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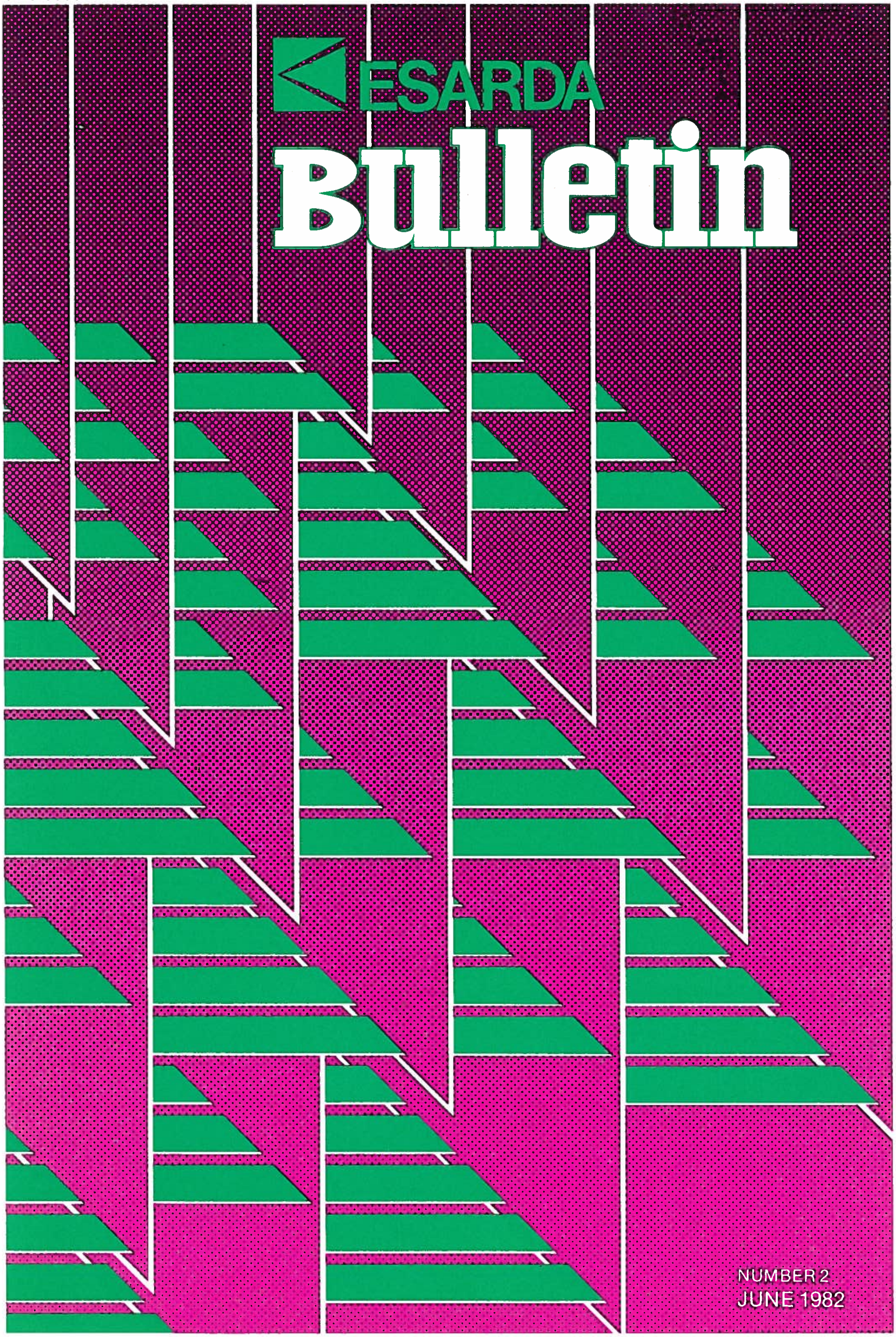
Bulletin



NUMBER 2
JUNE 1982

Editorial

The second issue of the ESARDA Bulletin is made without having initiated a periodical publication. The third issue is foreseen for next autumn and publication at regular intervals is expected starting next year.

Technical papers, information on programmes and developments, and news from the Nuclear Safeguards world are welcome. Research centres, safeguards authorities and operators are expected as contributors.

The Editorial Committee

News about ESARDA

The implementation of the new contract foresees, among other things, an updating of the representation of the parties in the managing bodies of our organization. You will find hereafter a list of newly nominated members to the Steering Committee.

CEN/SCK (Belgium)
Mr. Leblanc (Belgonucléaire)

KfK (F.R. Germany)
Mr. Boedege (DWK)
Mr. Munsch (KFA)
Mr. Stünkel (KfK)
Mr. Gerstler
(contact man from BMFT)

CEA (France)
Mr. Regnier (Cogéma)
Mr. Gloaguen (E.D.F.)

CEC
Mr. Gmelin (DG XVII, Safeguards Directorate)
Mr. Charrault (DG XVII, Nuclear Energy)

UKAEA (U.K.)
Mr. Marsh (BNFL)

These nominations represent for ESARDA a very important additional potential due to the wide general experience and specific knowledge of safeguards problems of all the new members.

Another news of prime importance is the formal set up of two new working groups, namely that of Mixed Oxide Fabrication Plant (MOX) and that of Statistical and Mathematical Problems whose convenors are Mr. Cuypers (JRC-Ispra) and Mr. Franklin (JRC-Ispra), respectively.

The first working group is obviously plant oriented and includes 6 plant operators, representing 5 countries, associated with R&D scientists from 4 research centres and the Euratom Safeguards Directorate.

The second working group is discipline oriented and it aims at solving problems of mathematical nature arising in other working groups or of general safeguards interest.

Finally, ESARDA announces the next two annual symposia to be held respectively in France (Versailles, 1983) and in Italy (Venice, 1984). The first one has already reached a good level of preparation. The call for papers has been diffused and is reproduced in this issue.

J. Ley
Secretary of ESARDA

Support Programmes to IAEA

The U.K. Safeguards R & D Programme

A.T.G. Ferguson

Introduction

In July 1980 the United Kingdom offered to help the IAEA by the provision of an R & D support programme. During the following year a programme was drawn up, agreed in detail with the IAEA and formally accepted by the Director General.

The work is carried out in the laboratories of the UKAEA at Harwell, Winfrith, Risley, Springfields and Dounreay. Close liaison is maintained with British Nuclear Fuels who independently support the Agency in a variety of ways. Liaison with the IAEA is through their Project Liaison Officers and a Steering Committee which reviews the progress and direction of the project.

The programme is aimed at safeguards of those parts of the nuclear fuel cycle with which we in the U.K. are particularly experienced such as the fast breeder reactor and its fuel cycle and uranium enrichment plants. Considerable emphasis is also given to the safeguarding of material in store which on many sites greatly exceeds the quantity of material in current use. The programme also contains a service element in which the U.K. assists the Agency with such matters as training, chemical and isotopic analysis, manual writing, etc.

In setting up the programme we have tried to avoid duplicating work in other countries or which is in progress in the U.K. under other programmes. As a result we have no general development work on seals nor generic work on nuclear material assay techniques based on gamma-ray and X-ray spectroscopy.

In the remainder of this article I will try to summarize the main content of the programme and conclude by reporting examples of progress made in one or two areas during the period of less than a year that the programme has run.

Service Programme

The calibration of chemical and isotopic reference standards and other samples by the Actinide Analysis group at Harwell supplements the work of the IAEA's own laboratory at Seibersdorf and provides another link in the international calibration net.

The principal training activity is an annual one week course run at the Atomic Energy Establishment, Winfrith, where the zero power fast reactor Zebra, and fuel cycle pilot plants provide scope for a variety of practical inspection exercises. The course has some formal lecture content but the practical exercises and their subsequent analysis provide the most important teaching medium. Two such courses have now been run and a further one is planned.

Generic Programmes

Safeguards instrumentation problems arise in a variety of contexts but instruments of varying applications may have common features. For example, most safeguards instruments require some degree of tamper resistance. Many instruments are based on neutron interrogation. We have identified a number of generic areas of this kind and set up projects whose aim is to have the necessary expertise to apply to a range of problems. In addition to the two examples already given we have work on ultrasonic inspection, nuclear reference materials and analytical methods, and applications of advanced statistical techniques and plant modelling. The latter generic project is expected to provide the basis for future work on near real time accountancy particularly the optimized design of such a system.

