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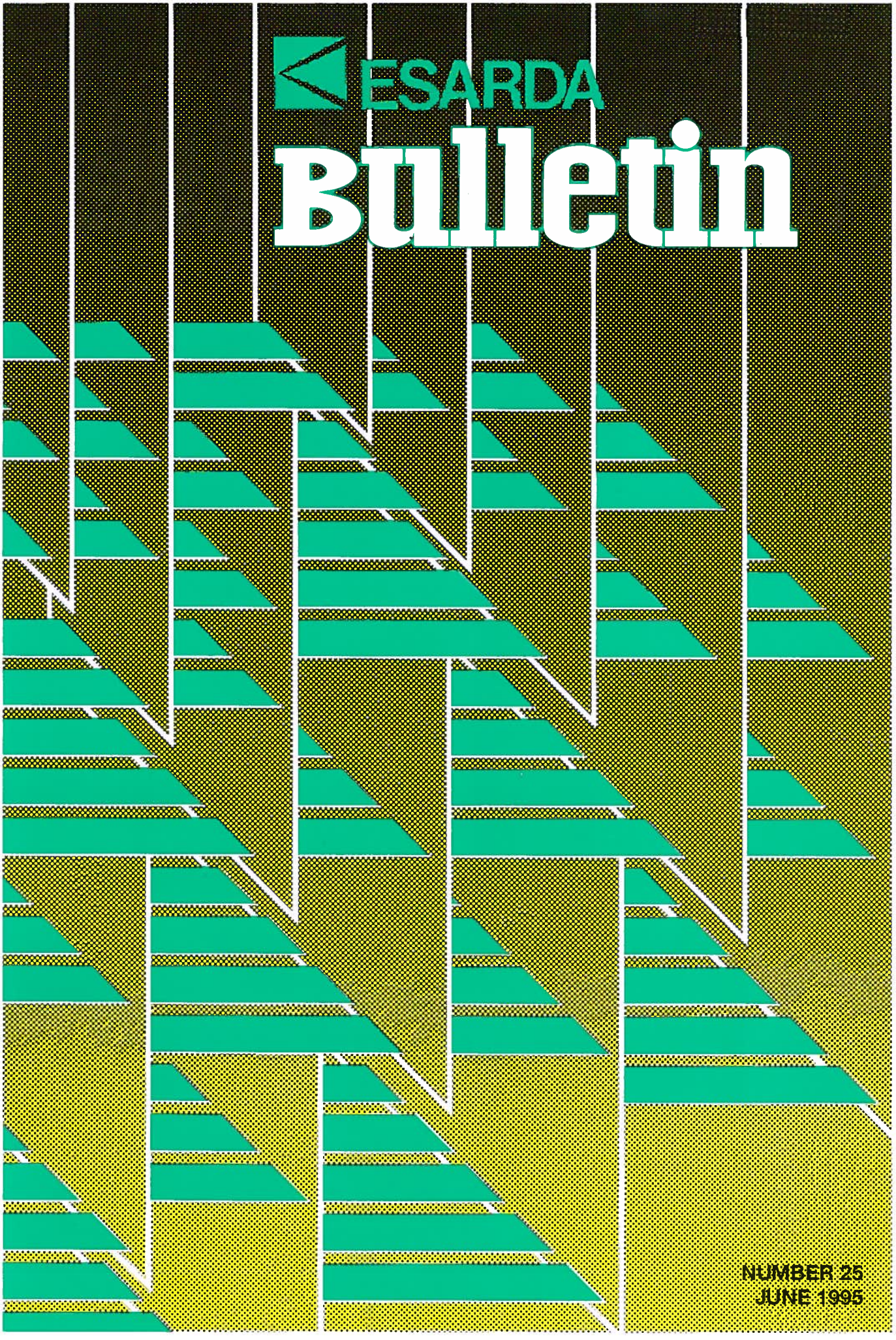

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ESARDA Meetings: A short history

A personal view of the previous Permanent ESARDA Symposia Scientific Secretary

L. Stanchi
Editor of the ESARDA Bulletin

ESARDA was founded in 1969 and celebrated its 25th anniversary during the meeting of Ghent, Belgium in May 1994.

On the occasion of its 10th anniversary the Steering Committee decided to hold in April 1979 a symposium on Safeguards and Nuclear Material Management and to start a series of annual symposia. Later the Steering Committee decided to have a general symposium every two years and hold a specialized meeting in the alternate years.

Other meetings were organized by ESARDA, such as a general symposium on Practical Applications of R&D in the Field of Safeguards held in Rome in 1974 and topical meetings depending on requirements. In the Table the full list of meetings is reported in brief.

International Meeting on NDA	Ispra, Italy	20-22 September 1971
Symposium on Applications of R&D	Rome, Italy	7-8 March 1974
Symposium on Isotopic Correlations	Stresa, Italy	9-11 May 1978
1st Seminar on C/S	Ispra, Italy	17-19 September 1980
ESARDA/INMM Joint Meeting on NDA Statistics	Ispra, Italy	12-14 September 1984
The series of annual meetings:		
1st Annual Symposium	Brussels, Belgium	25-27 April 1979
2nd Annual Symposium	Edinburgh, Scotland	26-28March 1980
3rd Annual Symposium	Karlsruhe, Germany	6-8 May 1981
4th Annual Specialist Meeting	Petten, The Netherlands	27-29 April 1982
5th Annual Symposium	Versailles, France	19-21 April 1983
6th Annual Symposium	Venice, Italy	14-18 May 1984
7th Annual Symposium	Liège, Belgium	21-23 May 1985
8th Annual Meeting	Copenhagen, Denmark	13-15 May 1986
9th Annual Symposium	London, England	12-14 May 1987
10th Annual Meeting	Karlsruhe, Germany	3-5 May 1988
11th Annual Symposium	Luxembourg	30 May-1st June 1989
12th Annual Meeting	Como, Italy	15-17 May 1990
13th Annual Symposium	Avignon, France	14-16 May 1991
14th Annual Meeting	Salamanca, Spain	5-8 May 1992
15th Annual Sympsium	Rome, Italy	11-13 May 1993
16th Annual Meeting	Ghent, Belgium	17-19 May 1994
17th Annual Symposium	Aachen, Germany	9-11 May 1995

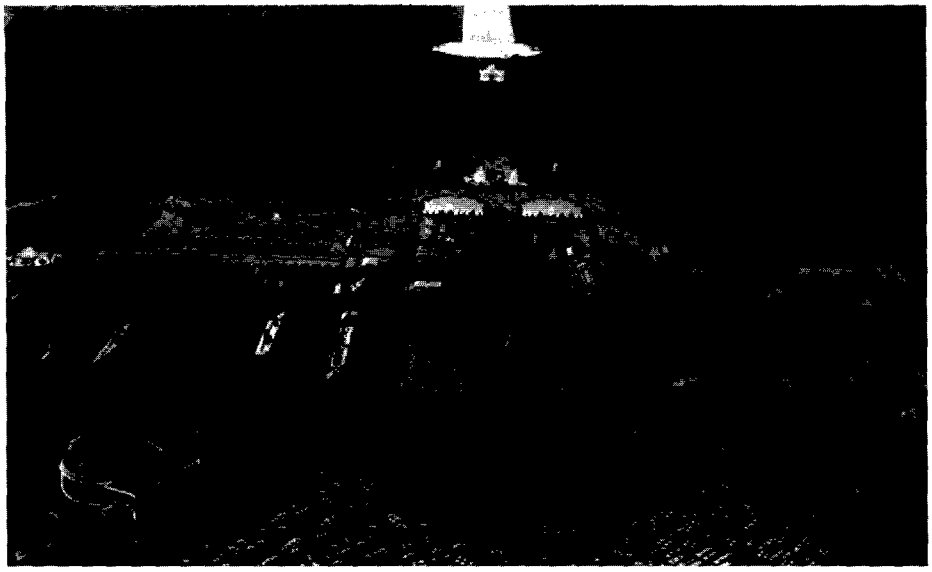
Dr. S. Eklund, *Director* General of IAEA at the third ESARDA Symposium

The annual meetings of the series which began in 1979 were always organized by a national research organization with the help of the European Commission, Joint Research Centre, Ispra Establishment. Some notes are given as seen from the point of view of the author.

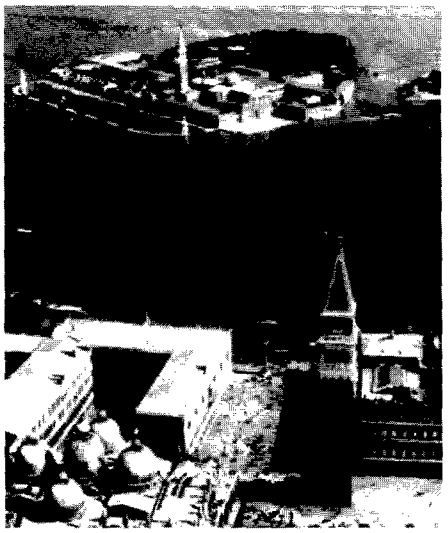
These notes concern technical facts and other events occurred on the occasion of all the meetings, starting from the series of the annual meetings, even though the chronological order should be different (see table aside).

• The first Annual Symposium on Safeguards and Nuclear Material Management was organized by the European Commission in the "Palais des Congrès, Salle Albert 1er", Brussels, Belgium on 25-27 April 1979. The Symposium had a duration of three days with oral presentations only and included a very well equipped exhibition of instruments for Safeguards use. The Chairman of the Symposium was D. Gupta who also chaired the celebration of the ESARDA's 10th Anniversary at the end of the Symposium. A total of 101 papers plus a luncheon speech by A.R. Anderson on "A Challenge to Communication" were presented.

• The second Annual Symposium on Safeguards and Nuclear Material Management was organized by NMACT, AERE Harwell, UK, in the Adam Ferguson Building of the University of Edinburgh on 26-28 March 1980. The second symposium was also chaired by D. Gupta and was based on a three-day oral session with a few papers presented in the form of a poster session. Some 98 papers plus a luncheon speech by G.R. Keepin on "Our Common Commitment to Safeguarding Nuclear Power" were presented. On the second day of the symposium a panel discussion on "Ex-



Panoramic view of Versailles



The Island of San Giorgio, Venice

perience on International Safeguards Facilities" was organized. A small instrument exhibition was also set up. A buffet reception was offered in the Old Library of the University.

• The third Annual Symposium on Safeguards and Nuclear Material Management was held in the School for Nuclear Technology of the Kernforschungszentrum Karlsruhe (KfK), Karlsruhe, Germany on 6-8 May 1981 and chaired by G. Stiennon. It saw the presentation of 81 papers more or less equally divided into oral and poster sessions plus a luncheon speech by L. Gillon on "Safeguards and Assurance Supply". In the second day of the symposium a panel discussion on "Interaction of International Safeguards, State Systems and Facility Operations" was organized. A buffet reception was very well organized in the historical castle of Karlsruhe.

• The fourth Annual Meeting was a Specialist Meeting on Harmonization and Standardization in Nuclear Safeguards. It was chaired by R.J.S. Harry and held in the premises of the ECN Research Centre of Petten, The Netherlands on 27-29 April 1982. Some 47 papers were presented during the oral sessions which lasted for three days. A dinner of local specialities was offered in the Bokkersprong, Hargen (Schorrl). The purpose of this meeting was to draw lines for the future activity of ESARDA and to constitute a valuable step on the way to convergence of thoughts and improvement of procedures.

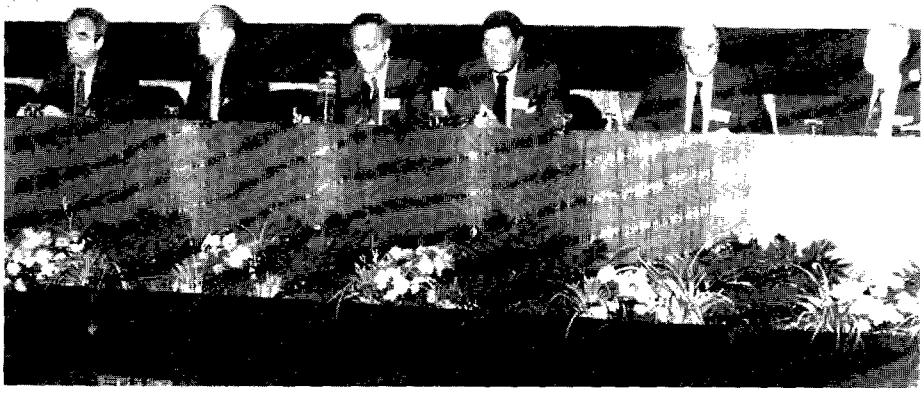
• The fifth Annual Symposium on Safeguards and Nuclear Material Management was held in the "Palais des Congrès" of Versailles near Paris, France on 19-21 April 1983 and chaired by W.L. Zijp. The main theme of the symposium was "Interaction between Safeguards Authorities and Operators". A total of 96 papers were presented, shared between poster and oral sessions. All oral sessions, as customary, were single, i.e. without parallel sessions. An instrument exhibition was held in one of the rooms of the congress hall. A magnificent reception was held in the Grand Hotel de Paris near the Opera. The spouses joined the participants: this became a tradition in the ESARDA meetings. The day after the conference a technical tour was organized by the Centre of Fontenay-aux-Roses. Using the very high speed train (TGV) to the Rhône Valley it was possible to pay a visit to the fast breeder reactor Phenix and to the Vitrification Prototype Plant (AWM) at Marcoule.

