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Report on the Operation of Euratom Safeguards

(presented by the Commission)

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Report on the Operation of Euratom Safeguards

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I. *INTRODUCTION*

Scope of this report

1. This report aims to provide a comprehensive survey on the operation of Euratom safeguards in the civil nuclear fuel cycle including research and other related activities of the European Community. The survey includes the safeguards findings with particular reference to 1988, the issues under discussion or consultation with operators or under consultation with national authorities, a survey on the available resources and an indication of the challenges to safeguards during the years to come.

2. It is intended that such a report should be prepared on a regular basis.

3. The report is addressed to the Council and to the European Parliament, which are invited to note its contents.

Safeguards

4. The word safeguards, in the framework of the Euratom Treaty, means the set of measures performed to make certain that nuclear material is not diverted from its intended and declared uses (namely to unlawful non-peaceful applications) (article 77a)) and to implement undertakings arising from International Agreements concluded by the Community (Article 77b)). Examples of the latter undertakings are (in addition to peaceful pledge) restrictions on retransfers outside the Community and certain controls on heavy water and equipment.

5. Safeguards is therefore not, as is sometimes mistakenly believed, concerned with nuclear safety nor with the protection of humans and of the environment from the hazards of ionizing radiation nor with physical protection. **Nuclear safety** relates to the safe design and operation of nuclear facilities. **Radiation protection controls** relate to health and safety, environmental protection, safe handling procedures for nuclear materials etc. **Physical protection** relates to the security measures taken to protect material from theft or other misuses. Safeguards may take advantage of such measures in designing verification schemes but they are, in themselves, quite independent. Whereas physical protection is mainly the responsibility of the Member States, the Commission is responsible to apply safeguards pursuant to Chapter VII of the Treaty.

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6. Chapter VII of the Treaty provides for safeguards to be applied to all civil nuclear materials stored, used or transported within the Community. The activities involved include therefore the main fuel cycle activities of uranium mining, conversion, enrichment, fabrication, power reactor operation, reprocessing and waste storage and disposal insofar as ores, source or special fissile material are concerned. Also included are the full range of other activities which use source or special fissile materials, viz: research and development, laboratories, service activities to the nuclear industry (e.g. analytical laboratories), research reactors and the use of nuclear materials in non-nuclear activities.

7. The Euratom Treaty provides for the application of safeguards to all civil nuclear material as a fundamental function of Community law establishing to this end a direct relation between the Commission and operators. The Non-Proliferation Treaty (NPT) provides for the application of safeguards by the International Atomic Energy Agency (I.A.E.A.) in the non-nuclear weapon States of the Community. I.A.E.A. safeguards also apply in nuclear weapon States following "voluntary offers" by those States. I.A.E.A. safeguards are exclusively aimed at ensuring peaceful use of safeguarded material and apply worlwide on a contractual basis, viz safeguards agreements and entail a direct relation only between the IAEA and its Member States. In the Community, the safeguards agreements (Verification Agreements) concluded by Euratom, the Member States and the I.A.E.A. ensure the necessary coordination between the two safeguards systems.

Legal bases

8. The mandate to the Commission of the European Communities in the field of safeguards is specified in Articles 77 to 85 of Chapter VII of the Treaty. It is European law.

9. The provisions of Articles 77 to 85 of the Treaty specify:

Art. 77: In essence, the Commission shall satisfy itself that the nuclear materials are not diverted from their intended uses as declared by the users and that the provisions relating to supply and any particular safeguarding obligations assumed by the Community under an agreement concluded with third countries or with an international organization (e.g. the International Atomic Energy Agency (IAEA)) are complied with. Pursuant to this article, Euratom Safeguards also monitor, and report on, the implementation of Chapter VI of the Treaty.

Art. 78: The declaration by operators of the basic technical characteristics of the installations as well as the need for Commission approval of techniques to be used for the chemical processing of irradiated materials;

Art. 79: Requirements on operators to maintain a system of nuclear materials accounting, including recording and reporting;

Art. 80: Deposit of excess plutonium not in use;

Art. 81: Inspections; right of access; procedures in case of opposition;

Art. 82: Recruitment of inspectors. Follow-up procedures involving Member States in case of infringement;

Art. 83: Sanctions in case of infringements by operators;

Art. 84: Scope of safeguards and exclusion for materials intended to meet defence requirements;

Art. 85: Adaptation by the Council of the procedures for applying safeguards.

10. Commission Regulation (Euratom) No 3227/76 of 19.10.1976 (O.J. E.C. No L363 of 31.12.1976), specifies general obligations on operators with respect to the provision of basic technical characteristics, recording, reporting, advance notification of transfers and the requirement to adopt Particular Safeguards Provisions (PSP) for each installation.

11. The Community has concluded agreements with the U.S., Canada and Australia. To verify the implementation of the undertakings included therein, Euratom safeguards tracks relevant material under specific safeguarding obligations, each identified by an appropriate code.

12. The Community has concluded three Verification Agreements with the IAEA based on model agreement INFCIRC/153, but including a protocol regulating the interface between the Euratom and IAEA safeguards systems:

a. Agreement[1)] between the Community, its Non-Nuclear Weapon States (NNWS) and the IAEA;

b. Agreement[2)] between the Community, the United Kingdom (UK) and the IAEA;

c. Agreement[3)] between the Community, France and the IAEA.

1) Published, p. ex., in IAEA document INFCIRC/193
2) Published, p. ex., in IAEA document INFCIRC/263
3) Published, p. ex., in IAEA document INFCIRC/290

Means

13. In order to fulfill the mandate of Article 77 of the Treaty, the Commission has, since 1958, deployed a corps of Euratom safeguards inspectors. The funds are provided through budget chapter 71.

14. In accordance with the legal provisions referred to above the Euratom safeguards inspectors of the safeguards directorate DG XVII-E ("DCS") perform inspections in the nuclear installations and perform relevant headquarters accountancy evaluation and follow-up.

15. Inspections and accountancy supported by appropriate logistics are the main pillars of Euratom safeguards; no adequate verification can be carried out unless these operate effectively.

II. *SAFEGUARDS OPERATION*

Number of installations and stocks of nuclear material

16. Table II.1 displays the number and type of installations (end 1988) under Euratom safeguards subdivided by Member States:

Table II.1

Type	Countries													EUR	IAEA 1)
	B	DK	D	F	GR	IRL	I	L	NL	P	E	UK	COM		
Research laboratories	4	1	7	12	.	.	3	.	2	.	2	21	3	55	22
Research reactors & critical assemblies	4	2	22	14	1	.	7	.	2	1	4	9	2	68	45
Mines and concentration plants	1	1	5	1	.	.	1	.	.	13	4	.	.	26	.
Enrichment plants	.	.	1	1	.	.	.	.	1	.	.	1	.	4	3
Fuel conversion/fabrication plants	3	1	4	10	.	.	3	.	.	.	2	5	.	28	13
Reprocessing plants	.	.	1	4	.	.	2	.	.	.	.	5	.	12	4
Power reactors	7	.	27	53	.	.	4	.	2	.	10	20	.	123	50
Storage installations	3	1	10	7	.	.	2	.	.	1	1	16	4	45	24
LOF[2], carriers, intermediaries, conditioning, others	10	19	126	41	2	2	35	3	15	2	1	98	1	355	109
TOTAL Euratom	32	25	203	143	3	2	57	3	22	17	24	175	10	716	
TOTAL IAEA 1)[3]	25	11	131	1	3	2	41	2	19	3	20	3	9		270

1) Under IAEA inspection. Reference (installations other than LOF): IAEA, the Annual Report for 1988.
2) Locations outside facilities (LOF) are installations holding less than 1 effective kilogramme. For the definition of an effective kilogram cf. Regulation 3227/76, quoted under paragraph 10 above, Article 36 (o).
3) In the NNWS a number of LOF's holding tiny quantities of NM are, for purposes of IAEA safeguards, combined into 1 accounting unit referred to as CAM (see Glossary attached).

