IAEA ACTIVITIES
on
NUCLEAR FUEL CYCLE

1997

N. Oi
Head, Nuclear Fuel Cycle and Materials Section

14th Plenary Meeting of the IWGFPT, Vienna, 21 - 23 May 1997

INTERNATIONAL ATOMI

ORGANIZATIO

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Deputy Directo
Mr. David W

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Assistant Director General
Mr. Mohamed ELBARADEI

DIVISION OF BUDGET AND FINANCE

Director
Mr. Abraham ESPINO

DIVISION OF LANGUAGES

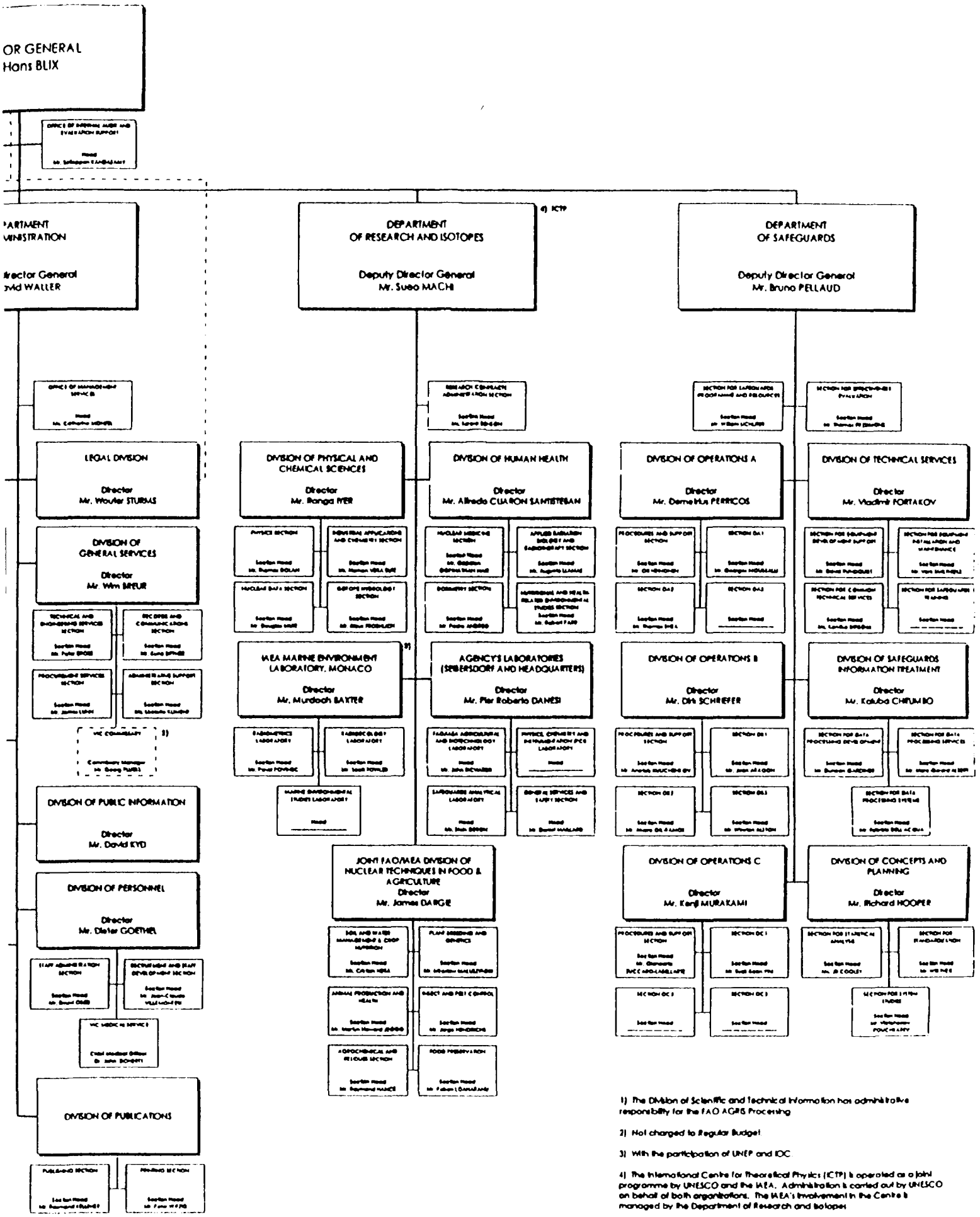
Director
Mr. Swapan Kumar DATTA

Source Inventory of Posts and Personnel
Status 1 January 1997
Please direct questions to the Office of Management Services