• The sixth Annual Symposium on Safeguards and Nuclear Material Management was held in the Cini Foundation of the Saint George's island, Venice, Italy on 14-18 May 1984. Exceptionally it extended over 5 days instead of 3 days as is customary. The main theme of the symposium was "International Collaboration: Need and Benefits". This symposium was organized by the European Commission, Joint Research Centre, Ispra. A total of 99 papers were presented divided into oral and poster sessions. During the third day of the symposium, only morning sessions were held and the afternoon was reserved for an excursion to the islands of Murano, Burano and Torcello in the Venice Lagoon or for other visits in this fascinating town. A remarkable dinner was organized in the Hotel Bauer-Grünwald. Eminent personalities such as H. Blix, Director General of the IAEA, C.J. Audland, Director General for Energy of the European Commission, and L. Noè, Vice-President of ENEA, attended this symposium. Chairman of this succesful symposium was B.W. Hooton.

The Director General of IAEA, H. Blix, at the fifth ESARDA Symposium

• The seventh Annual Symposium on Safeguards and Nuclear Material Management was held in the Congress Hall of Liège, Belgium on 21-23 May 1985 and chaired by B. Lerouge. The general theme of the symposium was "The impact of Advances in Data Processing on Safeguards Practices". Some 77 papers were presented in this symposium. A buffet dinner was organized out of town in the "Chateau de Colonster" owned by the University of Liège. This meeting faced a strike by the municipality of Liège, but the active help of the Belgian delegates was so efficient that the strike went unnoticed by the majority of the participants. Many delegates had the occasion to enjoy the special Belgian beers and the superb Belgian chocolate.

• The eighth Annual Meeting was the first of a series of specialized internal meetings with participation restricted to ESARDA members and permanent observers of the ESARDA Working Groups and to some distinguished invited specialists. The meetings of this type, held one every two years, are principally de-



The opening of the 7th ESARDA Symposium. From left to right: W. Gmellin, A. Ernemann, B. Lerouge, J. Ley, S. Finzi, L. Stanchi

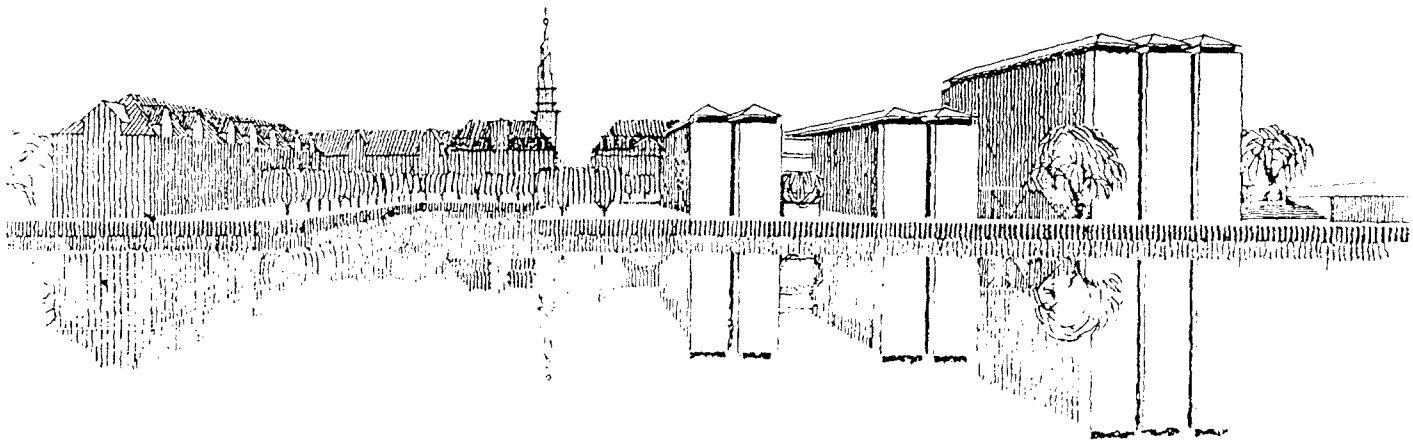
Mr. J.P. Contzen, Director General of the Joint Research Centre of the European Commission at the 9th ESARDA Symposium

voted to the outcome of the ESARDA Working Groups and to particular themes chosen by the Steering Committee according to the actual needs of the Safeguards field. The eighth annual meeting, having the title "Capabilities and Objectives of the Use of NDA-DA-C/S Measures in Safeguards", was organized in Copenhagen, Denmark on 13-15 May 1986 and chaired by S. Finzi. More than hundred specialists actively participated in the working group sessions and in the plenary session. The proccedings had a restricted circulation but a summary of the technical results was published in the ESARDA Bulletin No. 11, October 1986. The meeting was carefully organized in the "Eigtveds Pakhus" owned by the Royal Ministry of Foreign Affairs of Denmark. A lovely dinner in the town was organized.

• The ninth Annual Symposium on Safeguards and Nuclear Material Management was held in the Queen Elizabeth II Conference Centre, London, UK on 12-14 May 1987 and chaired by R.H. Kroebel. The ESARDA had the occasion to exploit the new conference centre situated in Broad Sanctuary, Westminster and just inaugurated by the Queen. The organization of the symposium started when the centre was under construction. For access to the cen-tre, the participants had to be subject to some smooth security controls. During this symposium 81 papers were presented in oral and poster sessions. No specific topic inside Safeguards was put as headline. No exhibition was organized but several specialists arrived with their instruments which were in operation during the poster sessions. An attractive buffet dinner was organized in the historical Whitehall Banqueting Hall.

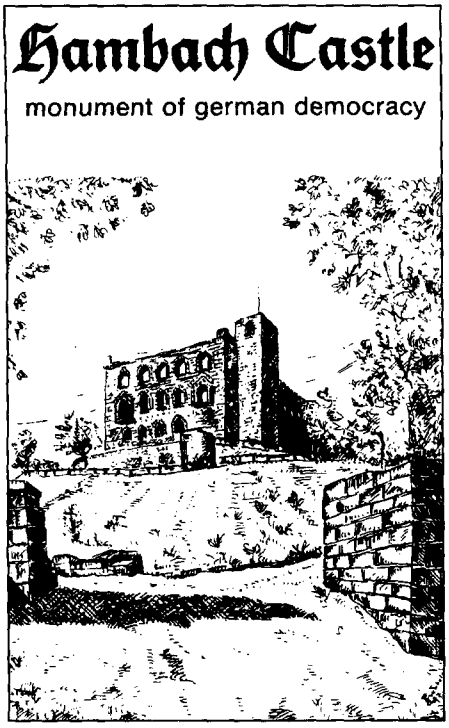
• The tenth Annual Meeting was a restricted meeting organized in KfK, Karlsruhe, Germany on 3-5 May 1988. The theme of this meeting was "Medium and Long Term Trends in ESARDA Working Group Activities". For the scientific preparation of the meeting, the ESARDA Steering Committee asked the ESARDA Coordinators to prepare an "Analysis of the Nuclear Fuel Cycle in EC-Countries up to the Year 2000". This meeting started and ended with a plenary session. In the meantime the specialists joined the seven ESARDA Working Groups. As a result of the meeting a reviewing of two years of activities since the Copenhagen meeting, having a good look into the future, was made. The matter discussed in the meeting was collected in a working document not suitable for the general public. The proceedings were therefore not published. A short summary of the meeting was published in the ESARDA Bulletin No. 15, November 1988 and presented at the INMM Annual Meeting in Las Vegas by the Chairman G. Stiennon. As a social event all the participants had the pleasure of being driven through the Rhine valley vineyards up to the Castle of Bad Dürkheim county, the so called Hambach Castle, which is considered a monument of German democracy. An excellent dinner was organized with a show of popular German songs. The participants and ladies also had the chance to dance in a very warm atmosphere.

• The eleventh Annual Symposium on Safeguards and Nuclear Material Management was held in Luxembourg on



Eigtveds Pakhus

The Royal Danish Ministry of Foreign Affairs



Castle of Bad Dürkheim - county

30 May - 1st June 1989 in the Hemicycle, European Centre, Kirchberg. This symposium was organized by the European Commission, Safeguards Directorate, on the occasion of the 20th Anniversary of ESARDA and was chaired by C. Fizzotti. A total of 92 papers presented plus a luncheon speech by W. Häfele on "The Safeguards Issue, Perpetuated and Revisited". The contributions were divided into single oral sessions and poster sessions with presentation of instruments in operation. A dinner was organized on the first evening in the "Salon Vert" of the Jean Monnet Building. A buffet dinner was offered by the Government of Luxembourg at the Municipal Theatre on the second evening.

• The twelfth Annual Meeting was a restricted meeting organized in the Congress Centre of Villa Olmo, Como, Italy on 15-17 May 1990. The theme of this meeting was "Technology Transfer in Safeguards". This meeting was organized by the European Commission, Joint Research Centre, Ispra and the chairman was A.M. Versteegh. In addition to the meeting, the Joint Research Centre organized a special visit for the participants to the PERLA Laboratory at Ispra for the day after the meeting. The proceedings had a restricted circulation as is customary for this type of meetings. They include the introductory paper of the ESARDA Coordinators, some invited papers, the Working Groups contributions and the conclusions drawn up by the coordinators. A charming trip on lake Como with a stop in the resort village of Bellagio and a dinner on board was enjoyed by participants and their spouses.

• The thirteenth Annual Symposium on Safeguards and Nuclear Material Management was held in the historical Palace of the Popes at Avignon, France on 14-16 May 1991. This symposium, chaired by B.H. Patrick, had an increased participation and the number of accepted papers rose to 126. A luncheon speech was given by P. Bachelier on "Electronic Data Interchanges in Banking Area". Both the number of posters and oral presentations increased. More specifically many papers were in the field of measurements. This means that there is great interest in this field, both in Destructive and Nondestructive assay. This symposium had a considerable participation of Eastern European Countries. The time allowed for oral presentations had to be strictly observed and a few oral papers squeezed to combined presentations: the result is that parallel sessions were still avoided allowing the participants to follow all the works. The organization in France saw the cooperation of two CEA Centres (Fontenay-aux-Roses and Cadarache). The oral sessions were held in the magnificent Room of the Conclave so that the participants were very aware of their role. There were some social events. In the first day there was a "Vin d'honneur" at the House of the Mayor. On the second evening a marvelous dinner was organized in a sort of gothic cathedral called "La Salle de la Grande Audience". This room is divided into five spaces by four big pillars. This made it possible to present five different shows during the dinner. These were alternated to permit participants to see all the shows. At the beginning an impressive show battle was played with horses. This, I think, will be remembered forever. The day after the symposium two technical visits to the EURODIF enrichment plant of Tricastin EDF plant or to the Pierrelatte FBFC fuel fabrication plant were possible.

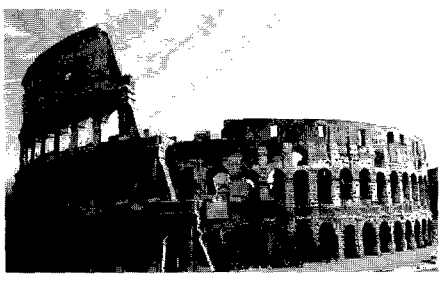
• The fourteenth Annual Meeting was a restricted meeting organized in Salamanca, Spain, on 5-8 May 1992, part in the old university and part in the Hotel Regio in the surroundings because of the need for separate rooms. The splendid old university hosted a few representative meetings, the social events and the final plenary session. Two different workshops were run in parallel during this congress. The titles of the two workshops organized by the C/S WG and the NDA WG, respectively, were: "C/S Safeguards Techniques Applicable

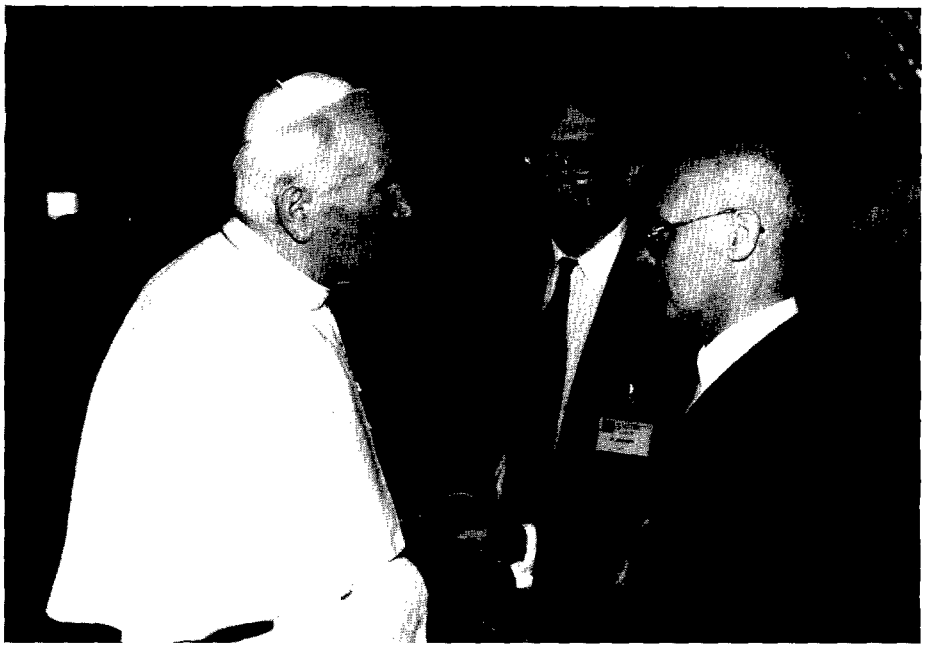
The Palace of the Popes at Avignon

The entrance of the old university of Salamanca

to Intermediate and Long-term Storage of Irradiated fuels" and "Non-Destructive Assay Techniques Applicable to Safeguarding Nuclear Material in Wastes". The proceedings were published quickly and circulated to ESARDA members. The social events comprised a concert, a welcome cocktail, a dinner offered by ENUSA and a guided visit to historical parts of Salamanca. A number of participants visited the ENUSA plant on the afternoon of the last day.

