Application of Safeguards Procedures

The earliest applications of safeguards procedures took place in a political and technical climate far different from that of today. In the early 1960's there was a fear of the proliferation possibilities which could arise as more and more countries acquired nuclear power plants. Today nuclear power is being produced in some 20 countries without resulting in nuclear weapons proliferation. The export of equipment and technology for the nuclear fuel cycle, however, has become the subject of current concern.

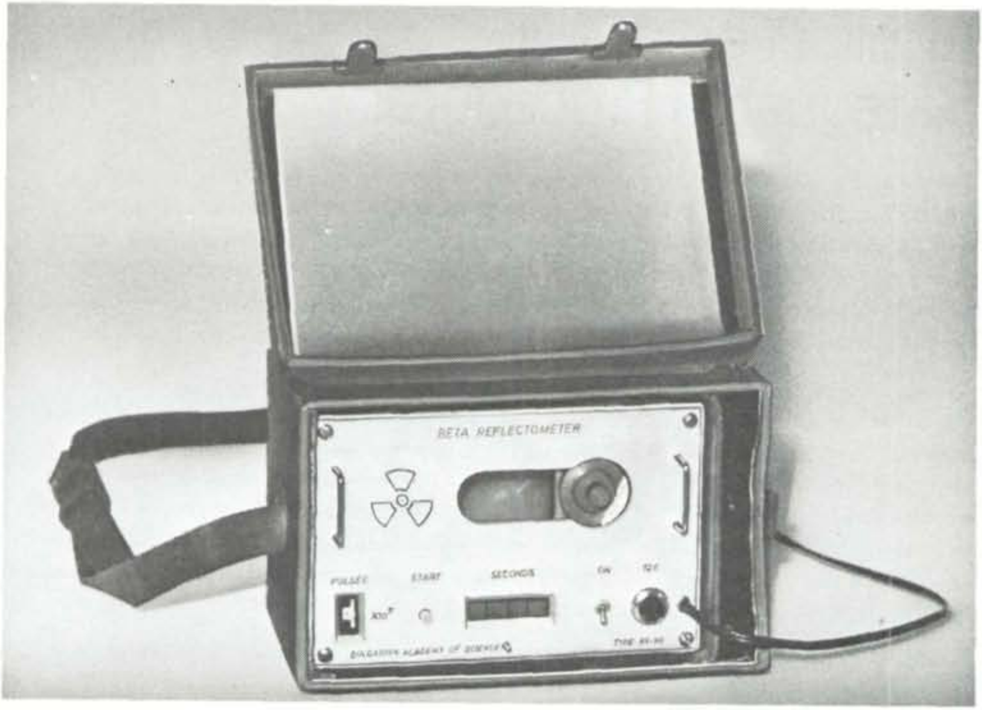
In view of these developments, it is not surprising that techniques in the application of safeguards have also changed. In order to appreciate the nature of these changes, it is important to be aware of the original general attitude towards the technical problems of safeguards applications. Originally, the common attitude was that the objectives of safeguards were self-evident and the methods, while in need of development, were known at least in outline. Today, it has become evident that before a safeguards procedure can be applied, the objectives must first be carefully defined, and the criteria against which success in meeting those objectives can be measured must also be developed.

In line with this change, a significant part of the effort of the safeguards inspectorate is concerned with work preliminary and subsequent to the actual inspection work in the field. Over the last two years, for example, a considerable part of the work of experienced safeguards staff has been spent in analysing the possibilities of diverting material at each facility to be safeguarded. These analyses are carried out in depth by a "facility officer" and are subjected to constructive criticism by teams composed of staff responsible for similar types of facilities as well as other technical experts. The analyses consider the measures currently considered practicable to meet the diversion possibilities and where necessary list the development work needed to overcome any present technical limitations. Upon completion each analysis is formalized in a Safeguards Implementation Practice (SIP) which becomes both an official guide and instruction to the field inspector for his day to day work.

Subsequent to the inspections, a formal report is prepared for each facility that has been visited. The report describes the work which was carried out and, most importantly, the technical conclusions which can be drawn are stated. The conclusions are reviewed at successively higher management levels. Starting in 1977, the conclusions of the reports are summarized and presented to the Board of Governors as a "Special Safeguards Implementation Report". To help in formulating the criteria for evaluating the reports, the IAEA Secretariat has been given the help of external consultants known colloquially as 'SAGSI', more formally as the "Standing Advisory Group on Safeguards Implementation".