17. The above table II.1 gives also the summary of the installations under I.A.E.A. inspection. All installations in the NNWS are under I.A.E.A. inspection pursuant to the Verification Agreement INFCIRC/193. Installations under I.A.E.A. safeguards in NWS are inspected by the I.A.E.A. if designated to this effect by the latter, pursuant to the provisions of the Verification Agreements INFCIRC/263 and INFCIRC/290.

18. Among the installations listed in table II.1 there are 17 installations, located in France and the United Kingdom, referred to as "mixed" installations. At these installations, civil and non-civil material are handled, processed or stored together either simultaneously or sequentially.

19. The following table II.2 gives the stocks of civil nuclear material by the end of 1988 for the installations listed in table II.1.

Table II.2

Stocks of nuclear material by end 1988[1]	
Uranium Depleted*)	107 600 t
Natural*)	46 400 t
Low Enriched*)	27 400 t
High Enriched**)	12 t
Plutonium**)	151 t
Thorium*)	1 500 t
Total effective kg***)	179 000

*) Rounded to nearest 100 t.
**) Rounded to nearest t.
***) Art. 36(o) of Regulation 3227/76.

Safeguards approaches and implementation

20. Pursuant to Art. 79 of the Treaty and to Articles 9 to 23 of Regulation 3227/76, the operators of all installations must establish a nuclear materials accounting system including recording and reporting thereby documenting the movements and disposition of the nuclear material.

1) Figures shown in the Commission Annual Report are extrapolations and represent the best estimates at the time of preparation, viz at a time the exact figures cannot be available.

In other words, the up-to-date inventory of nuclear material by:

- category of material[****)]
- safeguards obligation and
- material balance areas (MBA)

as established by the operator needs to be verified by inspectors, as well as the flow of nuclear materials. Verification relates to the set of activities independently performed by inspectors to establish the correctness of these records on flow and inventory leading to acceptance or rejection of the operators declarations.

21. There are several, basically different, safeguards verification techniques, certain of which are **quantifiable** and others which are **non-quantifiable**.

22. Commercialisation of the use of nuclear energy in the Community as well as the implementation of the NPT brought along a significant adaptation of the Euratom safeguards system. This adaptation was strongly influenced by the deliberation of the safeguards Committee held at the IAEA in 1970/71. Technically it established a methodology giving the primary role of accountancy for material balance verification under limited inspector access to operators data and to the nuclear material. Containment and surveillance measures and other safeguards measures difficult to quantify were given less weight. On the other hand the experience gained in the implementation of safeguards approaches to date shows that the information obtained through such non-quantifiable measures influence the decision processes in safeguards to a substantial degree.

23. Examples of safeguards measures which provide quantified information are measurements of nuclear material flow and inventory and information obtained through transit accountancy. Examples of measures providing non-quantifiable information are the verification and reverification of the technical characteristics of a plant, the verification of the detailed process and transfers inside a plant and containment and surveillance methods such as seals, camera/video surveillance and monitoring/logging devices. Euratom takes the view that these safeguards measures are frequently equivalent in effectiveness to and indissociable from those providing quantified information.

24. The following table II.3 provides an indication of the verification techniques deployed. Table II.4 provides the typical frequency of inspection and the Euratom inspection effort spent at the various types of installations.

****) Art. 21 of Regulation 3227/76.

Table II.3

Verification technique	Type(s) of installation*)
verification and periodic reverification of Basic Technical Characteristics (BTC)	all types
audit of accounts	all types
item counting and identification	all types
measurement and sampling	
- weighing	- research laboratories, research reactors & critical assemblies - enrichment, fabrication and reprocessing plants - (certain) power reactors - (certain) storage installations - others(A)
- non-destructive assay (NDA)	- research laboratories, research reactors & crit. assemblies - enrichment, fabrication and reprocessing plants - power reactors(A) - storage installations(A)
- sample taking for destructive assay (DA)	- research laboratories - enrichment, fabrication and reprocessing plants - storage installations(A)
- participation in calibration exercises of equipment	- research laboratories - enrichment, fabrication and reprocessing plants
- appropriate measurements (NDA and/or DA) on a low sampling basis	- LOF etc.

*) (A) denotes that a particular technique is deployed at a type of installation as a complementary technique.

Table II.3

(cont.)

Verification technique	Type(s) of installation
containment and surveillance	
- seals	- research laboratories, research reactors & critical assemblies - enrichment, fabrication and reprocessing plants(A) - power reactors - storage installations
- camera/video surveillance	- research laboratories(A), res. reactors & crit. assemblies - enrichment, fabrication(A) and reprocessing plants(A) - power reactors - storage installations
- independent monitoring of key data (tank levels, temperatures and other operator data)	- enrichment(A) - fabrication plants - reprocessing plants
- following detailed process operations and flows within the plant	- fabrication plants - reprocessing plants
- monitoring/logging systems	- enrichment plants(A) - power reactors - research reactors & critical assemblies - storage installations

Table II.4

Type of installation	Typical frequency of inspection ranging **from**	**to**	Inspection effort 1988 - man-days Euratom
Research laboratories	1/a	12/a	366
Research reactors & critical assemblies	2/a	6/a	368
Mines and concentration plants	0/a	2/a	14
Enrichment plants	12/a	1/week	678
Conversion and fabrication (uranium natural, LEU)	12/a	1/week	977
Conversion and fabrication (HEU and MOX)	12/a	continuous	1424
Reprocessing	12/a (when not operating)	continuous	1705
Power reactors	2/a	24/a	879
Storage installations	1/a	daily	849
Other	0*)	4/a	104

*) Holders of small amounts, e.g. holding less than 0.1 eff. kg of depleted and natural uranium or thorium used for non-nuclear purposes are inspected on a sampling basis or when discrepancies following declarations (also from other operators) need to be resolved.

25. In relation to tables II.3 and II.4 it may be noted that the frequency and intensity of inspections are also influenced by the established quantified inspection goals which depend on the strategic value, amounts and types of nuclear material, on the probabilities of detection and the detection times. These quantified inspection goals are reviewed from time to time so as to take account of new safeguards approaches and of the progress in research and development.

26. The safeguards approaches for "mixed" installations differ from those applied elsewhere in respect of their objective:

- For installations handling civil material exclusively the objective set out in article 77 of the Treaty applies to all nuclear material in inventory or throughput**).