• The fifteenth Annual Symposium on Safeguards and Nuclear Material Management was held in the Augustinianum Institute, Rome, Italy on 11-13 May 1993. The Augustinianum is situated in the heart of the ancient "Caput Mundi" just by the side of the colonnade of St. Peter's square. The number of accepted papers increased again reaching the number of 152 and the number of participants was 249. For the first time the organizers were compelled to set up parallel sessions for the oral presentation and to reduce the non-overlapping time for the posters. Moreover the audience with the Pope, that was only confirmed at the last minute for the morning of the second day, forced the organizers to change the programme and to make three instead of two parallel sessions in the afternoon sessions of the second and third days. This symposium was chaired by G. Déan and was very successful. The proceedings, bigger than ever, contain a great number of very interesting papers. As in the Symposium of Avignon many papers dealt with measurements. The proceedings were published, as for the preceding symposia, shortly after the meeting. Some social events were organized, in particular a welcome cocktail on the first day in the Capitol with a private visit of the historic museum and a dinner on the second day in Palazzo del Drago. But the most important event was undoubtedly the Audience with the Pope who spoke with several ESARDA members asking about our work and demonstrating great interest (see ESARDA Bulletin No. 22, September 1993).





The Pope speaking with the ESARDA Chaiman, G. Déan, on the occasion of the 15th Symposium

• The sixteenth Annual Meeting was a restricted meeting held in the former Dominican Monastery "Het Pand", now property of the University of Ghent, Belgium on 17-19 May 1994. It was organized by the CEN/SCK Mol and was chaired by P. De Regge. The meeting was based on individual and joint sessions of the ESARDA Working Groups, the programming of the Working Groups' operations and the prospective analysis of the ESARDA activities. We wish to remember the kind participation of the Mayor of Ghent at the first session. In the third day the six Working Groups made their reports to the Steering Committee in the plenary session and the past chairman of ESARDA, Mr. Déan, reported on the work of the reflection group. The afternoon was devoted to the celebration of the 25th anniversary of ESARDA with a summary of the 25 year activity by the ESARDA Chairman, Mr. Cuypers, and addresses by several specialists and Authorities. As social events we had a musical performance in the first evening with a piece for two pianos of Ravel and a very exciting execution of Carmina Burana of Carl Orff by the European Communities Choir accompanied by two pianos and percussions. This excellent performance was followed by a rich buffet dinner. The meeting was closed by a celebration cocktail in honour of the ESARDA 25th Anniversary.

• The seventeenth Annual Symposium on Safeguards and Nuclear Material Management was held in the Conference Centre EUROGRESS, Aachen, Germany on 9-11 May 1995. Aachen, which is an interesting and agreable town, was founded by the Romans (latin

Returning from the Pand to the Centre of Ghent

name Aquae Grani) and became in the Middle Ages the official residence of the emperor Charlemagne. The symposium, chaired by G. Stein, had plenary sessions in the mornings of all three days, with oral presentations of general interest given by authorities and specialists from the whole world. In the afternoon, parallel sessions were organized with more technical oral presentations. Two technical poster sessions of one and a half days each were organized in such a manner that suitable interval times allowed all the participants to visit posters and discuss with their authors. Specialists from Europe, North America, South America, Asia and Australia attended the symposium in which about 140 oral or poster presentations were given. The proceedings contain as usual the manuscripts related to both types of presentations. Accompanying persons enjoyed a well organized programme for visits to the town and outskirts. The participants and spouses were invited to a welcome cocktail at the Lenné Pavillon in the Aachen Casino on the first night and to an organ recital in the Aachen Cathedral, where Charlemagne is buried, on the second evening. The concert was followed by a rich dinner in the nearby Aula Carolina.

Some words on the other ESARDA Meetings:

• A first ESARDA meeting was organized in the JRC Ispra, Italy, on 20-22 September 1971. This meeting was organized by G. Birkhoff and M. Cuypers with the title: "International Meeting on Non Destructive Measurement and Identification Techniques in Nuclear Safeguards". It was attended by more than ninety renowned specialists. I like to remember that on that occasion Dr. Gupta opened his presentation speakig fluently and freely for about one minute while the attendees were looking around astonished... The speaker got the fact that something was going strange and stopped: then said that the atmosphere was so familiar and he was so at one's ease that inadvertently he went speaking in his mother tongue, from India! A cocktail in the second evening and a dinner in the third evening were offered by the JRC Ispra. During the meeting an excursion on lake Maggiore was organized for participants and spouses.

• The first open meeting organized by ESARDA was the Symposium on Practical Applications of R&D in the Field of Safeguards held at the Hotel Cavalieri Hilton in Rome, Italy on 7-8 March 1974. The symposium had the purpose of facilitating an exchange of views between the specialists engaged in the field of research and development in support of the nuclear safeguards. The chairman was M. Zifferero from C.N.E.N. (now ENEA). More than 150 specialists from several countries and international organizations attended the symposium. Some invited papers and a few contributed papers highlighted the status of the safeguards techniques. The proceedings were published by ESARDA and contain all the invited papers plus the opening remarks and the discussions of each of the three sessions and also a full report on the fourth session including a general discussion and some recommendations. The contributed papers were not included in the proceedings but were available on request to the authors.

• A topical meeting organized by ESARDA was on Isotopic Correlations and its Applications to the Nuclear Fuel Cycle held in the "Palazzo dei Congressi" of Stresa (Lake Maggiore), Italy on 9-11 May 1978. This meeting was chaired by S. Finzi with the participation of about eighty specialists. It was based on six sessions and a panel discussion. The material presented by the authors and the record of the panel discussion were collected and published. For this meeting a rich dinner was organized at the Grand Hotel des Iles Borromées of Stresa.

• When the series of annual meetings of ESARDA had already started the 1st Seminar on Containment and Surveillance was organized at the Joint Research Centre, Ispra, Italy on 17-19 September 1980. At that time the members of the ESARDA Working Group on C/S were of the opinion that extended discussions on the various aspects of Containment and Surveillance were necessary. This seminar was coordinated by S. Crutzen and considered as complementary to IAEA and ESARDA sym-posia. It was mainly attended by specialists of the field. All the material presented at the seminar was collected in the proceedings which constituted a valuable overview on the state of the art on C/S at that time. During this meeting a buffet reception was personally offered by S. Finzi at home.

• Another specialized meeting was the ESARDA/INMM Joint Specialist Meeting on NDA Statistical Problems held at the Joint Research Centre, Ispra, Italy, on 12-14 September 1984. This meeting was organized jointly by the INMM Statistics Technical Working Groups and the ESARDA Working Group on Mathematical and Statistical Problems and was chaired by R.J.S. Harry. The purpose of the meeting was to point out the validity of the assumption and error behaviour of the NDA methods used for calibration, measurement control and operator-inspector comparisons. The hope was to contribute to the design phase of future NDA data evaluation systems. All the contributions presented by the authors were published in the proceedings edited by the JRC Ispra. During this meeting a dinner was offered to the participants by the JRC Ispra.

View of the Joint Research Centre, Ispra site, Italy with the lake Maggiore and the Mount Rose

Report of the Reflection Group on the Future of ESARDA in a Changing World

G. Déan
CEA, Fontenay-aux-Roses
on behalf of the Reflection Group

This paper reflects the report of the Reflection Group on the Future of ESARDA presented by the past chairman of ESARDA, G. Déan, at the 16th Annual ESARDA Meeting at Ghent (see the programme of the Meeting published in ESARDA Bulletin No. 24, p. 4).
This report was reviewed afterwards and is now published in Bulletin No. 25 as a complement of Bulletin No. 24 containing all the other papers related to the 16th ESARDA Meeting.

Introduction

The first discussions on the "Future of ESARDA in a changing world" started during the ESARDA Board meeting held in Paris on October 29,1992.

The main contribution was an analysis presented by Mr. M. Cuypers, from EC-JRC, complemented by a presentation by Mr. G. Le Guelte, from CEA, France, on safeguards issues connected with the present situation of nuclear material accountancy and control in the Newly Independent States (NIS) of the Former Soviet Union (FSU).

At the end of the discussions the Board decided to submit the issue to the ESARDA Steering Committee at its meeting held in London on December 1, 1992. The Chairman of ESARDA for 1993, Mr. P. Frederiksen, charged the future Chairman, Mr. G. Dean, to take the lead on this initiative and to prepare a proposal for establishing a small Reflection Group on the subject. The Steering Committee accepted this proposal and decided to establish such a Group to consider the future orientations of the Association and the activities of the Working Groups. The terms of reference were adopted by the Board on March 26, 1993 in Brussels and, with the agreement of the Board, Mr. G. Dean co-opted onto the Reflection Group Messrs. G. Andrew (DTI, United Kingdom), M. Cuypers (EC-JRC), R.J.S. Harry (ECN, The Netherlands), G. Le Guelte (CEA, France) and R. Weh (GNS, Germany).

The Group met four times in 1993, and progress reports were presented orally to the Board, to the Steering Committee, to the Co-ordinators and to the Co-ordinators together with the Working Group Convenors and discussed.

The final report approved by the Steering Committee on May 16, 1994 was presented in the plenary session of the Ghent meeting on May 19, 1994. The present report summarizes the results of the Reflection Group.

The main subjects which were discussed by the Reflection Group are the following:

- Safeguards in large facilities;
- New Parties from the EFTA Countries;
- Co-operation with States of the Former Soviet Union (FSU) and East European Countries;
- Re-utilization of nuclear material from dismantled nuclear weapons;
- Strengthening of safeguards;
- Communication with the Public and non-safeguards experts;
- Proposals for streamlining the management and the structure of ESARDA.

This report presents the results of the discussions held in 1993 and the views of the Reflection Group; since this time the situation may have evolved in some areas.

Safeguards in Large Facilities

Most of the important large facilities are already in operation and others are nearly completed and will soon become operational. EURATOM and the Operators have taken certain important initiatives to cope with the safeguards problems raised by such plants (e.g. automation of measurement and monitoring devices, use of integrated systems). However there is still room for technical improvements, especially in the areas of the intermediate storage of spent fuel and measurements on waste.

The Reflection Group discussed this point and considered that the ESARDA Working Groups are addressing more specifically the problems related to intermediate storage of spent fuel and measurements on waste. More specifically, the NDA and C/S Working Groups are treating problems related to intermediate storage of spent fuel and nuclear waste (reference should also be made to the Salamanca meeting in 1992). However the techniques of monitoring should perhaps receive more attention in the future.

New Parties from the EFTA Countries

Austria, Finland, Norway, and Sweden have made official requests to join the European Union. The case of Switzerland was not discussed by the Reflection Group. It was felt quite natural that their R&D and technical Organizations would like to join ESARDA. The Association should therefore prepare itself for this possibility, since its enlargment from the present 11 Parties to possibly 15 will have consequences on the working methods of the existing Steering Committee, Board and Co-ordinators Committee.

After discussion with the Board and the Steering Committee the Reflection Group proposed to consider with sympathy the request for accession to the ESARDA Agreement by Organizations of the Countries which are expected to enter into the European Union, but only after the accession of the respective Countries to the European Union. In the meantime participation of Organizations of those Countries in the ESARDA Working Groups would be acceptable, but only as observers. The Steering Committee decided to implement this proposal.

Co-operation with the Former Soviet Union and East European Countries

The collapse of the Former Soviet Union (FSU) will bring institutional, procedural and technical consequences on the nuclear safeguards system in these States. The Newly Independent States (NIS) and other East European Countries will probably need stronger support from those which already have a well established and technically sound safe-

guards system. Several initiatives in this sense are being taken by some European Union Countries and by the European Commission which has a long standing experience in operating a Regional safeguards system. Thus several bilateral programmes (mainly under the form of seminars) have started between several Republics of the Former Soviet Union and some European Union Member States (e.g. United Kingdom) on one hand and a co-operation between the Russian Federation and EURATOM on the other hand. The IAEA is also taking some initiatives to co-ordinate assistance on the establishment of a SSAC in some of the NIS.

The Group felt that a co-ordinated effort is also required within the European Union and where and when necessary with other States (e.g. Sweden and possibly Japan and USA), in view of the dimension of the task to be accomplished. Collective actions could also be promoted by ESARDA (e.g. in the field of training and participation in Working Groups). Furthermore hands-on experience on NDA and C/S instrumentation could be provided at the test and training facilities at JRC-Ispra. However the materialization of this co-operative effort is difficult, because of the important political implications and it is not yet clear what role ESARDA could play in this context. The Reflection Group thinks that contacts with experts of the Former Soviet Union could notably contribute to identifying the specific problems and needs of those NIS in the field of nuclear safeguards.

Because of their technical expertise the Reflection Group felt it was also desirable that people from the Newly Independent States (and other East European Countries) Organizations participate to the "discipline-oriented" ESARDA Working Groups (DA, NDA, C/S) where they would have a positive input. It is proposed to invite Organizations and to give them the liberty to nominate their experts. The acceptance of the expert would be at the discretion of the Working Group Convenors and after agreement with the ESARDA Steering Committee. Financing could be made from ESARDA symposia surplus or, if possible, by ESARDA Parties, with a procedure for sharing the costs to be defined. In addition further thoughts are necessary to investigate the mechanism of the European Commission fundings for this type of activities. Ways and means to implement this idea have to be discussed with the Commission.

Re-utilization of Nuclear Material from Dismantled Nuclear Weapons

The re-utilization of the nuclear material coming from the dismantling of nuclear weapons (plutonium and highly enriched uranium) is a subject of concern for international safeguards at medium/long term and the technical consequences should be assessed.

The Reflection Group thinks that no new study seems to be needed, after the completion of the LASCAR project and previous studies on nuclear material storage.