Applications Programmes

The Fast Breeder Reactor (FBR) and its Fuel Cycle

This area of the programme is still in active development and consequently coverage of topics of interest is still incomplete.

All fast breeder development programmes require zero power reactor for reactor physics studies and we are examining ways of applying seals to a large part of such a core so as to minimize the amount of verification required.

For the manufacture of mixed oxide fuel it is important to assess the hold up in glove boxes at the end of a campaign. Techniques based on the use of thermoluminescent detectors are being refined and calibrated to assay this material. High accuracy is not essential provided that the quantity of material left in the box is minimized and detection of a large quantity is taken as a signal for a further clean out.

In the FBR fuel reprocessing plant we have been developing weighing techniques for accountancy tanks to replace the measurement of volume. This technique has been tried elsewhere with varying degrees of success. Initial results appear very promising but success clearly depends on having the space in plant to provide sufficiently long horizontal runs of pipe between tank and plant. Clearly there are existing plants where it will be impossible to meet these conditions and as an alternative there is development of acoustic techniques for determination of the volume of liquor in dissolving tanks and similar vessels.

While there is considerable work in the U.K. on the assay of Pu contaminated waste this is outside the support programme. Within the programme particular attention is being given to the study of alternative procedures for obtaining the fissile material content of hulls and insoluble material from the head end of the plant.

For the future, it is likely that there will be a major programme of development of on-line instruments for determination of U and Pu in plant solutions based on K-edge absorption and neutron interrogation.

Centrifuge Enrichment Plants

The precision and accuracy attainable in assay of UF_6 make it possible to close the material balance in an enrichment plant with great accuracy. Problems remain, however, of assay of plant gas dumped in sodium fluoride traps, and of ensuring that all material flows are according to the plant design information supplied. To meet the latter objective we are developing a package monitor that will examine ingoing and outgoing equipment packages, a system for monitoring the enrichment of uranic deposits in plant pipework, and a gamma ray transmission method to determine the content of traps.

Stores

Probably by far the largest fraction of the world's nuclear material is in stores and this is no less true in the United Kingdom. Operational research in the U.K. has shown that by far the greatest source of error in physical inventory taking and accountancy is human error. We have therefore begun a programme to develop systems which eliminate this element as far as possible. The first step is to have electronically readable labels and a system based on bar code has successfully undergone field trials and is now in service. Further development will give full alpha numeric capability in this form. Software to handle and file nuclear material accountancy information and carry out audit functions is also under development. A very simple platform monitor system useful for short term custody of material packages during audit and other operations is also entering the field trial stage.

Progress

The project has formally been under way for less than a year but some elements of it are based on previous work and have reached a stage where progress can be reported. Two projects will be discussed — the development of a package monitor and the ultrasonic verification of the integrity of storage cans.

Package monitor

There are a number of circumstances where one may wish to determine or set limits to the quantity of fissile material present in a large package which for operational reasons may not be opened. One example is in packages containing equipment whose detailed design reveals proprietary information but which should on the way in to the plant contain no fissile material and on the way out should at worst be contaminated. Without some form of inspection such a package could be a vehicle for transport of substantial quantities of material. The package offers the opportunity for shielding fissile material and so methods based on passive detection of neutrons or gamma rays could be rendered ineffective. After consideration of a number of alternatives a system based on interrogation by 14 MeV neutrons with detection of delayed fission neutrons was selected. The same apparatus may also be used to measure the die away time or mean lifetime of thermal neutrons in the chamber.

We have investigated by Monte Carlo computation a system consisting of a rectangular cavity 2m x 1m x 1m internally, enclosed on all sides by polyethylene 25 cm thick. In one wall a fast neutron detection array was located containing 20 Cd wrapped BF_3 detectors 5 cm diameter, and 100 cm long filled to a pressure of 700 Torr. The neutron source postulated was a tube emitting 10^8 14 MeV neutrons/sec. A bare BF_3 counter inside the chamber monitors the thermal flux. Delayed neutron counts were calculated on the basis of a total assay time of 630 sec, a background counting period of 210 sec together with thirty cycles of irradiation for 7 sec followed by counting for 7 sec. With a sample containing 5 kg of 20% enriched uranium the number of delayed counts was computed when the sample, wrapped in 1 mm of cadmium was enclosed in increasing thickness of shielding material. The effect of this shielding material on the die away time of the chamber was also estimated by extrapolation from experimental results with a small chamber. It was re-assuring to find that the quantity of shielding required to disguise the presence of uranium significantly lowered the die away time of the chamber. A full size chamber is under construction and it is planned to verify these conclusions experimentally.

Ultrasonic Weld Signature Verification

The precise quantitative assay of PuO_2 and mixed Pu and U oxides is a time consuming process and once carried out the material is stored in steel cans whose ends are sealed by a welded plate. In order to demonstrate that the assay continues to be valid it is desirable to verify the integrity and identity of the container. We have developed an ultrasonic method which provides a unique and reproducible signature from a weld.

The method involves launching ultrasound as a low order Lamb wave along the can parallel to the can axis and recording echoes from the welded region. Signatures are obtained by repeating this at all circumferential positions.

A transducer assembly was built which consisted of a 1 MHz piezoelectric transducer, a water wedge and a rotational position encoder. Type Ao Lamb waves were launched into the can wall from the transducer, through the wedge. Position around the can circumference was recorded by monitoring the output of the position encoder driven by a friction wheel as the assembly is moved around the can's circumference.

The transducer was driven in pulse echo mode. Echo waveforms were amplified using automatic gain control and digitized in a transient recorder and processed by an LSI-11 computer.

Tests were carried out on a can of 150 mm diameter. Figure 1 shows the juxtaposition of echo waveforms from 37 adjacent circumferential positions (separated by approximately 1 mm). The horizontal axis is flight time and the vertical axis is position. A changing pattern of echoes is seen in this figure. The data in Figure 1 are used as the signature and are stored on a floppy-disc. A correlation scheme was devised to compare any two signatures. It works by overlaying one signature on the other and calculating the absolute sum of differences of echo amplitudes along each circumference line. This result is plotted for all possible overlay displacements (i.e. for integer number of circumference points). The plot will show a sharp minimum for similar signatures at the displacement where the patterns are correctly aligned. If the signatures are identical then the minimum would become zero in the absence of noise.

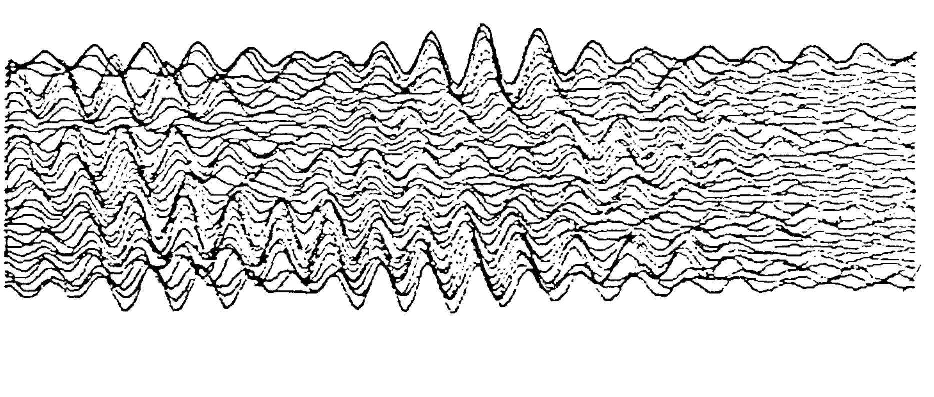


Fig. 1. Can signature (~ 1/10 circumference)

