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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

~~SECRET~~

NFAC 2436-81

Mr. Harry R. Marshall, Jr.
Principal Deputy Assistant Secretary
for Oceans and International
Environmental and Scientific Affairs
U. S. Department of State
Washington, DC 20520

Dear Mr. Marshall:

The Commission is today sending to appropriate congressional committees the attached letter, forwarding the "Report on the Implementation of IAEA Safeguards" recently prepared by an NRC staff member, along with the NRC staff's commentary on that report and an updating addendum. The original report was previously provided to Assistant Secretary Malone and other Executive Branch officials by Commissioner Gilinsky.

Sincerely,

James R. Shea

James R. Shea, Director
Office of International Programs

Enclosure:
As stated

cc: Richard T. Kennedy, DOS
Paul Wolfowitz, DOS
~~Henry S. Rowen, CIA~~
Fred C. Ikle, DOD
Harold Bengelsdorf, DOE
Norm Terrell, ACDA

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bcc w/encls:
Chairman Palladino
Commissioner Gilinsky
Commissioner Bradford
Commissioner Ahearne
Commissioner Roberts
S. J. Chilk (wo/encls)
L. Bickwit, OGC
F. Remick, OPE
H. K. Shapar, ELD
R. Burnett, NMSS
J. R. Shea
J. B. Devine
W. J. Dircks

Document No. 1P-21-311
This document consists of 1 page
No. 4 of 35 copies, Series B

The Honorable Alan Simpson, Chairman
Subcommittee on Nuclear Regulation
Committee on Environment and Public Works
United States Senate
Washington, D.C. 20510

Dear Mr. Chairman:

(S) In connection with the Commission's obligation to keep the Congress fully and currently informed, I have enclosed a report on International Atomic Energy Agency (IAEA) safeguards by a former NRC employee (Enclosure 1). The author was employed as an IAEA safeguards inspector from summer 1977 to summer 1980, following which he was employed by the NRC until resigning in July of this year.

(S) Although we recognize IAEA employees agree not to divulge this type of information, even after they leave the IAEA, the Commission believes we are obligated to inform you once we have such information. Obviously, we have not shared the report with the IAEA.

(U) The Commission's staff has reviewed the report in light of its relevant experience and has prepared a commentary, with an updated addendum, which is also enclosed for your information (Enclosures 2 and 3).

(U) This information is being provided to other appropriate congressional committees.

Sincerely,

Nunzio J. Palladino
Chairman

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Extended by RDS-3
Reason for Extension Foreign Relations Matter

Enclosures:
1. Report on IAEA Safeguards (S)
2. Staff Commentary (S)
3. Addendum to Staff Commentary (S)

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ENCLOSURE 1

DOCUMENT NO. ~~IP-81-238~~
This document consists of 21 pages
No. 4 of 7 copies, Series C

REPORT ON THE IMPLEMENTATION OF IAEA SAFEGUARDS

1. INTRODUCTION

The purpose of this report is to provide an inspector's insight into IAEA safeguards, based upon 7 years as a domestic safeguards inspector with the U.S. Atomic Energy Commission's Division of Nuclear Materials Safeguards and the successors of that organization in the AEC and NRC, 3 years as an international safeguards inspector with the IAEA, and, in addition, several years as an NRC headquarters staff member.

The concept has been advanced at high levels that a country's signature of the NPT is the principle aim of IAEA safeguards. This report is only concerned with the technical aspects of IAEA safeguards inspection activities, and does not address such broad issues.

The concept has also been advanced that IAEA safeguards are of more value than is apparent by virtue of their technical value per sé. This may be true where a State does not understand the means by which safeguards are applied. In my experience, the representatives of the state systems and the operators of the installations know exactly how effective international safeguards are and how the international safeguards system can be defeated. I can only address the technical capability to safeguard nuclear materials.

2. ORGANIZATION OF IAEA

The Board of Governors of the IAEA, on which 34 States are represented, is the principal authority which influences the policy of the Agency. Voting is on a one-member one-vote basis, so that less populous countries have as much influence as more populous ones. In terms of budget, however, a large proportion of funding is provided by the U.S., and the U.S. also provides additional monies and technical assistance to the Agency.

Classified By (Signed) William J. Dircks (Original Authority)
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Reason for Extension 2.5-3 foreign govt. relations matters

The Agency's Inspectorate is very responsive to concerns of the countries which it inspects. A complaint via the Board of Governors can end or alter the career of an Agency employee. Thus, the Inspectorate is controlled by the Inspected. A "diplomacy above all else" or "don't push your luck" mentality prevails.

Another point of interest about the IAEA organization in the Department of Safeguards is that nationals of the country inspected have access to inspection reports, seals, seal records, etc., that concern their own countries. For example, I once had to explain a report that I had written to an individual responsible for clearing it from the country that the report concerned. Although the IAEA takes modest steps to avoid this, it is unavoidable under the present controls.

Finally, it should be noted that the IAEA does not teach languages to inspectors and does not assist inspectors to learn the language of the country which he inspects. The IAEA operates in four official languages of the United Nations and on a semiofficial basis in German. Often the inspector cannot communicate with the party being inspected, except via a representative of the national authority or Euratom, who is conducting a parallel inspection. This occurs more often than not, I would estimate. A result of language difficulties is poor communications. For example, failure of an operator to carry out a commitment made to an inspector may be blamed on not having understood.

3. MISSIONS TO THE AGENCY

Member countries of the Agency provide liaison to the Agency by way of their Missions to the Agency. Some countries have a special staff for this purpose, such as the U.S. One of the comments one hears in Vienna is that "You can't get anything done around here without going to your Mission." As an example of this, I witnessed a case where a non-U.S. inspector was promoted to P-5 (ca. $55,000 p.a. tax free) while I was on inspection travel with him. He received two telegrams of congratulation concurrently. One of these came from his Section Head at the Agency; the other came from his Mission.

In my experience, I discerned inadequancy in the safeguards area. Most U.S. inspectors did not feel supported by the U.S. Mission.

4. SUBSIDIARY ARRANGEMENTS

A country that has signed the NPT in time concludes an agreement with the IAEA modeled after INF/CIRC 153. This agreement specifies in greater detail than that found in the NPT how safeguards are to be applied in the state. In addition to this agreement, subsidiary arrangements are concluded which specify how safeguards are to be applied. These subsidiary arrangements consist of a general part and of detailed attachments which specify how safeguards are to be applied to "facilities" and to "other locations" where nuclear material is present in small quantity.

4.1 Design Information

The facility attachments are concluded on the basis of "design information" (DI) submitted by the State. In my experience, the headquarters review of the DI and its field verification has been inadequate.

The Agency has the right to carry out DI verification, but often only three weeks' notice may be required to be given before an installation receives nuclear material from the time the DI is submitted. Thus, a review of the DI may not be possible and may not be permitted. Such a review is important in many types of installations, to assure that there are no undeclared diversion routes, connections to sampling stations, by-pass lines, etc. For example, once a reprocessing plant becomes radiologically contaminated, there is no further chance for a DI review. I am not aware of any DI review of any reprocessing plant.

Also, many tank calibrations in a reprocessing plant can be performed only before an area becomes contaminated. Although verification and witnessing of tank calibration is not a design information review activity per sé, it can only be performed before nuclear material is introduced. Due to the short time interval between the submittal of the design information and the introduction of nuclear material, as well as because the plant operator simply does

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not permit the witnessing of the calibrations, the verification activity is only rarely carried out by the IAEA. This lack of assurance of tank calibrations introduces an additional uncertainty in the quantities of nuclear material, transfered and in inventory.

In the case of facilities involving sensitive information, such as reprocessing plants and enrichment plants, DI review is typically not permitted, although newsmen may be given tours. This shows the seriousness with which the IAEA is regarded in the real world.

Another shortcoming in the design information is its completeness. For example, in comparing the information on piping and tanks available at one reprocessing plant, WAK, with that provided for another, the PNC reprocessing plant, one finds that the PNC information is orders of magnitude more detailed than in the WAK case. In comparison, the WAK data is scant and probably inadequate. This is because the diversion paths and falsification scenarios possible in a reprocessing plant can only be addressed with complete knowledge in hand regarding by-pass and recyle routes, and storage locations.

In spite of, or without regard to, the adequacy, completeness, or examination of the design information, negotiations are conducted to conclude a facility attachment, to specify how an installation will be safeguarded. The country may, however, fail to agree with the Agency on the facility attachment. Years may pass.

4.2 Facility Attachment

When the facility attachment (F/A) is concluded, it is a consensus document which may permanently emasculate efforts to safeguard the installation. For example, the "actual required inspection effort" (ARIE) agreed to may be barely enough to cover scheduled visits and may leave no time to resolve discrepancies or complete tasks that took longer than anticipated. And ARIE is taken very seriously. Quite often, ARIE is about 10% of "maximum required inspection effort" (MRIE), which is specified in the "Blue Book."

Another area, particularly in the case of bulk handling and reprocessing plants where the F/A falls short is in not requiring that a "tag list or "list of inventory items" showing the gross, tare, net, element, and fissile isotope weights be made available after the "physical inventory taking" (PIT) of the operator of the installation. This tag list would be used by the inspector in his physical inventory verification (PIV). Since a tag list is often not required, very often the inspector is left to take the inventory, rather than to verify it. This is an often impossible task for the inspector, due to his limited time and manpower.

When a tag list is required by the F/A, the specific bits of information required, such as element and isotopic weights, are not called for. Again, the inspector is defeated. The reason the inspector is defeated in such circumstances is that where the operator provides the tag list only after the inspector completes his verification activities, the operator is in the position to correctly report those items that he observed the inspector to have verified, but to falsify the reporting of those items that the inspector did not verify. Thus, the operator is in a position to falsify the material balance.

Typically, a stratified list of items on inventory is required prior to the PIT, for planning purposes. A record of actions taken during the physical inventory including a list of batch data is required. The list of batch data need not be available at the PIV, and further, is usually inadequate as a basis for verification, because individual items are usually not listed. Unfortunately, the distinction between PIT and PIV is often not comprehended.

Another shortcoming of the F/A is that it usually includes a clause such as, "inspection shall be by observation of the State authority's inspection only, unless observation is inadequate to permit the drawing of independent conclusions." This clause frequently leads to haggling and loss of precious time during the inspection as to what activities are actually permitted by the F/A, and often, to the failure of the inspector to carry out necessary activities.