In addition, the Reflection Group is of the opinion that matters related to the conversion of ex-military nuclear material to civil use are still too confused to be dealt with by ESARDA. The critical point is the interface between the military and the civilian cycles and applications will depend on the specific situations which are not yet known. It is only when the needs are clearly expressed that ESARDA would be able to reconsider this position. However the Association should try to keep informed (e.g. by studying the documents issued by specialized groups, by paying attention to the role of the IAEA in this field, and by being informed by the Member States already engaged in a co-operation with NIS).

Strengthening of Safeguards

The possible role of ESARDA in the development of techniques in support of the strengthening of IAEA safeguards have been discussed by the Reflection Group on the basis of SAGSI's recommendations and discussions and recommendations from the IAEA Board of Governors on strengthening the effectiveness and improving the efficiency of the safeguards system (e.g. use of new techniques, alternative approaches based on increased and more timely available safeguards-relevant data, extended access for inspections, greater unpredictability, improved analysis of information on State's nuclear programmes and activities, measures for increasing the confidence of the absence of undeclared activities, increased co-operation with States Systems of Accounting and Control and established Regional Systems).

The Group concluded that most of the issues were either too political or not yet sufficiently defined to be studied by ESARDA Working Groups. However this does not mean that in the future ESARDA should exclude itself systematically from "hot issues" but on the contrary it should address the issues important for safeguards.

Regarding the detection of undeclared activities by environmental monitoring, the subject was not seen by the Group as having a high priority in the context of safeguards in the European Union. For this reason, the Steering Committee was of the opinion that no research work on environmental monitoring methods was necessary for application in the European Union. Nevertheless, as the IAEA has a strong interest in the methods and as there is considerable expertise in the subject in Europe, some States will undertake R&D in support of the Agency, and the Reflection Group considered that ESARDA could include the topic in the programmes of the DA and NDA Working Groups, particularly in relation to environmental sampling and analysis.

Regarding co-operation with SSACs or Regional Systems, the Reflection Group took note of the criteria discussed by SAGSI on one hand and of the criteria for Regional Systems presented by the French Governor to the IAEA Board of Governors and by Mr. Gmelin at the ESARDA Symposium and at the INMM Meeting in 1993 on the other hand. The Reflection Group thinks that it could be useful for ESARDA to convene a small ad hoc Working Group to consider the criteria for a Regional System. However the current discussions on the EURATOM-IAEA New Partnership Agreement would not be the focus of the discussions.

Communication with the Public and Non-safeguards Experts

The Reflection Group examined the possible role of ESARDA in the field of communication and dialogue with non-safeguards experts (i.e. the general public and our colleagues in the nuclear fuel cycle that do not get frequent information on safeguards) on the features of nuclear safeguards and the experience gained in the implementation of a supranational and international inspection regime. This last point is considered important, because nonproliferation and safeguards issues become more and more key elements in addition to reactor safety, waste management and radiation protection for the acceptance of nuclear energy.

The Reflection Group agreed that ESARDA should be involved in the area of illustrating the features of nuclear safeguards for the benefit of those who need simple, clear and concise information on nuclear safeguards and the role it plays in the development of nuclear energy. Indeed the Association is the only international and informal forum in Europe where such issues could be discussed and collective actions could be taken. It was pointed out however that each State has its specific requirements of dialogue with non-experts.

As the IAEA has published a brochure for general public information, the Reflection Group advice is that the ESARDA inititiative should be aimed at colleagues in the nuclear industry. The

objective would then be to raise the profile of safeguards among other nuclear specialists and to record the achievements of the system to date.

The Reflection Group recommends ESARDA collecting information from Member States of the European Union on communication with the public and with non-experts in safeguards matters and, if necessary, to be in contact with public relations specialists in large organizations, such as AEA, CEA, BNFL, COGEMA, etc... Members of the Group have already provided the Chairman with some relevant publications.

On the basis of the available information a common action could be launched. The Chairman of ESARDA could be asked to present papers on the ESARDA work (and importance) on safeguards at relevant, large international meetings (symposia) on general nuclear energy topics. Messrs. Cuypers, Dean and Harry discussed this point in July 1993 with the ANS and the INMM Chairmen who agreed on the value of such an initiative and to co-operate with ESARDA.

Proposal for Streamlining the Management and the Structure of ESARDA

ESARDA characteristics

ESARDA has until now operated in a clearly defined, well characterized and rather stable environment (the European nuclear fuel cycle), with the aim of providing technical support to the Operators and the Inspectorates, and within the framework of settled industrial conditions. At present, the European nuclear environment is undergoing major changes, both structural and technical.

ESARDA has existed for 25 years and its type of activities have changed over the years. At present one may consider the Association as an important and unique international communication channel between safeguards technical experts in the European Union. These experts come from most of the Research Organizations involved in safeguards, plant Operators from facilities of the whole fuel cycle, the EURATOM Safeguards Directorate and representatives of National Authorities. In the six Working Groups technical experts of non-European Union Countries and Organizations, including the IAEA, are also largely represented. The annual symposium and special meetings, the Bulletin, the exchange on R&D programmes at the co-ordinators level and the more specific exchanges in the different Working Groups of experience and information on research activities in laboratories and operation of techniques in nuclear plants, are the practical means by which the communication between safeguards experts is performed and maintained. This is an area where ESARDA is very successful and the Reflection Group recommends that the managerial bodies of ESARDA should make sure that these working characteristics continue to be strongly maintained.

ESARDA is also performing a number of joint projects and activities, where the need exists to have an international Community. These are performed in the framework of the Working Groups. The results of the intense exchange of information and the execution of joint exercises is an integral part of the overall European safeguards system. As such ESARDA contributes to the elaboration of a sound technical safeguards system and is able to demonstrate to the outside the technical know-how available in the European Union and as a consequence contributes to the credibility and transparency of the safeguards system in the European Union facilities.

However the Reflection Group is not entirely convinced that the wealth of information exchanged in the framework of ESARDA is properly analyzed, exploited and presented to the outside or even to the managerial bodies of ESARDA.

It seemed to the Reflection Group necessary to proceed with the discussion on ESARDA activities in order to see if specific actions are required to integrate the Association more in the overall safeguards system.

During the discussions it was also strongly emphasized that the main (but not the only) reason for the existence of ESARDA is to treat technical subjects related to the application of nuclear safeguards in the European Union. Consequently the technical issues concerning EURATOM Safeguards and the Operators of nuclear facilities in the European Union have priority among other issues.

ESARDA structure

Several years ago the structure of ESARDA was changed by the introduction of the Board, with one representative from each Country, in order to streamline the preparation of the decisions of the Steering Committee on management and policy aspects. In 1993 the Board and the Steering Committee comprised respectively 9 members (and one observer from the EURATOM Safeguards Directorate) and 24 members. The Reflection Group had the feeling that, in practice after several years of experience, the present working procedures had to be reviewed. Indeed there was much duplication and redundancy in the activities of the Board and the Steering Committee. The Board is often busy with organizational problems (meetings, venues, etc...) and little time is left to discuss more fundamental problems, which could be of interest to ESARDA. In addition it is expected that in the near future the number of Parties to the Association will increase and this could lead to a size of the Board and of the Steering Committee difficult to manage efficiently. This fact also requires a thorough analysis and an adaptation, if necessary, of the working procedures.

Thus the Reflection Group felt that the time had come to streamline the structure of ESARDA and the new structure proposed is given in Figure 1.

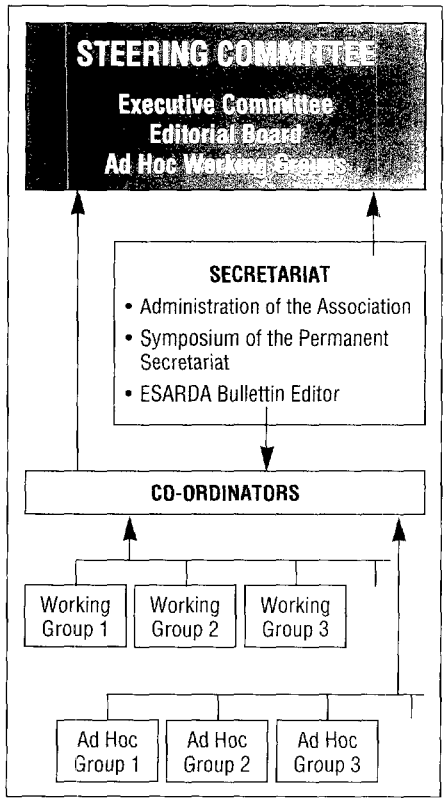


Figure 1

The Steering and Executive Committees

In order to streamline further the management aspects of ESARDA, the Reflection Group proposed to the Steering Committee that the Board be replaced by an Executive Committee which would be the hard core of the Association and would be empowered, under the direction of the Steering Committee, to take the routine day-to-day decisions on management of the Association and act more as the link between the political choices made in the field of safeguards and their possible consequences on the technical activities of ESARDA. At any given moment it would be composed of the following persons: the past Chairman, the present Chairman, the Chairman for the subsequent year, a person representing the Party which will take the Chair two years after, a person representing the Party which will take

the Chair three years after as members, the ESARDA Secretary, and a representative of the EURATOM Safeguards Directorate as observer.

According to this scheme, the Executive Committee would change one member every year. It could consult regularly, meet whenever necessary and be actively involved, particularly for the preparation of the important decisions of the Steering Committee. This small group could at any time call on experts or consultants, according to the problems to be treated. With the Executive Committee discharging the Steering Committee of all practical tasks related to the daily management of the Association, the Steering Committee could better dedicate itself to its institutional functions, (i.e. policy and decision making) and meet only once a year.

The Executive Committee should be activated on January 1, 1994, for a one year trial period. During the year 1994 the Executive Committee should operate by provisionally taking most of the activities of the Board which would be in stand-by. During the same year the Executive Committee would assess and review the ESARDA Internal Rules and prepare a set of "management rules" for the implementation of the new structure proposed by the Reflection Group and present this set to the Steering Committee in due time. In 1995, the results of the provisional restructuring would be evaluated and a decision would be taken on whether to continue it as proposed, or to revise it, or to terminate it.

During its December 1, 1993 meeting the Steering Committee agreed on this proposal and decided to establish the Executive Committee from January 1, 1994. It will operate for a period of one year, dealing with all the matters normally dealt by the Board. The Board meetings will be suspended until the end of 1994. At the end of 1994 the Steering Committee will evaluate the results of these changes and decide whether and how to continue in the restructuring.

The Editorial Board

The Editorial Board would be in charge of the approval of all publications made on behalf of ESARDA and of the papers published in the ESARDA Bulletin, instead of the present Board, and composed of a limited number of people from the Steering Committee. Another possibility would be to give this responsibility to the Co-ordinators Committee.

The Secretariat

As in the past, the Secretariat would be in charge of:

- the administration of ESARDA, in close contact with the Chairman;
- the symposia scientific secretariat;
- the Bulletin publication and distribution;
- the publication of proceedings of symposia and internal meetings.

The Secretariat acts as a general focus point for the Association and would continue to ensure the external relations of ESARDA.

The Co-ordinators Committee

The Reflection Group advices that the co-ordinators should have an increased scientific role and should take a more active role in respect of the Working Groups. They should be responsible for co-ordinating, harmonizing and monitoring all scientific and technical activities, including some of the aspects previously under the responsibility of the Board; their tasks would include:

- data collection and analysis on R&D programmes of the Parties and identification from the R&D data-base of the available or prospectively available techniques and of topics of common interest;
- harmonization of activities;
- preparation of summary and review reports on R&D projects;
- continuous monitoring of Working Groups activities (including critical analysis of their activities, technical guidance in taking care that their terms of reference are and remain in line with the policies and the needs of the Association) and reporting to the Executive Committee;
- identification of the needs and formulation of proposals for the creation, the duration, the modification or the termination of Working Groups or of ad hoc Technical Committees or Working Groups;
- technical advice to the Steering Committee and the Executive Committee in support of policy decisions;
- permanent analysis of the fuel cycle evolution in order to be prepared to satisfy the needs of future clients;
- identification of clients' needs (EURATOM and IAEA Safeguards Inspectorates, Operators), including the needs coming from non-European Union linked to safeguards;
- promotion of exchange of information including a new promotion of the ESARDA Bulletin.

The Co-ordinators should:

- produce global pictures of the ongoing R&D as well as of the trends;
- identify the gaps and the issues which are not addressed and address them having in mind to obtain added value and/or a consensus (e.g. inter-laboratories exercises, field tests, etc...) in working together; in addition even if ESARDA is not able to address all problems it should not exclude itself systematically from "hot issues" (e.g. plutonium management) but on the contrary it should address the issues important for safeguards; a correct balance has to be found;
- assess the on-going activities and the results of the Working Groups, in particular to ensure that Working Group reports of high quality are written and disclosed in due time and that the information circulates properly inside and outside ESARDA; however they would not be involved in the organization of symposia;
- pay attention to the R&D programme of the IAEA (especially the so-called "1993 + 2 programme").

Working Groups

The Reflection Group is of the opinion that:

- the "discipline-oriented" Working Groups (DA, NDA, C/S) which are the most basic bodies of ESARDA, should continue their present activities, although some revision of their terms of reference could take place and more use of ad hoc sub-groups might be useful; for DA and NDA they have to maintain an inventory of measurement systems and of their performance (e.g. target values); in addition it is not necessary to identify always a client because these groups constitute a "science-base"; for C/S the activities of the Working Groups are more equipment and facility specific;
- the objectives of the plant-oriented Working Groups should be reassessed in the light of their motivation and of the fuel cycle evolution.

In order to improve the efficiency and effectiveness of the Working Groups the Reflection Group recommends:

- a better analysis of the motivations of the "plant-oriented" Working Groups;
- a stratification of the agendas for the meetings concentrating over one or two days on topics pertinent to the Inspectorates' concerns (needs, discussion on the results), followed by the discussion of other topics between Operators and R&D experts relating mainly to the operating and nuclear material management aspects;
- preparation by the Working Groups of action work plans for a period of two years (3 meetings ahead);
- for each Working Group preparation for publication in the ESARDA Bulletin of a short executive summary on its activities once or twice a year and every two years a report on the scientific activities;
- to increase the communication between the different Working Groups (e.g. through the organization of joint meetings between "discipline-oriented" Working Groups or between "discipline-oriented" and "facility-oriented" Working Groups).