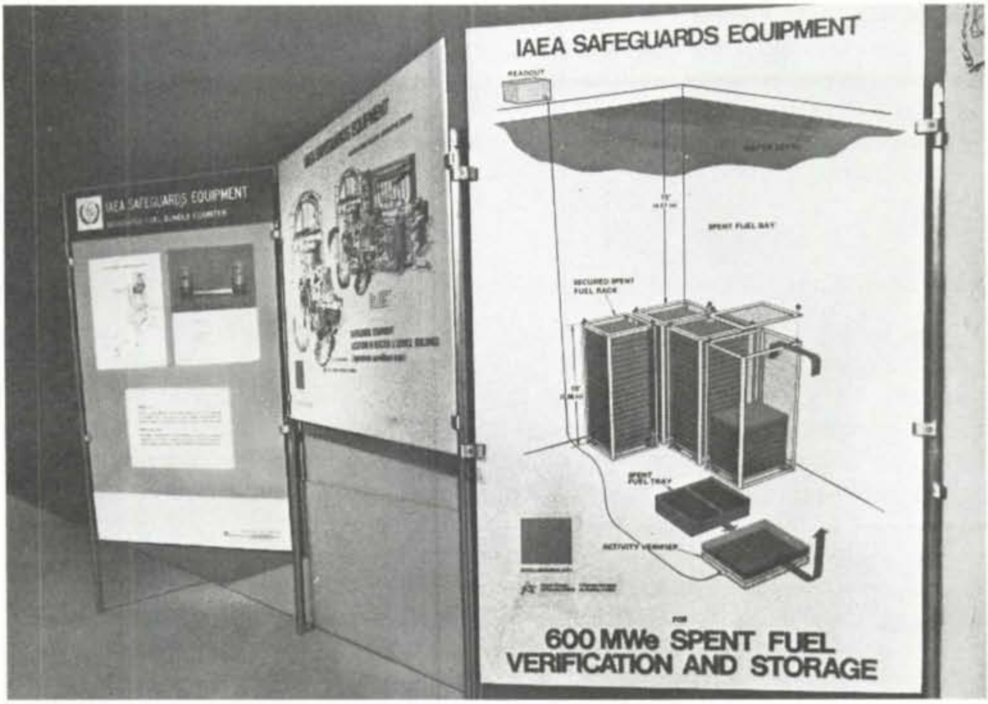
Reactors

Typically, a power reactor is the first industrial nuclear facility to be built in a country. Later when a number of reactors have been built, fuel fabrication plants become attractive, followed by uranium hexafluoride conversion plants, fuel reprocessing plants, and ultimately enrichment plants.



Portable Beta Reflectometer enables the safeguards inspector to identify the uranium or plutonium fraction of powder or pellet samples. The instrument was developed by the Bulgarian Academy of Sciences under contract to the IAEA.

Stabilized Assay Meter (SAM II), a two-channel gamma spectrometer, provides quick identification of uranium and the amount of its enrichment. This compact, portable instrument has become as important to the safeguards inspector as his briefcase. With a neutron detector, SAM II can be used for the measurement of plutonium.



Part of the safeguards equipment display at the IAEA's 21st General Conference. The panels show an irradiated fuel bundle counter, safeguards surveillance locations in a 600 MWe CANDU nuclear generating station, and verification of stored spent fuel. The techniques are being developed by the IAEA and Atomic Energy of Canada Limited.

Since the reactor has traditionally been the first type of nuclear plant to be built, early safeguards work was concentrated upon this type of facility. Experience has shown that reactors are one of the easiest facilities to safeguard, and today the development of techniques is concentrated on the other types of plant. The reason for the change in emphasis lies with the nature of the nuclear material in the reactor. Nuclear fuel is in the form of individual items, welded closed by the manufacturer, and which remain intact until after they have left the reactor site. Practical problems arise in uniquely identifying each item, should this be necessary, but this difficulty can be overcome if the criterion for adequate safeguards becomes confirmation of the total number of items on the books of the plant with the quantity of material in the items confirmed at the fabrication plant and reprocessing plant for the input and output respectively. In many respects, the verification problem for reactors is thereby transferred to other plants.

Since it is one of the objectives of the Department of Safeguards to keep manpower requirements to a minimum, containment and surveillance techniques are being increasingly employed to reduce the number of inspection visits. Camera installation is one of these and for some years now cameras have been successfully employed in some countries to provide confirmation that no fuel movements have taken place between annual shutdowns. Seals also have been used, but adequate seals capable of being checked in the field are only just passing the development stage. The camera technique is currently being boosted powerfully by the introduction of closed circuit TV recorders in place of the present film systems. Experience with TV units so far has led to a most enthusiastic demand for the new systems by both inspectorate and facility operators, since they provide for instant playback, longer intervals between servicing, selective recording of events and the ability to register events in the most adverse conditions of light and other environmental difficulties. With the use of these techniques, inspection at power plants now has the possibility of marked reduction in intensity.

