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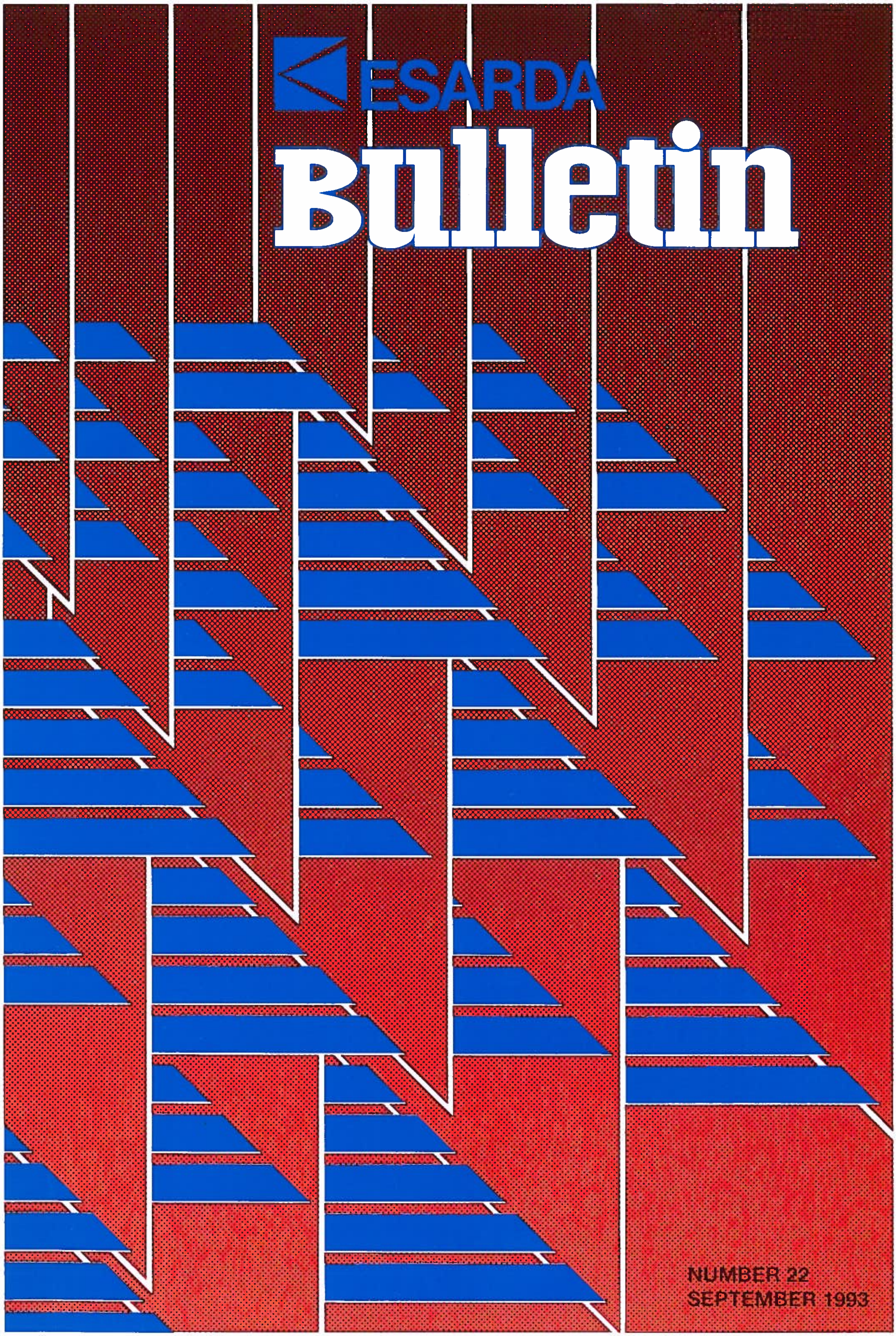


The 15th ESARDA Symposium

C. Foggi, Secretary of ESARDA
Commission of the European Communities
JRC Ispra, Italy

The 15th ESARDA Symposium on Safeguards and Nuclear Materials Management" took place at Rome (Italy) from 11 to 13 May, 1993, attracting 249 Participants from 23 Countries and 2 International Organizations and the presentation of 150 papers (see Table 2).

A certain number of speakers had received a special invitation to present their views on particular topics. They are, in order of presentation: Mr. G. Naschi, the Director of the ENEA Directorate for Nuclear Safety and Health Protection (DISP); Mr. H.J. Helms, the Director of Joint Research Programmes; Mr. W. Gmelin, the Director of EURATOM Safeguards; Mr. H. Blix, the Director General of the IAEA; Mr. G.N. Tsamerian, the Co-ordinator of the Support Programme of the Russian Federation to the IAEA and Mr. V. Shkolnik, the Director General of the Atomic Energy Authority of the Republic of Kazakhstan.

A special session was entrusted to the IAEA.

The Meeting was hosted in the "Augustinianum", a Patristic Institute belonging to the Holy See, situated just in front of the universally known colonnade of St. Peter's Basilica.

Figure 1: The Pope with the ESARDA Secretary, Mr. C. Foggi.

The Holy See governs the "State of the Vatican City". This is definitely the tiniest independent State in the World, with an area of 0.44 square km (a little more than 100 acres) and less than 1000 inhabitants. Yet, it is a Member of the United Nations and of the IAEA, and is a signatory to the Non-Proliferation Treaty. The Head of the State is the Pope, at present John Paul II, who is also Head of the Christian Roman Catholic Church. Its territory, completely embedded within the city of Rome, mainly includes St. Peter's Basilica and its immediate surroundings, all of which are located on a hill which was already named "Vatican" long before Christ: from this fact comes the name "Vatican City".

On Wednesday 12 May, the participants in the Symposium were received by Pope John Paul II, who personally talked to several ESARDA Members. The audience took place in the Vatican City, in the Hall designed by the architect Nervi, which can host more than 5,000 people under its single-arched vault.

On May 11, the participants were welcomed by the ENEA with a cocktail party organized right in the Capitol, the place from where the Romans ruled their empire. Twenty centuries of history are written into the stones of the buildings of all ages which compose the Capitol complex; the oldest of them has stood there since the 1st century B.C.; the most famous of them probably is the Palace designed and built by Michelangelo in the 16th century. Incidentally, "Capitol" is just the name of the hill on which these buildings stand, but the word has since long entered into the common language to designate a statehouse or a house where a State legislature sits: for this reason, many Countries have appropriately called the buildings seating their Parliament or their Government the "Capitol".

On May 13, ESARDA greeted its hosts with a dinner in another historical building (although this may be rated as a recent one, by Roman standards): the Santacroce Palace, dating from the 17th century and magnificently frescoed in all its rooms by leading artists of that period.

The Symposium ran very smoothly, thanks to the efficient ENEA organization. The participants and their spouses enjoyed the various events organized in

Table 1: The Symposium at a glance.

15th ESARDA Symposium on Safeguards and Nuclear Material Management	
Location:	Rome, Vatican City
Date:	From 11 to 13 May, 1993
Papers presented:	150
Participants:	249
Chairman:	G. Déan, Commissariat à l'Energie Atomique (CEA), France
Scientific secretaries:	M. Dionisi, Ente Nazionale per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA) and C. Foggi, Commission of the European Communities, Joint Research Centre, Ispra.
Proceedings have been issued.	