**) Plus, where applicable, to the equipment.

- For installations handling or storing civil and non-civil material simultaneously or sequentially the objective set out in Art. 77 of the Treaty applies equally to this civil material, a key condition being that there should be no net loss in quantity and quality of the civil material in a plant**).

27. Whenever **discrepancies** are detected:

- within the operator's accounting system
- between two operators
- between operator's records, reports and inspection findings

they are followed up immediately. Anomalies are unresolved discrepancies or prima facie evidence of an irregularity discovered as a result of records/reports examination or other inspection activities which may lead to the belief that the terms of the Treaty or other legal instruments have not been respected. The resolution of anomalies requires a sequence of actions normally additional to the safeguards measures indicated in table II.4. Anomalies once fully established, i.e. unresolvable, would be considered by the Commission as a presumed infringement of the Treaty.

28. The following paragraphs of this chapter provide findings resulting from the application of the safeguards measures in 1988.

Research laboratories, research reactors & critical assemblies

29. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

30. Following the reports of the inspectors, 23 (7 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

31. These communications and direct consultations with operators or government authorities aim at further improving safeguards implementation relating, inter alia, to:

- the promptness and correctness of records and declarations;
- the inventories of difficult to access nuclear materials;
- the definition of and safeguards measures to be applied to nuclear materials contained in wastes and discards.

Mines and concentration plants

32. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

33. Following the reports of the inspectors the inspections performed in 1988 did not give rise to particular observations.

Enrichment plants

34. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

35. Following the reports of the inspectors, 9 (13 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

36. In relation to enrichment plants it may be noted:

   a. In 1983 an international project, referred to as the Hexa-partite Safeguards Project, provided recommendations on how commercial centrifuge enrichment plants should be safeguarded while minimizing the risk of dissemination of sensitive technology.

   b. These recommendations to the IAEA included, apart from the "classical" safeguards measures listed in table II.3 above, "Limited Frequency Unannounced Access" to the cascade areas during which inspectors can convince themselves that the plants are operating as declared by the operator. Euratom observes these recommendations for the inspections conducted together with the IAEA.

37. While these recommendations have been implemented consultations with operators or government authorities continue to aim at further improving safeguards implementation relating, inter alia, to:

   - the use of non-destructive inspection instruments inside the cascade area versus the application of Containment and Surveillance (C/S) devices;

   - further improvement of the Non Destructive Assay (NDA) measurements for the depleted uranium tails;

   - measures to verify conclusively that there has been no net loss of civil material in certain installations relating, in particular, to procedures for the taking of the physical inventory.

Conversion plants, fuel preparation plants and fabrication plants processing natural uranium and/or low enriched uranium

38. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

39. Following the reports of the inspectors, 12 (15 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

40. These communications and direct consultations with operators or government authorities aim at further improving safeguards implementation relating, inter alia, to:

    a. Take account of certain technological developments which have strongly influenced the safeguards activities at these facilities, e.g. the availability of modern instrumentation based on neutron and/or gamma techniques. These modern instruments are being progessively introduced in the field and will lead to more effective safeguards.

    b. Testing and implementation of inspection schemes providing for random and/or short notice inspections.

Conversion/fabrication plants processing highly enriched uranium and/or plutonium

41. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4. It should be noted that for these installations the safeguards approach envisages a continuous inspection regime.

42. Following the reports of the inspectors, 26 (19 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

43. These communications and direct consultations with operators or government authorities aim at further improving safeguards implementation relating, inter alia, to:

    a. the further refinement of modern safeguards approaches such as the follow-up and balancing of mixes (FBOM), notably with respect to reducing the high cost of safeguards implementation;

    b. the testing and implementation of further advanced safeguards approaches;

    c. comprehensive verification measurements by modern instrumentation;

    d. physical inventory taking procedures;

    e. progressive resolution of issues related to the "mixed" character of certain plants;

    f. replacement of a large number of transports of samples by on-site analysis.

Reprocessing plants

44. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4. It should be noted that for these installations the safeguards approach envisages a continuous inspection regime during the operation of the facilities.

45. Following the reports of the inspectors, 28 (27 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

46. These communications and direct consultations with operators or government authorities aim at further improving safeguards implementation relating, inter alia, to:

    a. fully transparent records/reports systems;

    b. in-process monitoring and/or C/S applications;

    c. comprehensive verification measurements by modern instrumentation;

    d. progressive resolution of issues related to the "mixed" character of certain plants;

    e. replacement of a large number of transports of samples by on-site analysis.

Power reactors and storage installations

47. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

48. Following the reports of the inspectors, 35 (6 %) statements after inspection or separate communications were dispatched containing particular observations requiring follow-up.

49. These communications and direct consultations with operators or government authorities aim at further improving safeguards implementation relating, inter alia, to:

    a. step by step replacement of film cameras by modern video equipment;

    b. introduction, where applicable, of monitoring and logging systems;

    c. re-measurement of nuclear materials under effective containment and surveillance (C/S) systems;

    d. introduction of NDA measurements on fresh fuel stored under water.

Locations outside facilities (LOF) and other installations

50. The safeguards measures applied at these installations are described in table II.3, the inspection effort spent is described in table II.4.

51. At such installations which include those where uranium or thorium is being used for non-nuclear purposes (e.g. shielding, aircraft counter weights, production of lamps, catalysts, ceramics) and those installations at the backend of the fuel cycle (not including, of course, reprocessing), safeguards relies mainly on non-quantifiable measures such as Basic Technical Characteristics (BTC) verifications. The discussion, however, to which intensity such measures are to be performed has not yet been concluded. As far as waste treatment and disposal installations are concerned, safeguards techniques to be applied are still under discussion.

52. It should be mentioned that at these installations operators frequently are not aware of their safeguards obligations, including nuclear materials accounting. This is why Euratom has to spend a disproportionately high effort in administration and other follow-up measures to ensure full adherence to the legal requirements. This resulted in 21 % of the communications to operators of such installations requiring follow-up.

III. ACCOUNTANCY

General

53. Following the provisions of the Treaty and Regulation 3227/76, a nuclear material accounting system is established at all installations as described above. Reports are submitted according to the legal provisions to the Euratom Safeguards Directorate. Where appropriate, accounting reports are submitted to the IAEA by Euratom, pursuant to the Verification Agreements following processing by Euratom.

54. At the installations the nuclear material accounting system comprises the records and reports required in Regulation 3227/76 and in the Particular Safeguard Provisions. These records must be complete, consistent with each other and with the reality, and must be reflected in the reports made to DCS headquarters. The accountancy audits are carried out during inspections to check the above, and any remarks arising are advised to the operators and followed up for actions. A particularly important task is the physical inventory exercise where the book and physical inventories are verified, compared and any difference identified and investigated.

55. The activities at DCS headquarters comprise the independent updating of accounts by installation based on the reports received pursuant to Regulation 3227/76, consistency checks between inspection findings and accountancy reports provided by the operators, control of external obligations and transit accountancy.

Accounting system

56. The accounting system for nuclear material follows the classical rules of bookkeeping with respect to the nuclear materials under safeguards, the basic objective being that at all times the book inventories reflect the reality as closely as possible in terms of amounts and timing.

