectiveness of a safeguards system will depend very largely on the support of all the main countries producing nuclear plant and uranium. If, as must be anticipated, "recipient" countries develop their own "uncontrolled" reactors and other nuclear plant, acceptance of the principle of safeguards by uranium producing and fabricating countries will be all the more important, since the availability of substantial quantities of "uncontrolled" uranium on the world market would mean that countries with such plant could conduct nuclear programmes free of all safeguards. Moreover, producing countries would have to collaborate closely in the application of the safeguards system in order to permit strict accounting of materials and prevent evasion and deception. The chances of achieving agreement of this kind on a safeguards system among producing countries are highly uncertain. Quite apart from the commercial incentive to offering "uncontrolled" uranium for sale, there are some producing countries which are in principle opposed to safeguards and do not think that they will work and others whose position is as yet undefined but probably opposed to safeguards.

8. The views of "recipient" countries are equally important. Probably no such country would voluntarily submit to safeguards as a matter of principle under present circumstances. Some countries have accepted them, lacking any alternative means of obtaining nuclear materials, but other countries (India, Sweden

and France, for example) have curtailed their nuclear programmes or embarked on high-cost production of their own rather than purchase available material which entailed safeguards. A number of recipient countries are probably at present withholding judgment on this issue pending the establishment of a working safeguards system. From this point of view, it is desirable that such a system be put into effect as soon as possible, that it be adopted as widely as possible and, in consequence, be no more onerous than absolutely necessary and fully protect the amour propre and sovereignty of recipient governments.

Some methods of applying safeguards

9. The most effective means of preventing the diversion of fissile materials is by the international ownership of isotope separation and chemical processing plants, combined with a small staff of inspectors to detect the construction and operation of clandestine plants. Since plutonium is the main object of concern during the next few years, the international ownership of chemical processing plants could suffice during this period. There are, however, grave difficulties in the way of this solution. Not least among these is the fact that, since the three most advanced atomic powers would probably not consider accepting such a system themselves, national pride would certainly lead some other countries to a similar refusal.

10. The most effective safeguards system which could be established on the basis of inspection rather than ownership, would demand a fairly large resident inspection staff in each reactor complex. While we have not worked out the cost or other implications of such a system in detail, it is clear that the financial burden would be heavy and the system might well give rise to friction with the recipient country; diversion could only with certainty be restricted to 2% - 3%.

11. A third alternative would be a system based on a regular periodic audit of nuclear materials supplied to a recipient country, supplemented by spot checks by travelling inspectors. These checks would be designed to verify the accuracy of the audit reports. Such a system could probably not with certainty detect diversion of below 5% - 10%.

12. We have considered whether it would be possible to make a choice between the foregoing alternatives on the basis of a mathematical calculation. For example, the NRX and projected CANDU reactors may be taken as typical of a large research and of a large power reactor respectively. Their thermal outputs are 40 mw and 800 mw and their annual plutonium production 9 kg and 185 kg respectively. On the assumption that 10 kg is the quantity of fissile material required for an atomic weapon, it would follow that diversion at the rate of 5% would lead to the accumulation of enough diverted plutonium from NRX for the fabrication of one such weapon every 20 years or so and from CANDU for one every year. Thus if a country had only one power reactor of the CANDU type, and if it were considered that the acceptable level of possible clandestine production of atomic weapons was less than one per year, then it would be necessary to put into effect the more rigorous safeguards system aimed at restricting possible diversion to 2%, and even this would permit the production of one illicit weapon every 2½ years.

Conclusions

13. However, calculations of this kind are not particularly meaningful, except possibly in the very short run, since the most important factors for consideration are not mathematical

ones. In the first place, the clandestine fabrication of even one atomic weapon from materials intended for peaceful use can not be accepted with equanimity. Since diversion cannot, for technical reasons, be completely ruled out by any safeguards system, the conclusion would ~~have~~ seem to be that the objective of such a system should be to reinforce the moral and legal obligations undertaken by recipient countries in bilateral agreements, by making it unlikely that detection could be evaded in the long run. The corollary of this is that, so long as possible misuse of nuclear materials remains a cause for concern, the supply of materials to any country should be refused if there appeared to be serious doubt as to that country's good faith and willingness to carry out its obligations scrupulously.