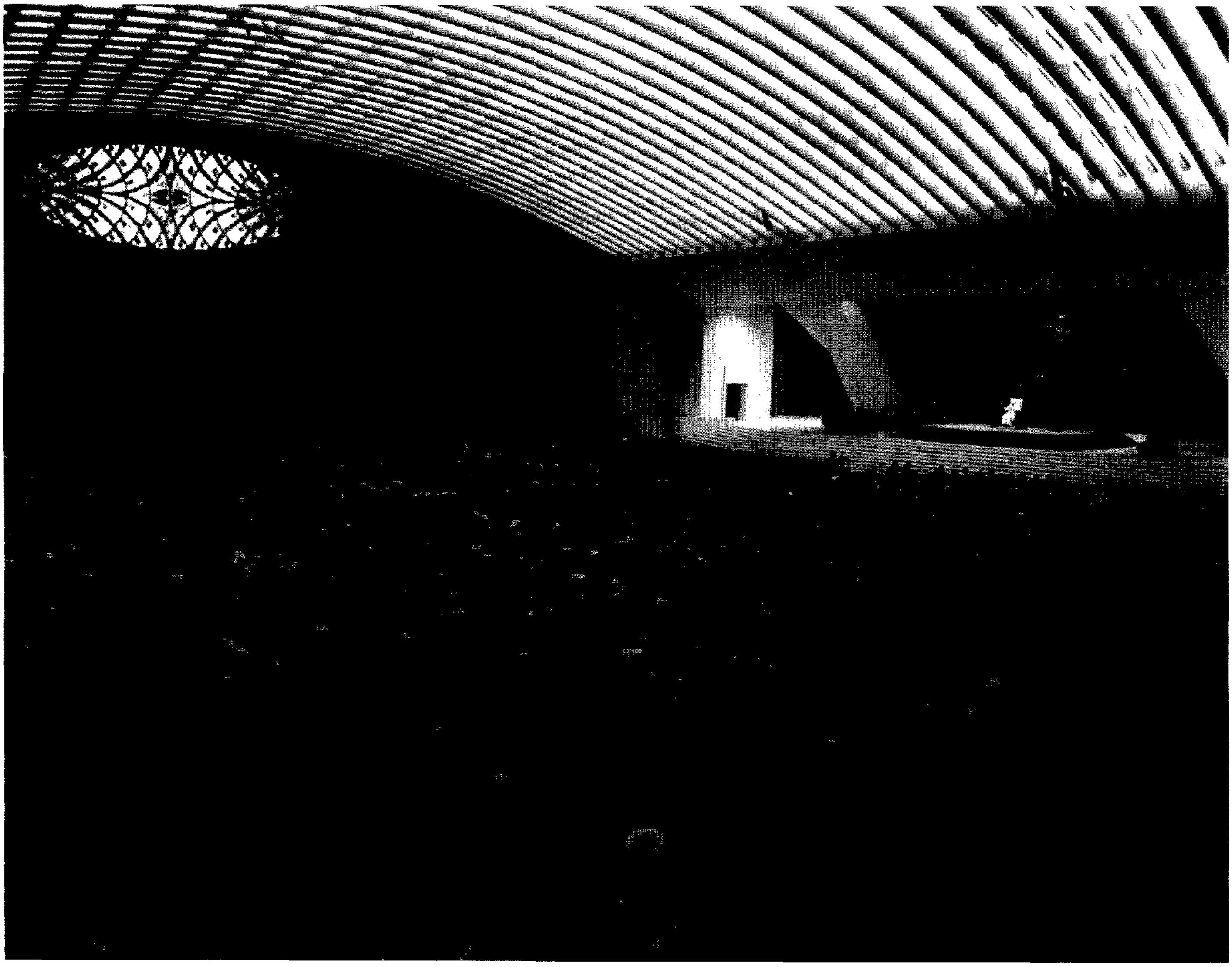


Figure 2: The "Nervi Hall" where the audience took place.

Figure 3: The Pope talking to the ESARDA Chairman, Mr. G. Déan (right) and Mr. G. Andrew.

Table 2: Subject covered by the papers.

General concepts and National Programmes	27
Measurement techniques	65
Accountancy and Data Processing	14
Containment and Surveillance	18
Plant specific experience	26
Total	**150**

connection with it and certainly appreciated the possibility given to them to explore the wonders of Rome, a city with more than 2700 years of history, sumptuously testified by its countless monuments, the art works preserved in its museums or on view in the open air, and its numerous historical buildings, some of which are still in use for the purpose for which they were built millennia ago.

The audience with the Pope will certainly remain in the participants' memory as a once-in-a-life time event, even for those who do not have any particular religious beliefs.

What is ESARDA

ESARDA is an association of European organizations formed to advance and harmonize research and development of safeguards. It also provides a forum for the exchange of information and ideas between nuclear facility operators and safeguarding authorities.

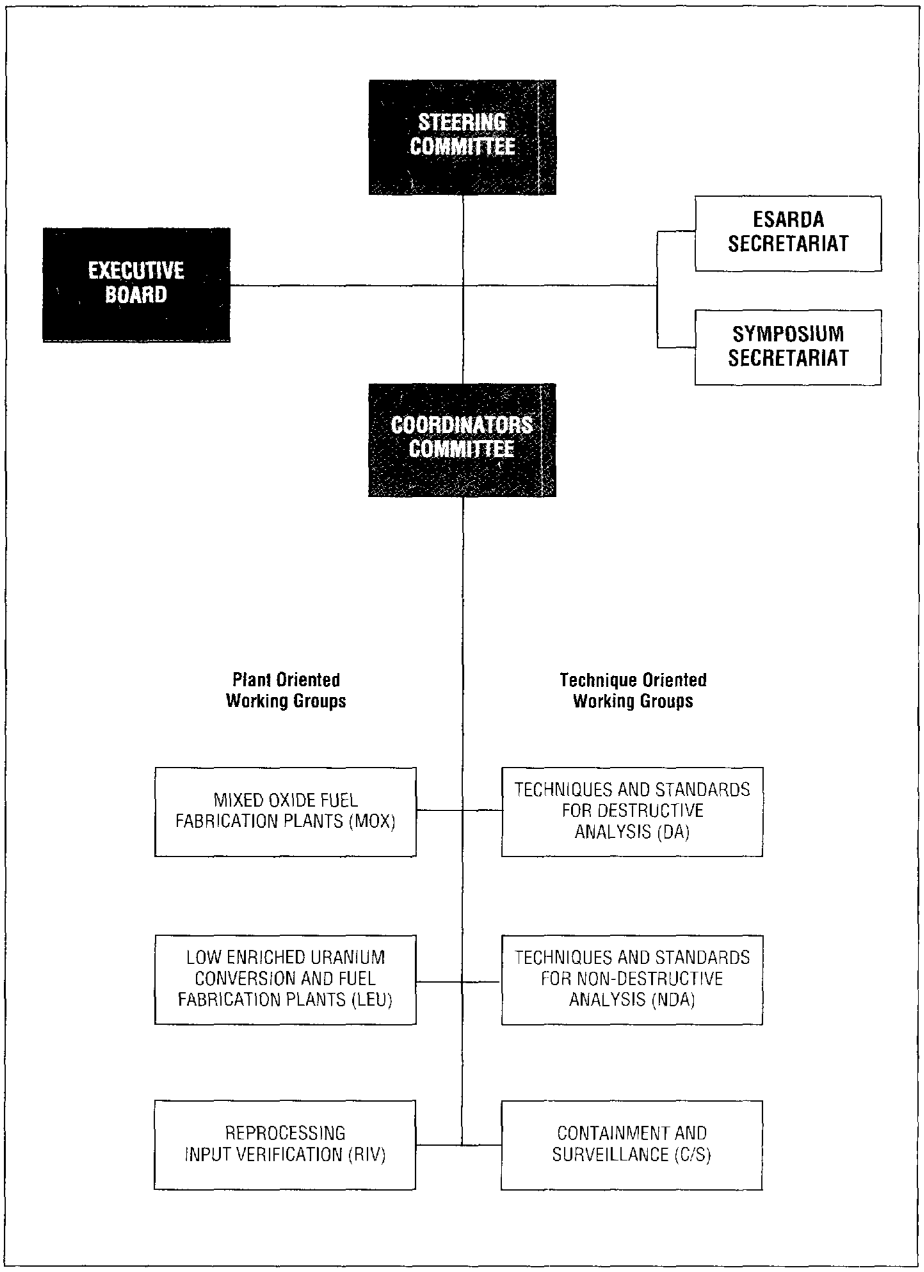
Its partners as of 1st May 1993 were:

- The European Atomic Energy Community
- The Kernforschungszentrum Karlsruhe (KfK), Germany
- The Centre d'Etude de l'Energie Nucléaire - Studiecentrum voor Kernenergie (CEN/SCK), Belgium
- The Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA), Italy
- The Stichting Energieonderzoek Centrum Nederland (ECN), The Netherlands
- The Atomic Energy Authority (AEA), United Kingdom
- The Commissariat à l'Energie Atomique (CEA), France
- The British Nuclear Fuels plc (BNFL), United Kingdom
- The Forschungszentrum Jülich GmbH (KFA), Germany
- The Centro de Investigaciones Energéticas Medioambientales y Tecnologicas (CIEMAT), Spain

The Governing Body of the Association is the Steering Committee, assisted by an Executive Board and by the Secretary. The chair of ESARDA is taken in rotation by one of the countries for the duration of one year.

The technical activities of ESARDA are coordinated and harmonized with the programmes of the partners by a Committee of Coordinators, one per Country. Annual Symposia (or Meetings) are organized by the Permanent Symposium Secretariat. Technical activities are carried out by 6 permanent Working Groups, each dealing with a specific area of R&D in Safeguards, as indicated in the table.

Structure of ESARDA



Who's Who in ESARDA?