57. All nuclear material accounting systems must provide for periodic exercises to take and verify the physical inventory. The frequency depends on the detection times which in themselves depend on the nature and amount of material involved in the flow and inventory in the installation. The timing may depend on operational constraints. The objective of the exercise is to compare the physical and book situations and make adjustments as necessary to ensure that the books continue to reflect the reality as closely as possible. Each exercise leads to an evaluation to assess the acceptability of any book/physical inventory difference in relation to the activities performed.

58. The comparison between inspection findings and records/reports for activities between physical inventories is a further important element of the chain which leads to the decision whether or not the operator's accounts can be accepted by the safeguards inspectors or whether follow-up within the appropriate time intervals has to be performed. The necessity for such follow-up is frequent and requires in certain cases long term follow up activities until a satisfactory resolution of the discrepancies is established. In pursuing such activities during 1988 Euratom did not obtain evidence of diversion.

External obligations

59. The control of external obligations is a further control, concerning the adherence to the provisions of the agreements with the USA, Canada and Australia and/or to the contractual provisions requiring peaceful use only. The checks are based on accountancy tracking by obligation (sometimes referred to as flag control) and encompass particular exports and imports and preparation of annual reports (balance sheets) as required for the third States. An important item is the administrative procedures and inspection activities related to approval and follow-up of exchanges of safeguarding obligations.

60. All such exchanges of safeguarding obligations are approved and carried out according to a set of technical criteria which guarantee that only equivalent amounts of nuclear materials are exchanged. Equivalence must be obtained on the level of physical form, on the total element and isotopes involved. A condition of performing any exchange of safeguarding obligations is that the obligation involved with the most stringent constraints shall not lose in quality or quantity.

61. International flag swaps are exchanges of safeguarding obligations where one quantity of material is located outside the Community and the other inside. During 1988, three such exchanges were performed. A reluctance to permit such flag swaps on the part of some supplier countries has been experienced since in some cases there was some confusion between safeguarding obligation and origin of the nuclear material. Origin is not tracked by DCS as it is not a concept relevant to safeguards since, inter alia, origin of nuclear material can no longer be verified after the material has entered the fuel cycle.

62. Internal flag swaps and substitution are exchanges of safeguarding obligations where quantities of nuclear material exchanged are subject to Euratom safeguards. During 1988, 25 such exchanges out of 33 requests were approved following verification by DCS that the quantities involved were equivalent.

63. As regards problems with respect to certain parts of Chapter VI of the Treaty, the role of Euratom safeguards is restricted to the monitoring and the reporting thereof.

Transit accounting

64. In the Euratom system, receivers are obliged to report movements in exactly the same way as the shipper. Transit accounting is the cross check (called also: tracking) at the level of the reports received from operators that in fact the nuclear materials are reported as having been received as shipped. As far as shipments and receipts inside the European Community are concerned the safeguards directorate follows up each transfer automatically until the official confirmation of the receipt is available. This involves physical verifications, and any discrepancy between shipper reports and receiver reports automatically triggers a follow-up action which may lead to an anomaly. All discrepancies must be resolved or justified. If justified, the receiver is nevertheless obliged to report the movement in the same way as the shipper accompanied by an appropriate shipper-receiver difference report.

65. The response time of the Euratom safeguards system to such differences in reports on transit is always less than a month for plutonium and highly enriched uranium. This detection mechanism of diversions is of fundamental importance. It may be recalled that it allowed two major anomalies to be discovered in the past.

66. A further feature of this activity is the contribution to the worldwide IAEA system of nuclear material control. The Community record has always been good in this respect and this exercise has allowed Euratom to observe that certain countries outside the Community do not report on time or with the necessary precision. The safeguards directorate has helped the IAEA in solving an important problem of this type with one country and a similar situation with another country is receiving careful attention.

Concluding remark

67. The above controls and audits provide the necessary verifications whether the relevant provisions of the Euratom Treaty, the agreements with third country suppliers and the safeguards agreements with IAEA are being complied with. As regards accountancy of safeguards obligations, balance sheets and exchanges of safeguarding obligations, no particular observations apply for the year 1988. The usual follow-up required in the cases of late submission of reports, incomplete records and reports and/or of discrepancies took place.

IV. *RESOURCES*

Inspection manpower resources

68. The development of the staff of the safeguards directorate is displayed in the following table IV.1. This table also displays the inspection effort spent and the amounts of nuclear material under safeguards.

Table IV.1*)

Year	Staff DCS	Index	Operational inspectors	Index	Inspection mandays spent	Index	Nuclear material under safeguards in eff. kg (divided by 1000)	Index
1982	179	100	108	100	4 489	100	78	100
1983	180	101	120	111	5 116	114	90	115
1984	177	99	131	121	6 047	135	105	134
1985	188	105	125	116	6 225	139	121	155
1986	202	113	134	124	6 196	138	139	177
1987	212	118	139	129	6 814	152	158	202
1988	228	127	155	144	7 364	164	179	229

69. The following additional remarks should be taken into account when considering table IV.1:

    a. Inspection effort is calculated through an internationally accepted definition (reference for example: Art. 98 L of the Verification Agreement), i.e. "... a man-day being a day during which a single inspector has access to a facility at any time for a total of not more than eight hours".

*) Figures shown in the Commission Annual Report are extrapolations and represent the best estimates at the time of preparation, viz at a time the exact figures cannot be available.

b. In addition to the inspection effort spent by Euratom, the IAEA has spent the following inspection effort in the Community:

year	1983	1984	1985	1986	1987	1988
man-days of inspection in the Community	2781	2545	3070	3442	3854	3591

c. The increase (in effective kg) of the nuclear materials is dominated by the plutonium. Currently most plutonium under safeguards is in store either in the form of irradiated fuel awaiting reprocessing or in oxide form in containers. Safeguards at such storage installations is based on item verification techniques with their well known advantages relating to effectiveness and cost.

70. While it would be misleading to link safeguards effectiveness exclusively to inspection effort spent it is nevertheless a fact that the increase in the nuclear materials has been accompanied by an increase in inspection manpower and by an increase in the average "productivity" of the inspectors.

Inspection manpower resources until 1995

71. In view of the continuing increase in the peaceful use of nuclear energy within the European Community and, in particular, the corresponding increase of civil nuclear material to be safeguarded, the need should be recognized to augment the number of nuclear safeguards inspectors within the years to come.

72. More specifically, the reasons for the additional manpower requirements are:

a. To meet the challenge posed by three large reprocessing plants, unprecedented in scale scheduled to start operations between 1989 and 1993.

b. To ensure that the safeguards coverage will keep pace with the growth of the nuclear industry in the Community and in particular with the increasing use of plutonium in MOX (mixed oxide) for nuclear electricity generation purposes;

c. To further improve safeguards at complex installations, particularly at installations where both civil and non-civil nuclear material are handled either simultaneously or sequentially.

73. Accordingly, the Commission will determine on how the appropriate resources can be made available. It should be noted that it is necessary to recruit persons with a suitable technical background, i.e. with a degree from university or an advanced technical school combined with experience gained in the nuclear field.

Operational credits

74. Budget chapter 71 provides the necessary credits for the operation of Euratom safeguards excluding staff cost and excluding cost for the computer main frames:

a. Budget line B 7100: missions
b. Budget line B 7110: training, meetings and experts
c. Budget line B 7120: procurement of instruments, samples analysis transports, temporary staff, technical and scientific studies, informatics software and PCs.