14. The foregoing conclusion is reinforced by the fact that no safeguards system can prevent the forcible seizure by a country of the atomic installations within its borders and of the fissile material contained in them. In view of the difficulty of hiding a clandestine atomic programme and of the political opprobrium which the discovery of attempted diversion would entail, it seems more likely that a country determined on a weapons programme, but without its own uncontrolled means of carrying one out, would rely on seizure rather than on diversion.

15. On the basis of the foregoing, it is the Canadian view that a simple audit and spot check system would, in the circumstances, provide the most satisfactory means of discharging the obligations incurred in the safeguards article of its bilateral agreements. Details of such a system, which is also recommended for the consideration of other interested countries, are given in Part II of this paper.

16. It is, of course, recognized that recipient countries might take advantage of the margin of uncertainty inherent in an audit system to divert quantities of fissile material less than the measurement and accounting error. On the other hand, a simple audit and spot check would fulfill the practical objectives of a safeguards system as outlined above, the positive advantages of which would seem overwhelming. It would be relatively inexpensive, even if introduced to cover large-scale operations, and it would be relatively inoffensive to recipient countries. This last may well prove to be a critical argument in its favour. While many countries are at present prepared to accept bilateral safeguards, at least in principle, in order to get their atomic programmes under way, they will certainly seek to free themselves of these safeguards if they prove onerous. As time passes, alternative "uncontrolled" sources of nuclear materials will become available and all producing countries will find themselves under increasing commercial and political pressure to relax the conditions they impose on the supply of materials. In these circumstances, it would seem that the only certain way in which to ensure that the bulk of the world's peaceful uses of atomic energy are subject to safeguards in the medium to long run is by the widespread acceptance of the idea that safeguards are desirable as a matter of principle. If this approach is to succeed, the safeguards system now advocated must be the least onerous one compatible with security (on the criteria developed in this paper).

17. It is generally accepted that the International Atomic Energy Agency is the appropriate forum in which to promote this idea and that through it a genuine multilateral safeguards system might be developed and applied. For practical reasons, however, the first steps towards such a system are likely to be taken on a bilateral basis. It would, therefore, seem important that Canada

and other countries which share our concern in this matter, should not now advocate a system which is likely to prove unacceptable to the majority at a later stage. To do so would be to invite the premature demise of the multilateral safeguards concept, involving a very embarrassing situation in respect of the more rigorous safeguards system which we might in the meantime have imposed bilaterally on some countries (among which will be some of our closest friends). The audit and spot system would seem to offer the best chances of gaining acceptance for multilateral safeguards and would also meet our immediate needs arising out of the safeguards provisions of our bilateral agreements.

PART II - Proposed Procedure for Audit and Inspection of Source and Special Nuclear Material Supplied by Canada under Bilateral Agreements for Co-Operation in the Peaceful Uses of Atomic Energy

Introduction

18. This proposed procedure covers the materials which might be supplied by Canada under bilateral agreements within the next three or four years. It assumes that no recipient country will have an isotope separation plant (e.g. diffusion plant) within that time. In particular, the procedure will cover -

(a) Uranium salts - such as mine concentrates and uranium oxide whether of reactor grade or not,

(b) Uranium metal in bulk form - normally this would be in the form of metal dingots or pieces,

(c) Unirradiated uranium metal or salts as fabricated units - these would normally be fuel elements and would have identifying numbers or markings,

(d) Irradiated uranium metal or salts - these would contain plutonium produced from the neutron irradiation,

(e) Separated plutonium as metal or salts - this material could either have been supplied by Canada or could have been produced from uranium supplied by Canada.