SEC. 1

ɔMIC ENERGY AGENCY

\TIONAL CHART



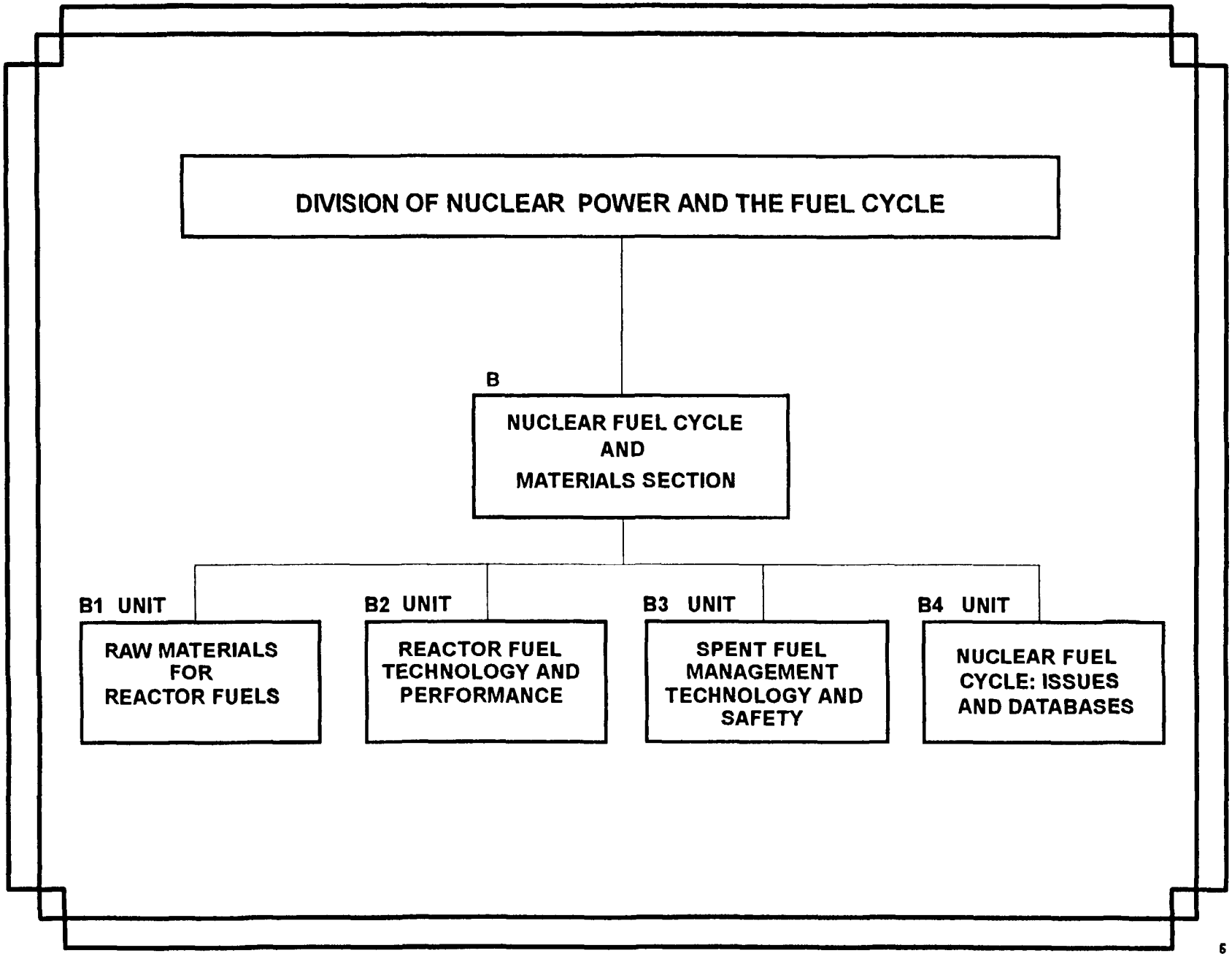
1) The Division of Scientific and Technical Information has administrative responsibility for the FAO AGRIS Processing