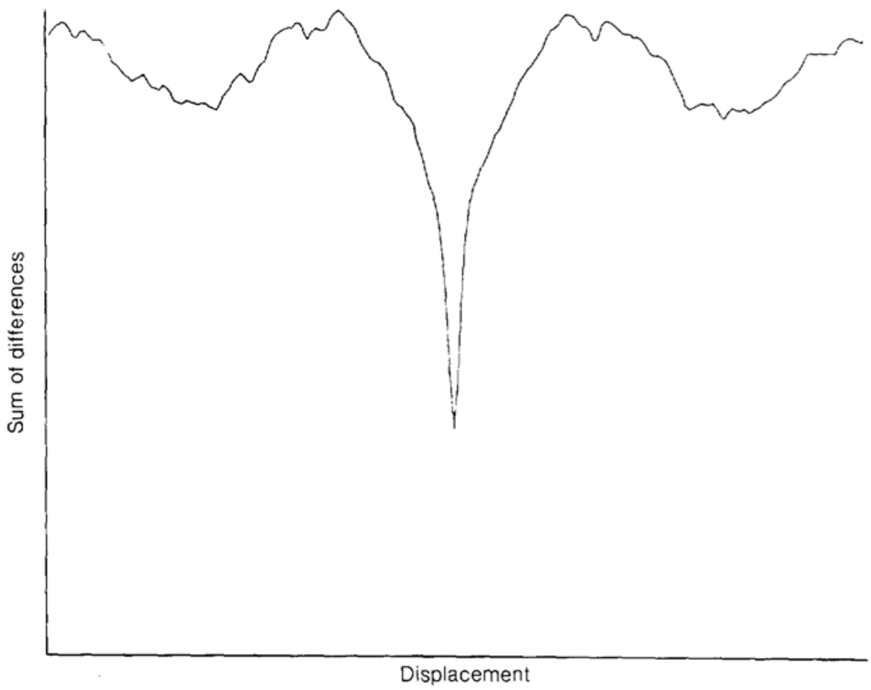


Fig. 2. Cross correlation

Figure 2 shows such a cross correlation of two signatures for a real situation.

In order to have a wider test for the correlation two signature records from the same can were each divided into four shorter signatures. These were used as if they were from four cans whose circumference is 1/4 that of the actual cans. There are 16 possible permutations of these signatures. Of these only four showed good correlation (when corresponding 1/4 cans are correlated).

Considerable work has been done to establish that transducers can be changed without selection and still give consistent signatures. The weld signatures are undoubtedly unique. Electronic hardware is available which can measure and analyse a signature in a few seconds. There is scope for further development towards the use of electromagnetic coupling which would eliminate the water coupling presently in use.

Joint Programme on the Technical Development and Further Improvement of IAEA Safeguards between the Government of the Federal Republic of Germany and the IAEA

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Nuclear Safeguards Project
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KfK, Karlsruhe, F.R. Germany

Introduction

The system of international safeguards has been accepted worldwide as a most important technical means of preventing proliferation. Establisment and maintenance of this reputation, i.e. of effectiveness, practicability and credibility of international safeguards, in view of a continuously growing nuclear energy market, consequently require continuous and multifarious research and development efforts. Since the International Atomic Energy Agency, IAEA, does not have the financial resources to operate a special research and development laboratory, it depends on the support of its Member States. Thus, extensive support programmes have been offered to the Agency by several Member States in the course of the past years, the U.S.A., Canada and the Federal Republic of Germany being the first. Projects with Australia, Japan, U.S.S.R., U.K. and Euratom have followed or are under preparation.

Scope of the German Support Programme

The "Joint Programme on the Technical Development and further Improvement of IAEA Safeguards between the Government of the Federal Republic of Germany and the IAEA" was offered to the Agency in late 1978. The aim of the programme is to assist the Agency in the elaboration of effective and practicable safeguards in accordance with the requirements of both the international supervisory authorities and the nuclear plant operators.

The joint programme covers a broad spectrum of safeguards problems in almost all parts of the nuclear fuel cycle, reflecting the extension of the peaceful use of nuclear power in the Federal Republic of Germany. The assistance offered refers to a variety of subjects such as safeguards approaches, systems studies, safeguards data and information processing, nuclear materials measurement and verification technologies and equipment, containment and surveillance measures and devices, etc. The assistance includes research and development work as well as the provision of equipment, field testing of equipment in nuclear facilities, training of Agency staff members in hot laboratories and nuclear facilities and, last but not least, the delegation of cost-free experts to the Agency.

The individual tasks of the joint programme are executed by public and private institutions in Germany. The major part of the work is carried out by the Nuclear Research Centres in Karlsruhe and in Jülich; besides, a considerable number of firms of the nuclear industry in Germany are involved (Table I). The Commission of the European Communities is participating in a twofold way. On the one hand, the Safeguards Directorate in Luxembourg acts as a permanent observer at the Joint Committee and "Programmrat"; on the other hand, its safeguards laboratories as well as those of the Joint Research Centres, Ispra and Karlsruhe, are actively co-working in several tasks.

Survey of Contents Main Progress

The joint programme is subdivided into four major task areas. The subject matter treated in each major area under the individual tasks is summarized in Table II. In this paper, the contents as well as the main results can be reported very briefly only; for further information see ref. 1-3.

Safeguards System Designs and Safeguards Approaches

This task area encompasses assistance to the Agency in the development, evaluation and testing of safeguards approaches for future reprocessing plants as well as for advanced reactor systems, the prototypes of which are under construction, and for the existing nuclear research centres KfK and KFA. While in the case of the SNR 300 fast breeder prototype, the discussion of the safeguards system has progressed well, it has been brought to a close in the case of the THTR thorium high temperature reactor prototype. Development and testing of computerized data acquisition and processing systems for nuclear materials control at KfK and KFA can be considered as nearly completed.

Emphasis will be put in the future on another task aiming at assisting the Agency in the development of a safeguards effectiveness assessment methodology. This task will be run on a long-term basis, starting with individual nuclear facilities like LWRs, passing to several facilities linked with each other via the fuel cycle and culminating in a complete state's fuel cycle. Delegation of a cost-free expert working on this subject underlines the importance attached to this task.

Safeguards Data Collection, Treatment and Evaluation

The development and implementation of statistical evaluation procedures relevant to safeguards in different nuclear facilities concentrated in the past, e.g. to the MUF-D-evaluation problem. This subject will be treated in the future as part of a safeguards approach for a reprocessing plant mainly based on near-real-time accountancy.

The specification, development and implementation of data evaluation software for supporting and increasing the effectivity of inspections in nuclear facilities is another important subject in this area. In the framework of supporting the IAEA information system, the delegation of a cost-free expert to the Agency's headquarters should be mentioned as well as the provision of funds for the ADABAS data base management system or the supply of hardware components such as computer terminals, printers, remote terminal controls, etc.

A cost-free expert is delegated to the Safeguards Evaluation section, especially for planning and implementing methods of evaluation of safeguards effectiveness from types of information already available at the IAEA.

Table I : JOINT PROGRAMME GERMANY, F.R. — IAEA

Organizations and Industries Involved

Nuclear Research Centres

Kernforschungsanlage Jülich GmbH (KFA)
Kernforschungszentrum Karlsruhe GmbH (KfK)

Nuclear Industry

ALKEM GmbH
Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH (DWK)
Hochtemperatur-Kernkraftwerke GmbH (HKG)
Hochtemperatur-Reaktorbau (HRB)
Internationale Natrium-Brutreaktorenbau Gesellschaft mbH (INB)
NUKEM GmbH
Reaktor-Brennelement-Union (RBU)
Schnelle-Brüter-Kernkraftwerksgesellschaft mbH (SBK)
URANIT GmbH
Vereinigung Deutscher Elektrizitätswerke (VDEW)
Vereinigte Elektrizitätswerke Westfalen AG (VEW)
Wiederaufarbeitungsanlage Karlsruhe Betriebsgesellschaft mbH (WAK)

Bundesanstalt für Materialprüfung (BAM)

Commission of the European Communities

Joint Research Centre, Ispra
European Institute for Transuranium Elements, Karlsruhe
Directorate Luxembourg (Observer)

Table II : JOINT PROGRAMME ON THE TECHNICAL DEVELOPMENT AND FURTHER IMPROVEMENT OF IAEA SAFEGUARDS BETWEEN THE FEDERAL REPUBLIC OF GERMANY AND THE IAEA

A. Safeguards system designs and safeguards approaches

- Reprocessing plants
- Sodium cooled fast breeder prototype (SNR 300)
- Thorium high temperature reactor prototype (THTR 300)
- Nuclear research centres (KFA, KfK)
- Safeguards effectiveness assessment methodology

B. Safeguards data collection, treatment and evaluation

- Statistical analysis of alternative data evaluation schemes
- Procedures for monitoring the quality of analytical data (evaluation of interlaboratory differences)
- Information system for nuclear facilities
- IAEA information system ISIS (ADABAS data base management system and hardware support)