The shortcomings mentioned above are not an exhaustive list, but should serve to illustrate that the inspector is often doomed from the start by an inadequately negotiated facility attachment.

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4.3 Subsidiary Arrangements-General Part

This part of the subsidiary arrangements specifies how a State formally reports the inventory and transfer activity to the IAEA. There are various categories of "inventory changes" permitted. One of these is the "measured discard."

Usually there is a specified limit on the amount of measured discards which may be discarded by the operator; such a limit may be, for example, 0.01 Kg effective per month per bulk handling or reprocessing installation, of material that is "disposed of in such a way that is not suitable for further nuclear use." When the amount exceeds the limit, the state is required to consult with the Agency before discarding takes place. Since the quantities and physical form of nuclear material reported to have been disposed of are typically not verified because the discards occur at times when no inspector is present, a credible diversion path is constituted by measured discards. This situtation is compounded in severity, it would seem, in a country such as FRG, where all waste is transferred to a central waste handling facility, which is not subject to IAEA safeguards. Once the waste goes to the central facility, pending resolution of the ultimate disposal of waste issue, it is "out of sight, out of mind." Why IAEA is not permitted to inspect such a waste handling facility is unclear. At the time that the nuclear material is sent to such a facility, it often is suitable for further nuclear use.

Another category of waste removal is "retained waste." Retained waste is defined as "nuclear material which is generated from processing or an operational accident, which is deemed to be unrecoverable for the time being, but which is stored." Waste in this category, without regard to quantity, may be transferred out of inventory. Such waste no longer appears in the operator's book inventory records and is not reported to IAEA in the physical inventory list after the operator's physical inventory taking. Only by searching back to the time the transfer to retained waste occurred would a record be found. It is, therefore, "out of sight, out of mind." Considerable quantitites of "retained waste" are stored at some bulk handling installations, but are not periodically verified by an IAEA inspector.

5. RECORDS AND REPORTS

Under this heading, I discuss the records of the installation and the reports that are submitted by the installation via the State (or regional authority such as Euratom) to the Agency.

5.1 Records

The Agency requires a system of records and reports in the facility attachment. The records are of two kinds, namely, (1) accounting records and (2) operating records.

I saw great differences between the quality of the accounting records from State to State and, within a State, from installation to installation.

I found, for example, that in FRG the records were not organized conveniently in the sense that in order for the inspector to perform a simple audit of the records, considerable time had to be wasted to summarize the activity that occurred since the previous visit. For example, in one major facility, the records were kept according to financial account. There were about 300 of these. There was no general ledger summarizing activity in the several hundred accounts, but there were numerous transactions within and between accounts. I found that to effectively carry out my audit, I had to create my own general ledger. During each inspection, I wasted several days in this activity. The facility simply saw no need to keep a general ledger, for its purposes. The point is that the operator or the State can cause the inspector to waste a lot of his limited time.

With regard to operating records, I also found deficiencies. For example, in one facility, there was no record kept of the final disposition of plutonium samples. Such samples were said to be returned to the process. But, one would expect a record kept showing date, time, and identity of the reintroduced

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samples. The Agency simply does not concern itself with material control at that level of detail.

5.2 Reports

I noted that neither in FRG nor in Japan, nor elsewhere as far as I know, did a system of material transaction reports exist, such as does exist in the U.S. with the form NRC/DOE-741. This system is effective, in that serially numbered forms are issued by the shipper of nuclear material and are acknowledged by distribution of return copies by the receiver. These forms are matched by computer in the U.S. system to detect material missing in transit and to flag shipper-receiver differences. In the absence of such a system, an item missing in transit or shipped to an unauthorized recipient could go undetected.

The Agency system, however, requires the reporting of transactions to the Agency one month after the month in which they occurred. One way to detect material missing in transit or not shipped to the stated recipient, after the fact (but rather shipped to an unauthorized or undeclared recipient), is to compare each shipment declared as shipped in the monthly report with each shipment declared as received. When I arrived at the Agency in 1977, I found that this was being done in summary form, well after the fact, by a clerk, in the case of Japan under the Far East Section. However, with the advent of magnetic tape reporting with NPT in January, 1978, this comparison, known as "running the transit accounts," became the responsibility of the Section for Data Processing Operations, Division of Safeguards Information Treatment, in the Department of Safeguards. This Section has responsibility for all NPT reporting. It was claimed that it was impossible to run the transit accounts because sufficient design information for all installations to permit preliminary error screening of reports had not been provided by the inspectors. Thus, the emphasis changed from accounting to that of the use of the computer as a device of interest in its own right. At a later date, it was claimed that transit accounts could not be run because batch numbers provided by shippers were not always the same as batch numbers provided by receivers. Another problem, in the case of EURATOM reporting, was that France did not report to the Agency except for the one facility under safeguards, so that transactions between France and another EURATOM country could not be checked. Thus, for a variety of reasons, I was repeatedly told that the transit accounts could not be run. It was our belief, in EURATOM section of IAEA, however, that transit accounts were run by EURATOM, EEC, Luxembourg prior to the dispatch of the monthly reports to the Agency. On one occasion, I was granted a special, nonroutine check of transit accounts, due to absence of supporting records. At that point, DIT was willing to entertain a special request. Several months elapsed in the course of running transit accounts for a single installation. I learned that there were shipments and receipts that did not match. We informed EURATOM, Luxembourg, who replied that they had not detected this due to a computer malfunction. This episode lead me to believe that Luxembourg was not running transit accounts either. Thus, the Agency had, and presumably still does not have, any routine assurance that a stated shipment to an installation within a State or a group of States, such as EURATOM, ever arrived. That is, with limited exception, when the Agency checks the reports of installation X, it does not compare those reports with the reports of other installations which reported transactions with installation X. Thus, it only verifies the internal arithmetic consistency of installation X's reports, in effect, treated in isolation.

Another problem area for the Agency has been its Advance Notification of Internation Transfer reports. These are not always reconciled either. And, when they are reconciled, they often don't agree, due to inability to match shipper's and receiver's reports.

Finally, the DOE sends copies of Form NRC-DOE-741 for international transfers to the IAEA. These also are gracefully allowed to pile up "in the corner." It seems that the IAEA does not need them.

6. INSPECTIONS

Although I have discussed inspections in other sections of this report, I will provide some background here as to what an inspection consists of and what it can and cannot do for various types of facilities.

During my employment with the IAEA, the types of installations that I inspected included reprocessing plants, conversion and fuel fabrication facilities (bulk handling facilities), reactors and critical facilities of various types, and laboratories.

The approach that I will employ here is to explain first how IAEA safeguards generally, comment briefly on the generic safeguards techniques, and then explain how safeguards are applied at various types of facilities.

6.1 How NRC Safeguards Generally

INF/CIRC 153, The Structure and Content of Agreements Between The Agency and States Required in Connection With the Treaty on the Non-Proliferation of Nuclear Weapons, popularly known as the "Blue Book," articles 28, 29, and 30, provides the following statement:

> 28. The Agreement should provide that the objective of safeguards is the timely detectio of diversion of significant quantities of nuclear material from peaceful nuclear activities to the manufacture of nuclear weapons or of other nuclear explosive devices or for purposes unknown, and deterrence of such diversion by the risk of early detection.
>
> 29. To this end the Agreement should provide for the use of material accountancy as a safeguards measure of fundamental importance, with containment and surveillance as important complementary measures.
>
> 30. The Agreement should provide that the technical conclusion of the Agency's verification activities shall be a statement, in respect of each material balance area, of the amount of material unaccounted for over a specific period, giving the limits of accuracy of the amounts stated.

It is important to note that in the context of article 28, "diversion" should not be equated with "removal." This is an important distinction, because typically, an Agency inspector is concerned with diversion in the narrow sense as removal.

With regard to article 29, one sees that the basis of IAEA safeguards is:

1. material accountancy
2. containment
3. surveillance

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6.2 Material Accountancy

In practice, "material accountancy" refers to the means by which the Agency verifies the presence of nuclear material that should be present at an installation based upon records and reports. This system is, in itself, made difficult because the reports occur several months after the actual movement of nuclear material. Thus, the Agency's material accountancy typically consists of verification of the arithmetic correctness of the operator's records, verification of the authenticity of the records by means of shipping documents and the like furnished by the operator, and several months after the fact, cross-comparison of this information with reports of the same operator, which he sent via his national system to the Agency on magnetic tape. As mentioned previously, the Agency has thus far found it virtually impossible to inter-compare an operator's reports with reports of any other operator, to verify the veracity of the reports, especially in the case of States under NPT.

Article 30 refers to the so-called MUF statistic, which is the operator's statement of the amount of nuclear material, based upon his physical inventory taking, that is apparently discrepant from the amount that is supposed to present, based upon his records over a period of time. The LE (MUF) is typically not calculated, although the Agency has good intentions of calculating an approximate LE (MUF) in the future.

Very rarely the Agency calculates a $\hat{D}$ statistic, which is the inspector's MUF, based upon his verification of the operator's statement. This is typically incomplete, because the inspector rarely, if ever, measures all components of the operator's material balance closure and does not possess the information necessary to perform a realistic calculation. The Agency just does not have the manpower to do much verification and often does not have time to take as many samples, even with a willing operator, as it believes necessary, of even the ending inventory component.

In the best of all possible worlds, the MUF statistic is the closest that the Agency verifies the material balance. In reality, it falls very far short of what is intended, because of holes in the system which provide the MUF.

Because of the inherent difficulties of the MUF statistic, the Agency has attempted to implement a system of "timely detection" at sensitive facilities. Such implementation is, at the present time, far beyond the capabilities of the Agency to implement and beyond the willingness of the countries to undertake. It goes beyond the Blue Book, some believe, and would require massive amounts of sampling and verification, and real-time knowledge of the amounts of nuclear material moving between installations, rather than after the fact notification. At the present time, such efforts are only in their early stages.

6.3 Containment and Surveillance Measures

Article 29 also refers to containment and surveillance measures. At the present time, this refers primarily to seals in the containment category, and cameras in the surveillance category.