Regarding the fuel cycle and its connection with the present Working Groups, discussions were held within the Re-

flection Group and the following considerations were made.

The front-end of the fuel cycle is well covered by the LEU Working Group. The MOX Working Group covers the plutonium leg of the cycle. The RIV Working Group could, in principle, widen its scope to cover the back-end of the fuel cycle. However the Reflection Group noted that according to the EURATOM Safeguards Directorate and the relevant Operators (BNFL and COGEMA) the new commercial large reprocessing plants are already under safeguards and therefore there is no need for R&D in the European Union in the medium term. Notwithstanding, ESARDA could be involved if a need was expressed outside the European Union (e.g. IAEA or Newly Independent States from the Former Soviet Union).

Regarding the enrichment plants, if a decision is taken to adopt a commercial laser enrichment plant, it might be helpful in due course, for safeguards relevant to AVLIS (and related laser technologies) to be discussed by European Union technology holders. This could be under the framework of ESARDA. The Reflection Group thinks it might be advantageous for this subject to be discussed within the Union prior to any possible wider (HSP or LASCAR-type) discussions which might be held internationally.

In addition recent development of safeguards is more focussing on systems and the Reflection Group is of the opinion that the "discipline-oriented" Working Groups should continue actions on remote/unattended/integrated systems. In the discussions of these systems within the "discipline-oriented" Working Groups the relevant plant Operators and the Inspectorates should be included for a better mutual understanding as well as for a clear identification of the needs.

Even if transport was discussed in the C/S Working Group in connection with THTR fuel transport to an intermediate dry storage this topic has never been discussed in ESARDA as a possible general safeguards issue. The continuity of knowledge on the nuclear material during transport relies on proper functioning of the physical protection systems which are under national sovereignties. But what would be the consequences in terms of safeguards if something happens? It is probably necessary to explain this point and to ask the Operators and the Safeguards Inspectorate if there is a real safeguards problem in the European Union in this area and if R&D activities are needed.

Ad hoc Working Groups

The Reflection Group strongly recommends an increased use of ad hoc Working Groups with limited duration and specified targets for discussing well defined issues. Within the established deadline they should report their results to the Steering Committee and then dissolve. The present Reflection Group is an example of an ad hoc Working Group resulting from a need expressed by the Steering Committee and the Board to prepare recommendations for some future orientations of the Association.

Discussions on issues influencing ESARDA policies should be made by ad hoc Working Groups created by the Steering Committee.

In the case of the Co-ordinators Committee and of the Working Groups, projects which can be performed by small ad hoc Working Groups in a limited and well defined period of time (e.g. 6 to 12 months) should be defined, when and where they would be useful to increase the external visibility of the results. The Co-ordinators and the Convenors of the Working Groups are responsible for the work performed and therefore their scientific and human qualities are key elements, in particular for the definition and the analysis of the short and long term objectives and of the terms of reference of these Groups and for stressing the ESARDA publication of results.

Conclusion

This report includes a certain number of suggestions or recommendations to the Steering Committee for streamlining the management of ESARDA and enlarging the scope of its activities outside the European Union, in taking into account the evolution of the European Union and the emerging problems to which international safeguards are or will be confronted in the near future.

The following points summarize the main conclusions of the Reflection Group:

- it is desirable that Organizations from the EFTA Countries and from the Newly Independent States of the Former Soviet Union participate to the "discipline-oriented" Working Groups; in the case of NIS representatives their participation could be financed by ESARDA symposia surplus or by the ESARDA Parties or by the Commission, according to means and rules to be investigated;
- no studies by ESARDA participants are thought to be needed on the technical issues raised by the possibility of ex-military nuclear material (e.g. from weapons dismantlement) being brought under safeguards; sufficient information on the safeguarding of stores for direct-use material is already available; ESARDA could reconsider this position in the case of specific projects or needs expressed either by Organizations of the FSU or by the IAEA;
- the subject of environmental monitoring methods is not seen as having a high priority in the context of safeguards in the European Union, but some of the members of the DA and NDA Working Groups have valuable expertise in this field and these Working Groups should not be prevented from discussing the subject;
- it could be useful for a small ad hoc ESARDA Working Group of ESARDA participants to consider the criteria that Regional Systems of Accounting and Control might be expected to fulfil before they could be considered for "special treatment" by the IAEA; however the current discussions over the EURATOM-IAEA new Partnership Agreement would not be the focus of the discussion which would concentrate on the definition of any new R&D requirements needed to support implementation of this new approach;
- in the area of communication the Chairman could be asked to present papers on the ESARDA work (and importance) on safeguards at relevant large international meetings on general nuclear energy topics, aimed at the nuclear colleagues non-experts in safeguards and pinpointing the importance of non-proliferation and safeguards aspects in addition to reactor safety, waste management and radiation protection for the acceptance of nuclear energy;
- regarding the management streamlining and the structure of ESARDA the Reflection Group proposes:

  – the establishment of an Executive Committee from January 1, 1994, which will operate for a period of one year, dealing with all the matters normally dealt by the Board; at the end of 1994 the Steering Committee will evaluate the results and decide whether and how to continue in the restructuring; during the same year the Executive Committee will assess and review the ESARDA internal rules and prepare a new set of management rules;

  – the Co-ordinators should have an increased scientific role and their tasks are essentially a technical coordination between the Parties, the Working Groups technical management and the promotion of exchange of information;

  – the "discipline-oriented" Working Groups (DA, NDA, C/S) should continue their present activities, although some revision of their terms of reference could take place and more use of ad hoc sub-groups might be useful; the objectives of "the plant-oriented" Working Groups should be reassessed in the light of their interests and of the fuel cycle evolution; increased communication between the Working Groups and through the ESARDA Bulletin is recommended;

  – an increased use of ad hoc Working Groups is recommended in order to improve the efficiency and the external visibility of ESARDA work.

Analysis of R&D Activities in the Field of Fabrication Plants

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on behalf of ESARDA Coordinators

Introduction

Following a request of the Steering Committee, the Coordinators have analysed the R&D Safeguards activities, as declared by ESARDA partners. Previous ESARDA bulletins have presented ESTABANK, the data base on which are classified and recorded the nuclear safeguards R&D tasks of the ESARDA partners, and the analysis of these nuclear activities in various fields such as Containment/Surveillance, Reprocessing Plants and DA and NDA techniques of nuclear material.

The present analysis is performed using the list of ESTABANK Tasks related to FABRICATION PLANTS, and has been prepared in consultation with Convenors of the LEU and MOX Working Groups.

General Analysis of Fabrication Plants Data

Fabrication Plants of fresh fuel can be classified in three categories:

- LEU fabrication plants = fabrication of low enriched uranium fuel
- HEU fabrication plants = fabrication of high enriched uranium fuel
- MOX fabrication plants = fabrication of mixed oxides fuel

There are 8 large operating uranium based fuel preparation and fabrication plants (LEU) operating in the European Union.

There is one major uranium (HEU) fuel preparation and fabrication plant in the European Union as well as several minor ones.

There are 3 plutonium-uranium based mixed oxide (MOX) fuel preparation and fabrication plants in the European Union and a large MOX plant under construction.

74 out of 250 tasks indexed in ESTABANK at the end 1993 have been identified as being relevant to fabrication plants:

- 34 tasks concern the LEU and HEU plants but only two are specific for HEU plants,
- 56 tasks concern the MOX-plants,

(The numbers above illustrate the fact that in this sort of analysis some tasks will be counted more than once. In this case it is because they are relevant to more than one type of plant).

For each type of plant these tasks can be classified in five general areas:

a) Safeguards and Nuclear Materials Management Approaches,
b) Computerized Accountancy,
c) Measurement System and Containment/Surveillance,
d) Assessment, (Safeguards Evaluation)
e) Training (operators, safeguards inspectors...).

Specific analysis of LEU and HEU fabrication plants tasks

Most of the techniques applicable to LEU are also of potential interest to HEU plants. Ten tasks are related to LEU plants only and two tasks are specific to HEU fuel.

Safeguards Approaches and Nuclear Materials Management

- only one task (SCK) "Strategy of inspections to verify the flow" is specific to LEU plants.
- one task (GNS) related to Modelling and NRT Accountancy and developed for reprocessing plant has a potential application to HEU and LEU.

Computerized Accountancy

Two tasks concern Advanced Multi-Language and PC System for single/multi MBA (ENS). These tasks are also applicable to others facilities.

Measurement System

This area is the most important because 26 tasks are listed under this heading. (But 17 of these are also applicable at MOX plants).

Although it would also be possible to classify the tasks according to "types" or "objectives" we have chosen to make the classification according to technical disciplines (DA, NDA, C/S, etc.)

Destructive Analysis (DA)

The 11 tasks concerned with destructive assay techniques were related to:

PERFORMANCE EVALUATION

The LEU Working Group organized interlaboratory comparisons in order to evaluate the performances of gravimetric and potentiometric uranium determination applied on a routine basis to pellets and nitrate solutions.

The JRC Geel and CEA are currently involved in interlaboratory measurement evaluation of uranium dioxide and uranylnitrate solution in the framework of programmes such REIMEP (Regular European Interlaboratory Measurement Evaluation Programme) and EQRAIN (Evaluation de la Qualité du Résultat d'Analyse dans l'Industrie Nucléaire). Another task concerns interlaboratory evaluation of UF_6 isotopic measurements (REIMEP).

PRODUCTION AND/OR QUALIFICATION OF REFERENCE OR STANDARD MATERIALS

CEA is distributing reference uranium materials and UKAEA characterized, as a service to IAEA, UO_2 pellets. JRC Geel supplies special reference and source materials for destructive assays (UO_2 powder and uranylnitrate).

IN FIELD USE OF ANALYTICAL TECHNIQUES

JRC Ispra offers technical support for in field use of analytical techniques such as mass spectrometry and spectrophotometry.

Non-Destructive Analysis (NDA)

17 tasks concerned on non-destructive assay techniques related to:

INSTRUMENT DEVELOMENT AND PERFORMANCE EVALUATION

The measurement of fresh fuel material is well established technique.

- JRC Ispra has developed software for uranium enrichment measurement by HRGS and also a transportable device - Phonid - for neutron measurement of uranium.
- another project, specific to HEU, is related to improvement of hardware and software for scanning MTR fuel elements.

JRC provides facilities at the PERLA laboratory for the testing of procedures, the calibration and the performance evaluation of NDA equipment in field conditions.

Much effort has been directed towards the determination of uranium in waste. Four tasks concern neutron interrogation of drums with Californium or pulsed neutron sources (UKAEA) and one task relates to integrated assay of intermediate level waste.

ESARDA has organised an important workshop on the measurement of fissile materials in waste (Salamanca 1992).

PRODUCTION AND/OR QUALIFICATION OF REFERENCE OR STANDARD MATERIALS (3 TASKS)

ESARDA NDA WG works on the definition of needs and specification for the preparation of Reference Materials. JRC Ispra proposes PERLA standards such as UO_2 pins, pellets and short assemblies.

Containment/Surveillance techniques

In practice only seals are used in LEU plants. The C/S tasks included in ESTABANK could also be applied here.

Other techniques

The ESARDA LEU WG organised a weighing intercomparison exercice with a range of reference weights and special software for data evaluation.

Training (operators, safeguards inspectors...)

Two tasks concern training of safeguards inspectors for work with a neutron collar and for the application of JRC Ispra developed instruments for C/S, DA and NDA.

One task, specific to HEU plant, is related to Physical Inventory Verification exercise for EURATOM and IAEA inspectors.

Specific Analysis of MOX Fabrication Plants Tasks

56 tasks concern plants for the "fabrication of mixed oxides fuel ". This large number emphasises the importance of the R&D ESARDA partners effort on Safeguards R&D relevant to the increasing production of this type of fuel for LWR and fast reactors.

Safeguards Approaches and Nuclear Materials Management

Two organizations (SiBW, KFA) are involved in this field and 2 tasks have been identified:

- one task (Expert Engineering Support) deals with the assistance to the Agency of a cost free expert at the Siemens MOX fabrication plant (KFA),
- one task relates to Safeguards Approach for the Siemens MOX Fuel Fabrication Plant,

A third task concerning Modelling and NRT Accountancy (GNS), developed for reprocessing plant, also has a potential application to MOX plants.

Measurement System

56 tasks are listed under this heading making this area the most important. But seventeen of these tasks are also applicable at LEU plants.

Destructive Analysis - DA

11 tasks are listed under this heading.

PERFORMANCE EVALUATION

The JRC Geel is currently involved in interlaboratory measurement evaluation programmes such as REIMEP.

The CEA organizes interlaboratory measurement evaluation programme, such as EQRAIN, for the determination of plutonium in nitrate solution.

UKAEA is evaluating controlled potential coulometers and developing analytical techniques to reduce sample size for potentiometric titration of plutonium.

PRODUCTION AND/OR QUALIFICATION OF REFERENCE OR STANDARD MATERIALS

UKAEA has an important programme of preparation and characterization of plutonium reference material; PuO_2 and several isotopic mixtures of plutonium.

CEA supplies special reference and source materials for destructive assays: plutonium nitrate and synthetic MOX pellets. JRC Geel provides synthetic isotope mixtures of plutonium and plutonium dioxide powder.

Non-Destructive Analysis - NDA

36 tasks come under this heading making it the most important technique of this analysis.