In addition, budget line A 1420 provides for costs associated with radioprotection of inspectors.

75. The following credits were made available over the last five years (in MECU):

	1985	1986	1987	1988	1989
B 7100 B 7110 B 7120	1,240 0,145 2,080	1,592 0,151 2,207	1,910 0,130 2,051	2,010 0,130 2,060	2,100 0,130 2,500
Total	3,465	3,950	4,091	4,200	4,730
A 1420	0,090	0,050	0,052	0,065	0,114
consumed resources (%)	82,59	95,5	95,12	93,77	99,81

Instruments, methods and techniques

76. The safeguards directorate at present possesses the following equipment used either at the nuclear installations or at headquarters.

EURATOM EQUIPMENT 12/88

A. Gamma equipment

1 NIS PITMAN } hand held
2 HM4 } syst.
10 SAM II (2 channel syst.)
2 Enrichment meters
6 Pu meters
16 Davidson MCA's
7 Silena Ciceros

2 MTR scanners

B. Neutron equipment

2 SAM II/SNAP
4 Cercueil (pins)
1 Octagon (waste)
13 HLNCC (Pu)
7 NCC (fuel elements)
4 AWCC (HEU, LEU)
2 Phonid (LEU, HEU)
3 CIND (UF6 cyl.)
4 UFBR (FBR ass., Pu cyl.)
1 Inventory sample counter
1 Sigma (THTR pebbles)

C. C/S equipment

80 Minolta camera units
6 Ministar TV systems
2 MIVS TV systems
11 EUR video systems (TLR)
23 VACOSS seals
6 Night vision devices
1 Pebble sampling device

D. "Other" equipment

6 ION-1 FORK (spent fuel)
1 UF6 mass spectrometer
1 UO2 mass spectrometer
1 potentiometer (U-factor)
various reference materials
11 Ultrasonic thickness gauges
10 Load cells
1 Portable K-edge
1 K-edge densitometer

Total: about 250 INSTRUMENTS

77. The application of technical measures for nuclear materials verification and containment/surveillance has largely increased over the last few years. This is illustrated in Fig. 1 attached for the years 1984 to 1987. The figures show (in percent) the number of inspections where sample taking, optical surveillance, non destructive assay (NDA) or use of seals is involved.

78. The use of technical measures per type of installation is illustrated in Figs. 2-5 for NDA equipment (Fig. 2), optical surveillance (Fig. 3), sample taking (Fig. 4) and use of seals (Fig. 5). The figures are self-explanatory.

79. 750 samples were taken by inspectors in the field. 170 samples were analysed on site using NDA equipment or our portable mass spectrometers. 580 samples were transported to the Commission laboratories at Karlsruhe, Ispra and Geel, where a total of 1624 chemical analysis were carried out.
The mean time for transport was 140 days, the mean time for analysis about 50 days. The total delay time is still unacceptably high.

In order to improve this situation there are, on the one hand, developments underway to install permanent on-site laboratories at large nuclear sites and on the other hand instruments are coming into routine use which allow the measurements of most of such safeguards samples on site thereby reducing the need for transports to a minimum.

80. About 18000 seals were placed by inspectors during 1988 of which about 3000 seals were placed on nuclear materials exported from the Community. About 15000 seals were removed and verified at headquarters. In addition about 8000 paper seals, about 2500 special seals and 60 new fibre optic seals were used and field tested in nuclear installations.

81. During 1988 more than 750 films from optical surveillance units have been developed, reviewed and evaluated at Luxembourg headquarters. The reliability of the optical surveillance units was 99.5%. From the new video systems introduced in installations, about 300 video tapes were replaced, reviewed and evaluated.

82. Equipment for Non Destructive Assay (NDA) was used for nuclear material verifications in almost 700 inspections, equivalent to about 32% of the total number of inspections.

83. Large plant-installed measurement and surveillance systems were discussed and designed in collaboration with the plant operators concerned for reprocessing and plutonium storage facilities.

Informatics

84. The following main systems are presently in operation (apart from a multitude of individual applications):

a. Accounting System (CMF - Comptabilité Matières Fissiles): ADP (Automatic Data Processing) and verification of operator reports (approximately 424000 lines per year). Reports to IAEA on magnetic tapes based on operator's reports but in a different format. Production of numerous reports for statistical purposes and for assisting the accounting unit in its checks.

b. Seals: ADP of approximately 18000 seals/year from fabrication, issue, placing, breaking, through to final verification.

c. Destructive Analysis: Storage and retrieval of data, both administrative and technical, related to the taking of samples for destructive analyses.

d. Inspection planning and follow-up: Input and storage of the scheduling of each inspection. Communication to IAEA of a subset of the plan. After the inspection, the system generates the necessary follow-up actions.

e. Management: List of personnel, management of missions, productions of mission statistics, presence list etc.

f. NUMSAS (Nuclear Material Statistical Analysis System): System to evaluate differences found in material balances.

85. Personal computers have become an indispensable tool to assist inspectors in the field as well as for purposes of headquarters evaluations. Particular attention is given to ensure compatibility between the hardware as well as between applications at the installations.

86. The following list gives a survey of the hardware available and used exclusively for safeguards:

- Siemens 7560, 1.7 mips and 36 terminals
- 1 UNIX computer (Olivetti 3B2) for office automatization including word processing etc. with 20 work stations
- 50 personal computers.

87. Relating to software the main components are the following:

- Operating system BS2000 allowing batch and on-line processing
- Database management system ADABAS including query language NATURAL
- Database management system dBASE III, for the operation of the personal computers and other software for PC's.

88. It is expected that the development of informatics will proceed in further decentralizing hardware while maintaining an integrated architecture permitting strict software compatibility and, of course, assuring strict data security (only off-line ciphered connection with the outside).

Support from the Joint Research Center (DG XII-JRC)

89. The DG XII-JRC supports the Euratom safeguards directorate by performing and financing a number of essential activities in the R&D field:

a. Development of instruments, methods and techniques as well as analysis of safeguards samples: Cost about 3,5 Mio ECU per annum.

b. Radiation protection (dosimetry and expertise) of the safeguards inspectors.

c. Training of safeguards personnel at ISPRA, mainly at the recently established PERLA laboratory.

90. The support by DG XII-JRC to the safeguards directorate is coordinated by a rigorous project management. The total number of such projects amounted to 38 in 1988.

91. The continuation of the effective support by DG XII-JRC to the Euratom safeguards directorate in an effective and efficient manner is considered essential.