In the case of seals, the Agency mainly uses the so-called "IRS Type-E" seal. This seal has been around for a long time, and as early as about 10 years ago, efforts were underway by at least one foreign government to "break it." The seal has been "beefed up" by the Agnecy, but is basically an old device that requires labor intensive "post-mortem" examination, which verifies that the seal removed is the same one that was originally emplaced, rather than a counterfeit. The post-mortem examination is not necessarily capable of determining whether the seal was sureptitiously opened and then reassembled.

The Agency also uses paper seals. According to expert authority, these seals are useful for only a few hours at best, because they can be removed and replaced, and also because they can be duplicated by a good printer.

There are several other seals around, but none of these have been used, except in limited tests.

In any case, a second basic shortcoming of the use of seals is that the item sealed can often be accessed by bypassing the seal.

Camera surveillance is of two types. One is the film camera, such as an 8mm Minolta. These are typically used in pairs in a sealed enclosure. They are set, in a power reactor, to each snap a picture at 15- or 20-minute intervals, so that, at best, there is only 7 to 10 minutes between snaps. These are intended to detect movements of large items, such as a cask bearing fuel assemblies.

The other type of camera is the TV camera, which turns on at predetermined intervals and snaps 8 or so frames.

Generally, the quality of pictures obtained is extremely poor. Further, there have been numerous failures. There have been significant improvements recently in reliability, but failures still occur at an alarming rate.

One scenario, which has appeared in several literary sources, is the placement of a photograph of the viewed scene in front of the camera. This is plausible, because the illumination level normally changes as lights are turned off and on, and the frames typically jump around. But there are also more sophisticated ways to defeat the camera.

A basic difficulty associated with containment and surveillance devices is that the device is not under the continuous observation of the inspector, as would be an alarm system in an industrial setting.

In my experience, another basic difficulty with both film type and TV type surveillance is that the image is often typically not clear enough to be meaningful. Typically, many activities occur on the film that are rather baffling. Also, people stand in front of the camera and barriers are erected that block the view. The camera may be moved. The lights may go out. And, often, the camera simply fails. Further, the interval between pictures is intended to protect against a known scenario, such as a cask movement to remove fuel, where it is assumed that the Agency really knows how long the activity will take, so that the movement would be caught on film, whereas it might not really be known.

6.4 Safeguards at Specific Types of Installations

6.4.1 Reprocessing Plants

During my employment with the IAEA, I inspected at the reprocessing plants of PNC at Tokai Mura in Japan, GWK (WAK) at Karlsruhe in FRG, and once, COGEMA at Cap de la Hague in France. The first two facilities were under "continuous" inspection regimes. The latter facility only stored fuel under safeguards, but had not reprocessed any of it. Basically, uncertainties associated with reprocessing plants involve, at best, a several per cent uncertainty of MUF. At worst, a lot of other possibilities open up, including the possibility that an installation might reprocess undeclared irradiated fuel, or understate the plutonium content of the declared fuel. One installation was rumored to have posessed an undeclared, never used, natural uranium storage pond, for example. In a reprocessing plant, therefore, one should look for hidden fuel as well as account for declared fuel. But the Agency does not attempt to find undeclared fuel. For example, if a plant operator says that no fuel will be processed for one month, the Agency will stop sending inspectors for a month.

In the case of understating the plutonium content of the input dissolver solution, the scenario would entail diverting some of the input dissolver solution to avoid measuring it in the input accountability tank. At a later time, the diverted solution would be transferred from its location in, say, a tank of the rework system, where it had been stored, to the extraction and purification systems, in order to extract the plutonium, at a time when the plant was declared "down" and not under inspection. The uranium solution needed to make up for the diverted uranium contained in the divertered dissolver solution would be replaced from uranium in storage, since uranium quantities are known from fuel element manufacturer's data. This type of scenario is simply not covered by IAEA safeguards. IAEA rather bases its safeguards primarily on operator's data supplemented by camera surveillance. I know of no case where recycle acid was verified, for example, or where valves were sealed to prevent undeclared transfers. Samples are taken of the input and output solution, but are drawn from sample ports that have not been verified by design information review, so that one can't be certain where the sample came from. Further, the samples are handled in the plant by the operator and may be prepared by the operator, before shipment to Vienna. In one case, the operator and country refused to allow shipment of samples for a year on the grounds that it was illegal due to the absence of an approved shipping container. Finally, after the samples had been in the operator's control for a year, the Agency was asked if they could be discarded, because they had been standing so long. The Agency agreed.

In addition, because the samples must be diluted before shipment, analytical accuracies are reduced at Seibersdorf.

In the case of the COGEMA facility, there is no input accountability tank, so that input accountability will probably have to be based on reactor data.

An independent means of assessing the plutonium content of spent fuel is by burnup calculations and isotopic correlation techniques. Unfortunately, burnup calculations, which require verification of reactor operator's data, is not even done on an occasional basis by the Agency. Neither are isotopic correlation techniques applied. The Agency simply takes the word of the operator as to the plutonium content of the spent fuel and checks that against what it finds at the reprocessing plant, subject, of course, to the limitations of that finding.

6.4.2 Research Reactors

In the case of research reactors, as in power reactors, the potential exists for undeclared breeding of plutonium and/or U-233. In the research reactors that I inspected, of which there were several, there were no containment or surveillance measures provided to address these possibilities, nor am I aware of any measures which would have been effective. Typically, research reactors are inspected infrequently, perhaps once annually. The Agency's camera surveillance would be unable to distinguish between irradiation of fertile material samples to produce plutonium or U-233 and irradiation of medical samples, for example, even if a camera could run unserviced for one year.

One medical use of research reactors, incidentally, is irradiation of highly enriched uranium to produce molybdenum-99, which is extracted and decays to technecium-99. The Tc-99 is used for medical scanning for tumors. After irradiation, most of the U-235 still remains in the target, which is typically mixed in concrete, prior to ultimate disposal. The highly enriched uranium could be extracted, however, as a potentially attractive source of kilogram quantities of weapons grade material prior to the mixing with concrete. This extraction would probably not be detected by IAEA safeguards, since an IAEA inspector may only visit such an installation annually for one day.

6.4.3 Critical Facilities

One critical facility which I visited contained hundreds of kilograms of low exposure, weapons grade plutonium. A facility of this type is sensitive from the abrogation scenario standpoint where, under some sort of immediate threat, the country simply takes possession of all the nuclear material for immediate manufacture into nuclear weapons components. About 100 Kg of this material was under IAEA seal. During biweekly "time detection" inspections, the inspectors would visually check the type E seals on this material, in spite of the fact that these seals can be counterfeited, so that only post-mortem examination at headquarters is meaningful. I once demonstrated to the operator and the inspection team leader that, due to the absence of some needed holes in the lid and body of the container, the sealing system was inadequate; the containers could be opened, the material removed, and the lid replaced simply by removing two bolts, without disturbing the seal. I also brought up this problem in Headquarters upon return from mission. However, this situation was not corrected, possibly because Agency personnel had collaborated with the operator on the method by which the seal would be applied in the first place and felt partially obligated to go along with the outcome, when the operator said that the holes could not be drilled.

The method of safeguarding a major critical facility entails monthly sampling and remeasurement of unsealed fuel plates. The fuel plates can be remeasured to within about 3% by NDA. Perhaps 1% of the material could be removed by, say, drilling or remanufacture of the plates, without detection likely but this type of scenario is considered unlikely. Chemical analysis by the agency for highly accurate measurement of a suspect fuel plate is not foreseen in the usual facility attachment.

6.4.4 Power Reactors

Power reactors are of various types, and can be classified according to whether on- or off-line refueled, types of moderator and coolant, whether natural or enriched uranium, etc. On-line refueled reactors are considered more sensitive and safeguarding was primarily by counting all fuel elements and check of serial numbers against the invoice of unirradiated fuel elements. Identification of serial numbers on spent fuel is usually impossible. Although there is work underway, especially in Canada, to automatically count fuel elements, this was not done in my experience. Counting of power pulses on a chart was the means of verifying the number of fuel elements changed in the core in one instance, but "noise" pulses on the chart made this of dubious value. Camera surveillance was intended for loadout pond, to detect undeclared loadout of irradiated fuel by that route.

In the case of off-line refueled reactors, camera surveillance was used in the spent fuel pond area to detect undeclared loadout and seals were employed on the reactor head and/or at the entrance gate to the spent fuel pond between refuelings. Fuel elements were counted and serial numbers on unirradiated fuel elements were verified at inspections. In both cases, physical inventories occurred at annual to 18-month intervals. Nondestructive assay verification was permitted at that time. Inspection frequency ran from 3-month to 6-month intervals.

Verification of reactor operating history was by reviewing strip charts of power, steam flow, temperature, or neutron flux. Typically, a maximum of two charts were permitted to be reviewed. Access to the control room was not permitted. Rather, the charts would be removed and brought to the inspector for review in a meeting room.

The possibility of irradiation of additional fuel contained in normally nonfuel-bearing structural components of the fuel assemblies was not covered by the inspection approach of power reactors, although this has been discussed in a report on technical assistance to the Agency by the U.S. The possibility of an adaptation to facilitate the irradiation of fertile fuel by other means was also not covered. For example, there is no close inspection of the reactor vessel prior to operation or at the time of maintenance to detect a shuttle system. Burnup calculations to determine the amount of plutonium in spent fuel were not verified, nor were power monitoring devices verified.

6.4.5 Fuel Fabrication, Conversion, and Unirradiated Scrap Recovery

This part of the fuel cycle centers around the fabrication of fuel for the various types of reactors and critical assemblies.

In larger facilities, the IAEA makes approximately monthly inspections of one day duration, performs an annual physical inventory verification of several days' duration and, where large quantitites of direct use material are present, more frequent inspections may be made. A basic difficulty that I observed here are unwillingness to take samples and ship them to the Agency's Seibersdorf Laboratory, on the grounds of cost or shipping regulations. In one European installation that I was aware of, the operator wanted $1000 per sample from the Agency. A problem that I encountered was unwillingness to allow the Agency to use nondestructive assay equipment that required small radioactive sources in their operation. The operator claimed that national regulations did not permit the presence of those particular sealed sources in his plant, in spite of the presence of large quantities of plutonium. In that installation, the operator and State had refused to permit the Agency to apply timely detection continuous inspection at the facility by virtue of its contention that inspection was limited by the Blue Book to flow and inventory key measurement points. As a result, the Agency "punished" the State by reduced inspection to 2- or 3-month intervals. In this case, the State did agree after several years to the timely detection inspections on a trial, informal basis to parts of the facility. But, without full cooperation and a serious investment in computer hardware and extensive accurate measurements, which I have yet to see, timely detection is of limited value.