PERFORMANCE EVALUATION

Neutron measurements (13 tasks) are widely used in whole fabrication process. The neutron coincidence collar is interesting for measuring input material and fresh fuel (UKAEA, SCK); but development work are studied furthermore as influence of unknown moisture content (SCK, ENEA), fission multiplicity (CEA) and coincidence counting (SCK, UKAEA). There has also been a study related to the interpretation model of neutron measurements (JRC).

Sampling can be avoided with direct neutron determination in glove-boxes (SCK). The determination of plutonium in various waste by passive or/and active neutron measurements is the subject of important studies (UKAEA).

In the area of gamma measurements (7 tasks) there are active tasks concerning isotopic plutonium analysis by HRGS with improved software and statistical package (JRC) and also plutonium verification in waste containers.

Only two tasks concern calorimetry as a reference method in combination with high resolution gamma spectrometry for the precise determination of plutonium in PuO_2 (but calorimetry is not currently used for inspection purposes).

The Plutonium Isotopic Determination Intercomparison Exercise (*PIDIE*) organized by the ESARDA NDA WG is worthy of a mention.

One task concerns in-field testing of procedures and calibration at PERLA laboratory for combined neutron/gamma measurements for Pu assay. Another task is the development of integrated station for in-field isotopic Pu composition measurements (ENEA).

JRC makes special PERLA MOX and PuO_2 reference materials available at ISPRA for NDA assays.

The presence of 15 tasks concerning neutron measurements for MOX plants indicates how important a role this technique is expected to play. This technique has application to waste as well as to the input nuclear material and the product.

Improvements of neutron coincidence counting are expected to come from the use of multiplicity counters and their associated software. Problems related to the interpretation of measurements, fission multiplicity, interpretation model, unknown moisture contribution, badly defined waste and development of equipments are under investigation.

Because of the high level of interest and activity in this topic ESARDA held a workshop on neutron counting at PERLA in April 1993. The main purpose was to review the current status of passive neutron assay. The main conclusion can be summarized as:

- shift register based instruments (SR) have been in use in safeguards and fissile accountancy for 15 years. Clean and well characterized process and product materials are monitored with satisfactory accuracies (1-2%) but there are still some problems to be solved.
- multiplicity counters have been developed to improve Pu assay of materials where shift register have problems. They are already giving good results and are being implemented in the field.

Containment/Surveillance techniques

- In ESTABANK there are 9 tasks related to Containment and Surveillance that are applicable to MOX plants. Video and sealing techniques are widely used in these facilities. More effort is required to combine NDA and C/S techniques in integrated systems particulary for these very automated plants.
- A first integrated safeguards system (seals, radiation monitoring, video cameras...) entirely networked with high tamper resistance data bus and enhanced video review station has been proposed for a new plant.
- JRC Ispra offers LASCO (LAboratory for Surveillance and COntainement) for testing and evaluation of the performance of C/S devices in field conditions. JRC is studying a guided instrumented vehicle for remote verification in storage areas.

Training (operators, safeguards inspectors...)

UKAEA is training safeguards inspectors on advanced NDA assay techniques. One JRC task concerns training on the use of instrumentation developed by Euratom for NDA, DA, and C/S and another relates to Physical Inventory Verification exercises.

Conclusion

Considering all types of plants together the distribution according to areas is very unequal:

- eight for Safeguards Approaches,
- three for Accountancy,
- fifty-six tasks for Measurements,
- four for Training

It is not surprising that the largest number of tasks addresses MOX plants since most of these are currently being implemented and efforts are being made to improve their Safeguards.

Although DA techniques still provide the basis of nuclear material management, NDA techniques are becoming quite competitive and are taking an increasingly important role throughout Safeguards.

Several tasks reflect the technology transfer from the laboratory to the industry with installation of advanced equipment, adaptation of existing equipment to specific situations and the training of inspectors.

The distribution shows three important classes; drawing up of performance data, standard/reference material and intercomparison exercise:

- Twenty-three tasks refer to improvement or assessment of performance of DA or NDA techniques.
- Twelve tasks are dealing with the preparation and the characterization of standard/reference material.
- Eight tasks are related to intercomparison

The important number of tasks in these two last classes indicates the necessity of checking the state of practice of the different analytical laboratories by using certified reference materials and NDA methodology.

This important number of tasks also indicates that although the techniques are maturing for well defined objects, such as fresh fuel elements, all problems are not solved.

Interlaboratory benchmark exercises must be planned on impure or inhomogeneous materials, for instance in scraps.

The PERLA laboratory at JRC ISPRA offers very comprehensive facilities for development of in-field testing techniques and for the training of the inspectors.

It is relevant to mention the Workshop on measurements of nuclear materials in waste at Salamamca in 1992 (even though this does not appear as an ESTABANK entry). That meeting suggested that although passive-active neutronic NDA methods are promising to detect very low quantities of nuclear materials in MOX waste, there is still need for research to find suitable NDA techniques to meet Safeguards requirements.

The ESARDA Working Groups play an important role for the establishement of performance values and for the intercomparison studies. This indispensable role of the ESARDA Working Groups must be emphasized and encouraged. It would be reasonable to increase contact between experts of these groups, the operators and inspectors, by holding more special meetings on particular topics following the example of recent ESARDA Workshops.

Analysis of R&D Activities for Reprocessing Plant Safeguards

M. Cuypers, M. Dionisi
on behalf of ESARDA Coordinators

Introduction

The ESARDA bulletin n. 21 of December 1992 did present the study of European R&D activities in the field of Containment/Surveillance and of Non Destructive techniques.

The ESARDA project coordinators have further analysed the R&D and technical support activities performed in view of their application to reprocessing plant safeguards.

R&D activities presented by the ESARDA Coordinators at the end of 1993 in the field of Reprocessing Plant applications are numerous. The analysis has been performed according to the following categories.

- Systems Analysis
- Measurement Techniques intended as tank volume and weight measurements
- Destructive Assay Techniques
- Non Destructive Assay Techniques
- Reference Materials
- Isotopic Correlation Techniques
- Containment and Surveillance Techniques
- Evaluation of Accountancy Data
- Training

Analysis

Systems Analysis

Six activities mentioned in the data base are related to Design Information Verification (DIV). IAEA has expressed considerable interest in the development of tools and procedures for DIV in large reprocessing plants and more specifically in the process area.

In Tank Measurements

These relate to the determination of the mass of liquids in tanks, particularly, but not exclusively, to the input accountancy tanks of reprocessing plants.

A number of measurement methods have been implemented routinely by plant operators and safeguards inspectors on small pilot facilities. The development work performed is oriented to the improvement of these techniques and calibration procedures.

Six organisations are active in this area with a total of 11 activities.

Exercises have been held in the past to test tank measurement techniques and procedures on small size tanks (e.g. RITCEX, MITA). Positive results were obtained, but further tests on large volume tanks, with new measurement techniques and under hot conditions are required. In 1989, an important exercise was organised by GNS at Karlsruhe for intercomparing different calibration and measurement systems on a large size (~12 m^3) tank in cold conditions, the so called CALDEX experiment. These measurement systems also included the Lu tracer technique. The results of the CALDEX exercise have been evaluated and presented in different symposia. This exercise is a very good example of cooperation between different organizations and of the active involvement of the ESARDA Reprocessing Input Verification (RIV) Working Group, which has played an essential role as a forum for technical discussions. In particular, the working group was involved in the evaluation of the Lu tracer experiment, considering both the chemical separator procedures for analysis and the procedures for the introduction of the spike material in the tank (problem of homogenization).

A new initiative has been launched recently at JRC Ispra in close cooperation with GNS to transfer the experimental set up of CALDEX from Karlsruhe to Ispra. Also the bulk calibration laboratory from IAEA (Vienna) has been transferred to Ispra. These two initiatives are the starting point for the establishment of a general European tank measurement/calibration laboratory (called TAME). It is expected that JRC Ispra will continue to enlarge and increase the international cooperation in this field, in close contact with the ESARDA RIV Working Group. The tank facility has been commissioned and is now operating. Meetings, including experts from major reprocessing plants, research establishments and safeguards inspectorates, were organized at Ispra on March 25-27, 1992 and on October 6-7, 1993, to discuss the future activities of the TAME laboratory.

Several organizations are developing or evaluating performances of specific techniques which may be installed in large reprocessing plants, such as the "monocanne" (CEA), weighing devices and pneumercators (UKAEA), time domain reflectometers (ENEA). It is to be noted that many experimental tests have been performed in cold conditions and little experience is available on irradiated solutions (see UKAEA Dounreay tasks). Further effort is needed to investigate the authentication of classical measurements performed on tanks.

Destructive Assay Techniques

Many R&D activities are performed within EU on destructive assay techniques. The major emphasis is put on the following subjects:

- Development/improvement in laboratory and under field conditions of DA techniques for isotopic and concentration measurements
- Use of spike and sample preparation
- On line measurements, automation
- On site laboratories/service analysis
- Evaluation of the quality of analytical measurements.

It is interesting to note the shift of many R&D activities of more general nature and performed in laboratory conditions to in-field implementation of these techniques, including on line measurements, preparation and characterization of spike material (dry and metal spikes) and the application of tracers techniques, use of robots for sample preparation and automation of techniques.

The evaluation of the performances of these techniques in respect, for instance, of representative sampling and sample conservation under real industrial conditions will be the next challenge.

Representativity of sampling is still a problem to be treated as a priority.

The installation of an on-site verification laboratory to eliminate sample transport is presently an important issue being addressed. This laboratory will perform independent measurements of input, process and output samples and verification of plant operators measurements. The problem of the authentication of results obtained by DA techniques was studied by some ESARDA partners and particularly for sample preparation (using also robots), for the data evaluation software and for the analytical procedure (VOPAN).

For the performance assessment of DA techniques, interlaboratory evaluation tests are organized and measurement

campaigns are performed on a variety of nuclear materials encountered in reprocessing plants. Eight activities are mentioned in the ESARDA data base, with the involvement of three organizations.

The REIMEP programme, organized by JRC-IRMM corresponds presently to the largest international effort for establishing the state of practice for analytical measurement techniques, including those suitable for reprocessing plants.

Non Destructive Assay Techniques

NDA techniques are extensivelystudied and applied in view of their utilisation in nuclear fuel reprocessing plants. 21 activities have been identified in the ESARDA Data Base.

The techniques studied are mainly:

- K-edge densitometry
- Neutron techniques and gamma spectroscopy for output
- Neutron techniques for waste streams
- Calorimetry
- In process NDA

K-edge densitometry is now a well established technique used in-field off line and further improvement is made for on line measurements and the assessment of its overall performances. The technique now starts to be applied on line to liquid streams at input of reprocessing and in the residue recovery plant of UKAEA.

On going activities are in general directed towards support to in-field operations.

Neutron and Pu isotopic measurement techniques are mainly applied to the output of reprocessing plants but also to waste streams.

The neutron coincidence and gamma spectroscopy measurement techniques applied to PuO_2 and MOX materials are well established and have been extensively used in-field. The emphases of on going studies are the more accurate evaluation of the performances of these techniques, also using the PERLA calibration laboratory, or adapting the techniques to specific measurement situations. The PIDIE exercise, organized by ESARDA, for the evaluation of plutonium isotopic measurements by gamma ray spectroscopy, was completed in 1991.

The measurement data evaluation methods are now being improved and more inspector oriented measurement systems are being prepared. Past inspection data evaluation systems to be used at Headquarters are also being developed.

Neutron Techniques for waste measurement have been developed in the past and are presently used mainly for waste management purposes. The ESARDA NDA Working Group examined in details at its topical meeting at Salamanca in 1992, the performances of existing techniques (state of art) in relation to safeguards requirements for waste measurements relevant to safeguards.

Calorimetry techniques are being studied for PuO_2 or MOX measurements in reprocessing plants. Feasibility studies are being conducted to adapt this technique to inspection conditions and to investigate optimal design features. An international workshop on the performances of calorimetry and their potential use in nuclear safeguards was held at Ispra in March 1992.

In process NDA is being tested, using different techniques such as K-edge densitometry and Dual Energy X-ray on pulsed column, voltammetry and plutonium inventory measurement system (PIMS) in Pu evaporator.

Reference Materials

For destructive assay techniques, REIMEP and interlab tests performed at national level are the major actions, and six tasks on preparation of reference materials are mentioned in this context.

For non destructive assay techniques it is worth mentioning that ESARDA has promoted in the past the procurement of NDA reference materials (PIDIE, U_3O_8 and Pu pilot samples) for U enrichment and Pu isotopic measurements. These reference materials have been prepared keeping in mind the traceability of NDA measurements to international standards.

The procurement and availability of well characterized NDA standards (LEU, Pu, MOX) is an essential component for the proper operation of. PERLA. A cooperative effort with other organizations is maintained and the JRC continues to put much emphasis on this activity.

In general, one may state that the ESARDA working groups on DA and NDA are well informed and involved in defining needs for standards and in discussing their preparation and characterization. Both EURATOM and IAEA Safeguards Directorate are showing interest in this type of activity.

Isotopic Correlation Techniques

The ESARDA RIV working group has studied for several years and tested extensively the isotopic correlation techniques. In particular, a bench mark exercise has been conducted by the working group. This exercise consisted in the intercomparison of the performances of different isotopic correlation techniques for the verification of the input inventory of a reprocessing plant. COGEMA supplied data (chemical and isotopic analysis and Pu/U ratio) from 3 routine reprocessing input batches made of 110 irradiated fuel assemblies to the seven participants in the exercise. The results of this exercise have been published.

The usefulness of the technique has been proven both for operators and safeguards inspectors at the input of reprocessing plant.

Containment and Surveillance Techniques

These activities are mainly oriented to the development, test and installation of multisensor systems for the surveillance of storage ponds and areas, which rely mainly on C/S measures. Furthermore, due to the very large amount of data which is created by these systems, the computer aided review of surveillance pictures is becoming an essential tool for front end and back end review.