19. The procedure does not cover items such as enriched uranium, heavy water or reactors, or major reactor components.

Accounting Records to be Maintained by the Receiving Country

20. Any country receiving material from Canada subject to inspection would be required to set up a system of accounts for this material so that a record was kept of the quantity and location of all stocks. No specific method of accounting need be followed by the country but the procedure should be such that the information required for the reports described below could be obtained from these records.

21. The receiving country would be required to give a distinctive serial number of each fuel element made from Canadian uranium supplied. The accounting records should show the location of each fuel element up to the point where it loses its identity. (This would occur should it be dissolved).

22. The receiving country would prepare a report which would answer the questions listed in Appendix A as often as may prove necessary in order to meet the purposes of control. This might vary from once every two months to once every six months. Copies of each report would be sent to the Canadian Government (or, if it were agreed, to an outside organization designated by the Canadian Government).

Audit and Inspection by the Canadian Government

23. The Canadian Government would assign to a committee or group (or, if agreed, to some outside organization) the responsibility for checking the accuracy of the reports submitted. Each report would be examined to determine whether or not there were any apparent inconsistencies and this would be followed by spot-checks in the country concerned by representatives of the designated inspection organization. The extent of such inspection would depend upon the amount of material held by the country concerned, the complexity of the processes containing the plutonium and uranium and on the general integrity of the country being inspected. For example, should a country only have fabricated natural uranium fuel elements, inspection would largely consist of a physical inventory check. It must be expected, however, that in most cases competent scientists or engineers will be needed for this work. They must be alert to detect any possible flaws in the answers given to their questions. They will be at a great disadvantage if they are not good linguists. It is believed that they will be most successful if they are technical experts who would be welcomed by the organizations in the country concerned on this account.

24. The "inspector(s)" would select at random information listed in the reports received and perform such examination of the country's own records and of the actual material as may be required to check the accuracy of the submitted reports. If these random selected items were found to be correct, the whole report would be assumed to be accurate.

25. The physical check might in some cases be a direct count or measurement of the physical inventory. In other cases it might be an indirect check on the accuracy of the data. Examples of such indirect checks might be -

(a) An isotopic measurement of the uranium in irradiated fuel elements or in the solution formed on dissolving these elements to determine if the isotopic composition was in accord with the reported power output.

(b) An isotopic analysis of plutonium in solution to determine if the plutonium composition agreed with the reported irradiation of the uranium from which the plutonium was formed.

(c) Radiation measurements of monitors placed in the reactor to determine total power production.

26. After each report had been found to contain no errors, the receiving country would be notified that the report was accepted by the Government of Canada. The receiving country

might well wish to publicize this acceptance as evidence that its atomic energy activities were entirely peaceful.

Personnel and Costs Involved

27. The routine reports on the receipt and disposition of uranium and fissile material will require analysis by experts. This might be done by a committee or similar body consisting of personnel drawn from a number of departments and agencies in Ottawa who would do this work as part of their regular duties. The subsequent inspections will almost always have to be carried out by experts drawn from the Atomic Energy Control Board, Atomic Energy of Canada Limited, Eldorado Mining and Refining Limited, and perhaps Mines and Technical Surveys. It is thought that the work might be carried out by such officials without significant interference with their present duties. The precise number of experts required can only be determined on an ad hoc basis at the time and in the light of the particular purposes for which the materials in question are being used.

28. It is unlikely that in the next few years the cost of carrying out control activities of this type will be significant. The main additional expense will be the cost of travelling, and this could be in the region of $10,000 to $20,000 per annum. It would appear difficult and undesirable to seek to charge control costs to the receiving organization. It is suggested that such costs as there may be should in principle be met by the Canadian Government and it would not appear necessary at this stage to consider precisely how this should be done.

APPENDIX A

Proposed Periodic Report on Uranium and Plutonium Supplied by Canada and on Plutonium Derived from Uranium Supplied by Canada

In this report weight should be given in metric units as accurately as are known. When weights are not known, approximate weights should be given, together with an estimate of probable error.