FIG.1

Usage of Technical Measures

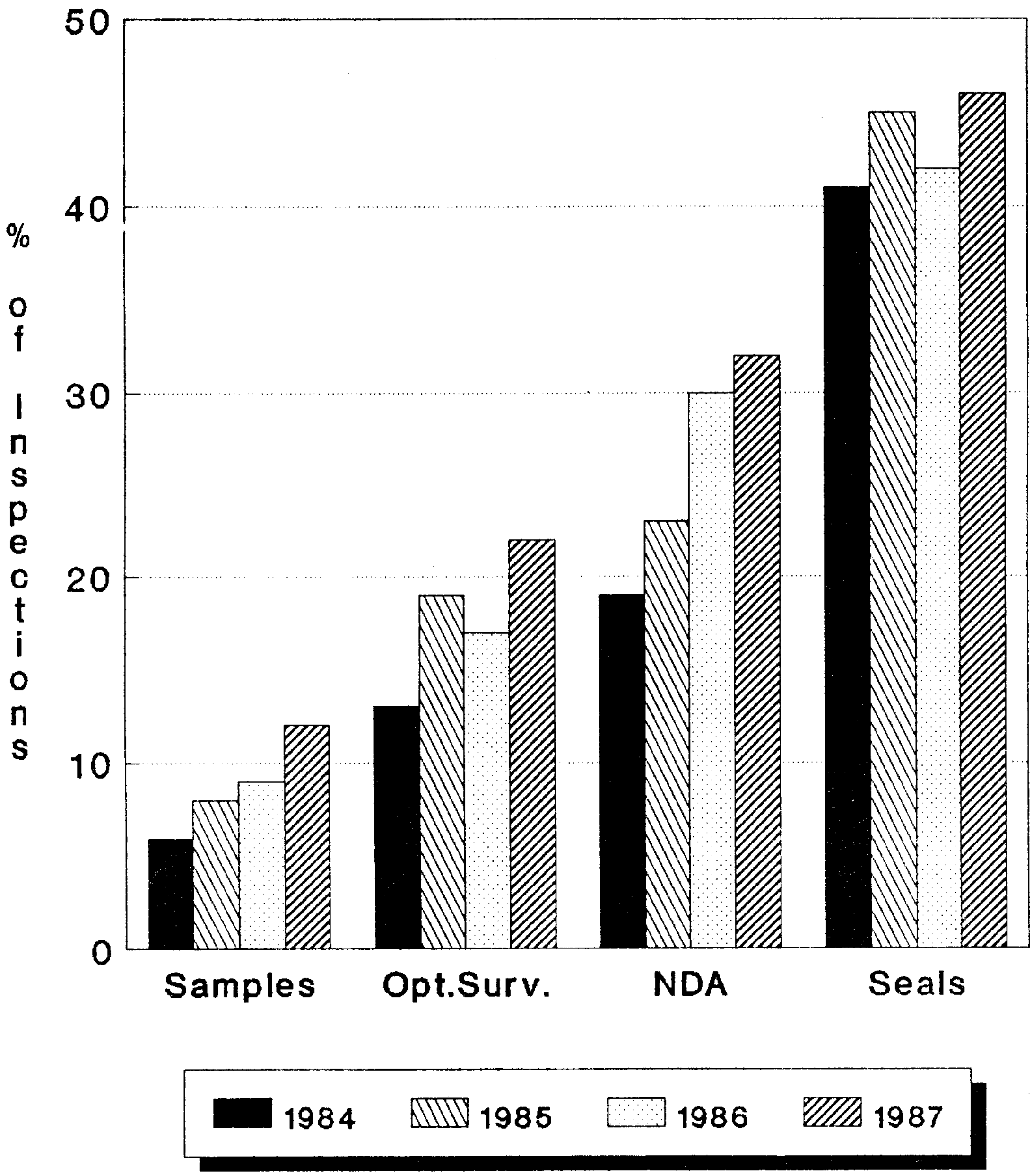


FIG.2

Usage of NDA by Installation

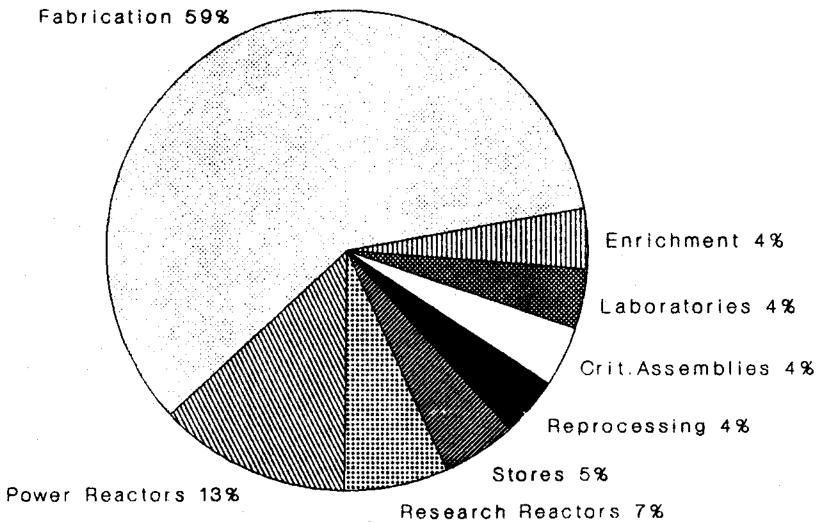


FIG.3

Usage of Optical Surveillance by Installation

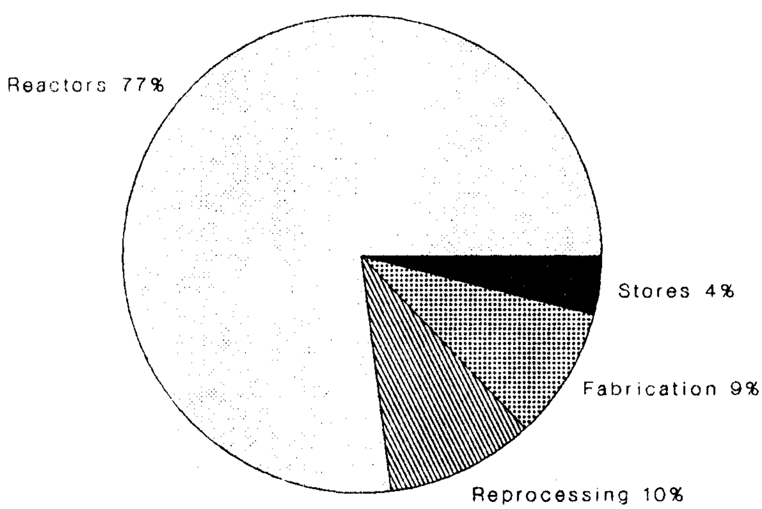


FIG.4
Origin of Samples by Installation

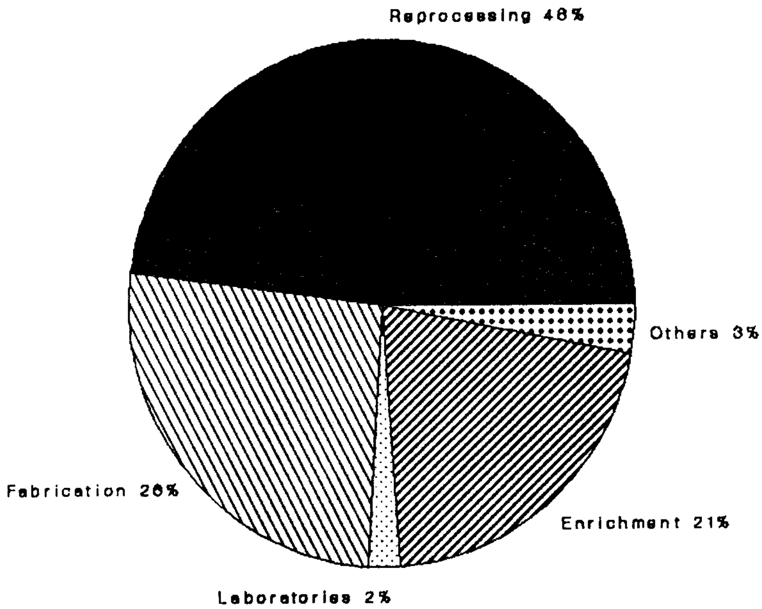
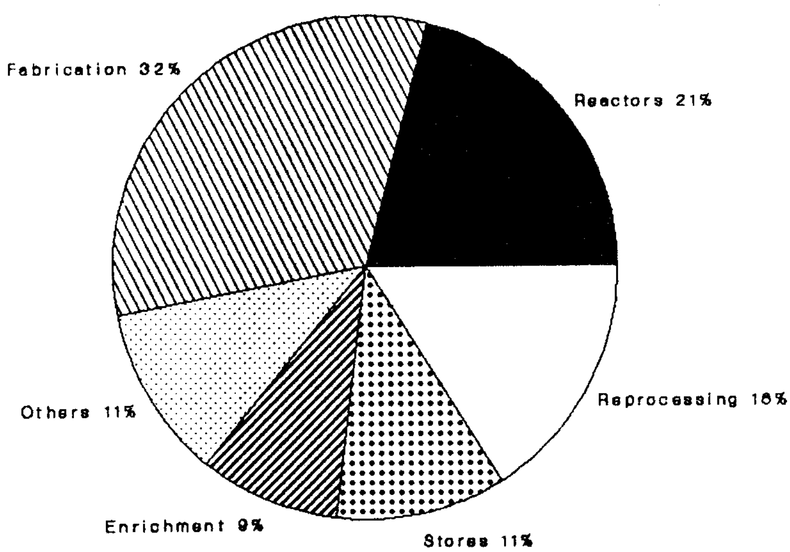


FIG.5
Usage of Seals by Installation



V. *RELATIONS WITH THE INTERNATIONAL ATOMIC ENERGY AGENCY (IAEA)*

92. The IAEA, a member of the UN family of specialized agencies, is the international Agency responsible on a worldwide basis for carrying out safeguards under the Non-Proliferation Treaty or other agreements relating to the peaceful use of nuclear energy. As already described before (para. I.12) three Verification Agreements have been concluded between the Community, its Member States and the IAEA. They establish the responsibilities of Euratom, its Member States and the IAEA.

93. The structure of the relations with the IAEA may be summarized as follows:

    a. Participation of the IAEA in Euratom inspections. This is a daily operational task. At about 50 % of all Euratom inspections IAEA inspectors participate.

    b. Reporting of the nuclear material movements and inventories pursuant to the provisions of the Verification Agreements and support to the IAEA system of world wide accounting for the transit of nuclear materials.

    c. Meetings of the Liaison Committee pursuant to Art. 25 of the Protocol to the VA. The purpose of these meetings is to discuss, coordinate, negotiate general issues relating to or influencing IAEA safeguards in the Community.

    d. Negotiations of documents of a technical/legal nature called the **Facility Attachments** (F.A.) or **installation attachments**. This requires a major negotiation effort on all sides. Some 50 Attachments, including the attachments for new installations and existing attachments in need of revision, still need to be negotiated, about 200 being already in force.

    e. Numerous contacts and working groups, participation in seminars, common training activities;

    f. Collaboration with the IAEA in the development, testing and implementation of instruments, methods and techniques.

94. The relations are satisfactory. It should be noted that Euratom is the **only** safeguards inspectorate of a multinational character the IAEA has to deal with.

95. The result is that a constructive collaboration between the two inspectorates has developed which is frequently appreciated by operators and Member States.

96. Among the issues to be further discussed with the IAEA the following may be listed:

    a. Maintenance of a steady progress in the early conclusion of Facility Attachments;

    b. Inspection goals and evaluation criteria will have to be further discussed and, as far as possible, brought into line with each other;

    c. The implementation of IAEA safeguards in the Nuclear Weapon States.

97. It is clear that the Commission would continue to support the worlwide role and responsabilities of I.A.E.A. safeguards. For its part Euratom would expect the I.A.E.A. to maintain its relationship with the Community on the basis of the responsibilities laid down in the Euratom Treaty.

98. A certain duplication in the application of safeguards procedures is however unavoidable, but:

    - as a consequence, the effectiveness of safeguards in the Community NNWS is, when taken together, superior to any other region in the world;