(as of 15th May 1993)

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Secretary *C. Foggi*, CEC Ispra, Italy

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J.A. Cookson, AEA Technology, Harwell, U.K.
H. Lefèvre, CEA, Fontenay-aux-Roses, France
R. Schenkel, CEC, Safeguards Directorate, Luxembourg

ESARDA Working Group Convenors

Techniques and Standards for Non-Destructive Analysis (NDA)
S. Guardini, CEC, JRC Ispra, Italy

Techniques and Standards for Destructive Analysis (DA)
P. De Bièvre, CEC, JRC Geel, Belgium

Reprocessing Input Verification (RIV)
vacant

Containment and Surveillance (C/S)
B. Richter, KFA Jülich, Germany

Low-Enriched Uranium Conversion and Fuel Fabrication Plants (LEU)
P.P.A. Boermans, FBFC, Belgium

Mixed Oxide Fuel Fabrication Plants (MOX)
G. Le Goff, CEA, Paris, France

ESARDA Bulletin Editor

L. Stanchi, Italy

Analysis of R&D Activities in the Field of Destructive Analysis

prepared by M. Dionisi
on behalf of ESARDA Coordinators

This analysis has been prepared in close cooperation with the Convenor of the ESARDA Destructive Analysis Working Group.

In the area of Destructive Analysis the ESARDA R&D activities are mainly related to:

a) Development/improvement of DA techniques for isotopic and concentration measurements (5 tasks)
b) Performance evaluation (10 tasks)
c) Automation of analytical procedures (3 tasks)
d) On-site measurements (4 tasks)
e) Production of Reference Materials (4 tasks)

a) Development/Improvement of DA techniques

Several Organizations are involved in inproving and updating the technologies of consolidated measurement techniques, such as:

- software development for mass spectrometry (JRC Geel);
- computer controlled analytical procedures (JRC Karlsruhe);
- procedures for reducing the sample size in titrimetry (UKAEA);
- improvements in UF_6 mass spectrometry (JRC Geel)

As far as development of laboratory analitycal techniques is concerned, only the UKAEA is involved in studying a spectro-photometry technique for the high precision determination of Pu(VI).

In this context it should be noticed that the ESARDA DA Working Group is continuouosly focussing by exchange of information at regular intervals during the Working Group meetings, on the development of analytical techniques especially aiming at improved accuracy of results, ease of application and implementation.

b) Performance evaluation

The activities in the field of performance evaluation relate to:

- Measurement evaluation programmes
  - The JRC Geel is currently leading an extensive interlaboratory measurement evaluation programme (REIMEP) continuously estabilishing the State of Practice of nuclear material measurements, and the results are (amongst others) examined in the framework of the ESARDA DA Working Group.
  - CEA and JRC Geel are currently involved in the field of the Quality Control of analytical procedures (in the EQRAIN and ECSAM exercises respectively), by distributing characterized samples to the interested laboratories.
- Intercomparison of different analytical techniques
  The UKAEA is evaluating several different controlled Potential Coulometers
- In-field testing of measurement techniques and procedures for use by inspectors (ESD, JRC Ispra).

As far as cooperative efforts and exchange of information are concerned ESARDA DA, LEU and RIV Working Groups play an important role in the field of Destructive Assay.

Since 1979, the DA Working Group established, and periodically updated, "Target Values" for analytical techniques. The group is studying the performance values as obtained from interlaboratory exercises such as REIMEP. On the basis of these values, present and future needs for measurement uncertainties are estimated.

Currently the Safeguards Authorities, in close collaboration with the ESARDA DA Working Group, are evaluating the "International Target Values for Uncertainty Components in measurements of amounts of nuclear materials for Safeguards purposes".

The LEU Working Group is evaluating the results of the interlaboratory comparisons carried out in order to evaluate the performances of gravimetric and potentiometric analytical techniques, as applied, on a routine basis, to pellets and impure materials in LEU fabrication plants.

A section of the RIV Working Group is evaluating the results of experiments with tracers conducted within the framework of the CALDEX exercise.

With respect to "in field" testing of the tracer technique, ENEA and JRC Ispra carried out a series of experiments aimed at demostrating the applicability of this technique to the direct determination of the Nuclear Material in the input tank of the ENEA ITREC pilot reprocessing plant. The elements used as tracers were lutetium and erbium.

c) Automation of analytical procedures, sample treatment and verification of the analytical results

Three organizations are involved in this area:

- JRC Karlsruhe, in collaboration with SAL and Khlopin Institute (St. Petersburg, Russia), is testing a robot for the preparation of mass spectrometry samples;
- UKAEA and Euratom Safeguards Directorate are gaining experience in the application of VOPAN (Verification of OPerator ANalysis)

d) On-site measurements

The main activities comprise:

- JRC support to the Euratom Safeguards Directorate (ESD) in the form of study and design activities to get estabilished on-site laboratories making use for expert systems, robotised IDA, titrimetry and NDA techniques: JRC Karlsruhe is engaged in setting up such a lab with complete analytical capabilities at a reprocessing plant site.
- JRCs Ispra and Karlsruhe support the ESD to implement trasportable analytical equipment (mass spectrometer and gravimetric methods) for U isotopic and concentration measurements in bulk handling facilities (LEU and Reprocessing plants);
- BNFL and COGEMA are currently involved in feasibility and evaluation studies on the realization of on-site analytical laboratories.

e) Production of Reference materials

The JRC Geel is currently involved in preparing and characterizing different Solid Spikes (Dried and Metallic) and a set of Pu isotopic Reference Materials for Destructive Analysis, and is planning to prepare a MOX reference material as well. A considerable stock of reference materials of U and Pu as been built up and is continuously being expanded.

The UKAEA and CEA also are providing a range of Reference Materials for both Destructive and Non Destructive Analysis.

Table 1: Destructive Analysis

Activity	N° of Tasks	Organizations Involved	R&D	State of Development	
				Field Test	Implementation
• Development of Laboratory Analytical Techniques	1	UKAEA	X		
– Improvement	3	UKAEA, JRC	X		
– Software development	1	JRC Geel	X	X	
• Automation of Analytical Procedures	3	UKAEA, ESD, JRC Karlsruhe	X	X	
• Performance evaluation	9	WAK, CEA, UKAEA, ENEA, JRC(Ispra, Geel) WGs DA, LEU and RIV		X	X[a]
• Target Values	1	WG DA	X[a]	X[a]	X[c]
• On-Site Laboratories	2	UKAEA, ESD, JRC Karlsruhe	X	X	
• Use of transportable analytical equipments	2	ESD, JCR Ispra			X[b]
• Production RMs	4	JCR Geel	X	X	X[c]

a - ESD and IAEA
b - ESD
c - Plant Operators, ESD and IAEA

List of abbreviations

BNFL	British Nuclear Fuels plc
CEA	Commissariat à l'Energie Atomique
ENEA	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente
IAEA	International Atomic Energy Agency
LEU	Low Enriched Uranium
REIMEP	Regular European Interlaboratory Measurement Evaluation Programme
RIV	Reprocessing Imput Verification
SAL	Seibersdorf Analytical Laboratory

Conclusions

The ESTABANK database and Table 1, which summarizes the R&D activities related to DA in the EC, display the following key points:

1) In the field of DA there has been a substancial shift from R&D towards field testing activities. For several years sample preparation/treatment and in particular the shipping of samples were studied extensively. The recent trend is to establish laboratories for performing analytical measurements close to large nuclear facilities, in order to eliminate or reduce to a minimun the preparation, conditioning and transport of samples for DA.
2) Until now very little effort has been invested in authentication measures. As to verification techniques, the UKAEA is developing and testing a system for the verification of the operator's analytical measurements (VOPAN)
3) DA remains the basis for nuclear material management and safeguards accountancy verification and in this respect it is a routinely used approach.
4) Several Member States provide tasks within their Support Programmes to IAEA on DA, but the current R&D programme of the IAEA does not include any activities on destructive analysis.

Formalizing the Performance of Containment and Surveillance Devices and Systems

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Consultant to AEA Technology

Abstract

The paper describes the study carried out to develop a technique for characterizing containment and surveillance devices and systems. The method is based on the principle of defining the task to be performed in such a way that the performance capabilities of alternative devices or systems can be compared against the task. The proposed technique allows the suitability or "goodness-of-fit for the purpose" to be demonstrated.

In order to formalise the procedures it has been necessary to identify and define all the main factors which have to be taken into consideration when determining the ultimate selection of C/S devices for application at a facility. These factors, or characteristics, are defined and classified into four categories, namely:

- those which contribute to the safeguards assurance offered by the C/S system, provided that the devices function correctly;
- those which contribute to the probability of the C/S system functioning correctly;
- those practical matters which determine whether particular devices should be considered suitable for the proposed locations; and
- administrative matters related to the availability of devices and their appropriate support services.