I. Unirradiated Uranium

(a) Quantity of uranium that is not in form of numbered fuel elements

(i) received since last report
(ii) tranferred from this category since last report
(iii) quantity and location of material in stock at time of report

(b) Quantity and serial number of fuel elements

(i) received as finished fuel elements since last report
(ii) produced in country from material in category I(a) since last report
(iii) added to reactors since last report
(iv) removed from stock for reasons other than adding to reactors since last report
(v) quantity, location and serial numbers of elements in stock at time of report.

II. Uranium undergoing Irradiation - A separate report should be made for each reactor

(a) Quantity and serial number of fuel elements added to each reactor since last report.

(b) Quantity, serial number and location in reactor of fuel elements in each reactor at time of report.

(c) Power generated since last report by each element in the reactors.

(d) Calculated plutonium content of each element in the reactor.

(e) Quantity, serial number, power generated during period irradiated and calculated plutonium content at time of removal of elements removed from reactors since last report.

III. Irradiated Uranium - A separate report should be submitted for each storage area.

(a) Quantity, serial number, and plutonium content and source of elements placed in storage since last report.

(b) Quantity, serial number and plutonium content of elements removed from storage, and explanation of what has been done with these elements since last report.

(c) Quantity, location, serial number and plutonium content of elements in stock at time of report.

IV. Chemical Processing of Uranium Procured from Canada - A separate report should be submitted for each chemical processing installation.

(a) Quantity, serial number and plutonium content of irradiated elements removed from storage for which processing has commenced since last report.

(b) Quantity, serial number and measured plutonium content of irradiated elements for which chemical processing has been completed since last report.

(c) Quantity and location of material separated in chemical processing installation since last report.

(i) Plutonium
(ii) Depleted uranium

(d) Estimated losses in chemical processing installation since last report.

(i) Plutonium
(ii) Depleted uranium

(e) Quantity and location of material in storage after chemical processing at time of report.

(i) Plutonium
(ii) Depleted uranium

V. Separated Plutonium received from Canada or Separated from Irradiated Uranium.

(a) Quantity at start of report period, showing source compound, isotope composition and location.

(b) Receipts since last report.

(c) Disbursements and losses since last report, with explanation for each entry.

(d) Quantity at end of report period showing compound, isotope composition and location.

Safeguards Article from Canadian Standard Draft of a Bilateral Agreement for Cooperation in the Peaceful Uses of Atomic Energy

Each supplying Contracting Party shall be permitted to assure itself that the provisions of this Agreement are complied with and, in particular, that identified material is being used for peaceful purposes only, and to that end the supplying Contracting Party shall have the right

(a) to examine the designs of equipment (including nuclear reactors) or facilities in which identified material is to be used or stored, with a view to ensuring that such identified material will not further any military purpose and that effective application of the safeguards provided for in this Agreement shall be feasible;

(b) to require the maintenance and production of adequate records to assist in ensuring accountability for identified material;

(c) to call for and receive progress reports;

(d) to approve the means to be used for the chemical processing of identified material after irradiation, with a view to ensuring that such processing will not lend itself to diversion of identified material to military use;

(e) to send representatives, designated by it after consultation with the other Contracting Party, into the territory of the latter, which representatives shall have access at all times to all places, equipment and facilities where identified material is used, stored or located, to all data relating to such identified material, and to all persons who by reason of their occupation deal with such identified material or such data, as may be necessary to account for all identified material and to determine whether such identified material is being used for peaceful purposes only. Such representatives, provided they shall not thereby be delayed or otherwise impeded in the exercise of their functions, shall be accompanied by representatives of the other Contracting Party if the latter so requests.

2. At or after the time the International Atomic Energy Agency is in a position to carry out the safeguards functions provided for in its Statute, the Contracting Parties will consult together to determine whether and to what extent they may wish to modify the safeguards provisions set out in this Agreement so that they may conform more closely with those of the said Statute, and to have the application of safeguards carried out by the said Agency.

3. Each Contracting Party, if it has determined that identified material is furthering a military purpose, shall have the right to suspend or cancel scheduled delivery of source material, special nuclear material, and fuel, and to require the return of all identified material under the control of the other Contracting Party.

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