The Agency's approach to verification is based upon a report, BNWL-1852, "Example of Verification and Acceptance of Operator Data - Low Enriched Uranium Fabrication Plant," Battelle Pacific Northwest Laboratory, Richland, Washington, August 1974. This report provides the framework for the concept of verification of strata of flows into and out of the plant, as well as in beginning and ending physical inventories. A material balance for a period of time is formed by the plant operator from the following components on the right side of the equation:

$$MUF = BI + A - R - SR = EI$$

Where = MUF = material unaccounted for
BI = beginning physical inventory
A = additions to inventory
R = removals from inventory
SR = shipper-receiver difference
EI = ending physical inventory

If everything could be measured perfectly and there were no mistakes or unaccounted for losses or diversion, MUF would come out equal to zero for a material balance period. But due to normally occurring errors of measurement, MUF is typically not zero, but indicates apparent "loss" or "gain." The idea is to determine whether the MUF is only due to measurement error or also due to unaccounted for loss, diversion, or a mistake.

Normally, the components of the material balance will be composed of several strata each. For example, BI may be composed of good substrate material, the product material which is manufactured from the substrate, scrap, and waste. The Agency, ideally, verifies each stratum of each component of the material balance. In reality, it seldom is able to verify each component. In any case, it attempts to detect a diversion of a significant quantity of nuclear material by verifying a sufficient number of items in each stratum to provide a desired power of detection, (1-B), of the loss of a significant quantity with a tolerable false alarm rate, α. A theorem is derived which addresses the problem of whether the diversion of a significant quantity, if "partitioned across" (took place in) more than one stratum, would be detected with adequate power. The theorem shows that, if diversion were partitioned across more than one stratum, the power of detection would be as great as or greater, by virtue of a defect being found in at least one stratum, than if the diversion of the significant quantity had occurred all in one stratum.

The falacy inherent in this approach is that there will often be at least one defect due to a mistake. Thus, if any mistake is found, the Agency must alarm to the hypothesis of diversion by partitioning. And there are often false alarms (mistakes). This is even more serious when one considers that the country is the adversary, so that partitioning across all installations in a country must be assumed if any alarm occurs. Since it is patently not feasible to alarm to the possibility of diversion by partitioning across the State whenever a mistake is found, the conclusion that one reaches is that the Agency is incapable of detecting the diversion of a significant quantity or of several significant quantities, by partitioning, in any State with a moderate to large nuclear energy establishment.

7.0 What Materials This Report Has Concerned

IAEA safeguards are aimed at the control of certain direct-use materials, namely: high enriched uranium, U-233, and plutonium; and certain indirect-use materials, namely: low enriched, natural, and depleted uranium and thorium which can be converted to direct-use materials. IAEA safeguards do not control uranium ore, neptunium, and a number of other materials which are controlled in the United States by DOE and/or the NRC. Uranium ore, for example, can be converted rather simply to uranium in a form that is an indirect-use material. Absence of its control is probably one of the glaring weaknesses of international safeguards today.

A large LWR produces roughly 15 Kg of neptunium-237 per year, according to the NASAP study. The unmoderated, spherical, critical mass of neptunium-237 is roughly 60 Kg. Its control will probably be required in the future.

8.0 Summary

In this report, I have attempted to describe how IAEA safeguards work and some of their weaknesses. I have not addressed all issues; there are many which are presently the subject of R&D efforts by several countries, for example. But I hope that I have identified some of them. I think that it is clear at this point that there are not many simple solutions and that a great deal of effort and commitment of all parties will be required to address these issues.

ENCLOSURE 2

STAFF COMMENTARY ON MORGAN REPORT

Executive Summary

At the request of Commissioner Gilinsky, E. R. Morgan wrote a report based on his experience as an IAEA inspector between the summers of 1977 and 1980. The purpose of his report was to provide insight into IAEA safeguards. In particular, he addressed the technical capability of the IAEA to safeguard nuclear material. In his report, Morgan highlights a number of problem areas in the implementation of IAEA safeguards:

--Inadequate verification of facility design information
--Negotiated limitations on inspection effort in facility attachments (as well as shortage of available inspectors)
--Differences in quality of accounting records as well as operating records
--Inadequate use of accounting reports sent to the IAEA
--Incomplete MUF analysis by the IAEA
--Deficiencies in containment and surveillance equipment
--Lack of cooperation by facility operators and States in implementing IAEA safeguards
--Deficiencies in IAEA safeguards approaches for particular types of facilities (especially reprocessing plants, research reactors, and fuel fabrication/conversion plants)
--Limitations on IAEA control of certain types of nuclear material (i.e., uranium ore, neptunium, and waste material)
--Waste removal as a credible diversion path
--Lack of language training for field activities

As indicated in the staff's review of the annual IAEA Safeguards Implementation Report (SIR) and in other reports prepared for the Commission, the NRC is already generally aware of the IAEA safeguards implementation problems the report discusses. Although Morgan has provided additional specificity, he does not identify any additional significant problem areas. As indicated in the SIRs and the staff's comments on the SIRs and on Morgan's report, some of these problems seriously impact the IAEA's ability to effectively implement IAEA safeguards. While we know that some of the particular problems still exist, we do not have sufficient information to enable us to confirm whether all the identified specific problems continue to exist.

Classified By Memo from Shea to Dircks dtd 8/3/81
☐ Declassify or ☒ Review on 8/3/2001 (Date or Event)
Derivative Classifier: James D. Shea

Extended by RDS-3
Reason for Extension Foreign Relations Matter

NATIONAL SECURITY INFORMATION

Unauthorized disclosure subject to Administrative and Criminal sanctions.

1. Introduction

Staff has no comments.

2. Organization of IAEA

The report mentions a particular case where an IAEA staff member was responsible for clearing on an inspection report pertaining to his own country. Staff understands that the IAEA tries to keep an individual's responsibility for his own country to a minimum, e.g., inspectors are not permitted to do inspections in their own country (coincidentally, this is not the practice by EURATOM). On occasion, an individual may necessarily undertake certain responsibilities or require access to certain information related to his own country. This is handled on a "need-to-know" basis.

The report also notes that the IAEA does not provide language training to inspectors although there have been poor communications in the field as a result of language difficulties. Staff understands that the IAEA practice is to hold individual staff members responsible for being proficient in at least one of the four official languages of the IAEA. Member States may carry out business in one of these languages. For other languages a translator may be used. Staff is unaware of the degree to which problems have been caused by language differences. To the knowledge of the staff, the IAEA does not formally provide language training to inspectors.

3. Missions to the Agency

Staff has no comments.

4. Subsidiary Arrangements

4.1 Design Information

The first step in the application of IAEA safeguards to a facility is the completion, by the facility operator or the State, of a Design Information Questionnaire (DIQ). This information is to include (a) identification of the facility, (b) a description of the general arrangement of the facility, including the form, location, and flow of nuclear materials, (c) a description of facility features relating to material accountancy, containment and surveillance, (d) a description of the existing and proposed procedures for nuclear material accountancy and control, and (e) other information relevant to the application of safeguards, in particular organizational responsibility for material accountancy and control (INFCIRC/153, paragraphs 43 and 44). The IAEA <u>reviews</u> this design information in order to develop the facility attachment and safeguards approach. In addition, the IAEA has the right, established in each safeguards agreement, to physically examine the facility and process equipment to verify that the design information provided is accurate and complete.

In his report, Morgan states that "[i]n my experience, the headquarters review of the DI (design information) and its field verification has [sic] been inadequate." In this regard he cites the following:

1) because the General Part of the Subsidiary Arrangements may permit the DIQ to be provided only three weeks before the facility receives nuclear material, "a review* of the DI may not be possible and may not be permitted;"

2) Morgan is "not aware of DI review* of any reprocessing plant;"

3) "many tank calibrations in a reprocessing plant can be performed only before an area becomes contaminated," and verification of the tank calibration "is only rarely carried out by the IAEA;"

4) at facilities involving sensitive information (e.g., reprocessing and enrichment plants) "DI review* is typically not permitted, although newsmen may be given tours;" and

5) the design information provided for the WAK reprocessing plant (FRG) "is scant and probably inadequate."

With regard to the first point, design verification can only be accomplished after the IAEA has reviewed the DIQ and had an opportunity to become familiar with particulars of the facility design. For any bulk handling plant, the review alone is a substantial undertaking. To the extent that the Subsidiary Arrangements-General Part require the State to provide design information only three weeks before the facility receives nuclear material, the IAEA might be precluded from properly verifying the design information. The staff does not have any information as to the provisions of most NPT parties' Subsidiary Arrangements regarding when design information must be provided. While the staff does not have access to most of these documents, and does not know about the degree of compliance with the requirements they establish, in the two cases where we do know the time limits established, they are longer. The NPT Subsidiary Arrangements-General Part for the Safeguards Agreement between the IAEA, EURATOM, and the non-nuclear weapons states members of EURATOM require design information to be provided "no later than 30 days before the facility is scheduled to go into operation." The "model" Subsidiary Arrangements for the IAEA's Project Accounting Comparability Exercise (PACE)** provides that design information for new facilities is to be provided "[n]ormally not later than 180 days before the facility is scheduled to receive for the first time nuclear material or safeguarded items."

*In this section the report uses the term "review" when "verification" is apparently intended.

**PACE is a project to develop Subsidiary Arrangements based on INFCIRC/66-type safeguards agreements which will provide for full-scope safeguards comparable to NPT-type safeguards; Taiwan is currently the only country with PACE type Subsidiary Arrangements in force.

With regard to the report's second point, the IAEA routinely reviews design information for completeness at headquarters before inspectors go into the field to verify it. We understand this practice was followed for the four reprocessing plants in EURATOM and Japan, except for certain sensitive design information for WAK which was reviewed on site.

With respect to the third point, staff notes that tank calibrations can be accurately performed even when the tank has been contaminated. For example, at the Tokai-Mura reprocessing plant, tank calibration has been performed several times, including just recently.