Only the first two categories are considered in detail in this paper.

The method for demonstrating "goodness-of-fit" is outlined in the paper. The possibilities of developing a figure-of-merit to express the 'goodness-of-fit' for the task is also discussed.

1. Background

The topic of how to express the detection capability of Containment and Surveillance (C/S) devices and systems was considered in the late 1970's in the context of IWG-RPS*. It was reasonably convincingly demonstrated that there was little likelihood of being able to present C/S performance capabilities in a form similar to that of accountancy techniques (eg. quantities and probabilities) except for devices which employed NDA devices as detectors.

As far as more recent activities are concerned, the first occasion on which the topic was addressed in any depth was at an IAEA Advisory Group Meeting (AGM) in Vienna in 1989 as reported in STR-247 /1/. The motivation for taking a fresh look at the possibilities of expressing C/S performance in some way was multifold:

- there was a feeling amongst C/S technical and systems experts that C/S measures were regarded more as a subordinate measure rather than as a complementary safeguards measure, and that it could be useful to be able to demonstrate the real contribution of C/S to the effectiveness of safeguards;
- there was clearly a trend towards the need for greater reliance on C/S techniques as more facilities and more material came under safeguards at the same time as budgetary constraints were being imposed. Hence it would be helpful to be able to demonstrate the effectiveness of C/S techniques;
- the concept of multiple (dual) C/S systems to provide greater assurance was being proposed for the IAEA's 1991-95 Criteria. It was felt that this required some method of evaluating systems in a way that would demonstrate that some enhancement of performance could be (and was being) achieved;
- there was also a belief amongst some C/S analysts that devices were not always used in the most advantageous way and that some formalisation of the selection procedures for C/S implementation would either show the belief to be misguided or it would encourage the selection process to be improved, in a transparent way.

At the 1989 Advisory Group Meeting there was insufficient time for the attendees to pursue the possibilities in any depth, but they did demonstrate that, in principle, some formalization of C/S performance was feasible. Consequently they recommended that an Expert Group Meeting should be set up in order to pursue the possibilities further. This Group met in late 1989 in Vienna. A summary of their discussions was presented to the INMM Annual Meeting in 1990 /2/. By the end of the Expert Group Meeting it was clear that there were good reasons for developing a method which could formalize the performance of C/S devices and systems. It was the view of the Group that development of a credible methodology was feasible and should be pursued.

A task was defined and taken up in mid-1990 by the author, within the UK Support Programme to the IAEA. The purpose of this paper is to report the progress in developing the methodology and to consider the potential benefits of the technique.

2. Basic Principles

It may be argued by sceptics that it is an impossible task to satisfy the motivations identified above. However, the view was taken from the start that the precise benefits of any formalizing technique could not be assessed effectively until a method had been developed and tested. Since individuals are frequently (if not continuously) making decisions by evaluating subjective data, imperfect data and quantifiable data, it would seem credible to formalize such procedures and to test them within the context of the application of C/S devices. Indeed there is a fairly good analogue of the C/S application which is worth considering because it illustrates, in a familiar way, the basic principles behind the proposed methodology.

3. The Consumer Analogue

Consumer research organisations (CRO) conduct comparative performance tests on consumer goods and send reports of their tests to their members. The CRO endeavour to assess how well individual makes of equipment (or services) perform against a set of performance criteria. The criteria are selected by the CRO as being the most probable criteria which individual consumers would take into account in making their choice of equipment to purchase. The criteria are a mixture of both quantifiable and subjective values. The performance

* International Working Group on Reprocessing Plant Safeguards, set up under the auspices of the IAEA.

evaluations are based on formalised test procedures, to the extent possible, and the comparative performances are scored on a subjective scale, for each criterion; for example, from *very poor* to *very good*.

One may choose to criticise or question the design and implementation of the test procedures. Problems can be anticipated if the key criteria are not reasonably independent of each other. However, the basic principle of providing comparative performance data against a set of key criteria would appear to be valid. Where a CRO can be criticised with some justification is in the concept of a "Best Buy". The selection process by which the best buy is identified is necessarily subjective. The choice by the CRO may be made on the assumption that all the criteria are equally important; in which case the device with high scores against the largest number of criteria is determined to be the best device. Alternatively, the CRO may use some subjective judgement as to which are the most important criteria. In this case, the device with the largest number of high scores against these key criteria may be judged to be the best device. Methodical consumers will make their own judgement of the relative importance of each criterion so as to weight the importance of the individual test scores. They will then combine the weighted scores in to a comparative figure-of-merit in order to reach some conclusion. The consumer's combinatorial model may seem ill-defined but must surely have some structure. /3/

4. Application of Analogue Principles to C/S

When introducing C/S devices and systems into a safeguards regime, a potential need is identified from which some particular safeguards functions can be defined in order to meet the need. A choice has then to be made in order to obtain the most cost-effective method of deploying the most appropriate (or readily available) equipment. In an informal way one may intuitively arrive at the most appropriate devices, given the constraints within which the decision has to be made. One can make the choice in a more formal way by identifying the key criteria against which the judgement is made; as described above in the consumer case.

The technique which was tested in principle by the Expert Group, has been pursued in this project. The method involves structuring the criteria (henceforth referred to as task characteristics) in a formal manner. This allows the C/S task to be defined in a transparent way and thereby enables the "goodness-of-fit for the purpose" of device types to be illustrated. Thus, one arrives at a "task profile" in which the key C/S characteristics are weighted (or ranked) relative to each other and at a "performance profile" in which individual devices are scored in accordance with their relative performance against other devices for each characteristic.

Progress in the project has resulted in the identification, the definition and the categorization of the key characteristics which make up the task and performance profiles. The use of a visual technique using overlays to illustrate goodness-of-fit is demonstrated in the progress report (4). Additionally, some alternative definitions of performance figures-of-merit are considered in that report.

5. Identification of the Key Characteristics

The starting point of the Expert Group methodology was to define a set of safeguards functions (or requirements) which a C/S device or system would be required to perform in any specific application. In drawing up this list of task characteristics the Group recognised that there were problems of independence, interpretation and consistency of definition. In this study it was possible to consider the list of characteristics in greater detail. The processes of identification and defining these was a lengthy part of the overall study.

It is suggested that there are, four categories to be considered. These are:

a) **safeguards characteristics**, which contribute to the level of safeguards assurance gained from the C/S device or system;
b) **operational characteristics**, which contribute to the technical performance, such as its suitability for installing and operating effectively;
c) **external characteristics**, (or externalities) which are factors that may have a direct influence upon the choice of a device but which do not contribute to safeguards assurance. These factors will depend very much upon the particular location being considered;
d) **administrative characteristics**, which are essential requirements to be met before any device can be considered suitable for the application.

These four categories can be seen to cover, respectively, four very simple questions appertaining to a device or system:

a) is it capable of providing good quality C/S safeguards information?
b) will it work effectively in this application in order to provide that assurance?
c) how costly and convenient is it to install and operate and is it acceptable to the facility operator?
d) is it available, with adequate support services?

For performance characterization we are concerned only with the safeguards and the operational characteristics.

Table 1 presents the list of characteristics, with brief definitions, which contribute to safeguards assurance and Table 2 contains those characteristics which contribute to operational performance. The project report /4/ contains detailed consideration of the issues involved in establishing and defining the characteristics.

To the extent possible the characteristics have been defined to be independent of each other, but it was inevitable that there would be some instances of interdependence or over-

Table 1: Safeguards Characteristics with Brief Definitions

1. Tamper Resistance	An indicator of the extent of the resources (including skill and time) required in order to defeat a seal, on to corrupt data, with a low probability of the attack being detected.
2. Tamper Indication	A measure of the ability of the device to provide hight assurance that tampering has been attempted when that is the case or to indicate that accidental damage may have permitted a breach of the sealed access.
3. Operating Status - Concealment	A indicator of the ability to ensure that information relating to the operating status of the device is not accessible to unauthorised people.
4. False Alarm Probability	The probability that a device will generate *unanbiguous* evidence of either a tampering attempt, or an undeclared event of safeguards significance, when *no such event* has occurred.
5. Detection Probability	An indicator of the probability that a (surveillance) device will detect all events which have been defined in the Task Objectives as having safeguards significance
6. Probability of Inconclusive Outcome	The probability of being unable to reach confidently a concluse verdict (positive or negative) from analysis of the data provided by the device.