C. Measurement methods and techniques

Assay systems (development and testing)

- K-edge densitometer for U and Pu concentration measurements in solutions
- μ-processor based γ-spectrometer for determination of relative isotopic content of Pu in solids
- automated X-ray spectrometer for reprocessing input verification

Measurement techniques (development, assessment, examination)

- tracer technique to verify calibration of accountability vessels
- mass determination of UF_6 in cylinders
- resin bead technology
- DA and NDA techniques for analysis of U/Th fuel
- laser fluorimetry for trace U analysis in waste streams

Service

- field testing of NDA-equipment in nuclear facilities
- training of IAEA staff in analytical methods at hot laboratories
- provision of analytical capacity, e.g. for interlaboratory comparison experiments

D. Containment and surveillance

Sealing systems and techniques for

- LWR-reactor fuel assemblies (BWR and PWR)
- research reactors
- multiple purposes

Super-8 film camera system

Service

- test of C/S-systems under field conditions in typical nuclear facilities
- test of remote communication system (RECOVER)

Measurement Methods and Techniques

In the area of measurement technology, tasks relate to the examination, assessment, and further improvement of existing measurement techniques as well as to the construction and in-field demonstration of instruments for dedicated purposes. As one of the most important contributions in this area, the X-ray generator based K-edge photon absorptiometer developed at KfK should be mentioned (Fig. 1). After successful off-line testing and performance evaluation, the densitometer will soon be installed and operated in hot field service of a plutonium processing facility. Within the development of a multi-purpose automated system for NDA-analysis by inspectors performed by JRC-Ispra, the specific data evaluation software for plutonium isotopic determination by γ-spectrometric measurement has been elaborated. Several kinds of services rendered to the IAEA take an important rank; e.g. field testing of NDA equipment in German facilities offered in some cases in the framework of the U.S. support programme, is of particular importance to the Agency.

Containment and Surveillance

Containment and surveillance systems and techniques are also considered according to their increasing importance as a complementary safeguards measure. A demonstration experiment for sealing of LWR fuel assemblies has been started at VAK-Kahl with the sealing of KWU as well as EXXON-BWR fuel elements. This task, i.e. the demonstration of the ultrasonic sealing technique, is performed in a close cooperation with the Joint Research Centre Ispra (see Fig. 2).

An electronic sealing system, VACOSS, using fibre optics, has been developed to seal rooms and containers accommodating nuclear material, nuclear instrumentation and equipment*. Adapter boxes have been constructed for active interrogation of the integrity and identity of the seals. Ten complete VACOSS-III systems will be delivered to the Agency for field tests.

As a contribution to the development work on optical surveillance systems an advanced film camera system should be mentioned (Fig. 3). Based on optical and mechanical components of a commercial super-8 movie camera, it has been equipped with completely novel electronics and an optical supplement for date and time annotation on each frame. A small series will be manufactured and submitted to the Agency.

Organization

The execution of the support programme is supervised by the Joint Committee, the members of which include representatives of the Agency and of the Federal Ministry for Research and Technology. At its semi-annual meetings, the Joint Committee takes the appropriate decisions with regard to supplementing and updating the list of tasks, clarifying issues raised by either side during the execution of the programme, and examining results of the individual tasks.

A "Programmrat" convened by the Federal Ministry for Research and Technology and composed of representatives of the Nuclear Research Centres of Karlsruhe and Jülich, and the nuclear industry involved in the support programme is responsible for internal harmonization. The "Programmrat" advises on the continuation of the programme, the distribution of the funding allocated to the programme and on other subjects to be treated by the Joint Committee.

Contact persons nominated for each individual task by both the Agency and the German side are responsible for close cooperation and timely exchange of information.

On behalf of the Federal Ministry for Research and Technology, the "Projekt Kernmaterialüberwachung" (formerly "Projekt Spaltstoffflusskontrolle") of the Karlsruhe Nuclear Research Centre has been charged with the coordination of programme implementation.

References

1 List of Tasks, Edition October 1981; JOPAG/10.81-LOT-5
2 List of Progress Reports 1978-1980, June 1981; JOPAG/06.81-LPR-1
3 List of Progress Reports 1981; JOPAG/10.81-LPR-2

* For detailed information see: F. Arning, H. Reuters, H. Büker, "Remote Veryable Sealing System for Safeguards Application", this issue of the ESARDA Bulletin.

Fig. 1. K-edge Photon Absorptiometer Developed at KfK (Task C.2)

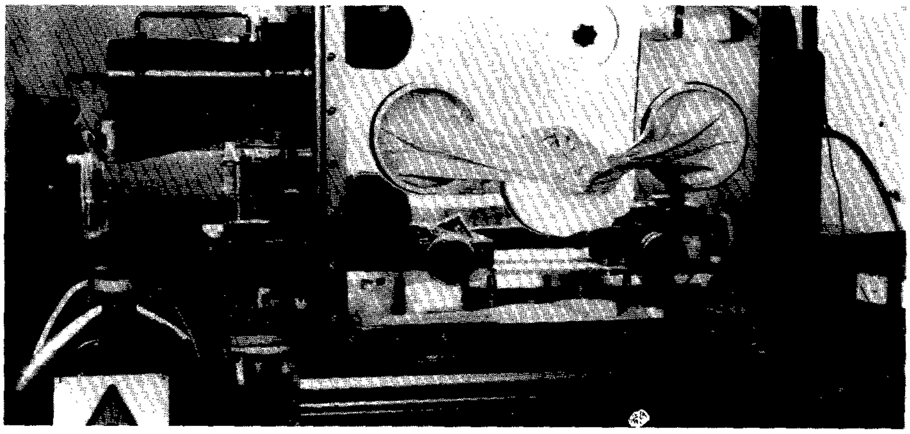
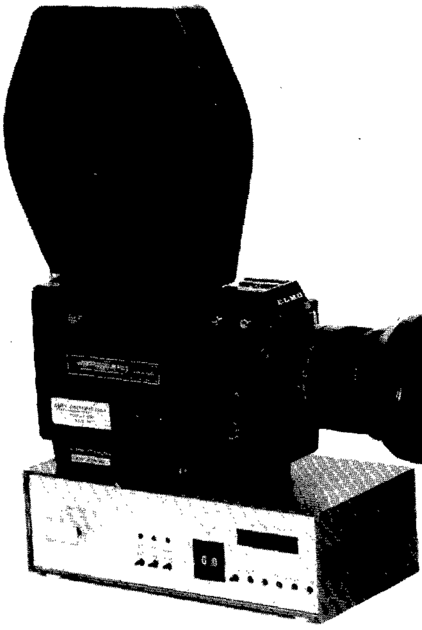


Fig. 2. Ispra Ultrasonic Seal Attached to LWR Fuel Assembly (Task D.3)

Fig. 3. Advanced KfK Film Camera System (Task D.5)



Activities of the ESARDA Working Groups

Destructive Analysis

P. De Bièvre, CBNM, Geel
Convenor of the ESARDA Working Group on Destructive Analysis

Destructive measurements form the basis of any nuclear material accountancy by providing the values for the amounts of fissionable elements and isotopes in circulation. Presently they are also used to provide the characterization values of samples and materials used to calibrate non-destructive methods of assay. Both 'declaration' values from nuclear plants and organizations and 'verification' values obtained by Safeguards Authorities, are presently based on destructive measurements by laboratories.

There are good reasons, therefore, for a regular meeting of representatives of European laboratories involved in measuring fissionable material. Such a meeting forum has gradually come into being in the ESARDA working group on Destructive Methods. Thirty laboratories are now represented in the group including plant operator laboratories. They meet twice a year (1.5 - 2 days) preferably on a laboratory site (Karlsruhe, Harwell, Mol, Grenoble, Berlin). Meetings are sometimes preceeded by a one day topical meeting where specialists treat topics such as :

- UF_6 isotopic measurements
- UF_6 element assay
- European laboratories participating in the US SALE programme (Safeguards Analytical Laboratory Evaluation).

This mode of organization gives the opportunity for colleagues in the field to both discuss highly specialized matters and meet during the plenum many other colleagues responsible for 'measuring fissionable material'.

The group has received the IAEA Safeguards Technical Manual, Part E, Methods and Techniques, and transmitted a number of comments to the IAEA.