As to the fourth point, that design verification typically is not permitted at facilities involving sensitive information, although we know that there have been such problems in the past, the staff has no information as to whether this is a current problem. However, there remains the question of whether IAEA inspectors should be permitted access to the cascade hall of gas centrifuge enrichment plants in view of the sensitive information which is visually ascertainable. Both Japan and the Urenco partners (which operate the only gas centrifuge enrichment plants currently subject to safeguards) have indicated their desire to establish, consistent with the terms of their safeguards agreements (see INFCIRC/153, paragraph 45(b)(iv)), "a special material balance area around a process step involving commercially sensitive information." The U.S. has taken the same position regarding the Portsmouth, Ohio gas centrifuge enrichment plant (which, when it is completed, will be eligible for safeguards under the US/IAEA Safeguards Agreement). Establishing such a special material balance area would require that the IAEA agree that its inspectors be denied access to that special material balance area (the cascade hall). There is currently an on-going informal Hexapartite group examing the whole question of how to safeguard gas centrifuge enrichment plants. It consists of the Urenco partners (the U.K., the Netherlands, and the Federal Republic of Germany), Japan, the U.S., and Australia. The safeguards inspectorates of EURATOM and the IAEA participate as observers.

With regard to the fifth point, that the design information for the WAK reprocessing plant in the FRG "is scant and probably inadequate," we would only note that this plant was one of the first reprocessing plants for which the IAEA received design information. (Its Facility Attachment entered into force June 1, 1978.) By today's standards, the design information provided to the IAEA might be considered by some to be inadequate. We are not aware of specific problems regarding the completeness of design information for other reprocessing plants.

4.2 Facility Attachments

The facility attachment is the document ("attachment" to the Subsidiary Arrangements - General Part) which establishes the rights and obligations of the IAEA and the operator with respect to the application of IAEA safeguards to that facility. Each facility attachment is negotiated between the IAEA and the State (often with the facility operator's participation). Although the IAEA uses its most recent "model" facility attachment for each type of facility, there are variations among facility attachments due primarily to changes in the "model" facility attachment and safeguards technology over time, the inclination and ability of the State and operator to extract concessions from the IAEA during negotiations, and differences in facility design and duration.

The report notes that facility attachments for some facilities have been pending for substantial periods of time (years in some important cases) because the State (and the operator) do not agree to provisions which the IAEA considers important or necessary. This is principally the case with gas centrifuge enrichment plants (as discussed above) and several unique facilities in the FRG. INFCIRC/153 establishes more extensive (and intrusive) safeguards rights before the facility attachment is in force ("ad hoc" inspections) than for the "routine" inspections conducted under the terms of a facility attachment. However, the IAEA generally has not been inclined to exercise these more extensive inspection rights fully, and in particular not to do so as a means of pressuring the State to agree to a facility attachment.

As the report notes, the facility attachment specifies the "actual routine inspection effort" (ARIE) by the IAEA, which "may leave no time to resolve discrepancies or complete tasks that took longer than anticipated." The ARIE, to our knowledge, always has been less than the "maximum routine inspection effort" (MRIE) provided for in INFCIRC/153 type agreements. The subject of IAEA inspection effort levels and inspection frequency will be discussed in a separate paper currently being prepared in response to Commission Gilinsky's request during the June 17 Commission meeting on SECY-81-170.

In this section, Morgan also observes that IAEA inspectors usually must conduct a physical inventory verification without a "tag list" or comparable list of the materials and items in the facility, including weights, quantities, and locations. When the IAEA conducts an inspection for purposes of physical inventory verification, it may be done either simultaneously with the operator's physical inventory taking or afterwards. In either case, the IAEA needs a "list of inventory items" (LII), variously referred to as a "tag list" or "pre-physical inventory list", for purposes of planning the inspection and for facilitating the inspection when it is carried out, especially for bulk handling facilities, where the inventory may be large and complex.

Since safeguards agreements do not explicitly require this type of reporting, the vast majority of facilities do not provide an LII to the IAEA. In certain specific cases (e.g. all LWRs in EURATOM), the IAEA has achieved stipulation in the facility attachments that an LII be prepared in advance of the physical inventory taking (but not necessarily provided for the IAEA before its physical inventory verification). Therefore, the inspection activities are planned after the inspectors arrive on site and receive an LII or enough information to serve the purpose of an LII. However, even in the cases where an LII is provided to the IAEA, the type and amount of information (batch data, including weights, isotopic compositions, etc.) are not specified. Consequently, the data may be incomplete and of limited use; or if comprehensive raw data are provided, a computer may be necessary for the IAEA to derive the specific information (e.g. stratification) necessary for the inspection.

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Morgan also cites as a shortcoming, that Facility Attachments usually include a clause such as, "inspection shall be by observation of the State authority's inspection only, unless observation is inadequate to permit the drawing of independent conclusions." This phrase reflects the desire of EURATOM and Japan that the IAEA take account of their strong state systems of accounting and control in its verification activities. In the case of the multi-national EURATOM system, this approach is implemented through "joint-team" concept.

The "joint-team" approach developed following an expression of concern by EURATOM member-states that IAEA safeguards would duplicate EURATOM safeguards and ultimately undermine the necessity and importance of EURATOM safeguards. The safeguards approach which ultimately developed recognized the fact that EURATOM has an extensive system for nuclear material accounting and control and that the IAEA should "take due account of the technical effectiveness of the State's system." Japan utilized a "most favored nation" approach to achieve the inclusion of similar provisions in its facility attachments. It can be seen how negotiation of responsibilities for certain inspection activities by a joint-team might lead to "haggling and loss of precious time." However, the Agency recognized the value of a strong State System of Accounting and Control when developing the IAEA's safeguards approach and is obligated under NPT Agreements (cf. INFCIRC/153, paragraphs 7, 31, and 81) to take such systems into account. Without more specific information the staff is not able to assess the degree to which this affects the IAEA's ability to reach independent conclusions.

4.3 Subsidiary Arrangements - General Part

In NPT-type safeguards, the Subsidiary Arrangements - General Part specifies those details of safeguards which apply to the State (such as the form and structure of reports to the IAEA) and those practices and procedures which apply to all facilities and installations in the State. In this section the report describes the accounting and inspection practices for the waste materials produced at bulk handling plants, which may be handled either as "measured discards" or as "retained waste", and expresses concern about the lack of verification by the IAEA of these waste materials.

Each facility that handles nuclear material in bulk form (as opposed to item forms, e.g., fuel assemblies) is permitted to discard up to a specified quantity of nuclear material each month as measured discards without consulting the IAEA. (The precise limit is prescribed for each facility in its facility attachment.) Measured discards are nuclear material contained in waste products which result from facility operations and which are not, in practice (which usually is to say, not economically), recoverable. The IAEA has the right to verify measured discards, but, as Morgan notes, it rarely does so, apparently due to lack of resources. In the FRG, all measured discards are transferred to one of two central waste handling facilities where the materials are held pending ultimate disposal. Contrary to Morgan's statement, the IAEA has the legal right to apply safeguards to both these facilities, but it is the staff's understanding that, lacking a safeguards approach for such facilities and apparently deeming them to be of secondary concern (see INFCIRC/153, paragraph 6(c)), facility attachments have not been negotiated for these facilities and the IAEA has not conducted any inspections of them.

"Retained waste" consists of the same sort of materials as go into measured discards, but are retained on-site instead of being discarded. Retained wastes are removed from the reported inventory after notification to the IAEA. As with measured discards, retained wastes are subject to inspection at the time they are declared to be waste. The IAEA may verify retained wastes at a future date only if the retained waste is returned (by a paper "inventory change") to the reported inventory.

5. Records and Reports

In this section the report describes some of the differences among facilities and States in the quality of record-keeping and reporting systems. The comment about one facility which maintained its materials accounts as some 300 separate financial accounts provides an example of where a good SSAC could facilitate IAEA verification activities, and how a poorly organized set of records can complicate audit functions. It must be noted that the SIR has not identified significant concerns about record-keeping. In this connection, however, the Secretariat has recently published (December 1980) recommended "Guidelines for States' Systems of Accounting for and Control of Nuclear Materials" prescribing the organization and functions of an SSAC with respect to obligations arising from a safeguards agreement with the IAEA.

Morgan also describes the IAEA's problems with "running the transit accounts", or tracking transfers of nuclear material from country to country on the basis of the reports provided by each country. Problems with the quality and timeliness of reporting by many states of their imports and exports have been described in several SIRs. In addition to serious deficiencies in the reporting of many States, it is the staff's impression that some of the problem is due to the IAEA's own procedures for processing such information.

6. Inspections

6.1 How NRC [sic]*** Safeguards Generally

Staff has no comment

6.2 Material Accountancy

In this section Morgan observes that much of the IAEA material accountancy consists of verifying the arithmetical correctness of the operator's records and verifying the "authenticity" of the records on the basis of other documentation provided by the operator. An inspector performs two basic functions, auditing the operator's records, and obtaining independent measurements to verify the types and quantities of nuclear material actually present in the facility. The latter activity includes calibrating

***Clearly,"IAEA"was intended.

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the operator's scales and other measurement equipment which the IAEA uses, making independent measurements on-site with IAEA instruments and standards, and obtaining samples of material for laboratory analysis. Although the intent of the first several paragraphs in this section of the report is not entirely clear, it may be to call attention to the IAEA placing a large degree of emphasis on auditing records relative to that placed on independent measurement of nuclear material. Staff reviews of the annual SIR and its Technical Annex make clear that the IAEA conducts only partial verification of nuclear material, as a result of limited resources and capabilities. (Section 6.4.1, on reprocessing plants, returns to this thesis that IAEA safeguards are too dependent on data provided by the operator and not sufficiently based on independent verification by the inspector.)

Morgan's statements that the Agency typically does not calculate either the D statistic (which is the MUF predicted by the comparison of the operator's reported data with the inspector's measurement data) or the limit of error on MUF (which provides the statistical, and only, basis for determining the probability that the operator's MUF represents routine measurement errors and minor operating losses, as opposed to potential diversion) are consistent with SIR information and the staff's understanding of actual IAEA practices in many, or possibly most, instances. Staff notes that the ability of the IAEA to effectively apply the D statistics is hindered by the lack of measured material balances at bulk handling facilities as well as the failure to conduct physical inventories at the frequencies specified in the facility attachments. Regarding the statement that "the Agency just does not have the manpower to do much verification and often does not have time to take as many samples, even with a willing operator, as it believes necessary, of even the ending inventory component," see also our comments on Section 6.4.5.