    - the IAEA can participate in safeguarding activities (which Euratom needs to perform) of an intensity and depth which it may not perform elsewhere.

99. Thus, the Community can claim high Non-Proliferation credentials.

VI. *TRENDS*

100. Safeguards up to 1995 can be characterized both through the way it will cope with the increased availability and use of plutonium in the commercial fuel cycle of the Community and through the desirability to continue to improve the effectiveness and efficiency of the safeguards operation in general.

101. Based on the current operation of the industry and the construction schedules for fuel cycle facilities it is expected that the routine use of plutonium fuel in LWR's (MOX) and in FBR's will continue to increase thereby significantly increasing the throughputs of recycled plutonium, three reprocessing plants with design throughput capacities of up to 7 t Pu per annum commencing operation between late 1989 and 1993 in the European Community. Several fabrication plants with design throughput capacities of around 1 t Pu per annum are presently in operation and the operation of at least one more fabrication plant with an annual design throughput capacity of up to 5 t Pu is expected to commence in the early 1990's.

102. Safeguards at these new generation facilities, some of which are of unprecedented scale and complexity, will be performed in addition to the safeguards operation in the remainder of the fuel cycle including the back-end. In the operational reality of today and in view of the trends mentioned, the technical challenge to safeguards under the Treaty relates to the operation at Light Water Reactors using MOX, to MOX fabrication facilities and to reprocessing as well as maintaining the standards set for other installation types.

103. For LWR-MOX the safeguards approaches have been developed and are in the course of implementation. They do not rely in first instance on verification by measurements of nuclear material at the reactors - such measurements will, of course, have to be performed in the case of discrepancies/anomalies - but on preservation of continuity of knowledge through the use of video and other advanced containment/surveillance techniques during all phases of reactor operation.

104. Relating to MOX fabrication facilities, modern safeguards approaches have been developed during the recent years and are based on a continuous or quasi continuous inspection regime. The experience gained so far is that conclusive safeguards can be implemented successfully through comprehensive access to data and to the nuclear material in utilizing both destructive and non-destructive measurement techniques, containment/surveillance techniques and the necessary informatics. The safeguards approaches have, where implemented, proven their effectiveness but need to be further refined due to the high cost of their operation.

105. Three large scale reprocessing plants are presently under construction within the European Community. The attainment of conclusive safeguards for the new generation commercial reprocessing plants presents one of the major tasks for the 1990's. Following intensive consultations with operators and authorities concerned it appears that conclusive safeguards will be possible at these installations provided the necessary resources in terms of budget and manpower are available. The preparations to obtain these resources are fully under way and considerable effort has been expended in defining the overall approaches and detailed inspection activities which will need to be applied.