As mentioned in the ESARDA analysis on C/S activities, several systems are now being installed and are undergoing performance tests.

Specific developments or test activities related to reprocessing safeguards are:

- CONSULHA, which corresponds to a multicamera and radiation monitoring system for movement detection of spent fuel assemblies in storage areas and which is now installed at the La Hague COGEMA plant
- Test of cameras under gamma radiation
- Laser surveillance system, which was extensively tested at the Saluggia spent fuel pond, but not yet implemented for safeguards.

Concerning sealing techniques, JRC Ispra is dedicating a substantial effort in implementing the ultrasonic identification of seals for spent fuel storage casks and for PuO_2 transport containers. A harmonisation of ultrasonic reading devices is underway in a cooperative effort with AECL (Canada).

Evaluation of Accountancy Data

At present some effort is dedicated to this area, more particularly oriented to near real time accountancy.

The emphasis is put on:

- ensuring that reliable measurement data are available
- statistical evaluation of the data in order to detect short term diversion
- incorporating and comparing verification data with operators accountancy data

Several studies have been completed and implementation of these techniques is now expected.

Training

Three activities are related to this area.

Significant contribution is provided to IAEA inspectors training at reprocessing plants, by organizing design information verification exercises, integrated verification exercises at BNFL (Sellafield) and advanced NDA courses. UKAEA (Dounreay, Windscale) and JRC at the PERLA laboratory are presently used for this purpose.

Conclusions

The LASCAR project, which was completed in 1992 has provided a systematic overview of the presently used and required developments for the efficient and effective safeguards of large size reprocessing plants.

Many R&D and technical support activities in EU laboratories are oriented to reprocessing plant safeguards. The implementation of these techniques, as is currently taking place by the EURATOM Safeguards Directorate, requires large resources and it is expected that the technical support for specific application will continue.

This technical support is mostly oriented to:

- the practical implementation of newly developed techniques or their improvement
- the evaluation of the performances of DA, NDA and mass/volume measurement techniques
- the integration of measurement methods and C/S systems
- training.

New issues being addressed are techniques for design information verification and authentication of measurement systems and data transmission.

It is to be noted that the ESARDA activities in this area were essentially limited, over the years, to the study of problems related to the use of ICT and input accountancy tank measurements.

Scraps in the Nuclear Fuel Cycle Aspects of Safeguards NDA Measurements*

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Introduction

In 1991 the ESARDA Board requested a document for the Steering Committee pointing out the problems related to the Safeguards measurement of "scraps" and suggesting objectives for a possible discussion of this issue within the different Working Groups, which in the meantime has happened. The principle objective of these discussions was to

- characterize the main types of scraps;
- specify measurement, performance and equipment (present);
- identify desired performance and/or equipment capabilities (future) and
- review the current status and necessary developments in NDA for safeguarding scraps.

This paper presents the outcome of discussions of this subject within the ESARDA NDA WG and of dialogues of group members with operators, measurement technique developers and safeguards authorities. Consequently, attention is mainly directed to NDA aspects of the scrap issue.

What is "Scrap"?

First problems already occur when trying to give a definition for "scrap" and/or to distinguish it from its "neighbouring" material categories, namely "waste" and "product". It appears that, while developers favour more "science oriented" definitions (i.e. discriminating by e.g. physical/chemical properties or necessary measurement methods), operators seem to consider the subject rather from the economical point of view (i.e. discriminating by e.g. re-work or storage costs) and from the points of view of legal restraints (considering, e.g., uranium residues as waste or scrap has legal consequences). In addition, safeguards authorities mainly tend to judge the impact on the material balance. Some examples of the various definition statements are given below.

LEU operator

Consider waste to be any radioactive material which is of no further use to the manufacturing process, either because of its uneconomical recovery prospect or its unacceptable impurity level (due, maybe, to some processing malfunction or to some unforeseen contamination). Scrap, on the other hand is considered to be in a reasonably short time usable or recoverable material which can be reintroduced to mainstream manufacture in a short time-scale.

LEU operator

Current residue stocks are categorised according to their economic usage following what maybe a rather complicated recovery route.

LEU operator

Scrap is Uranium "rejected" during the fabrication process under a physical, chemical form which is not directly usable for fabrication purposes. Scraps have a concentration of uranium higher than the magnitude of a few %. Recycling is possible within a reasonable time. Two categories can be distinguished:

- Recycling is performed in the fabrication line
- Recycling is performed in a particular workshop.
- Recovery by incineration and extraction techniques is applicable.

Waste is Uranium "lost" during the fabrication process under a physical and/or chemical form which is not suitable for fabrication purposes. Waste has a concentration of uranium less than the magnitude of a few %, recycling is not possible. Incineration and extraction cannot be applied.

MOX operators

Consider scrap being defined as rejected material removed from the process stream, including clean and dirty scraps. Clean scrap is mixed oxide material which can be reused directly after physical treatment alone. All other scraps are classified dirty.

Reprocessing plant operators:

"Scrap" does not exist, only

- Re-work: Product solution not meeting quality requirements (too high in fission products, normal in nuclear material)
- Waste: Solution or solid to be discarded (contents of nuclear material below fixed limits), no further treatment except conditioning.

Developer

Scrap is more or less the same material as processed usually (powder, pellets, fuel rods, etc.) the specifications of which do not meet all requirements. At some moment in time it would or could be reused, if necessary after some "improving procedure" (chemical cleaning of powder, grinding of pellets, unpacking of fuel rods...).

Waste consists of a variety of different types of materials from process materials down to very diluted stages, e.g. cleaning solutions or used tissues. Reinjection is not reasonably achievable.

Safeguards authority

Product: nuclear material processed to the point of being ready for shipment from a plant e.g. UF_6 from an enrichment plant or fuel assemblies from a fuel fabrication operation.

List of abbreviation

BNFL	British Nuclear Fuels plc
DA	Destructive Analysis
ESARDA	European Safeguards Research and Development Association
IAEA	International Atomic Energy Agency
JRC	Joint Research Centre of the European Union
LEMUF	Limits of Error on MUF
LEU	Low Enriched Uranium
MBA	Material Balance Area
MOX	Uranium/Plutonium Mixed Oxide
MUF	Material Unaccounted For
NDA	Non-Destructive Analysis
PIV	Physical Inventory Verification
SRD	Shipper-Receiver Difference
WG-NDA	Working Group for Techniques and Standards for Non-Destructive Analysis

* This report was previously produced for internal use at JRC

Scrap: rejected nuclear material removed from the process stream. Clean scrap comprises all rejected process material that can be introduced into the process stream without the need for purification, dirty scrap requires separation of the nuclear material from contaminants, or chemical treatment to return the material to a state acceptable for subsequent processing.

Waste: nuclear material in concentrations or chemical forms which do not permit economic recovery and which is desig nated for disposal.

The discrepancies of opinions are obvious from these statements. Nevertheless, a reasonable compromise between most of them seems to be the "scrap" definitition from the IAEA's Safeguards Glossary /1/ which is given above under the heading "Safeguards Authority". In addition, since in contrast to measured discards and retained wastes which raise non-technical questions for termination of safeguards or for the removal of nuclear material from the safeguarded inventory, scraps which remain under safeguards are only confronted to possible measurement difficulties. Thus, there are no non-technical difficulties in adopting these definitions as a basis for discussion which is done in the course of this document.

What Problems to Expect?

Clean scraps rejected from the process stream and dirty scraps, obtained either during routine plant operation or recovered from equipment clean-up, may represent several percent of the throughput and/or of the inventory. Such scraps are often stored several months or even years before being recycled into the process stream or recovered by the scrap recovery plant. Consequently, the availability of NDA may be an important issue, particularly for:

- the improvement of the material balance uncertainties in the two facilities,
- SRD's between the two facilities.

This is true for operators as well as for safeguards Authorities.

As scraps comprise all rejected process material, difficulties encountered for measurement may result, for example:

- from the wide range of concentrations of nuclear material, from the variety of chemical compositions, matrices and shapes, requiring a variety of measurement performance and equipment which are not necessarily implemented for normal plant operation,
- from the presence of contaminants or matrices interfering with routine measurements.

How was Information obtained?

Apart from direct discussions with persons or institutions concerned, an attempt was made to collect information with the help of a written inquiry. Therein, nine plant operators of the nuclear fuel cycle, i.e.

- two enrichment facilitites
- two LEU facilities
- two MOX facilities
- two reprocessing plants
- one waste conditioning facility

were asked to identify and characterize the main types of scraps handled in their plants according to the following scheme:

- Type of material
- Physical Characteristics
- Chemical Characteristics
- Approximate quantity (kg/y, % flux)
- NDA methods used for measurement (including achieved uncertainty on fissile material content)
- DA methods used for measurement (including achieved uncertainty on fissile material content).

Although the general response was not overwhelming some of the plants concerned gave detailed answers thus helping to establish the collection of information which is presented below.

Scrap in the Different Facilities

In the course of this text, reference will be given to the "International Target Values for Uncertainty Components" presented and explained in /3/. In addition, some of the tables at the end contain values taken from there.

In that paper two parameters characterize the precision and accuracy which should be aimed for in a specific measurement of a given material using a specified method at a single laboratory:

RAN is the relative standard deviation of the repeatability to be expected in the random uncertainty components encountered during a single inspection;

BIF is the relative standard deviation of the changes in the systematic error which may occur between inspections.

Attempts were made in /3/ to include in these parameters all uncertainty components which determine the potential difference between the measured and the true value.

It has not yet been possible to propose Target Values for the term BIF applicable to sampling.

The combination of the RAN and BIF parameters

$$S_R = (RAN^2 + BIF^2)^{1/2}$$

should be equivalent to the relative standard deviation of the reproducibility of the measurement at one laboratory.

Uranium Enrichment Plants

A typical enrichment plant produces approximately 8 kg/y and 20 kg/y of uranium in gaseous and solid waste streams, respectively. This corresponds to 0.0003% of the total throughput and hence is considered non-significant /2/.

Scrap, according to the definition of operators, does not occur. However, large amounts of depleted uranium, referred to as "retained waste" or sometimes as "depleted product" are generated at the low enrichment end of these plants. According to the safeguards glossary /1/ retained waste is "deemed to be unrecoverable for the time being but which is stored", and product corresponds to material to be shipped for further use in the fuel cycle. The putting into category is difficult.

The determination of the uranium mass and the uranium enrichment of this UF_6 certainly is done using the same methods as for low enriched UF_6, i.e. by weighing and mass spectrometry. Safeguards verification is also done with gamma spectrometry using NaI or Ge detectors. Measurement performances are not as good as those achieved during the enrichment measurement of low enriched UF_6 with the same methods due to the heterogeneity of the material and the low ^{235}U content. However, they can be estimated from the "Tables of the 1993 International Target Values for Uncertainty Components in Measurements of Amount of Nuclear Material for Safeguards Purposes" /3/.

From there uncertainties in the range of

- > 5% relative and > 2% relative for random and systematic errors, respectively, in low resolution gamma spectrometry (NaI) and
- > 3% relative and > 2% relative for random and systematic errors, repectively, in high resolution gamma spectrometry (Ge)

would be expected. This estimation agrees with another source /7/, where values of 7% (random) and of 2-10% (systematic) are given.

LEU Fabrication Plants

A part of the information contained in this chapter was extracted from a working document of the ESARDA LEU-WG /4/.

Here, scraps are mostly characterized by a "nominal uranium content factor" per type of material because of loss of traceability. The nominal uranium factor is based on stoichiometric data, or on spot check measurements by "classical" (N)DA measurements. The following scrap categories are recognised, taking into account the way of recycling:

Table 1: Scraps in a LEU fabrication plant

Category/Material	% through-put	% inventory	% σ^2_{MUF}	storage time	measurement techniques	performance % uncertainties		future trends
						RAN[a]	BIF[a]	
Clean Scraps (A) Disqualified pellets UO_2 powders U_3O_8 powders UO_2-U_3O_8 powders Dry grinding residues		2	2	weeks	LMCN[b] PMCN[c]/PMCG[d] PMCN[c]/PMCG[d] PMCN[c]/PMCG[d] PMCNc)/PMCGd)	1.5 2.5/1.5 2.5/1.5 2.5/1.5 2.5/1.5	1.0 1.5/1.0 1.5/1.0 1.5/1.0 1.5/1.0	
Dirty Scraps (B) Impure material	1	< 1	6	months	LMCN[a]	7.0	7.0	
Dirty residues (C) Plastic bags Air Filters Other residues	~ 0.1	<1	1	years				
Σ		< 3	9					

a) RAN and BIF as defined in Chapter 2
b) LMCN: Laboratory Multichannel Analyzer, NaI
c) PMCN: Portable Multichannel Analyzer, NaI
d) PMCG: Portable Multichannel Analyzer, Ge

Category A

Recycling in the fabrication line ("clean scrap"):

Due to the low concentration of impurities, chemical processing is not necessary.

The real uranium factor can deviate from the nominal one to an extent of a few percent relative, but the contribution to the physical inventory is small (see table 1: about 2% for a typical inventory). Because of the small amounts involved, the influence of this type of material on LEMUF is very limited (see table 1: $\sigma^2/\sigma^2_{MUF} \cong 2\%$ for one year balance period).

The concerned material is recycled in the fabrication lines, by means of a dry physical process. Normally the material does not leave the plant under this form. The recycling time is a few days/weeks.

Examples are:

- disqualified pellets, etc.,
- remainder UO_2 powder, U_3O_8 powder, UO_2-U_3O_8 blendings etc. (small amounts) coming from different batches,
- dry grinding residues.

Category B

Recycling in a particular workshop ("dirty scrap" "clean residues"):

Due to the higher concentration of impurities, a recognised (chemical) reprocessing strategy is required to obtain purification for this type of materials.