6.3 Containment and Surveillance Measures

Containment and surveillance measures are used by the IAEA to maintain continuity of knowledge over nuclear material in discrete item forms (such as canisters or fuel rods) in order to preserve the integrity of prior measurements, and to monitor facility equipment to preclude or detect undeclared flows of nuclear material. Containment measures essentially consist of seals, and surveillance consists of either film or television cameras with recorders.

Seals

As the report notes, the IAEA relies primarily on the IRS E-type seal (as do NRC and EURATOM). In his comments, Morgan states that "as early as about 10 years ago, efforts were underway by at least one foreign government to 'break it' (the E-type seal)." The Brookhaven National Laboratory did a study in the late 1960's for the IAEA on the tamper-resistance of this seal, and recommended changes in the procedures for its application and verification. Following this the IAEA modified the seal to make it more tamper-indicating. The staff is not aware of any attempts by other countries to develop procedures to subvert this seal (although possibly EURATOM might have given some thought to potential weaknesses of this seal as part of its independent work on the use of seals in safeguards). We are checking this point with the Executive Branch.

The report also mentions the problems with verifying E-type seals, stating that "post-mortem examination is not necessarily capable of determining whether the seal was surreptitiously opened and then reassembled." This statement is supported by the following description of these seals, contained in a 1979 IAEA report entitled "A Review of Security Seals and Sealing Systems":

> [The E-type seal] has most of the attributes required of a seal except for some of major importance. The first is that because it is a standard type of seal used all over the world it could be readily replaced by another identical seal. Although it can have specific internal markings, these are not unique and could be reproduced on a substitute seal. The second major disadvantage is that the seal identity must be determined by removing the seal and returning it to Headquarters for examination. This process can take anywhere from weeks to months. Another disadvantage is that tamper resistance of the seal itself is questionable.

In addition to the E-type seal, the IAEA uses paper seals. These seals are used when, for example, during the course of a physical inventory verification, the inspector wishes to seal something for a short period of time (hours to several days). The IAEA staff report referred to above provides the following evaluation of paper seals:

> This seal is considered to have limited tamper resistance but is considered acceptable for short time use when it would be difficult to replace or successfully remove it in the time available. Its cost is very low and it is very easy to carry and store.
>
> The paper seal has many advantages for sealing containers, rooms, or items which can be sealed by a strip across a joint. Aside from its limited tamper resistance one disadvantage is its difficult handling, particularly with gloves. The protective sheet is difficult to remove and the seal tends to tear easily when being installed (this is one of the tamper resistant features). It is also felt that because it is easily damaged it could suffer inadvertent damage due to normal handling.

The IAEA, the U.S. and several other countries have research and development programs to produce more secure seals. To date, these programs have produced seals which are significantly more reliably tamper-indicating but which are also substantially more expensive and, for some systems, much more cumbersome to use. None of these seals has yet reached the commercial production stage.

Finally, Morgan states that "a second basic shortcoming of the use of seals is that the item sealed can often be accessed by bypassing the seal." (In another section of his paper Morgan describes an instance where seals were applied to a container in such a way that the container could be opened without breaking the seal.) If applied properly, seals cannot be bypassed without clear evidence of the attempt unless extraordinary measures are undertaken. Obviously mistakes in seals application are made from time to time.

Cameras

With respect to surveillance, the report notes a number of problems with the effectiveness of both film camera units (which normally consist of two commercial 8-millimeter film cameras for redundancy, sealed in a common housing) and television camera units (which consist of a television camera and a magnetic tape recorder similar to commercial home units). The problems Morgan identifies with cameras can be summarized as:

- picture quality is often quite poor,
- failures are frequent,
- there are various ways to defeat cameras,
- the units are "not under the continuous observation of the inspector,"
- cameras may be moved,
- cameras are sometimes blocked,
- in many cases the IAEA does not actually know how long the illicit activities to be detected would actually take (hence the chosen picture frequency may be wrong).

As both the staff and the Commission are aware, the reliability of the camera systems have improved significantly, "but failures still occur at an alarming rate," as the report notes. The SIR for 1980 states that the failure rate for film cameras during 1980 was 12% (compared to 10% in 1979.) Cable Vienna 04686 of May 21 (Secret Exdis) for the IAEA states that for cameras tested before re-installation at LWRs in EURATOM, the failure rate is 30% during the testing.

The picture quality of both types of cameras remains another serious concern. Film cameras are very sensitive to fluctuations in light levels, such as will occur whenever working lights are installed or moved. Television cameras can be blinded by working lights being directed (inadvertently or otherwise) at the camera. We understand that on a number of occasions there have been problems with film being fogged by radiation. In addition, as Morgan notes and as Roger Richter pointed out in his Senate testimony, in some situations it may be difficult or impossible to interpret the actions recorded on the film (remembering that the camera takes pictures at intervals, one is not watching a continuous sequence). The camera's field of view may also be blocked or partially blocked by activities it is meant to record, or by activities that are not clear from the film.

The staff is not aware of any cases in which IAEA cameras have been moved by an operator. Any such movement would be highly unusual, and would require some justification based on the safe operation of the facility.

There are certainly methods to subvert or fool cameras, including the popular scenario of placing a large photograph of the camera's routine field of view before the lens. As the report explains, each camera takes a picture at intervals. It is the staff's understanding that, while the average interval between pictures will be adjusted according to where the camera is installed, the actual interval between any two pictures is randomly determined by the timer. Thus, while the operator may know that the camera unit takes an average of one picture every 10 minutes, or whatever, he cannot be sure when the next picture will be taken even if he has detected when the last one was taken.

The fact that IAEA cameras are timed to take pictures at random intervals would seem to respond to some degree to Morgan's concern that the IAEA might not really know how long a particular illicit activity (such as loading spent fuel into a cask) might take. Clearly, the time normally required to perform a given task will be longer, in some cases much longer, when performed for legitimate purposes than when the risk of detection must be minimized, and thus health and safety procedures are omitted. However, these times can be reasonably estimated in most cases, and the necessary number of repetitions to divert a significant quantity**** of SNM would run a high probability of being detected by randomly and frequently tripped cameras.

The report states that "[a] basic difficulty with containment and surveillance devices is that the device is not under the continuous observation of the inspector." The purpose of containment and surveillance devices is to provide some assurance as to the continued status of materials or equipment in the absence of inspectors. Although camera units are sealed to detect tampering, this detection is not immediate, but only after the seal is removed during a subsequent inspection and then examined at headquarters.

6.4 Safeguards at Specific Types of Installations

6.4.1 Reprocessing Plants

In this section the report makes the following observations about the application of safeguards at reprocessing plants:

****As defined by the IAEA, a significant quantity (or SQ) is 8 kilograms of plutonium (total element) or uranium-233 (total isotope), or 25 kilograms of U-235 contained in uranium enriched to 20% or more.

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1) Uncertainties of MUF are, at best, only several percent;
2) Undeclared irradiated fuel might be processed without IAEA detection;
3) The plutonium content of declared fuel may be understated;
4) Sample verification is inadequate; and
5) Independent assessment of plutonium content of spent fuel is not performed.

The operators' measurement uncertainties at reprocessing plants are a concern because they may be large. However, a number of studies have indicated that performance should be better than "several percent" at commercial reprocessing plants. Staff notes that Morgan made his observations on the basis of a small commercial plant (WAK) and values obtained during the startup operations at Tokai-Mura, both characterized by small throughput where relative values of MUF in terms of "percent" tend to be sizable. Nevertheless, staff believes that measurement uncertainties will be a continuing problem at reprocessing plants.

With respect to the second observation, about the possibility of processing undeclared fuel, staff agrees that any safeguards approach should include provisions for detecting such activities. The presence of undeclared fuel is less likely to occur in NPT-countries where the IAEA is charged with the responsibility of applying safeguards to all nuclear material in peaceful nuclear activities than in a country such as India, where only part of the nuclear material processed at a reprocessing plant is actually subject to IAEA accounting and surveillance; undeclared material is processed outside of IAEA safeguards. In its safeguards approach, the IAEA does include measures to detect the misuse of facilities and equipment. In recent years, the IAEA's overall safeguards conclusions in annual reports have included statements with regard to the misuse of facilities or equipment, "under certain agreements," i.e. non-NPT type, as well as diversion of declared nuclear material. Staff agrees with the report's conclusion that "one should look for hidden (undeclared) fuel as well as account for declared fuel" at reprocessing plants. However, there are some limitations deriving from the IAEA Statute with regard to the scope of IAEA activities in this area.

In regard to the third observation, scenarios for understating the plutonium content of the input dissolver solution are generally recognized by the IAEA. In its safeguards approach, the IAEA considers such diversion concerns as liquid bypassing the accountability tank, unrecorded transfers from the accountability tank and incorrect statements of recycle acid containing undeclared uranium and/or plutonium (cf. "INFCE - The Present Status of IAEA Safeguards on Nuclear Fuel Cycle Facilities", INFCE/SEC/11). It is our understanding that safeguards approaches for reprocessing plants do include consideration of scenarios which would lead to understatement of values for input dissolver solution.

With regard to the fourth observation, the report identifies deficiencies in verification of input and output solutions, and of recycled acid. The general problem of verifying design information was discussed in the commentary on Section 4.1. As a general practice, the IAEA must rely on the operator for taking and preparing samples for shipment, usually under the observation of an inspector.

The staff has been aware for some time of the problems cited by Morgan regarding the shipment of samples to the Safeguards Analytical Laboratory (SAL) in Vienna. The staff provided its analysis of the sample shipment problems which the IAEA was experiencing in a March 30, 1980 memorandum (SUBJECT: RESPONSE TO COMMISSION QUESTIONS IN CONNECTION WITH LIBRARY OF CONGRESS REPORT OF S. NAKICENOVIC) to Commissioners Gilinsky and Bradford. In that memorandum, the staff noted that restrictions on the air transport of plutonium and the lack of an appropriate shipping container were responsible for such sample shipment problems. Efforts to alleviate these problems through the dilution of samples and other more advanced approaches were also noted.