It also discusses interlaboratory measurement evaluation programmes aiming at

- establishing the present state of the art of a given method of analysis or technique under realistic operational conditions
- establishing an objective basis for regarding difference between measurements from different laboratories as significant
- promoting improvement of precision and accuracy amongst laboratories measuring fissionable material
- determining in a uniform manner for all laboratories the reproducibility of the measurements of each laboratory
- allowing each participating laboratory to determine its bias.

The interlaboratory programmes considered so far are AS-76 concerned with the determination of Pu-238 abundance by the measurement of the Pu-238/Pu-239 + Pu-240 activity ratio, IDA-80 concerned mass spectrometric isotope dilution measurements of uranium and plutonium in feed solutions of reprocessing plants and an interlaboratory measurement evaluation programme on UF_6 isotopic measurements.

A total of 38 laboratories from 11 countries are participating in IDA-80. The test material was an input solution of 15 MWd/kg burn-up from which three kinds of test samples were prepared, characterized and distributed :

1. undiluted feed solution ("A"-solution)
2. diluted feed solution ("B"-solution)
3. reference solution, fission product free ("R"-solution).

The following spikes were used for the required Isotope Dilution Measurements : a) U/0.3%Pu solid mixed spike with U-235/U = 0.88 and Pu-242/Pu = 0.875; b) U/Pu mixed spike solution with U-233/U = 0.997 and Pu-242/Pu = 0.875. Accurate isotopic and elemental assay of the test samples to serve as reference, is being performed by CBNM-Geel and NBS-Washington.

The final results are expected by the end of 1982 and will allow a clear judgement of the degree of credibility of measuring U and Pu worldwide.

The interlaboratory measurement evaluation programme on UF_6 (isotopic) is to be understood as a continuous measurement evaluation programme with a cycle time of one or half a year. In the first round a sample pair at enrichments of U-235/U = 0.028 and U-235/U = 0.030 was sent to 8 participating European laboratories. Each sample was characterized by CBNM-Geel.

One of the early achievements of the group (1976) was to review the status of reference materials for safeguards measurements and advise on projects for acquiring materials which are presently lacking. It agreed with CBNM in its initiative to obtain enriched U-233, Pu-242 and Pu-244 spike isotopes so that discrepancies between declaration and verification measurements would be minimised by the use of spikes from the same source. It also supported CBNM to improve the precision on its existing UF_6 reference materials from 0.15% to 0.05% total uncertainty. A list of these materials discussed and approved by the group and now available from CBNM is given in Appendix I.

A difficult problem for a safeguards inspectorate is to decide when two independent values of analytical measurements, the "declared" value of the operator and the "verification" value of the control differ significantly and the working group addressed itself to this problem. Considerable problems and objections arose during the discussions on this topic and the matter was postponed until it would be better known which use would be made of it by Safeguards Authorities.

A less ambitious approach to this problem was then taken by trying to establish a list of analytical methods potentially useful in safeguards to indicate for each method a target value for its reproducibility (1s) and an estimate of its systematic uncertainty (e). These values have been labelled 'Target Values for Uncertainty Components 1979 of Destructive Analysis Methods' and are intended to set a goal of what should be aimed at in that year. They do not represent "state of the art" or even "good" values, but just goals which the group agreed should be achieved at least in 1979. The IAEA took a genuine interest in the list.

Common opinions are also formulated on specific points. For example, the European laboratories participating in the U.S. SALE Programme came to the view that because of the high percentage of European participation in the programme, more European involvement in the concept and organization of the programme was desirable. This opinion was formally submitted to the SALE Programme Management by representatives and resulted in the invitation for three European experts to become members of the SALE Steering Committee in 1978.

The group discusses frequently evaluation methods for results of interlaboratory measurement programmes and for comparisons between "declared" and "verification" values.

Finally, at each of its meetings, an informal talk is presented by one of its members on new techniques or new developments such as: X-ray fluorescence, inductively coupled plasma torch, present capabilities of gas source and thermal ionization mass spectrometers for the isotopic analysis of uranium - and many others. This gives advance information to interested members and provides an informal but competent discussion forum for the author.

Appendix I - List of Isotopic Reference Materials Available from CBNM - Geel

U-233 spike solution
(U-233/U = 0.996 - 1.0 mg/g)
Pu-242 spike solution
(Pu-242/Pu = 0.87 - 10 μg/g and 75 μg/g)
Pu-244 spike solution
(Pu-244/Pu = 0.98 - 1μg/g)
Th-230 (Th-230/Th = 0.0998 - 50 μg/g)

synthetic U/Pu input solution:
U-235/U = 0.01 - 250 mg/g;
U-235/U = 0.01 - 2 mg/g
Pu-239/Pu = 0.75 - 1 mg/g;
Pu-239/Pu = 0.75 - 10 μg/g

mixed spike solution:
Pu-242/Pu = 0.87 - 6 μg/g
U-233/U = 0.996 - 1.75 mg/g
UF_6 with U-235/U = 0.0044 - 0.0072
- 0.033 - 0.053

Mathematical and Statistical Problems

Michael Franklin
Convener of the ESARDA Working Group on Mathematical and Statistical Problems

The Board of ESARDA at its meeting on June 18, 1981 asked the JRC to organise a preliminary meeting with a view to setting up an ESARDA working group on mathematical and statistical problems. This preliminary meeting was held at Ispra on the 18th November 1981. The meeting was attended by representatives of UKAEA, CEN, CEA, FBFC-France, KFK, ECN, DCS-Luxembourg and JRC-Ispra. The attendance at the meeting included the conveners of the ESARDA working groups on Isotopic Correlation Techniques and Containment and Surveillance and a representative of the working group on MOX Fuel Fabrication Plants.

The subjects treated during the meeting included:

1) the research activities of the establishments represented at the meeting in the fields of mathematical modelling or statistical methods for safeguards
2) the desirability of an ESARDA working group on mathematical and statistical problems and the formulation of the terms of reference of such a group
3) identification of priority problems to which the working group could address itself in the immediate future.

The participants at the preliminary meeting felt that the creation of a working group on mathematical and statistical problems was appropriate and useful. Based on the discussion at the meeting a draft terms of reference was prepared. After the meeting, this draft was circulated to the participants, to the conveners of other working groups, to the coordinators and to the members of the Board for comments. In the light of these comments, the terms of reference will be discussed and formalised at the next meeting of the working group.

The participants also felt that the orientation of the new working group should emphasise the solution of practical problems identified by other working groups. This emphasis has been given effect in the terms of reference. In particular, it was felt that the working group should not (and certainly not in the initial stages) be concerned to launch completely independent projects. Instead, the working group will review existing methods and current research in the context of specific requests by other working groups. This will lead the working group to recommend among existing solutions and/or identify gaps. In as far as undertaking new projects to bridge such gaps is concerned, ESARDA may, through the coordinators, stimulate such projects in the member establishments.

Before the preliminary meeting the other ESARDA working groups had identified a series of problems which they wished the statistics working group to treat. These suggestions were discussed at the preliminary meeting which adopted a list of these problems as being of immediate interest to the working group. This list included:

- statistical methods for seal verification (C/S WG)
- statistical methods for data comparison in isotopic correlation techniques (ICT WG)
- statistical guidelines for scale calibration (LEU WG)
- statistical methods for tank calibration
- the relationship between verification effort and goal quantity in LEU plant (LEU WG)
- modelling of process flows and measurement system for dynamic verification in order to obtain a satisfactory mix of dynamic verification and complete inventory verification in a MOX plant (MOX WG).

This list is not in any sense final. It is a selection, from the suggestions put before the preliminary meeting, of those problems which were of interest to a number of people. The working group will certainly have other problems suggested to it as they arise. The Steering Committee (March 3rd, 1982) in its reaction to the outcome of the first meeting suggested that the highest priority should be given to scale calibration, modelling for dynamic verification in a MOX plant and seal verification. The Steering Committee suggested that second priority be given to data comparison in ICT.

The next meeting of the working group (June 21st and 22nd in Karlsruhe) is being focussed on a number of problems on this list. Participants will present working papers on what they see as the operational requirements which statistical or mathematical methods have to meet. The working papers will also include a description of existing methods and an evaluation of them in the light of the requirements. Since all members of the working group are not equally familiar with all problems, these papers will allow the working group to formulate in more detail each of the problems raised for consideration. The working group will then have to plan its own future work programme. This will be based on what it feels it can achieve in providing answers to the problems and also on the members' estimation of how much work they can contribute to the objectives of the working group.