106. From a technical point of view, a trend in installation design presents a major challenge to the application of safeguards. For obvious security and health physics reasons installations are being designed in which the nuclear material which is subject to safeguards is more and more inaccessible (massive transport/storage containers not designed for routine opening; heavily shielded, secure storage of sensitive nuclear material). Developments now being applied include advanced measurement instrumentation and sophisticated C/S systems including monitoring/logging systems designed to react to and record events which might be of interest to safeguards. These developments will need to be continued to keep pace with design changes and adapted to specific situations. These developments need to involve safeguards experts in the design/construction work at an early stage before commissioning in order to optimize safeguards necessities and to minimize costs.

VII. *SUMMARY*

107. The effectiveness of Euratom safeguards depends as outlined in this report on the manner in which the inspection service is organized and motivated, on the promptness and the extent to which operators and State authorities fulfill the responsibilities and on the resources available to safeguards.

108. Relating to the mandate, the intensity and depth of Euratom safeguards, the Commission has been entrusted with extensive responsibilities. However, the budgetary appropriations made available largely determine the discharge of these responsibilities as well as the ability to make progress in the way indicated in this report.

109. In view of the challenges to safeguards during the years to come, particularly with respect to the use of recycled plutonium in the European nuclear fuel cycle, the Commission has established a medium term plan of staffing which, if adopted and put into effect, will make a decisive contribution to enable its responsibilities under the Euratom Treaty to continue to be discharged effectively and, in concert with the IAEA inspectorate, to enable the implementation of non-proliferation safeguards in the European Community to remain at its present high level.

Abbreviations currently used in Safeguards

AGR	Advanced Gaz-cooled Reactor
AECB	Atomic Energy Control Board (Canada)
AIEA	Agence Internationale de l'Energie Atomique (see IAEA)
AQG	Atomic Questions Group (see GQA)
ARIE 1	Actual Routine Inspection Effort (of Euratom)
ARIE 2	Actual Routine Inspection Effort (of IAEA)
AWCC	Active Well Coincidence Counter
BMFT	Bundesministerium für Forschung und Technologie
BTC	Basic Technical Characteristics (see CTF)
BWR	Boiling Water Reactor
CAM	Catch-all MBA (=Very small installations)
CCAM	Commission Consultative des Achats et des Marchés
CCR	Centre Commun de Recherche (see JRC)
CCTV	Closed Circuit Television
CEGB	Central Electricity Generating Board (UK)
COPO	Coopération Politique
COREPER	Comité des Représentants Permanents
CRP	= COREPER
C/S	Containment and Surveillance
CTC	Communication to Council
CTF	Caractéristiques Techniques Fondamentales (see BTC)
CTI	Comité Technique Interministériel pour l'Euratom
CVD	Cerenkov Viewing Device
DA	Destructive Analysis (see also NDA)
DCS	Direction Contrôle de Sécurité (see ESD)
DGM	Director General meeting
DI	Design Information
DOE	Department of Energy
DPC	Dispositions Particulières de Controle (see PSP)
ECSAM	European Commission Safeguards Analytical Measurement Committee
EDAN	Etat Doté d'Armements Nucléaires (see NWS)
ekg	Effective Kilogram
ENDAN	Etat Non-Doté d'Armements Nucléaires (see NNWS)
ESA	Euratom Supply Agency (see SA)
ESARDA	European Safeguards Research and Development Association
ESD	Euratom Safeguards Directorate (see DCS)
ESP	Etat des Stocks Physiques (see PIL)
EUR	EURATOM
FA	Facility Attachment
FANT	Facility Attachments Negotiating Teams
FBOM	Follow-up and Balancing Of Mixes
GQA	Groupe des Questions Atomiques (see AQG)
HEU	Highly Enriched Uranium
HLLC	High Level Liaison Committee (Art. 25 Protocol VA)
HLNCC	High Level Neutron Coincidence Counter
HSP	Hexapartite Safeguards Project
IAEA	International Atomic Energy Agency (see AIEA)
ICR	Inventory Change Report (see RVS)
ICT	Isotopic Correlation Technique
IMD	Inspection Mission Day
IMS	Integrated Monitoring System
ISM	Inter-Service Meeting
JRC	Joint Research Centre (see CCR)
JT	Joint Team
JTWG	Joint Technical Working Group
KMP	Key Measurement Point (see PMP)

LEMUF	Limits of Error of MUF
LEU	Low Enriched Uranium
LFUA	Limited Frequency Unannounced Access
LII	List of Inventory Items (see LOI)
LOI	Liste des Objets en Inventaire (see LII)
LLLC	Lower Level Liaison Committee (Art. 25 Protocol VA)
LOF	Location Outside Facility (Holding less than 1 EKg)
LWR	Light Water Reactor
MBA	Material Balance Area (see ZBM)
MBR	Material Balance Report (see RBM)
MD	Man-day(s)
MUF	Material Unaccounted For
NCC	Neutron Coincidence Collar
NDA	Non Destructive Analysis (see also DA)
NM	Nuclear Material
NMACT	Nuclear Material Accounting Control Team (UK)
NMTR	Nuclear Material Transfert Report
NNWS	Non-Nuclear Weapon State (see ENDAN)
NPT	Non-Proliferation Treaty (see TNP)
NRTA	Near Real Time Accountancy
NUMSAS	Nuclear Material Statistical Accountancy System
NVD	Night Vision Device
NWS	Nuclear Weapon State (see EDAN)
OJOM	One Job-One Man
OTTO (list)	Other Than Through Observation
PICF	Physical Inventory Control and Follow-up
PIL	Physical Inventory Listing (see ESP)
PIT	Physical Inventory Taking
PIV	Physical Inventory Verification
PMP	Point de Mesure Principal (see KMP)
PSEP	Particular Safeguards Evaluation Procedures
PSP	Particular Safeguards Provisions (see DPC)
PWR	Pressurized Water Reactor
RBM	Rapport de Bilan Matières (see MBR)
RCD	Réunion des Chefs de Division
R&D	Research and Development
RVS	Rapport de Variation de Stocks (see ICR)
SA	Supply Agency (see ESA)
SAGSI	Standing Advisory Group for Safeguards Implementation
SEAM	Safeguards Effectiveness Assessment Methodology
SGHWR	Steam Generating Heavy Water Reactor
SIC	Summary Inventory Changes
SIR	Safeguards Implementation Report (IAEA)
SOM	Senior Officers Meeting
SP	Strategic Point
SPI	Summary Physical Inventory
SRD	Shipper/Receiver Difference
SSAC	State System of Accountancy and Control
TNP	Traité de Non-Prolifération (see NPT)
TO (list)	Through Observation (see also OTTO)
UFBR	Universal Fast Breeder Reactor Counter
VA	Verification Agreement(s)
VDC	Variable Dead-time Counter
WGAR	Working Group on Accountancy and Reporting
WGGC	Working Group on inspection Goals and acceptance Criteria
WPDE	Working Party on Data Evaluation
WPIA	Working Party on Informatics and Accountancy

WPIP	Working Party on Planning of Inspections
WPIT	Working Party on Instruments and Techniques
WPSA	Working Party on Safeguards Approaches
WWTP	Working party on Working conditions,Training and Procedures
ZBM	Zone de Bilan Matière (see MBA)