Shipment of samples from facilities subject to safeguards continues to be a generic problem affecting the implementation of safeguards. The 1980 SIR states that "the arrival of inspection samples at SAL during 1980 was subject to serious delays, with the situation deteriorating once again." The most seriously affected were plutonium bearing samples. Regulatory constraints, the availability of suitable shipping containers, export licensing, and questions relating to payment for sampled materials are cited as the limiting factors. The 1980 SIR also notes efforts by the IAEA and Member States to mitigate these problems through the development of analytical techniques which use micro-samples, consultations regarding regulatory and financial questions, the development of a lightweight air transportable container, and the development of non-destructive assay techniques which would enable inspectors to perform preliminary measurements at the facility.

Staff also has been aware of at least some of the occasions where Agency samples have been discarded after extended holding periods. The decisions of the Agency in such situations to agree to discarding samples appear to be reasonable because the shelf-life of samples is often far less than a year. This is especially true in the case of plutonium. Of course, these situations are undesirable in that serious gaps in verification are incurred.

The final observation from this section of the report is related to assessment of plutonium generation in irradiated fuel and involves consideration of a number of coupled technical issues. The IAEA has under investigation a number of methods to verify plutonium generation and content of irradiated fuel, including burnup calculation and isotope correlation techniques. All of these are subject to considerable measurement uncertainty. The staff is not aware of the degree to which any of these techniques are applied to verify the content of irradiated fuel. Some form of independent verification is needed for safeguards purposes.

6.4.2 Research Reactors

In this section Morgan states that, in the research reactors he inspected, there were no containment or surveillance measures provided to address the possible undeclared breeding of plutonium or uranium-233. We are aware that the safeguards approach for research reactors, except for a few large reactors, does not normally include camera surveillance measures, although seals may be used more routinely.

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This lack of widespread use of surveillance cameras reflects the IAEA's main inspection goal at research reactors. As stated in the SIR for 1980, the main inspection goal is "to detect the absence of fuel items (assemblies, rods, bundles, plates, pins, etc.) containing one or more [significant quantities] of safeguarded nuclear material within the timeliness guidelines." The safeguards approach which has been developed to achieve this inspection goal places emphasis on those facilities possessing one significant quantity or more of nuclear material. It is at some of these facilities (but apparently not all) that the IAEA installs surveillance cameras. The decision to install cameras is highly facility specific and depends on such factors as the amount of material present, the purpose of the facility, and such core parameters as the power and neutron flux level.

In a June 18, 1981 report by Warren Donnelly of the Congressional Research Service, the Iraqi Tamuz-1 research reactor, with a design power level of 40 megawatts (thermal), was estimated to be capable of producing no more than one kilogram of plutonium per year at normal levels of operation. Donnelly estimated a likely production rate of 6 to 10 kilograms of plutonium (approximately one significant quantity) per year if the reactor were operated solely to produce plutonium. Operation in this manner would require much more frequent refueling than would normal operation.

Assuming that these estimated production rates are accurate (the Executive Branch has stated that Donnelly's estimates coincide with its own), one can see that the clandestine production of significant quantities of plutonium in research reactors with power levels less than 40 MW (th) would be exceedingly difficult, if not impossible in the majority of research reactors which are less than 1 MW (th). The importance of this point can be demonstrated by a brief survey of the rated power capacities of research reactors and critical assemblies under IAEA safeguards. The IAEA Annual Report for 1980 indicates that 175 research reactors and critical assemblies were under IAEA safeguards or contained safeguarded nuclear material. Only twelve of the 175 facilities have power levels of 40 MW (th) or more, of the 163 with rated power levels of less than 40 MW (th), 107 are rated at less than 1 MW (th) and another 48 are rated at between 1 and 10 MW (th). The vast majority of research reactors do not have power levels sufficient to breed anything close to a significant quantity of plutonium per year. For this reason, as well as the difficulties of interpreting pictures of research activities at such reactors, the IAEA places little emphasis on the use of cameras to detect clandestine plutonium production at these reactors.

6.4.3 Critical Assemblies

This section of the report observes that a critical facility, containing hundreds of kilograms of low exposure weapons grade plutonium "is sensitive from the abrogation scenario standpoint where, under some sort of immediate threat, the country simply takes possession of all the nuclear material for immediate manufacture into nuclear weapons components." This particular scenario has long been recognized. More generally, there are several scenarios, the realization of which could result in the termination of safeguards on sensitive materials in many countries. For example, an NPT party may renounce the treaty, giving the required 90 days notice and statement of reason.

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Morgan's scenario regarding the "drilling or remanufacture" of critical facility fuel plates in order to divert a small percentage of the plutonium or HEU are, to a degree, credible. Non-destructive assay (NDA) equipment, including that used by the IAEA, is not 100% accurate. However, while the resultant margin of error could theoretically be utilized to conceal a diversion of material, such a scenario ignores the fact that if a significant number of the plates which the IAEA measured contained just 99% of the declared quantity of material, there would be a systematic negative bias in the data, easily detected as a difference in the mean of the measurements from the declared quantities. Even so, a State willing to undertake this tedious task and maintain the quality control necessary to ensure that the optimal amount of material (and certainly no more) is removed from each plate might escape detection. However, at the largest critical assembly in a non-nuclear weapons state, this scenario would net the diverter no more than 3.3 kilograms of plutonium and 5.8 kilograms of HEU (these being 1% of the total inventory), substantially less than one significant quantity of either material. For this reason, and given that the countries with large critical assemblies also have pilot enrichment and reprocessing capabilities, the staff does not consider this to be a realistic scenario.

With regard to the reports observations on seals in this section, see the staff's comments on section 6.3.

6.4.4 Power Reactors

For safeguards purposes, there are two basic types of nuclear power reactors, those frequently refuelled (a number of times a week) while the reactor continues to operate, and those which are refuelled very infrequently when the reactor is off-line. On-line refuelled reactors are generally heavy water reactors (principally CANDUs), and off-line reactors are light water reactors (LWRs). Safeguarding LWRs is relatively straight-forward, generally consisting of a physical inventory verification each time the reactor is opened for refuelling, with cameras and seals to monitor the reactor head and spent fuel pond in the interim. Safeguards for on-line refuelled reactors remain a serious problem for the IAEA. As the report notes, identification of fuel elements by serial number is usually impossible at on-line fuelled reactors, both because the serial numbers are often obscured by the effects of irradiation in the core and because of the way the fuel is discharged and stacked in the spent fuel pool. The spent fuel is stacked so that many elements cannot be verified. Unstacking would be a major job requiring substantial time and effort on the parts of both the facility operator and the IAEA inspectors. Canada is developing machines to count fuel elements as they are discharged from the core (the installation of a prototype fuel bundle counter on the KANUPP reactor in Pakistan has been the subject of recent cable traffic).

The report also identifies concerns that a State could locate fuel for breeding plutonium in structural elements of the reactor which are not normally designed for such a purpose, and thereby conceal such illicit diversion. The IAEA has contracted with Argonne National Laboratory to study these and related adaptations of reactors for diversion. The status of this project is not known.

While at the reactor site, all uranium and all bred plutonium remain in the fuel elements, which are safeguarded on an item accounting basis. Burnup calculations (estimates), are, as Morgan states, only infrequently verified at the reactor facility. These calculations do not become important for safeguards purposes until the fuel is shipped to a reprocessing plant, at which point the burnup calculations can be confirmed when the spent fuel is finally reprocessed and the recovered plutonium and uranium are measured. At this point the burnup calculations, although the best available independent estimate of plutonium and uranium input, do not provide the degree of accounting precision which is to be desired. Power monitors, although the subject of frequent interest, are not currently used by the IAEA, even though the U.S. has developed a power monitor (based on gross neutron flux monitoring) for the IAEA.

6.4.5 Fuel Fabrication, Conversion, and Unirradiated Scrap Recovery

In describing the application of safeguards to these bulk handling facilities, the report describes a variety of problems with recalcitrant facility operators, such as operator reluctance to draw and ship requested safeguards samples, excessive charges for sample material, and claims that the operators license does not permit possession at his facility of sealed sources (which contain byproduct or special nuclear material) which inspectors need to calibrate or otherwise operate non-destructive assay (NDA) equipment. Recalcitrant operators can be a real impediment to safeguards inspections, as indicated in several SIRs. Historically, one of the proposed solutions to this type of problem is to strengthen the IAEAs limited range of sanctions. Currently the IAEA staff raises such matters with the national authorities, who may either lack the appropriate framework (i.e., regulations) for applying sanctions or may not be inclined to impose sanctions on operators.

The staff notes that the formula on page 1-19 for material unaccounted for contains a typographical error. The formula should read:

$$MUF = BI + A - R - SR - EI$$

(with all terms defined as described there).

In describing the use of the MUF equation for IAEA inspection purposes, Morgan states that the inspector "seldom is able to verify each component" of the equation. As he explains, each component of the equation consists of several strata (each stratum consists of all material of a particular type, for example all UF_6 or all uranium oxide power in that equation component). For a variety of reasons the IAEA inspector is frequently unable to verify each stratum of each component of the material balance, and when any one stratum of a component is not verified, that component remains unverified. The principal reasons for the inability of the IAEA to verify all strata of each component historically have been:

- Insufficient number of inspectors to permit a team large enouch to carry out all necessary verifications at the time of physical inventory verification (for beginning and ending inventories values) as well as between physical inventory verifications (for the additions to inventory and removal from inventory);
- Insufficient equipment or techniques to measure all types of material in the strata;
- Insufficient information from the operator about the nuclear material to make a meaningful measurement; and
- Insufficient statistical methods and procedures for selecting samples on a statistically meaningful basis.

The report expresses concern about detecting a diversion "partitioned across" several installations (and strata) within a country. In past staff reviews of the SIRs, it has been clear that the IAEA has had difficulty in drawing conclusions for each facility type and especially for States as a whole. Staff is aware that the IAEA currently is focusing its attention on being able to analyze diversion for States as a whole in addition to analyzing individual facilities.

7. What Materials This Report Has Concerned

The report notes that certain forms of source material are before the starting point of safeguards, and that these forms of source material can be converted to direct use materials (that is, high enriched uranium, uranium-233, or plutonium). INFCIRC/153 defines that starting point of safeguards as "[w]hen any nuclear material of a composition and purity suitable for fuel fabrication or for being isotopically enriched leaves the plant or the process stage in which it has been produced, or when such nuclear material, or any other nuclear material produced at a later stage in the nuclear fuel cycle, is imported into the State" (paragraph 34(c)). (As INFCIRC/66-type safeguards are not full-scope safeguards, but apply only to specifically agreed to nuclear facilities and/or materials, no starting point is specified, but as a policy matter the same starting point is used for determining whether particular material is eligible for INFCIRC/66-type safeguards.) Thus, while the IAEA is informed of imports and exports of yellowcake and thorium compounds, it has no basis for verifying the condition or use of these materials until the State informs the IAEA that the material has been processed into a form suitable for fuel fabrication or enrichment. There is no obligation on the part of the State to inform the IAEA of indigenous yellowcake or thorium compounds that remain within the State until they are converted to forms suitable for fuel fabrication or enrichment.