Remote Verifiable Sealing System for Safeguards Application

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Abstract

Seal systems for C/S instrumentation used at present need considerable technical and personal expenditure for installation and verification. A new electronic seal system VACOSS 3, developed by ProCom GmbH, Aachen, and the Nuclear Research Center, Jülich, within the framework of an IAEA research contract, allows simple installation, verification, the possibility of remote verification and has high tamper resistance.

Moreover it is able to store several seal data and the seal can be used as often as desired.

The VACOSS 3 system consists of the seal unit with a fibre optic light guide and of two types of adapter boxes. The seal stores up to 10 opening and closing events, the present status of the fibre optic light guide, the status of battery and seal housing. Seal data are encrypted for tamper safe data transmission.

With adapter box I the seal can be initialized and seal data can be read out and decrypted.

With adapter box II only encrypted seal data can be read out.

Introduction

The substantial growth of nuclear energy in all parts of the world involves high costs and efforts related to personnel, instrumentation, and methods for international safeguards of nuclear materials. To keep the whole safeguards system within reasonable costs, priority is given to the development of low-cost, effective, and manpower-saving control procedures.

In the international agreements on non-proliferation of nuclear weapons the basic safeguards measures are material accountancy while containment and surveillance are important complementary measures.

Surveillance means application of instruments or human observation to verify the inventory and motion of nuclear materials. Containment methods primarily employ seals to control storage facilities and containers of nuclear materials.

Sealing offers the special advantage of rapid and simple checks of the seal integrity by the inspector in place of costly measurements to verify the inventory of nuclear materials in rooms or containers.

At present the International Atomic Energy Agency, IAEA, mainly applies Label Seals, Cup-and-Wire-Seals and General-Purpose Ultrasonic Seals.

But still an effective control of the seals can only be performed by the control authority with considerable technical and personnel expenditure.

The control authority attaches a characteristic fingerprint onto each seal which has to be checked again after finishing of application. An unnoticed seal infringement cannot be excluded for these seals. They can only be used once.

In 1979 and 1980 the IAEA applied more than 6000 seals in each year and more than 5000 seals have been returned for photographic verification.

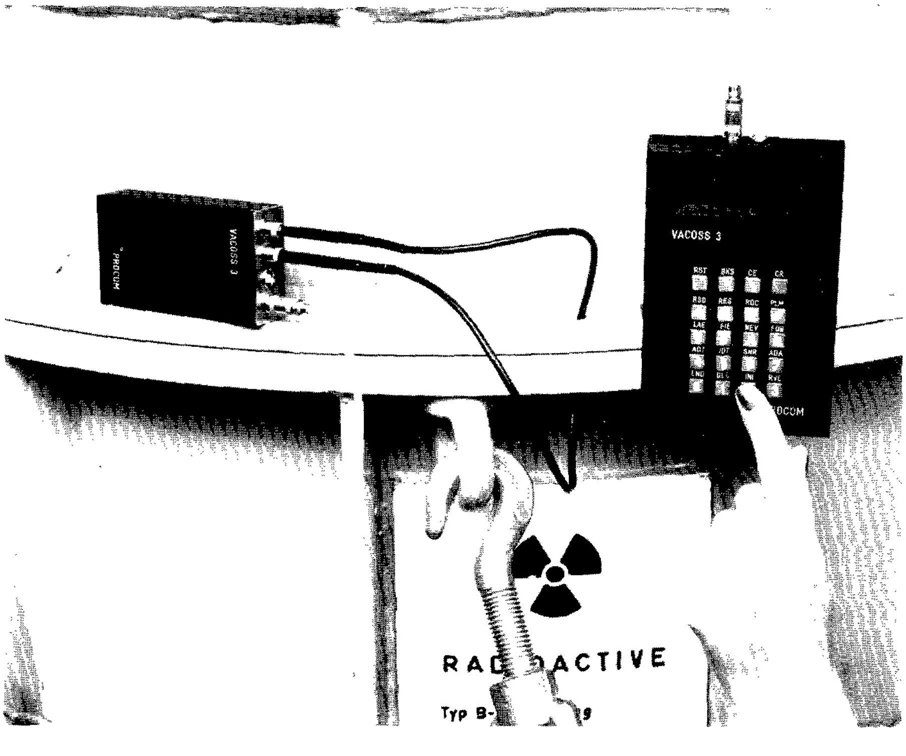
The shortcomings of the seal systems used until today led to the development of new electronic seals, i.e. the ELECTRONIC SEAL developed by the Sandia Laboratories and the VACOSS (VARIABLE CODING SEAL SYSTEM) developed in Germany by ProCom and the Nuclear Research Centre Jülich. Progress in microelectronics, the availability of large-integrated components of small dimensions at low cost enable the development of an efficient and handy seal system : VACOSS 3 (Fig. 1).

The VACOSS System

VACOSS 3 is based on the seal systems VACOSS 1 and VACOSS 2 developed by KFA Jülich, FRG. In VACOSS 1, the idea of an electronic seal with a light guide as the seal wire and data encryption was put into practice for the first time. The seal functions were controlled by hardware; a computer was required for reading out the seal data.

In VACOSS 2, the dimensions of the seal could be substantially reduced, the seal functions were controlled by software, and the readout of seal data was effected using a hand held adapter box. The size of the seal, safety of operation and data coding still presented problems for users.

Fig. 1. VACOSS 3 Seal and Adapter Box 1



VACOSS 2 was presented for trial operation at the IAEA and Euratom. The deficiencies ascertained by the IAEA and Euratom during trial operation of VACOSS 2 could be eliminated with the development of VACOSS 3.

The seal system VACOSS 3 (Fig. 1) consists of three microcomputer based components:

- electronic seal
- adapter box I for initializing and verification of the seal by an inspector
- adapter box II for remote verification with the aid of the operator of the plant to be supervised and oral transmission via telephone.

The main seal functions are to

- detect opening and closing operations of its light guide circuit
- store these events along with their opening and closing times
- notify and react to manipulation attempts at the seal
- communicate with the adapter boxes.

The adapter box programs assist the operator with guided dialogues, error messages and comfortable input editing functions.

Seal Operation

The seal is ready for operation after being programmed through the adapter box I. The correct keyword — 16 characters — gives way to the initializing function.

Input data to the seal are a new keyword and the initialization date and time. Programming can be done at the control authority's headquarter in order to keep the persons involved in programming at a minimum or alternatively the inspector initializes the seal in situ if he has knowledge of the keyword. The seal is in service when it is initialized and attached to the object of interest.

The seal checks approximately every 250 ms the fibreoptic loop by sending a light pulse through the fiber. If an opening or closing of the loop is detected, a counter is incremented and the opening or closing time is stored with a resolution of 1 min. Up to ten time values can be stored. If the loop was opened and closed more than five times (10 events) always the first, the second and the last eight events will be kept in memory.

While in service the seal can be inspected in situ at any time. Three procedures of seal inspections are possible:

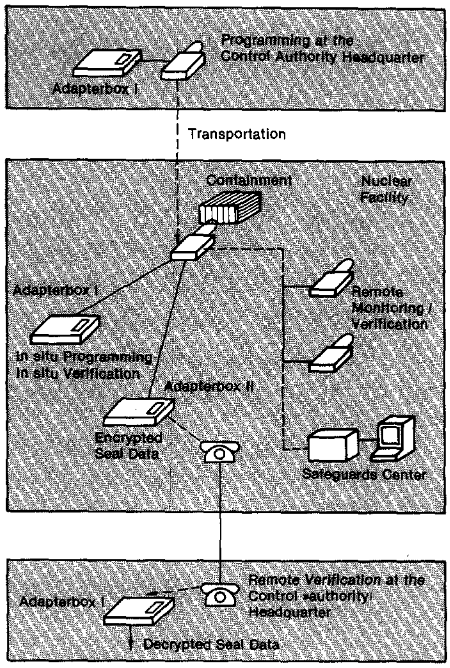
- inspection by the inspector himself
- remote inspection via telephone communication
- automatic remote monitoring/inspection in a distributed computerized verification system.

These three inspection types are different in:

- the seal data used
- the mode of seal data display and
- the type of adapter box used.