Table 2: Operational Characteristics with Brief Definitions

7. Reliability	An indicator of the probability of a device failure occurring which could results in a loss of continuity of safeguards knowledge.
8. Durability	An indicator of the impact that the local operating environment could have in degrading the reliability performance assessed above.
9. Reliance on facility	An indicator of the extent to which the operation of a device depends upon the provision of support services by the facility operator.
10. Data capture and storage	An indicator of the importance of ensuring that the selected device has the capability to meet the performance specification in terms of the specified data capacity and data capture rates.
11. Evaluation Time	An indicator of the ability to interrogate the C/S data from a device whilst at the facility, in order to have the opportunity to reach some preliminary conclusions.

lapping of definitions. For example, the tamper capabilities of a device depend upon two factors; namely tamper resistance and tamper indication, which are independent but related, to some extent:

- if a device has good tamper indicating features, greater levels of resources, skill and time would be required to effect a successful (undetected) defeat than would be the case if it had poor tamper indicating features, however;
- if a device has poor tamper indicating features it may still have good tamper resistance (with respect to resources required to defeat it) but one may not have high assurance as to the possibility of tampering having occurred.

It was concluded that tamper resistance and tamper indication should be recognised separately as safeguards functions for the purpose of performance characterization.

Obviously there are also matters of inter-relationships between detection of attack, false alarm, and inconclusive outcomes. Furthermore, in the case of a seal which has a principal function of detecting tampering attempts, detection probability is equivalent to its tampering indicating capabilities.

The next stage in the evolution of the study was to devise a set of procedures whereby quantitative and qualitative performance data could be collected in a consistent and formalised way, against the list of relevant characteristics, in order to build up task and performance profiles.

6. Acquisition of Task and Performance Profile Data

Preparation of the task profiles and the device performance profiles require the treatment of quantitative and descriptive (non-quantifiable) data. The task profile for a particular application is best defined by the appropriate experts, namely the facility inspection team; preferably by consensus. The items in the list of characteristics identified in Tables 1 and 2 need to be weighted in terms of their relative importance for the particular application being considered. A five point scale of task importance is proposed, ranging from *essential*, through *very important, fairly important* and *desirable*, to *not relevant.*

The ranking of the characteristics for a particular application should preferably be made without taking into account the type of device which one might have in mind as being the most likely to be installed. To the extent possible it should be independent of expected performance. Ranking should be based on the importance of each characteristic relative to the other characteristics, for the particular application. Although this is the ideal procedure it will be found in practice that in a few cases the "importance score" evaluation cannot be totally independent of the device type.

In a similar way, the performance profile of individual device types can be built up by establishing the relative performance scores of the devices against the same set of characteristics. However, in this case the performance of a device is ranked by comparing its performance against that of other (competing) devices for each characteristic. A five point scale is proposed for expressing the relative performance of devices, namely; *excellent, good, moderate, poor, ineffective*. This assessment should be made in close collaboration with instrumentation experts. Ideally the ranking should be made independently of the application but it will be found in practice that this independence cannot always be achieved.

In order to achieve a consistent process for arriving at task and performance profile scoring, a procedure is proposed which makes use of questioning prompts. Separate questionnaires are used for each task characteristic and each performance characteristic. Each provides a brief definition of the characteristics in a similar way to that shown in Tables 1 and 2. There are also some advisory notes which clarify some of the important points to bear in mind when making the relative score. The score level adopted by the inspector is in response to a direct question which allows one of the five relative scores to be selected.

For some of the characteristics it is necessary to have defined the performance requirements in quantified terms before any attempt is made to assess either task importance or device performance scores. For example, in the case of Data Capture and Storage, a task specification is a pre-requisite. A task importance ranking can then be made in response to a question of the form "how important is it that one uses a device whose performance will adequately meet the requirement specification?". This enables the task performance ranking to be expressed in identical ways to that of the non-quantifiable characteristics. Similarly the device performance score would be assessed as an indicator of how well the device capability compares with the specification.

The process of developing performance profiles has been described above in the context of comparing individual device types. It may be more appropriate to evaluate a set of devices or a system rather than a single device. Thus one may assess the application of a CCTV system consisting of several cameras. The use of the prompting questions is to encourage a structured analysis of the task requirements and technical capabilities. The use of the technique is not invalidated by the level of complexity of the application.

7. Performance Scoring Options

The purpose of establishing the task and performance profiles is, inter alia, to enable the relative merits of individual device types or systems to be compared for particular applications. There are several options which could be considered as suitable methods for illustrating the comparative suitability of devices. One of these, the overlay technique, has the merit of providing a visual presentation of both the task importance profile and the device performance profile. Figures 1 and 2 illustrate the basic principle. The descriptive scores of task importance profile and the device performance are converted into shaded areas as shown in Figure 1. This can be done for each of the characteristics listed in Tables 1 and 2 for the particular application and for

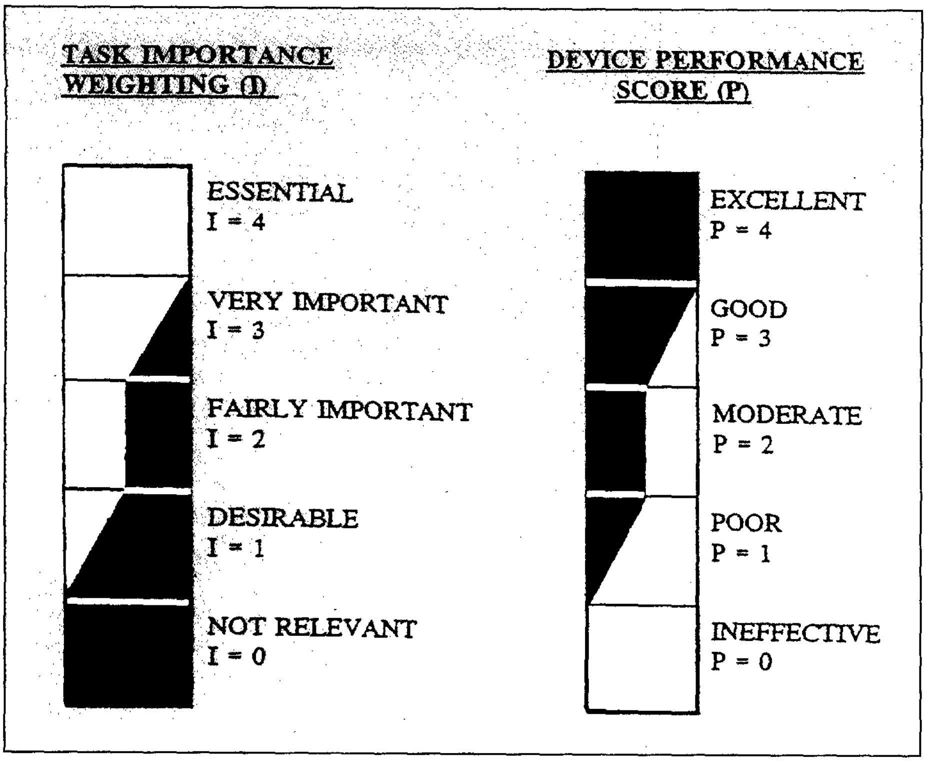

Figure 1: Task and performance scoring scales (visual and numerical).

the device or system being considered. The device performance scores (ie the performance profile) are prepared on a transparent sheet which can be laid over the task scores (ie the task profile).

Figure 2 illustrates examples where there is mismatching between the device performance and the task requirement. The presence of the white triangles arising in the overlay technique indicate where deficiencies in performance arise. The position of the white areas within the box is indicative of the importance of the task to which the deficiency applies. The number of white triangles per box is indicative of the extent of the deficiency.

Thus a simple technique can be used to provide a visual demonstration of "goodness-of-fit for the task". The technique relies upon the subjective assessments of importance and capability. These have to be made in a manner which is consistent with the overlay scoring system. For example, the assessing inspector would appreciate that a task importance score of *very important* implies that a performance score of not less than *good* will be required to meet the requirement (and vice versa).

An alternative option for expressing overall performance, is to convert the ranking levels in the task and performance profiles to some numerical scales so that they can be used as individual multipliers in order to weight the individual performance scores. Thus, for characteristic *i*,

let a device have a performance score P_i

and a task importance weighting I_i

Then;

Weighted performance Score $W_i = P_i \times I_i$ (1)

Thus, weighted performance scores W can be derived for each characteristic for each device being considered for a particular task. The question then arises as to the most appropriate way of combining the weighted scores for a device type in order to arrive at an appropriate figure-of-merit. Before considering suitable formulae for a figure-of-merit it is important to identify the key criteria which can determine the choice of numerical equivalents to the ranking levels of importance and performance.