While this aspect of NPT-type safeguards can clearly be construed to constitute a "loophole" in certain scenarios, it would be a vast undertaking for the IAEA to attempt to verify all uranium and thorium holdings in all NPT parties. Some starting point for safeguards must be established. In developing INFCIRC/153 it was determined that the point described strikes a balance between the relative utility of the material for proliferation purposes and the magnitude of the undertaking involved to adequately verify the status of the material.

Finally, Morgan notes that neptunium-237, which is produced in reactors along with plutonium (and at approximately one-tenth the rate of plutonium), could theoretically be used to fabricate a nuclear explosive. While the bare sphere critical mass of neptunium-237 is on the same order of magnitude as that of HEU, there are several reasons whyt it has not, to date, been of either international or domestic safeguards concern. One reason may be that there is no history of commercial neptunium separation. More importantly, as stated in a recent DOE memorandum:

> neptunium-237 has a daughter which emits gammas with high energy levels. This means that neptunium is hot, and when it is collected in the kilogram quantities sufficient for a nuclear device, it is extremely hot. This factor makes working with and stockpiling of neptunium for nuclear explosives extremely hazardous.

In addition, while the neptunium-237 in spent fuel may be separated by reprocessing the fuel, this involves a process at least as complex as that for separating plutonium. Thus any diverter capable of obtaining neptunium-237 is also capable of obtaining approximately ten times as much plutonium from the same spent fuel, which (because of the greater bare shpere critical mass of neptunium-237) could be used to fabricate on the order of 100 times as many explosive devices, and the plutonium, for all its difficulties in handling, is apparently easier to fabricate into weapons. However, since the technology for separating neptunium exists, we should continue to watch for indications for such activities in other countries.

ENCLOSURE 3

Addendum
to
Staff Commentary on Morgan Report

1. "[N]ationals of the country inspected have access to inspection reports, seals, seal records, etc., that concern their own country." (p. 2) In our Commentary on the Morgan report the staff noted that "[o]n occasion, an individual may necessarily undertake certain responsibilities or require access to certain information related to his own country." Particularly in cases where only one or two staff positions perform a particular function for the whole Inspectorate, it will be difficult or impossible to keep an individual from direct access to and responsibility for "inspection reports, seals, seal records, etc." concerning his own country. In these circumstances the individual's responsibilities as an international civil servant could come into apparent or real conflict with his allegiance to his country. In the latter case, the integrity of the international safeguards system itself could be seriously jeopardized.

2. "Another shortcoming in the design information is its completeness." (p. 4) As we indicated in the Commentary, the general standard as to what constitutes adequately detailed design information has evolved in recent years towards requiring more detail. In the case of facilities which have been under safeguards for more than a few years, a related issue, is the adequacy of the IAEA system for formally recording design information and maintaining records of all such information.

3. "When the facility attachment is concluded, it is a consensus document which may permanently emasculate efforts to safeguard the installation." (p. 4) As noted in the staff Commentary, individual facility attachments reflect the "model" facility attachment (and thus the accepted safeguards approach) current at the time of negotiation, with some variations due to concessions extracted by a particular state, or differences in facility design and operation. Once a facility attachment has been agreed to, many states have been quite reluctant to renegotiate to afford the IAEA rights or access not originally provided for. As the IAEA's understanding of what activities are necessary to adequately safeguard a particular type of facility has developed, the Agency has found that old facility attachments do not afford it the right to collect information or place surveillance equipment as now deemed necessary. In addition, in the case of most safeguards agreements based on INFCIRC/66/Rev. 2, the safeguards agreement itself does not provide for the use of containment/surveillance equipment, even as "complementary measures." The right to use such equipment must either be provided for in renegotiated facility attachments or under the guise of test and evaluation programs. So long as the safeguards approaches for particular types of facilities continue to develop in

Classified By Multiple sources
☐ Declassify or on 10/01
☒ Review (Date or Event)
Derivative Classifier: [signature]
Extended by DRV D9c11
Reason for Extension Intelligence information

NATIONAL SECURITY INFORMATION
Unauthorized disclosure subject to Administrative and Criminal sanctions.

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the direction of more equipment and more detailed information, while many states continue to take a very narrow legalistic view of the rights afforded the IAEA in safeguards agreements and facility attachments, old agreements will constrain the application of safeguards, and sometimes render safeguards ineffective.

4. In his discussion of material accountancy (section 6.2), Morgan seems to call attention to the large degree of emphasis placed on auditing records relative to that placed on the independent measurement of nuclear material, that is, the concentration on evaluating the consistency of all accounting documentation without necessarily verifying independently the basic data contained in those documents. Morgan makes this point in connection with safeguards at bulk-handling facilities. However, it has recently become apparent that, in a facility handling large numbers of discrete items (such as fuel elements in a CANDU reactor or a large critical assembly), the same problems can exist. In facilities with a large flow of discrete items (such as a CANDU reactor), the lack of a method for independently verifying the number of fuel elements entering and leaving the core would render the consistency of records relatively meaningless. Containment/surveillance devices installed at the facility, so long as they are properly installed and do not fail, will provide substantial assurance that all fuel elements which enter the reactor are either in core or have been placed in the spent fuel pool. However, when containment/surveillance devices fail and continuity of knowledge is lost, assurance that no diversion has occurred can only be established by a complete re-inventory of the fuel.

5. A "basic shortcoming of the use of seals is that the item sealed can often be accessed by bypassing the seal." (p. 12) That is, the seal is only as good as the integrity and tamper-indicating properties of the surrounding containment. The staff Commentary noted that: "If applied properly, seals cannot be bypassed without clear evidence of the attempt unless extraordinary measures are undertaken. Obviously mistakes in seals application are made from time to time." This is obviously true of other containment/surveillance devices, such as dosimeter yes/no monitors, as well.

6. "There have been significant improvements recently in [camera] reliability, but failures still occur at an alarming rate." (p. 13) Failure rates for movie cameras were provided in the staff Commentary. These failure rates indicate that camera failures, resulting in loss of continuity of knowledge regarding the nuclear material, remain a serious deficiency in IAEA safeguards. Apparently, even redundant equipment sometimes fails.

7. "One scenario...is the placement of a photograph of the viewed scene in front of the camera. ...But there are also more sophisticated ways to defeat the cameras." (p. 13) In the case of TV camera - video recorder systems, a more sophisticated version of this scenario is to tap into the transmission cable and feed a picture from some source other than the IAEA camera. (But see paragraph 8 below.)

8. A "basic difficulty associated with containment and surveillance devices is that the device is not under the continuous observation of the inspector, as would be an alarm system in an industrial setting." (p. 13) In the case of cameras, and other surveillance equipment, some form of tamper-indication is necessary to maintain the integrity of the equipment. Apparently IAEA TV camera systems do not have this feature (although, as noted in the Commentary, movie camera units are sealed with IAEA seals), thus requiring that scenarios such as that discussed above be considered serious possibilities.

9. "Also, people stand in front of the camera and barriers are erected that block the view. The camera may be moved. The lights may go out." (p. 13) As noted in the Commentary, a camera's field of view is sometimes blocked by the operator without first having informed the IAEA of the activity and the need to block the camera. Maintenance work is an example of legitimate activities which require temporarily blocking a camera, but, by the terms of NPT-type subsidiary arrangements, the IAEA is to be informed of such activities before they occur, except in emergencies, in which case the IAEA is to be informed promptly. However, in the case of INFCIRC/66-type safeguards agreements, where the subsidiary arrangements normally do not contain any provision for containment/surveillance measures other than seals, and cameras have been installed on an "experimental" or "test" basis, the state would have no legal obligation to inform the IAEA in advance of such operations. Thus, some states with facilities subject to safeguards under INFCIRC/66-type safeguards agreements could easily block cameras temporarily and resist any implication that this violated the safeguards agreement.

10. "Further, the samples [of nuclear material] are handled in the plant by the operator, and may be prepared by the operator before shipment to Vienna." (p. 15) In addition, there is a comparable point about camera films and tapes: that these are frequently deemed (in the facility attachment) to be the property of the operator and cannot be removed from the site, thus requiring that all development, review, and storage of the film be at the facility.

11. Morgan describes how a type of surveillance device (seals) was applied in a fashion that permitted access to the container without violating the seal. Morgan notes that he discussed this problem both with the inspection team leader and with people (he does not indicate who) at IAEA Headquarters. "However, this situation was not corrected, possibly because Agency personnel had collaborated with the operator on the method by which the seal would be applied in the first

place and felt partially obligated to go along with the outcome, when the operator said that the holes could not be drilled." (p. 16) Cases where IAEA inspectors, including section chiefs, were involved in the incorrect application of containment/surveillance equipment, or other safeguards deficiencies at a particular facility, constitute a serious problem which existing IAEA management procedures do not adequately address.

12. "In both cases, physical inventories occurred at annual to 18-month intervals. Nondestructive assay verification was permitted at that time. Inspection frequency ran from 3-month to 6-month intervals." (p. 17) It is not clear what Morgan refers to when he begins "in both cases," as this statement appears in a paragraph which otherwise describes safeguards for off-line refuelled reactors (LWRs), but the only "other case" which could be relevant is that of on-line refuelled reactors (such as CANDUs), discussed in the previous paragraph of his report. Each such physical inventory normally does not include a verification of spent fuel elements which were previously inventoried and for which "continuity of knowledge" has been maintained in the interim by cameras or other containment/surveillance equipment. When containment/surveillance fails and continuity of knowledge is lost, a complete re-inventory of the spent fuel pool is necessary. For CANDU reactors, which utilize large numbers of relatively small fuel elements, such re-inventory can be an arduous and lengthy exercise. When questions about Pakistani intentions arose in 1979, it took more than a year to arrange for and conduct a physical inventory of the contents of the reactor's spent fuel pool.

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