Fabrication Plants

Turning to fuel fabrication plants the picture becomes less well defined. By their very nature such plants have to be capable of handling large throughputs to be economically justifiable, and so both the quantity and nature of the material can present an initially daunting picture to an inspector. No longer is he faced with well defined items. Typically he will be faced with hundreds, perhaps thousands, of drums of powder. Completed fuel assemblies, perhaps up to several hundred in number, equivalent to several reactor charges, will be in storage, many times stacked inaccessibly. Fuel pellets will be distributed throughout the plant in all stages of manufacture and hence of composition, quantity and quality. Nevertheless despite this initial impression, the task of safeguarding is not an impossible one, though the technical and managerial problems should not be underestimated. The essential point at the present stage of development of safeguards techniques is to identify the problems and decide upon the type of quantitative statements that can be made relating to each strata of material at such plants. The measurement possibilities for discarded scrap, recycled scrap, "contaminated and don't know what to do with it" scrap are all different and all have different strategic significances. In evaluating this lies the difficulty and fascination of safeguards work.

Regarding the techniques used in inspection work at these plants the importance of non-destructive, 'on the spot' analyses should be emphasized. The two main instruments used are the 'SAM II' which has become to the inspector as important as his brief case, and the Beta-reflectometer. The SAM II is a portable, two-channel gamma-spectrometer which can be set up to provide quick identification of uranium and its enrichment. The Beta-reflectometer identifies the heavy element (i.e. uranium or plutonium) fraction of a powder or pellet sample. By a combination of these two instruments it is therefore possible to get a quick reassurance of the nature of the materials being examined without the expense and time-delay of shipping samples to the Safeguards Analytical Laboratory. Of course, for precise measurements and calibration some shipment of samples is necessary.

Other more advanced instruments are used in the field for specialized purposes but their use is not widespread as yet because of the time required to transport and set up the associated subsidiary equipment. Such an instrument is the 'SELINA', a marvel of reliable miniaturization which has proved invaluable in such situations as verifying the irradiated fuel elements in reactor storage ponds in unusual circumstances where other safeguards techniques such as accountancy or surveillance have been inadequate.

To continue this description of problems and techniques for each type of plant would tax the reader's patience beyond the point at which he is willing to continue. Instead it may be of more interest to point out changes in the work in the field which have come about in the past year and which will be of increasing importance in the future.

Safeguards Agreements

Since all safeguards work is based on agreements concluded between the Government of a State and the IAEA, it was felt necessary to lay down the essential points for co-operation between the States and the Agency. As a result, the safeguards agreement under the Non-Proliferation Treaty requires that the State establishes and maintains a State System of Accountancy and Control (SSAC) of nuclear material, and lays down the types of measures to be provided by the SSAC. In this way, the SSAC becomes an essential link between the operator of a nuclear facility and the Agency. The more effective and complete the work of the SSAC, the easier it is for the Agency to reach timely safeguards conclusions.

But the conditions for taking over the operator's accountancy information vary considerably from State to State. While some States may either require that the plant operator has an adequate capability to account for the nuclear material, or even check the operator's accountancy, other States may verify independently that the plant's accountancy and control has been effective. In some cases, the verification is carried out in a similar way as the Agency is required to do. For these cases, a special protocol has been attached to the safeguards agreement regulating the co-ordination of both verification activities, those of the States and those of IAEA. Such are the cases of the safeguards agreements with EURATOM and Japan.

Many readers are aware of the EURATOM safeguards organization. Before February 1977, the EURATOM inspectorate had been alone responsible for safeguarding the nuclear material within the territory of the European Community. But since the agreement with the European Community and its non-nuclear-weapon Member States entered into force in February 1977, there is a continuous build-up of co-operation of the IAEA and EURATOM inspectorates. This year has also seen the start of co-operation with the Japanese State System which will be formalized with the expected conclusion later this year of the NPT arrangements. Although this co-operation is a novel and not an easy task, there is a common interest to provide effective co-ordinated verification arrangements.

What can be said at the present is that at field level a clear identity of interest has been found and indications for the future are excellent for establishing a working relationship which will achieve the prime aims of the working inspector — safeguards which are credible, effective and unobtrusive.