Pursuit of a suitable scoring scheme has led to the conclusion that the following features would be desirable:

- the best features of a device which correspond (match) to the most important task requirements need to be highlighted;
- the cases where the important tasks correspond with poor performance by the device need to be highlighted;
- details where the boundary between acceptable and unacceptable levels of performance occur need to be overtly presented;
- tasks having no relevance must not be expressed in a way which might have any influence in calculating an overall figure-of-merit for a device in a particular application.

Two alternative scoring options were considered during the project, with more attention being given to the simpler of the two systems. This latter system makes use of simple linear scales for the conversion of descriptive terms into numerical values suitable for processing into a figure-of-merit.

The performance characteristics are graded in the prompt questionnaires on a five point scale of descriptive terms from *excellent* to *ineffective*, as described above. These are converted to numerical scores (P_i) in the range of *four* to *zero*. Similarly the task importance weightings are graded from *essential* to not *relevant* and these are converted to numerical scores (I_i) in the range *four* to *zero*, as shown in Figure 1.

Having developed a method of deriving numerical values for a weighted performance score for individual characteristics, it is then necessary to consider how to combine these separate scores into an overall figure-of-merit.

8. Figure-of-merit

It is not obvious that one can develop a theory starting from basic physical laws which would lead to a defined figure-of-merit that could be shown to be consistent and logically correct. The procedures described above are a process whereby the many attributes (in this case, characteristics) which are not normally assessed in a common dimension can be treated as being expressed in common units.

The question then arises of how to establish a suitable figure-of-merit based on subjective evaluation. If we consider the six characteristics in Table 1 which contribute to the safeguards objectives for C/S, is it feasible to produce a formula which combines these characteristics in a way which is a measure (or an indicator) of the level of safeguards assurance? It will be assumed that the level of assurance is defined as the probability that if a safeguards significant event occurs it will be detected and if no significant event is detected it is because no such event has occurred.

The definition of assurance does suggest that a figure-of-merit should be based on detection probability combined with a low false alarm probability - as is the case with the materials accountancy criteria. An appropriate figure-of-merit for the safeguards assurance component of the performance assessment could be:

- the aggregated total of all the relevant weighted performance scores from the six characteristics (1-6) normalised by the maximum achievable weighted performance scores.

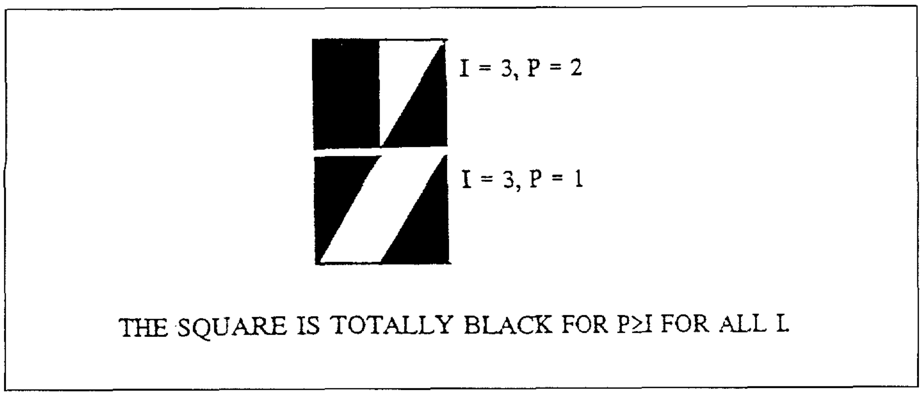

Figure 2: Illustrative examples of the overlay principle.

A similar aggregate figure-of-merit for the operational component of the performance assessment could be based on characteristics 7-11.

If it is thought desirable to arrive at an overall single figure-of-merit, then it would be possible to combine the two separate figures-of-merit proposed above. However, it can be argued that it is useful and sensible to retain their separate identities because they serve two fundamentally different purposes. Evaluation of the safeguards characteristics and the operational characteristics are intended to provide comparative answers to the following questions:

- what is the safeguards assurance that an inspector would gain from the device given that it operates correctly?
- what is the probability that correct operation will be achieved?

In line with the ideas presented by the Expert Group, a figure-of-merit could be seen to be made up of:

tamper quality x detection quality x operational quality;

being based on normalised aggregate scores of characteristics 1-3, 4-6 and 7-11 respectively.

To convert the combined system numerical scores back to descriptive terms requires inversion of the arithmetical process. One cannot use the conversion scale exactly as it was used on the input data, partly because the derived system scores are not generally discrete integer values. It is, therefore, necessary to adopt an arbitrary (but credible) conversion scale. Some sensitivity tests were carried out in order to examine the effect of changes in the input performance and task estimates upon the derived system performance scores. A rule for converting system numerical scores to descriptive scores was selected as a consequence of those sensitivity tests. It is acknowledged that this conversion scale is, to some extent, arbitrary. Nevertheless, a more satisfactory scale should be achievable by consensus amongst experienced inspectors, based on real in-field applications.

9. Demonstration using Simulated Data

In order to test the proposed procedures, the Agency's Task Officer was invited to provide some data which could be considered to be typical of that which might be generated for a real field application. In order to produce realistic data it was necessary to have some typical application in mind. The Task Officer provided the author with his responses to the questions presented in the draft questionnaires. This process showed that it would be desirable to clarify the requirements and definitions in some of the screens.

The overlay technique and the method of deriving aggregated performance scores for devices and for dual systems was demonstrated. The concept of a "deficiency" score was introduced in place of a "performance" score. Deficiency indicates the (numerical) extent to which a device matches up to or fails to match up to the level of performance considered necessary, based on the importance weighting (I) of the particular task. No credit is given for performance capability in excess of that required to meet the task requirement. A negative score indicates a performance below that required, and is equivalent to the size and position of the white triangles in the overlay techniques.

The procedure as shown allows the inspector to see clearly the extent to which the task and performance profiles match both for devices and for dual systems. It allows relative performances to be compared. Thus, the inspector can review the input data and observe whether the data processing is consistent with expectations. If the outcome is consistent with expectation, there is some encouragement that the method may have validity as a technique for characterising individual devices. If there are surprises or inconsistencies in the observations it will be necessary to establish whether the cause is due to an inadequate method of data collection, invalid methods of converting the subjective values, invalid processing logic or whether the inspector can detect inconsistencies in his judgement of relative performance or task importance levels.

Application of the procedures to duplicate devices was also pursued in the study. The combinatorial rules were based on reference /5/. The effectiveness of the technique for duplicate devices/systems was not adequately investigated in the study.

10. Comments on the Processes

The sequence of data collection, processing and analysis involves the following steps:

- estimation, in descriptive terms, of the relative importance of characteristics to the safeguards task at specific locations;
- estimation, in descriptive terms, of the relative capabilities of individual device types, or systems, to fulfil the particular task, judged against the relevant characteristics;
- presentation of the data using the overlay techniques; *or*
- conversion of these descriptive terms into numerical values in order to facilitate the processing function;
- application of the numerical values to a formula which combines the various characteristics into a device performance figure-of-merit;
- application of combinatorial rules to enable dual and duplicate C/S performance scores to be established from device type scores;
- conversion of overall device and system numerical scores into descriptive terms.

Overview comments are now presented with respect to each step in the process. Issues arise at each of the steps which need to be resolved and clearly understood if the procedure is to gain acceptance. It should be remembered that the proposed procedures are intended to formalize overtly some of the decision processes which routinely take place. The first two stages of estimation almost certainly occur in some form already when judgement is being made as to the most suitable equipment to use; although probably not in such a formal way as is proposed here. The eleven characteristics which have been identified as being the key components contributing to safeguards assurance and to operational effectiveness have been selected from an extensive list. The process of categorizing and defining the characteristics received a lot of attention in the study. Whilst individuals may feel that the categorization is slightly arbitrary, the method of selection does have a coherent logic. It may be that the definitions of the characteristics need to be refined.

There should not be too much difficulty in persuading individual inspectors, having the appropriate knowledge, to produce relative rankings of importance and performance capability. The issue arises as to the extent of the bias (optimism, pessimism, etc) and spread (extremes of values attributed to scores) of subjective values between individual inspectors. The impact of variations in bias and spread can only be investigated by testing the estimation process on a group of individuals. From the limited amount of testing done so far it is clear that there is need for more clarification in the wording used in the questionnaires, in order to reduce the spread due to ambiguities. One should also pursue the relative merits of individuals making their own estimates as against the promotion of consensus estimations. There are many alternative ways of gathering a consensus of subjective opinions /3/.