The different types of VACOSS 3 operation are shown in skeleton form in Fig. 2.

Fig. 2. VACOSS 3 Seal Application



Inspection by the Inspector

The inspector connects the adapter box I to the seal ano initiates a short communication procedure by operating the 'read seal data' function key. By operating the assigned function keys the following seal data will be displayed :

- the seals present date and time
- seal number
- number of fiber optic loop opening and closing events
- number of adapter box attachments
- present fiber optic loop status (open/closed)
- battery status (normal/low)
- initialisation date and time
- the first, the second and the last eight opening- and closing-times (if any).

In case of a seal box opening (tampering attempt) an unsolicited warning is given when the seal box is closed again, together with the date and time of the seal box closing.

Remote Verification via Telephone

This control procedure can be achieved as follows. On request of the control authority, seal data are read out by the operator with the adapter box II. The display data will then be reported to the control authority via telephone (Fig. 2). These data are encrypted. The encryption key was programmed into the seal during the initialisation process. At the control authority the inspector enters the received data along with the seals initialisation date and time and the encryption key into the adapter box I. This adapter box decrypts the data and gives information about:

- the last fiber optic loop opening and closing time
- the total of fiber optic loop openings and closings
- the date and time of the moment when the reported data have been read out of the seal
- the fiber optic loop and battery status at the read-out time.

If the data cannot be decrypted tampering with the seal has possibly happened. Then an additional test on the received data indicates whether the seal box was opened and when it has happened.

Automatic Monitoring and Verification in a Distributed Computerized Verification System

In large nuclear facilities with high throughput of SNM an almost continuous inspection is necessary. For these purposes a distributed computerized C/S-system is being developed at ProCom in which the VACOSS-seal is one of the integrated sensors. For this type of application the seal is connected among others via a party line to the next highest hierarchical level, the safeguard centre (Fig.2).

When selected in the polling cycle it sends

- the number of fiber optic loop openings and closings
- the fiber optic loop status
- the battery status
- the seal housing status.

In this mode the seal remains autonomous, i.e. :

- even if the rest of the system is down it detects and stores the seal events and reports them after system restauration.
- the seal can be removed from the party line, interrogated through the adapter boxes and reconnected to the system at any time.

Tamper Proofness-Verification

The following attempts to tamper the seal will be detected :

- bypassing the fiber optic loops
- opening of the seal housing
- non-authorized access via the I/O-interface
- transmission of seal data which makes believe the seal to be in a different status than it really is (remote verification/monitoring).

The seal is verified through its programmable, unique password/keyword. 28×10^{18} word combinations are possible. In the remote verification via telephone and in the automatic monitoring/verification this password/keyword serves as the encrytion/decryption key. It is achieved that the bit pattern of the encrypted data is always changing completely although the relevant seal status data (fo-status etc.) has not changed. Tampering of the seal housing erases the password/keyword.

Seal Characteristics

Technical data

Seals dimension:
10.5 cm x 6 cm x 2.5 cm
Light guide:
1 glass fiber, 50 μm diameter
2.5 or 5.0 mm outer diameter
up to 10 m length
5 cm bend radius
field exchangeable
Technology:
CMOS; microcomputer based
Power supply:
lithium batteries/external
battery service life: 1.5 years
I/O interface:
serial line, 300 bit/sec,
voltage protected
Environmental:
0 - 50°C
Humidity:
100% non condensing
Shock/vibration:
5 g, 100 Hz, 30 min in all directions

Status of Development

Prototypes of the VACOSS 3 seal and of the adapter boxes have been delivered to the IAEA in November 1981 for a first test of the system. After the successful completion of this test the IAEA has received 10 seals, two adapter boxes I and three adapter boxes II for field evaluation.

Euratom has got three seals and two adapter boxes I in January 1982. As a part of the joint U.S./FRG electronic seal evaluation programme a complete VACOSS 3 system has been handed over to the Sandia Laboratories, Albuquerque, U.S.A.

We hope, that the VACOSS 3 seal will be applied by the control authorities on a routine basis before the end of 1982.

Preparation and Characterization of Plant-Specific Reference Materials

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Introduction

An extensive programme for the preparation of Plant-Specific Reference Materials (PSRMs) for Non-Destructive Assay (NDA) verification activities has been launched by the Euratom Safeguards Directorate with the technical support of the JRC and in co-operation with the International Atomic Energy Agency (IAEA).

The need for these plant-specific reference materials stemmed from several aspects of the verification activities which are intrinsic to NDA measurements. In fact, the required high accuracy of the results and the short measuring time imposed in order not to impede the plant production, led to the extensive application of measurement procedures consisting in the combination of consistency checks of good precision on the majority of the production, with reference to calibration standards or calibration curves which minimize the systematic error.

This procedure is widely applied by safeguards authorities especially for those production batches which represent an important part of the plant production. For such batches well characterized working standards are required and the PSRMs then play an increasing role in the instrumental verification by inspection. A long list of PSRMs is under preparation or under consideration by Safeguards authorities.

General Requirements

As a preliminary there are some fundamental requirements which these PSRMs must fulfil, which are frequently different from those requested by the so-called Certified Reference Materials (CRMs)[1], which are prepared and certified by internationally recognized laboratories. The PSRMs are, in fact, employed for monitoring a particular production and serve as reference for the measurements carried out with a specific instrument. For this reason a PSRM has a restricted application generally limited to one plant : in this sense it is a plant-specific working standard.

As the working standard is dedicated to one instrument with a definite range of utilization it can be characterized with a predefined uncertainty level, the definition of which depends on the specific verification procedure. This uncertainty level is normally a priori stated in such a way that it does not significantly affect the overall error of the production measurements, when transferred to the material balance evaluation.

The intrinsic difference between PSRMs and CRMs should now be clear : schematically the former are dedicated to the monitoring of a particular production, while the latter are mainly dedicated to improving a method[1,2].

There is another point which has been solved with an approach different from that taken for CRMs; the certification and the acceptance of the PSRMs is not provided by national or international bureaux, but by the safeguards authorities themselves.

The plant operator concerned is also invited to participate in all phases from the preparation of the RMs to their characterization and certification making safeguards implementation more straightforward, at least in certain points of the fuel cycle.

In this way the certified standards can really be defined as plant specific **common** reference materials.

Having now established general rules valid for all the PSRMs, the individual standard dedicated to one specific production of one plant is analysed and very detailed schemes for its preparation and characterization are worked out.

- The first step of the scheme always consists in a detailed analysis of the use of the standard, its scope and its role in the plant-specific strategy of NDA verification. This analysis allows us first of all to evaluate the target error admitted for that standard characterization.
- As a consequence of this target error evaluation the various procedures and steps to be followed for the PSRM preparation are described in great detail, indicating NDA measurements, DA measurements, and requested uncertainty levels as well as fabrication, identification and surveillance procedures.
- When the standard is ready a detailed protocol is issued for it, which describes the steps followed, the uncertainty actually achieved and the indication for the users of how to employ it. The protocol guarantees recording and traceability of all the certified data pertinent to the standard from raw data to the final results and uncertainties.

Preparation of PSRMs

The schemes and the principles indicated above have been applied to the preparation of some PSRMs, namely a MOX pin and LEU rods.

a) MOX pin

In the MOX standard pin preparation the procurement scheme consisted of the following steps :

- random selection of two pins from the same batch and use of NDA techniques to quantify any correlation between the two pins
- dismantling of one of the two pins and sampling of some pellets for DA
- evaluation of the overall uncertainty by transmitting the DA results and the correlation factors obtained by NDA.

The NDA measurements performed were :

1 a longitudinal scan with a rod scanning device, equipped with a GeLi detector, to check the longitudinal homogeneity of the pin.
Many runs along the pin have been carried out with different collimators and different spectrum thresholds: the Pu distribution was verified to be homogeneous along the pin within the limit of experimental uncertainty which was evaluated to be 0.8%[3].

2 then an accurate comparison of Pu isotopic ratios in the two pins was carried out with the aid of a high resolution germanium detector. The measurement was repeated at different points along the pins to verify (in combination with the preceeding measurement) the longitudinal homogeneity of the Pu isotopic composition along the rods.
The average uncertainty evaluated in the results by internal error propagation was always in good agreement with the standard deviation evaluated from point to point variability (for details, see ref. 3).