The real uranium factor can deviate from the nominal one up to 10%, but here also the contribution to the physical inventory is small (see table 1: about <1% in U for a typical inventory). Because of the very small quantities concerned the influence of this type of material on LEMUF is also limited, but higher than the influence of material from the former category (see table 1 for a typical one year balance period: $\sigma^2/\sigma^2_{MUF} \cong 6\%$).

The material concerned is recycled in a particular workshop by means of a wet chemical process. In some cases recycling is carried out in another facility. For this reason it is interesting to know that the total amount of material can represent ~ 1% in U of the flow, being a fraction of the shipments. The recovery time is normally a few weeks/months (if the same facility is concerned).

Examples are:

- sludges from decontamination workshops,
- other impure material (residues from labs, cleanings of workshop floors, etc.).

An additional, third category was identified by the LEU operators, lying in the grey zone between "scrap" and "waste". In analogy to the expression "clean residues" for "dirty scrap", the name "dirty residues" was used here.

Category C

Recovery by incineration and extraction techniques are applicable ("ex-waste", "dirty residues", ...):

The material is very inhomogeneous from physical and chemical point of view, and real U weights can differ up to 10% or more from the estimated values.

The total contribution of this material to LEMUF is very small (see table 1: $\sigma^2/\sigma^2_{MUF} \cong 1\%$ for one year balance period).

The recovery time is more than 1 year. Incineration techniques are rather new and stocks are built up in the past, but this type of material represents normally not more than 0.5% in U of a physical inventory. In some cases recovery is carried out in another facility. For this reason it is interesting to know that the total amount of material can represent ~ 0.1% in U of the flow. In the past this type of material was often considered as "waste".

Examples are:

- plastic bags used for the transportation of uranium oxide powder,
- combustible airfilters with a measurable uranium content,
- residues obtained after sedimentation of water coming from cleaning operations.

The - mostly DA - measurement systems applied by the operators for scrap are the same as those applied for direct usable material in the main process stream material. If NDA measurement systems are used, the precision is lower than in the case of clean material. For category C sometimes typical measurement systems are developed appropriate to the type of material (NDA systems, determination of differences of weight in the case of filters, measurements of height of liquid levels, ...).

At the occasion of the physical inventory verification, measurements are performed by the safeguards authorities by means of NDA techniques (Davidson-Phonid) and DA techniques (potentiometric analyses and γ spectrometry in situ or at headquarters). Problems encountered by operators as well as by authorities are:

- inhomogeneity in the measured batches,
- inhomogeneity between different batches,
- lack of suitable common standards.

An overview on parameters of the three different categories related to their amounts, and on measurement performances is given in table 1. Performances are extracted from /3/, taking into account the discrimination betweeen

homogenous and heterogenous (clean and dirty) scraps made therein. In addition, single values for the various clean scrap sub categories (material types) are listed, taken from the respective tables /3/ for UO_2-pellets and uranium oxide powders. This seems adequate, since clean scraps do not differ strongly from products with respect to their physical and chemical properties. In the case of the "dirty residues" it appears more logical to use performance values relating to waste measurements when considering the types of materials.

Items, where no information was available at the moment of drafting this document are left blank in the table to be completed at a later time.

What became evident was the need to obtain a more accurate asssessment of the uranium/fissile content of what would ultimately be called waste, since this could have a significant effect on the calculation of the MUF, sigmaMUF and LEMUF following a PIV exercise. Currently a joint research project is under progress between BNFL Springfields, UK and JRC Ispra, Italy using the Phonid 3B analyser to determine levels of different product, waste and scrap materials. Results on product and waste powder materials are quite good for samples with a diameter of less than 100 mm (table 2) /5/, therefore scrap, lying between the two extremes, should be measurable with similar performances.

Table 2: Results of Phonid 3B Measurements /5/ (holds for powder samples of a diameter < 100 mm)

Material	Way of Measurement	Accuracy [%]
Bulk product	discriminating between different chemical states not discriminating	1 3
LEU waste	powder liquid	2.5 10
U_{nat} waste	synthetic mixture U/C natural residues, depending on origin	5 5-30

MOX fabrication plants

A significant part of the information contained in this chapter was extracted from a working document of the ESARDA MOX-WG /6/.

Each Pu fuel fabrication plant receives plutonium feed material as PuO_2 and uranium feed as UO_2, to manufacture oxide pellets, rods and fuel assemblies. During manufacturing operations, some fractions of the materials produced may be found to be defective and are rejected during testing and inspection procedures associated with the quality control programme.

A batch of scraps can be defined as homogeneous, for a given physico-chemical form, if the Pu/U ratio and the isotopic composition can be determined unambiguously on a representative sample. If a scrap cannot be defined in such a way it should be categorized as inhomogeneous.

This distinction leads to the following four categories of scraps:

- clean homogeneous
- clean inhomogeneous
- dirty homogeneous
- dirty inhomogeneous

In practice the main categories of scraps occurring can be summarized as follows:

Dirty scraps

These scraps would normally be processed outside the process line, within or without the facility. Moreover, they may be present during physical inventory verifications. There is thus a need for the best possible measurement of such scraps, although the yearly amount is likely to remain low (in the range of 0.5% or below).

Clean scraps

These would normally be recycled within the process, but may be stored for short or longer periods.

For homogeneous scraps the problems are not different from those raised by the material in the production line, and will not be discussed here. For those which are inhomogeneous, they can be split within the two basic following categories:

- green products (powder or pellets)
- sintered products (powder or pellets).

Such scraps may be recycled nearly immediately, or stored for longer or shorter periods in storages accessible or not, inside or outside the production line.

The problem of safeguarding inhomogeneous scrap batches in MOX fabrication plants, is not, in principle, different from the one of similar batches in other fuel fabrication plants, but it is different in practice because of the smaller significant quantities, which means that several significant quantities of nuclear materials may be present in such batches in a large scale MOX fuel fabrication plant.

To give an example, in one facility under consideration in-line storage silos for clean scraps have a maximum capacity of about 1t of ceramics which corresponds to about 50 kg of Pu. Such storage silos would be inhomogeneous, and, as such, inaccessible for sampling.

Designs involving shorter recycling delays would, of course, result in reduced quantities in such storages, but the overall amount of clean scraps in

Table 3: Scraps in a MOX fabrication plant*

Category/Material	% through-put	% inventory	% σ^2_{MUF}	storage time	measurement techniques	performance % uncertainties		future trends
						RAN[a]	BIF[a]	
Clean homogeneous heterogeneous	5-10				INVS[b]/HLNC[c] INVS/HLNC	2.0/4.0[d,e] 7.0/7.0[d,e]	1.5/1.0[d,e] 5.0/3.0[d,e]	
Dirty homogeneous heterogeneous	0.5				INVS/HLNC	7.0/7.0[d]	5.0/3.0[d]	

a) RAN and BIF as defined in Chapter 2
b) INVS: Inventory Sample Coincidence Counter
c) HLNC: High level Neutron Coincidence Counter
d) Measurements time 300 s
e) Better performance to be expected for material in standardized container

* The values given represent average performance observed on historical data. No estimates are given for the individual characteristics. Sampling errors are the main contribution to the overall errors observed. Scraps can contain various levels of interfering impurities which could result in larger measurement errors.

such facilities is likely to be in the order of 5 to 10% of the throughput.

The respective available parameters are listed in table 3. Performances again are taken from ref. /3/. In the case of clean, homogeneous scraps target values of light water reactor MOX product were used due to the reasons mentioned above. For clean heterogeneous and dirty, homogeneous scraps data were taken from the table referring to MOX scrap. No entries were made for dirty, heterogeneous scraps due to the non-availibility of data. There, probably still higher uncertainties are to be expected than in the former two cases.

Items where no information was available at the moment of drafting this document are left blank in the table to be completed at a later time.

One problem concerning NDA techniques is measuring dirty scraps when they leave the MBA for further processing, or for the purpose of inventory verifications. The measurements actually applied are neutron coincidence measurements in combination with the determination of isotopic composition.

Especially with regard to neutron measurements, further investigations about the influence of impurities and inhomogenities are needed to improve the results.

With respect to clean scraps, problems are limited to heterogeneity. They are not in principle different from the problems of heterogeneity encountered from scraps in uranium fuel fabrication plants. The presence of plutonium is, on the contrary, a positive element which could facilitate the solution of the problem.

The progress achieved in NDA methods during the last years has significantly improved the verification capabilities of the inspectorates in the area of scraps. But further improvements were recommended particularly for inhomogeneous materials containing impurities influencing the neutron flux.

The best use in any facility of the existing measurement devices, as well as of those which will be developed in the future for measuring scraps is closely related to the technical characteristics of each facility and to the overall safeguards approach adopted for the production line. It must be noted that the problems raised by the verification of scraps recycled in line are not different from those of verifying the product itself.

Problems related to the determination of uranium in MOX scraps were regarded as negligible.

Reprocessing Plants

In the reprocessing plants taken into consideration "scrap" does not exist. The material categories characterized there are

Rework: Product solution not meeting quality requirements (too high in fission products, normal in nuclear material)

Waste: Solution or solid to be discarded (contents of nuclear material below fixed limits), no further treatment except conditioning.

Waste solutions will be analysed and solid waste will be estimated for fissile material before discarding.

Rework will not be accounted for, because it remains within the process MBA. Normal process control analysis methods are applied in the same way as to the common process solutions. Rework is never stored, but always reinjected into the same process campaign.

Waste Treatment Facilities

The basic purpose of this kind of plant already implies that all material entering it is to be considered as "waste". Logically, these facilities do not have to be taken into account when discussing "scrap" issues.

Conclusions

An investigation was led through on the subject of scraps in the nuclear fuel cycle, particularly directed towards

- the identification and characterization of scraps occurring at different parts of the nuclear fuel cycle.
- the review of the current status of NDA measuring techniques for the various categories of scrap and
- the indication of desirable NDA method improvements or developments.

A reasonable definition of "scrap" appeared to be the one of the IAEA's Safeguards Glossary:

Scrap is rejected nuclear material removed from the process stream. Clean scrap comprises all rejected process material that can be reintroduced into the process stream without the need for purification; dirty scrap requires separation of the nuclear material from contaminants, or chemical treatment to return the material to a state acceptable for subsequent processing.

Five different kinds of facilities of the nuclear fuel cycle were considered:

In processing plants and waste handling facilities scraps do not occur. While in the former materials corresponding to above definition are reinjected directly into the same cycle and stay in the same MBA, in the latter scrap is excluded by principle.

The accumulation of large amounts of depleted uranium tails from enrichment should be dealt with separately. It could be considered, like the irradiated fuel that will be stored in long term monitored and retrievable storage facilities, as an immobilized inventory covered by appropriate containment and surveillance measures in a more effective way, than by regular verification measurements.

In fabrication plants (LEU and MOX) scraps clearly have an influence on material balances. For a LEU plant the order of magnitude is approximately 9% of the σ^2_{MUF}, for MOX plants respective data was not available. In both cases, desirable developments are:

- Improvement of measurement accuracies.
- Development of calibration measures and procedures.
- Investigations of the effect of impurities, particularly those influencing neutron fluxes.
- Investigations on the impact of heterogeneity on measurement performances.

Acknowledgement

The inputs and stimulations during various discussions of the ESARDA LEU WG, DCS Luxembourg and the IAEA are greatly appreciated.

References

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/4/ Impact of Waste and Scrap on the Material Balance of a LEU Facility, Working Document of ESARDA LEU-WG, version 28 Jan.1992

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Letter to the Editor of the ESARDA Bulletin

Geel, 24 May 1995

Dear Sir,

The ESARDA Bulletin no. 23 in March 1994 published an article titled

"1993 International Target Values for Uncertainty Components in Measurements of Amount of Nuclear Material for Safeguards Purposes"

by S. Deron, E. Kuhn, C. Pietri, P. De Bièvre, T. Adachi, K. Iwamoto, S.G. de Almeida, P. Doutreluingne, R. Schott, S. Guardini, H. Wagner, R. Weh, J.L. Jaech.

The ESARDA Board decided upon this title though the original title as given by the authors was

"1993 International Target Values for Uncertainty Components in Fissile Isotopes and Element Accountancy for the Effective Safeguarding of Nuclear Materials".

This decision, for whatever good arguments, such as given in the heading of the paper, is likely to cause confusion since the IAEA decided to issue a special report and the Journal of the Institute for Nuclear Materials Management decided to publish the same article both under the same original title.

The authors do want to point out to the readers of the Bulletin that they were not aware of the modification of the title prior to the publication in the ESARDA Bulletin. They would like to let the readers of this Bulletin know that exactly the same paper - and Target Values - were published on all three occasions.

Prof. Dr. P. De Brièvre
Convenor ESARDA WG Destructive Analysis
IRMM Stable Isotope Measurements

Preliminary Announcement

The 1996 ESARDA Internal Meeting will take place at BATH (UK) in the week 13-17 May, 1996

it will also include a

Joint Meeting (14-15 May) with the Analytical Division of the Royal Society of Chemistry on

Analytical Measurements and their Interpretation for Regulatory Purposes

ESARDA and the Analytical Division of the Royal Society of Chemistry each have strong interests in analytical methods as a means of providing reliable measurements of specified substances. Although the two organisations exercise analytical techniques in different fields of applications, there is a common thread resulting from a need to use the measurements to verify implementation of regulatory demands, necessitating strict control of methods, use of international reference materials and validation of results: ESARDA in the nuclear field where safeguards regulations and a need for accurate control of strategic and sometimes hazardous materials provide the principal motivations; the Analytical Division of the Royal Society of Chemistry in a variety of complementary areas including nuclear, food, pharmaceutical industries, forensic science and the environment.

The aims of the Joint Meeting are:

- to explore similarities in the tasks
- to examine quality related procedures
- to stimulate ideas and improve practices to the benefit of both parties.

more information will be given in due time

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