Several issues arise with respect to the rules for converting descriptive terms into numerical values. The scales of zero to four adopted in the demonstration with simulated data have the merit of probably being the simplest one could choose. If these conversion scales can be shown to be adequate when and if further demonstrations are carried out, there should be no reason to pursue more complex rules for conversion. Complex models are not always the best way to simulate complex processes.

The use of the overlay technique alone is sufficient to highlight any mismatching and provides a visual presentation of goodnes-of-fit for the task. However, if one wishes to pursue the figure-of-merit, the next step is to apply the numerical values to some formula which reflects the performance (in relative terms) of the device at the particular location. In the overlay technique, the deficiencies (or mismatch) of the device for the task are highlighted as white areas in a box. The basic assumption implied by this visual technique is that the "degree of whiteness" in the task importance can be matched (or satisfied) by the "degree of blackness" in the performance capability. (ie. that a *Good* performance score is adequate for a *Very Important* task). This should not be a difficult concept to accept provided that the inspectors are made aware of this fundamental assumption when being introduced to the estimation process. This assumption is also the basis of the calculation of a figure-of-merit for the device at the defined location.

The choice of definition of a suitable figure-of-merit is open to discussion. A simple additive formula was used to produce a normalised aggregate score separately for safeguards assurance and for operational effectiveness. Again this was based on the principle of adopting the simplest option unless one can justify an alternative on some logical or practical grounds. An alternative multiplicative formula was proposed by the Expert Group but has not been tested against the test data.

It will be necessary to gather "real" data from experienced inspectors with several alternative applications in mind in order to establish whether the procedures are credible and whether the output of overall device and system performance are consistent with the inspectors' subjective expectations. Where the outcomes are counter-intuitive the causes will need to be sought. It may well turn out that the inspectors' thought processes are inconsistent rather than that the proposed characterization procedures are faulty in some way.

The use of fuzzy mathematical techniques may well be an appropriate way to handle the collection of the descriptive input data and its conversion into a form suitable for processing. /6/. At the present state of the project it has not been felt that the use of fuzzy sets and linguistic variables in a formal way would contribute usefully. Firstly, it has been necessary to establish the basic principles of the characterization process into a credible form. Fuzzy maths is then a possible tool that could be used in data manipulation.

11. Conclusions

Methods have been investigated which have the potential to formalise the processes of selection of C/S devices for defined applications. The processes make use of both quantified and unquantifiable device performance data. The device performance capabilities are compared with the task requirements, enabling device performance levels to be compared. By formalising these procedures certain unquantifiable benefits can arise:

- the method makes use of expert opinions and data;
- the strengths and weaknesses of devices and systems are highlighted;
- the method allows the facility inspection teams to justify their choice of devices by demonstrating that they have traded-off the deficiencies in favour of the overall performance;
- there is the potential to illustrate the additional merits of dual C/S systems.

The study has pursued several issues which are not reported here because they lie outside the purposes of this report. Issues relating to the possible application to a complete C/S regime, integration of item identification and counting techniques, for example, should be pursued if it is proposed that the work should be continued further.

The work to date shows that it is feasible to produce a set of procedures which would allow device and system performances to be evaluated in a comparative way. Whether the benefits of such a technique justify further work is for others to decide. If the decision to proceed is made, a programme of development work can be defined, based on the experience gained so far. It will involve considerable input from experienced inspectors in order to acquire an adequate reaction to the screen prompts and a sufficient data base on which to perfect the procedures.

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/1/ Safeguards C/S and In-Situ Verifiable Seals". Report of AGM, 1988. IAEA, STR-247

/2/ Characterization of the Performances of C/S Devices and Systems". FJ Walford and E Yellin. INMM 31 Annual Conference, July 1990.

/3/ Readers wishing to pursue these ideas further might choose to start with "Judgement and Choice. The Psychology of Decision". Robin M Hogarth. John Wiley, 1988

/4/ "Characterization of C/S Devices and Systems" FJ Walford. SRDP-R-195. AEA Technology. September 1992.

/5/ "The Use of Dual C/S Systems". UK Safeguards R&D Programme. K Taylor and FJ Walford. SRDP-R177. AEA Technology. December 1990.

/6/ "Fuzzy Methods for System Performance". A Zardecki and EA Hakkila. ESARDA Symposium, Avignon, 1991.

EQUIS: Safeguards Equipment Information System

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Introduction

The effectiveness of the International Atomic Energy Agency (IAEA) safeguards effort depends in part on the reliability and availability of the equipment used. An automated system to inventory Safeguard's equipment and which can provide comprehensive information on each piece of equipment was required. EQUIS, the Safeguards Equipment Information System, was modified and enhanced with support from the Commission of European Communities cooperative support program to the IAEA, Task NMA-8A.

The system uses the Software AG products: the ADABAS data base system and the fourth generation language, NATURAL. The purpose of this multiuser, interactive system is to assure that all Safeguards Staff have prompt and easy access to up-to-date information on equipment that they require and for which they are responsible.

System Environment

The IAEA Section for Equipment Management (DEM) has overall responsibility for the data in the EQUIS data base. The Safeguards Operations Divisions also maintain data on equipment for the time during which they are responsible for it, i.e. when they are using the equipment. An interface which allows for online queries and report generation is available to all Safeguards staff who need access to this information.

Figure 1 shows the flow of information and the organizational units involved in maintaining and using the EQUIS data.

New equipment is received at the IAEA headquarters by the Division of General Services in the Department of Administration (ADGS). Safeguards equipment is forwarded to DEM. DEM assigns the Safeguards Equipment Number (barcode) and updates the EQUIS data base.

When an equipment item is shipped to a Safeguards Regional Office or to a facility, the relevant Operations Division assumes responsibility for the data on the equipment and updates the data base. When equipment is no longer needed, if it needs servicing, or if it has become obsolete, DEM or the Field Office arrange the return of equipment from the field to headquarters. On return of the equipment, DEM again assumes responsibility for the equipment information and updates the data base accordingly.

Special programs interfacing with other IAEA Safeguards Information System (ISIS) components extract, compare, verify, and load information from the ISIS data base. The main source is the ISIS Inspection Data System which stores information on equipment reported by Safeguards inspectors. Information on NDA and Containment/Surveillance equipment reported as "in use" in the Computerized Inspection Report (CIR) system is loaded directly into the EQUIS data base by the CIR Data Entry routines. This inspection data is extensively quality controlled and is considered the authority; i.e., if there is a discrepancy with the location or status between Inspection data and the EQUIS data, the Inspection data is used after appropriate QC measures have been taken.

System Description

EQUIS is an online mainframe system. Functions to update, retrieve, and produce reports have been implemented via a common user interface; however, this interface is different according to the requirements and responsibilities of the user. The system tests who is the current user and presents menus and data entry screens tailored to the Division of that user: DEM may update all data in the data base, the Operations divisions may update only those records

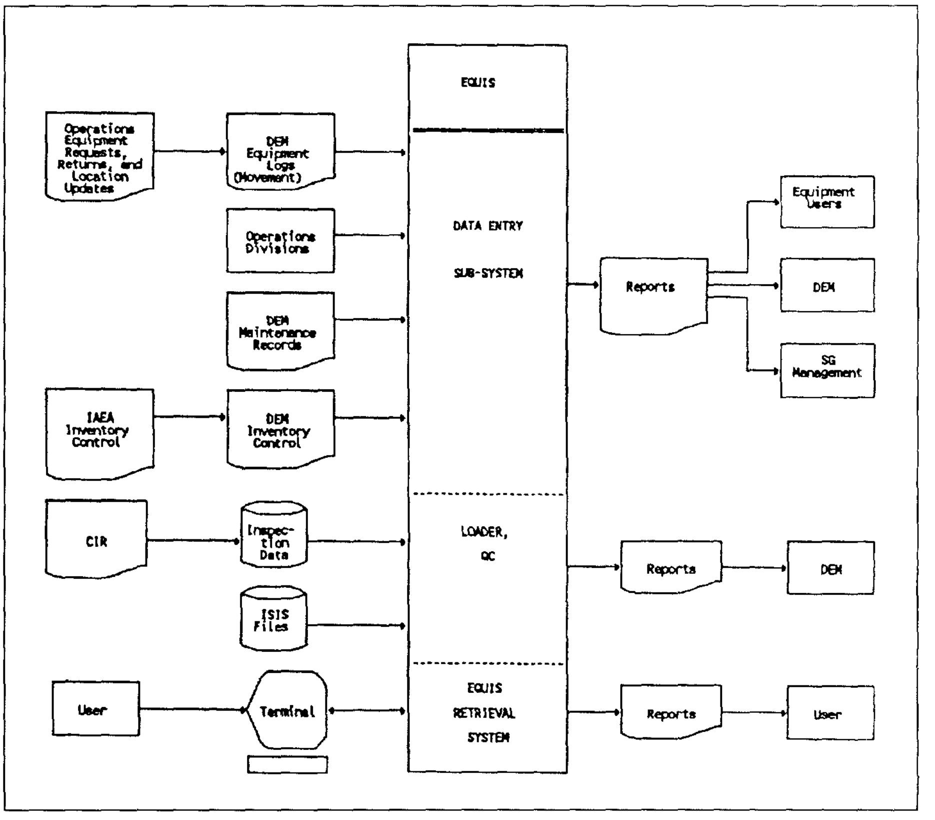

Figure 1: Information flow diagram.

pertaining to equipment which has been signed out to them and for which they are responsible. All users can query and produce reports on the complete data base.