3 the total plutonium content ratio between the two rods and the 240-Pu equivalent ratio were then monitored using a pin calorimeter and also a coffin type variable dead-time counter (VDC).
Again within the limit of experimental error (evaluated at a few tenths of a percent for calorimetry, and of the order of 1% for VDC) the measured ratios were in good agreement with the declared ones[3].

4 and finally, a suitable sample of MOX pellets was selected for subjection to destructive analysis (DA) which will give highly accurate results for the Pu isotope content.
A detailed scheme for the analysis of samples has been prepared which foresees distribution of samples to different laboratories, with consequent estimates of systematic and random errors.

b) LEU rods

A second example of working standards already prepared concerns LEU rods prepared for monitoring U-235 enrichment of LWR fuel rods. Four different enrichments covering a range typical of BWRs and PWRs were selected for the preparation of four different RMs. The sample pellets were measured through high resolution γ- spectrometry for the relative determination of U-235 enrichment and a sample of each population was sent to DA.

The γ- spectrometry measurements consisted of an homogeneity check separately for the four enrichments, by measuring the 185.7 keV U-235 γ- ray emission of all the pellets. The results were always consistent with the statistically evaluated uncertainty.

Again a suitable statistical analysis combining NDA and DA results will give the overall evaluated error in U-235 enrichment of the prepared standards.

Conclusions

As well as the above working standards many other are under study by the control authorities.

The resons for the great interest in the preparation of numerous working standards for many measurement points in the fuel cycle have already been pointed out at various points throughout the paper, but it is perhaps worthwhile summarizing them here.

- An extensive use of working standards will reduce the measuring time of the production without decreasing the overall accuracy. Indeed frequently an improvement of the accuracy can be expected due to better measuring procedures which inevitably follow the preparation of the standards.
- As a consequence NDA measurements, which have frequently in the past been used as an attribute verification tool, could now be seen with the implementation of PSRMs, as variable measurements, improving the NDA efficiency in the verification activities.
- Well characterized standards agreed, certified and accepted by the control authorities and by operators certainly make the implementation of safeguards in the fuel cycle easier.

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Notes on the 4th Annual ESARDA Symposium 1982

Specialist Meeting on Harmonization and Standardization in Nuclear Safeguards

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The fourth ESARDA Annual Symposium was held at Petten, in the Netherlands on April 27th - 29th, 1982. As this year is linked to the IAEA Symposium which will be held in Vienna next November, ESARDA decided to limit the theme of the meeting to a specialized item of current interest. Therefore we had a specialist meeting instead of a general symposium on nuclear safeguards. The purpose was to bring out the state of the art in the field of Harmonization and Standardization in nuclear safeguards.

ESARDA has already organized two specialist meetings in addition to general symposia : in 1978, a symposium on Isotopic Correlation Techniques; in 1980, a seminar on Containment and Surveillance Techniques. These two meetings had in effect a quite specialized theme and gathered together most of the specialists of the particular fields.

The specialist meeting 1982 revealed itself to be quite general and not as specialized as was at first intended. In fact Harmonization and Standardization are felt to be fundamentally important in any field related to nuclear safeguards, and hence they cover practically all the matters related to fissile materials. As a consequence the organization was faced with the dilemma of having a specialist meeting and at the same time a very general topic.

With these premises we tried to organize the meeting in a satisfactory way but we do not know if we succeded completely. As many people, and first of all Mr. W.L. Zijp, present chairman of ESARDA, congratulated us on the organization, we would like anyhow to make a criticism, which may be constructive, concerning the organizational aspects of the meeting, and also to draw some conclusions which may possibly apply to future meetings of this type or the general ESARDA symposia.

The first remark which appears to be obvious is that several authors who had presented accepted contributions were completely ignored both by the invited speaker who introduced the subject, and by the chairman. This was unfair for these people. This, we think, showed a lack of organization even if all invited speakers received copies of the summaries accepted for the session in order "to adapt their presentation which should stimulate the discussion". The chairmen were also advised to conduct the discussion taking account of the general theme and the contributions to the session, and the authors had the possibility of taking part in the discussion making reference to their contribution. As a matter of fact the booklet of abstracts distributed to all participants contained the following instruction :

"The programme is structured so that invited speakers will introduce the subjects of the sessions, based upon their knowledge and the papers contributed. After this introduction ample time is allotted for discussions in which the participants are, of course, free to refer to their own contributions, but participants should restrict themselves to the point under discussion and not expand their intervention into a full individual presentation of the submitted paper."

We would like to thank all those who collaborated in producing the meeting's fairly successful outcome : invited speakers, authors of contributed papers, chairmen and secretaries of the sessions and all other participants who were actively engaged in this specialist meeting. We would like to thank particularly those who followed the instructions well, even if they were not given so strictly and exhaustively, and who helped the purpose of stimulating the discussion on Harmonization and Standardization. This particular acknowledgement applies specially to chairmen and invited speakers who carried out their job having a clear idea of the contributions and trying to give hints of them to the session.

A second remark which was made and which applies to all the conferences (general symposia or seminars or specialist meetings) is that it is a pity that no extensive reporting on the discussion is provided. We agree in principle with this concept and think it would be marvelous to have each paper followed by an extensive and clarifying discussion or, in the case of a specialist meeting, a general discussion with all the interventions fully reported with their statements and contradictions. This is a good idea in principle, but in practice it is quite difficult and often the results are deceiving. Usually only few items of the discussions in fact deserve publication. In the past, when the fields were restricted to a few specialists it was easier to report discussions. Now this practice is more or less abandoned. The discussions are for the benefit of the participants and constitute one important reason for participation in a congress. It is sometime recalled that the discussions could easily be reported if suitable forms were distributed during the meeting for writing questions and answers, or the discussions could be recorded, typed and sent to speakers for corrections. Apart from the terrible waste of time for probably unimportant matters we have found in our experience that the written questions and answers are quite different from the actual discussions as they are remembered by the participants. If the drafts of recorded discussions are sent to authors they will be returned after a long time and will be even more different ! We do not know, in this case, if they have any value. In any case these observations can be taken into account especially for specialist meetings or workshops on very restricted topics.

The third remark which we can objectively make is that from the point of view of Harmonization and Standardization the sessions were not homogeneous. Some of them were well oriented and other were restricted both in the presentations and in the discussion. This is perhaps the greatest reprimand which can be made to the organization because, we think, all chairmen and speakers tried to do their best but they could have been better coordinated. Probably it was preferable to reduce the number of the sessions and to increase the time for the discussion, but we made the realistic consideration that many people can justify their travel funds if they have some official job such as chairman, secretary, invited speaker and so on.

But having made this criticism with the aim of improving future meetings we can also affirm that the meeting was very successful in stimulating high quality discussions touching several fundamental safeguards issues. The participants contributed actively and an important exchange of information in safeguards took place. If one tries to judge the discussion bearing in mind the central theme of the meeting, i.e. "Harmonization and Standardization, Status of Measurement and Evaluation Techniques for Safeguards", the conclusion becomes a little more differentiated. In general the sessions dealing with subjects such as data evaluation, reference materials, measurement procedures and interlaboratory evaluation programmes seemed to focus very well around the central theme of the meeting.

The last three sessions dealing with the fuel cycle, containment and surveillance and nuclear material accountancy seemed to deviate increasingly from the central theme.

The idea of having a short introduction to the session topic by a renowned speaker is of interest and can be further developed in future for such meetings. Ampler time for discussions could improve efficiency but the referenced papers should be taken as a basis by the speaker and possibly known in advance by the participants via a previous distribution or by offering at the beginning a poster session presentation so that the participants can acquaint themselves with the papers contributed before the discussions start. For this meeting the quick appearance of the proceedings at least atones a little for this organizational imperfection.

Besides the shortcomings mentioned, which are not intended as negative criticism, it must be emphasized that many participants have expressed their full satisfaction with the meeting, and all agreed that it was a great success with respect to the quality of the papers as well as in producing so many and valid reactions in the discussion on Harmonization and Standardization. The audience comprised specialists from the sides of research organizations, safeguards authorities and nuclear plant operators. Substantial contributions were made for clarification of the present situation and for obtaining guidance for future work.

ESARDA has the pleasure to announce that the next annual symposium on Safeguards and Nuclear Material Management will be held in 1984 in Venice, Italy.

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