EQUIS consists of two major components: the data entry system and the query system; the query system is used also for producing printed reports. These two components are described below. Quality control of the data is performed at data entry time.

EQUIS data is stored in four ADABAS files: EQUIS-HDR, EQUIS-DETAIL, EQUIS-HISTORY, and EQUIS-TEXT.

The file EQUIS-HDR contains general data on equipment; there is one record for each type or model of equipment. The record includes: a description of the item of equipment; the type of the equipment (NDA, C/S, LAB); the manufacturer's model designation number; and the Equipment code.

The file EQUIS-DETAIL contains data on the current detailed status of equipment; there is one record for each individual item of equipment. The record includes: the date the item was purchased; its cost; the IAEA assigned inventory number; the current status; the current location; the currently responsible Staff Member, Section, Division, and a system configuration field.

The file EQUIS-HISTORY contains a historic record of the individual equipment items: history of the location; the responsible Staff, Section, and Division; status; maintenance and repair information; and the inspection (identified by the facility code, inspection year, and inspection number) where the equipment was used. One history record is written to this file whenever the status or the location of an equipment item changes, for example, when the status changes from "shipping" to "in use", a record containing complete information of the new "in use" status of the equipment is stored in EQUIS-HISTORY. The relevant record in EQUIS-DETAIL is updated to include the same "in use" information. This duplication of data on the newest status of the equipment makes it possible to review a complete history of the equipment by reading only EQUIS-HISTORY; the current status of a selection of equipment items can be obtained by reading the EQUIS-DETAIL file.

The file EQUIS-TEXT can contain any free text comments or calibration data relevant to the equipment item.

```
+----------------------- Equis Selection Criteria -------------------+
|                                                                     |
| Division: _           Resp-Section: __       Country: _            |
|                                                                     |
| Equip.-Number: ___ / __                      Equip-Code: ___       |
|                                                                     |
| Model: ________       Item-Descr.: ________________                |
|                                                                     |
| Location: ______      Destination: ______    Resp-Pers.: ________  |
|                                                                     |
| Status: ______                                                      |
|                                                                     |
| Period-From: _____                           Period-To : _____     |
|                                                                     |
|                       System-Ident: ___ / __                        |
|                                                                     |
+---------------------------------------------------------------------+

Enter-PF1---PF2---PF3---PF4---PF5---PF6---PF7---PF8---PF9---PF10--PF11--P
      HELP        QUIT        TYPE                        NOQC
```

Figure 2: EQUIS selection criteria

```
+------------------------------+
| Help for-Loc                 | Selection Criteria -------------------+
| W1BW           5             |                                        |
| W1GA           5             |                                        |
| W1SA           2             | Section: __        Country: _          |
| W1SP          12             |                                        |
| W2GA           5             |                    Equip-Code: ___     |
| W3DL           4             |                                        |
| W3GA           5             | Descr.:                 _____          |
| W4DL           5             |                                        |
|                              | nation: ______     Resp-Pers.: ________|
|                              |                                        |
|                              |                    Period-To : _____   |
|                              |                                        |
|                              | m-Ident: ___ / __                      |
|                              |                                        |
| ---------------------------- |             --------------------------+
| PF3 PF7 PF8  PF5  PF6        | ress
| ---------------------------- |             7---PF8---PF9---PF10--PF11--P
| QUIT UP DOWN TOP BOTTOM      | YPE                   NOQC
+------------------------------+
```

Figure 3: Help for location.

EQUIS Data Entry System

There are several user interfaces to the EQUIS Data Entry system. The system tests the identity of the current user, distinguishes between users in DEM authorized to perform comprehensive updates to the EQUIS data and users in the Operations Divisions who may perform more restricted updates to the data base, and presents menus and screens tailored to each user.

The Data Entry system makes use of program function keys which allow the user to easily navigate the system, to obtain "pick lists" - lists of valid values for various data base fields, and to obtain help information. Where possible, information to be stored is checked for validity and consistency.

EQUIS Query System

The EQUIS Query system functions on the Query-By-Example (QBE) principle. Retrievals are formulated by entering valid combinations of values in the fields of the EQUIS Selection Criteria screen, Figure 2.

There are two ways to enter data to the fields of the selection criteria screen. A user familiar with the value required can type the value directly into the field. Alternatively, for most fields on the screen, the user can ask the system to present a list of possible values, a "pick list" from which a value can be selected. When the system displays a pick list, it also displays the count of records (equipment items) that exist in the data base for all items in the list.

Two mechanisms are provided which limit the results of pick lists and retrievals: the wildcard character, "*", can be used at the end of a character string to limit the search to values starting with the specified string; and the pipe character, " ¦ ", to obtain a range of values. Figure 3 is an example of a pick list produced when "W1 ¦ W4" was entered in the Location field.

SAFEGUARDS EQUIS REPORT   Page 1 of 1   92-07-31 11:42:28

Selected by :   Loc.:

Equipment Number	I A E A Inv. No.	Item Description	Equip Code	System Ident.	Resp Sect	Staff Member	CC	Location	Date	Status	Facility from	Facility to	Return Date
4411/100	4411100	CAMERA	PHSR		OB1		CN		920610	TRANSFER			
4411/123	4411123	CAMERA	PHSR		OB1	BADALAMENTE	CN		920508	IN USE			
4411/622	4411622	CAMERA	PHSR		OB1		CN		920610	TRANSFER			
4699/005	4699005	NEUTRON DETECTOR	AWCC		OB1	BAROCAS	CN		910809	IN USE			
4892/022	4892022	ASSAY METER	HM-4		OB1	AHN	CN		910710	IN USE			
6019/005	6019005	LOAD CELL 20T	LCBS		OB1	BERKMEN	CN		910108	IN USE			
6454/004	6454004	COBRA SEAL VERIFIE	FBOS		OB1		CN		920412	TRANSFER			
9160/001	9160001	MIVS MAINFRAME	MIVS	9160/001	OB1	SMITH,J	CN		920624	IN USE			
9160/002	9160002	MIVS MAINFRAME	MIVS	9160/002	OB1	SMITH,J	CN		920702	IN USE			
9162/175	9162175	MIVS CONTROLMODULE	MIVS		OB1	SMITH,P	CN		920620	IN USE			
9162/181	9162181	MIVS CONTROLMODULE	MIVS		OB1		CN		920617	TRANSFER			
9162/182	9162182	MIVS CONTROLMODULE	MIVS		OB1		CN		920617	TRANSFER			
9167/026	9167026	SEAL	VCOS		OB1		CN		920617	TRANSFER			

Figure 4: EQUIS report type "C".

EQUIS Reports

Four different formats for printed reports are available. The retrievals for the reports are produced in exactly the same way as online retrievals are produced, using the EQUIS Selection Criteria screen. Dialog boxes and program function keys are used to select the report type and to request the system to save reports for printing: the system is set in either "save reports for printing" or "do not save reports for printing" mode. In either mode, the executed retrievals are displayed on the screen. Hardcopy printouts of all queries executed in the "save reports for printing" mode will be produced at the end of the online session. An example of one type of report is given in Figure 4.

16th Annual ESARDA Meeting (Restricted Participation)

Ghent, Belgium
Probable date 17-19 May 1994

Attendance will be limited to the ESARDA Steering Committee members, Working Group members and observers, coordinators and a few experts invited to the meeting.

This meeting will celebrate the 25th Anniversary of ESARDA and will be held in a historical building of the University of Ghent.

17th ESARDA Symposium

Germany, May 1995

The 17th Annual Meeting will be a general ESARDA Symposium on Safeguards and Nuclear Material Management. It will be held in Germany. The venue will be decided soon. The date will be, as customary, in May.

Attendance and contributions to the ESARDA Symposium will be open to people from all the world.

LB-AB-93-022-EN-N