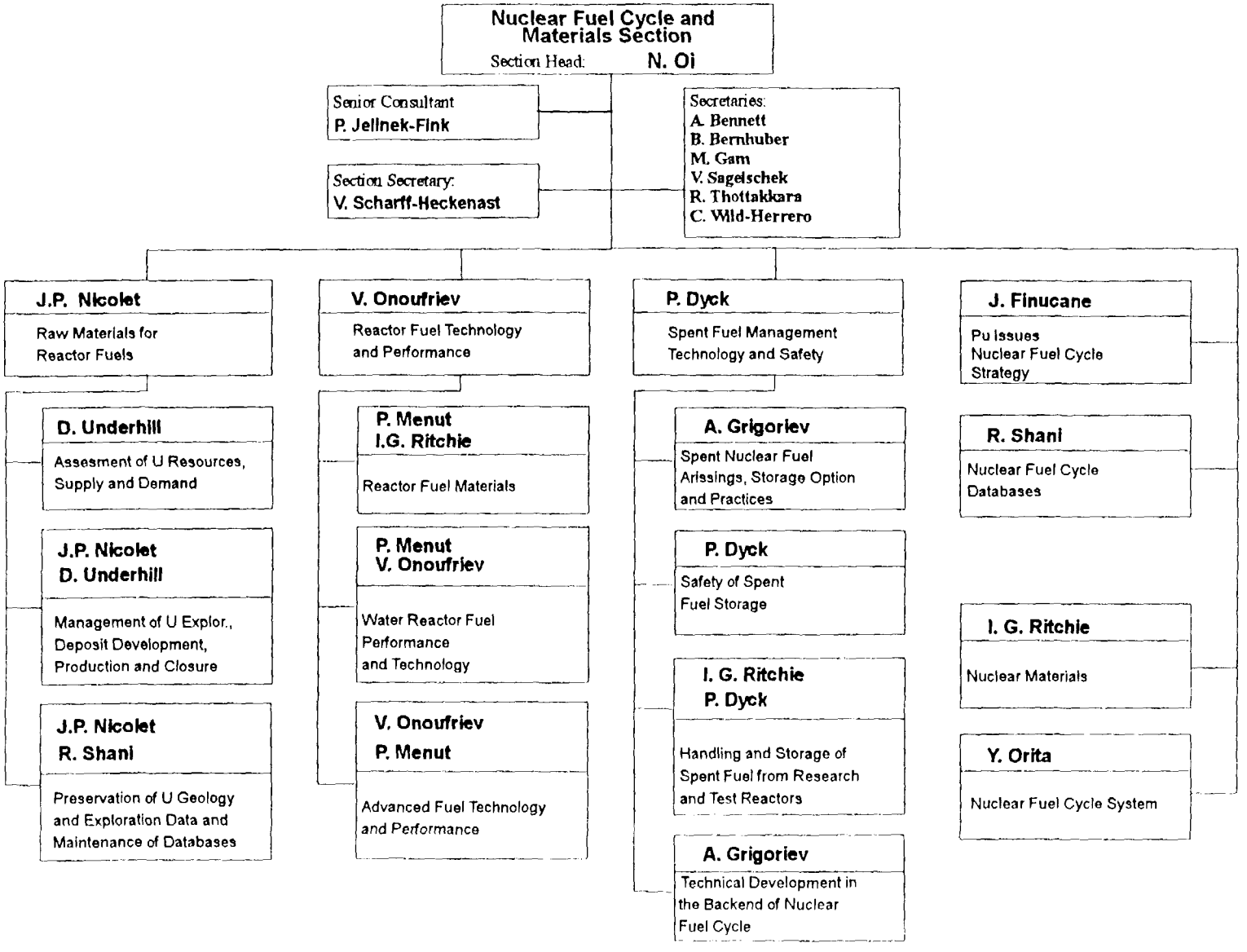
2) Not charged to Regular Budget

3) With the participation of UNEP and IOC

4) The International Centre for Theoretical Physics (ICTP) is operated as a joint programme by UNESCO and the IAEA. Administration is carried out by UNESCO on behalf of both organizations. The IAEA's involvement in the Centre is managed by the Department of Research and Isotopes

SEC. 2


DIVISION OF NUCLEAR POWER AND THE FUEL CYCLE
B
NUCLEAR FUEL CYCLE AND MATERIALS SECTION
B1 UNIT
RAW MATERIALS FOR REACTOR FUELS
B2 UNIT
REACTOR FUEL TECHNOLOGY AND PERFORMANCE
B3 UNIT
SPENT FUEL MANAGEMENT TECHNOLOGY AND SAFETY
B4 UNIT
NUCLEAR FUEL CYCLE: ISSUES AND DATABASES


Nuclear Fuel Cycle and Materials Section
Section Head: N. Oi
Senior Consultant
P. Jelinek-Fink
Section Secretary:
V. Scharff-Heckenast
Secretaries:
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B. Bernhuber
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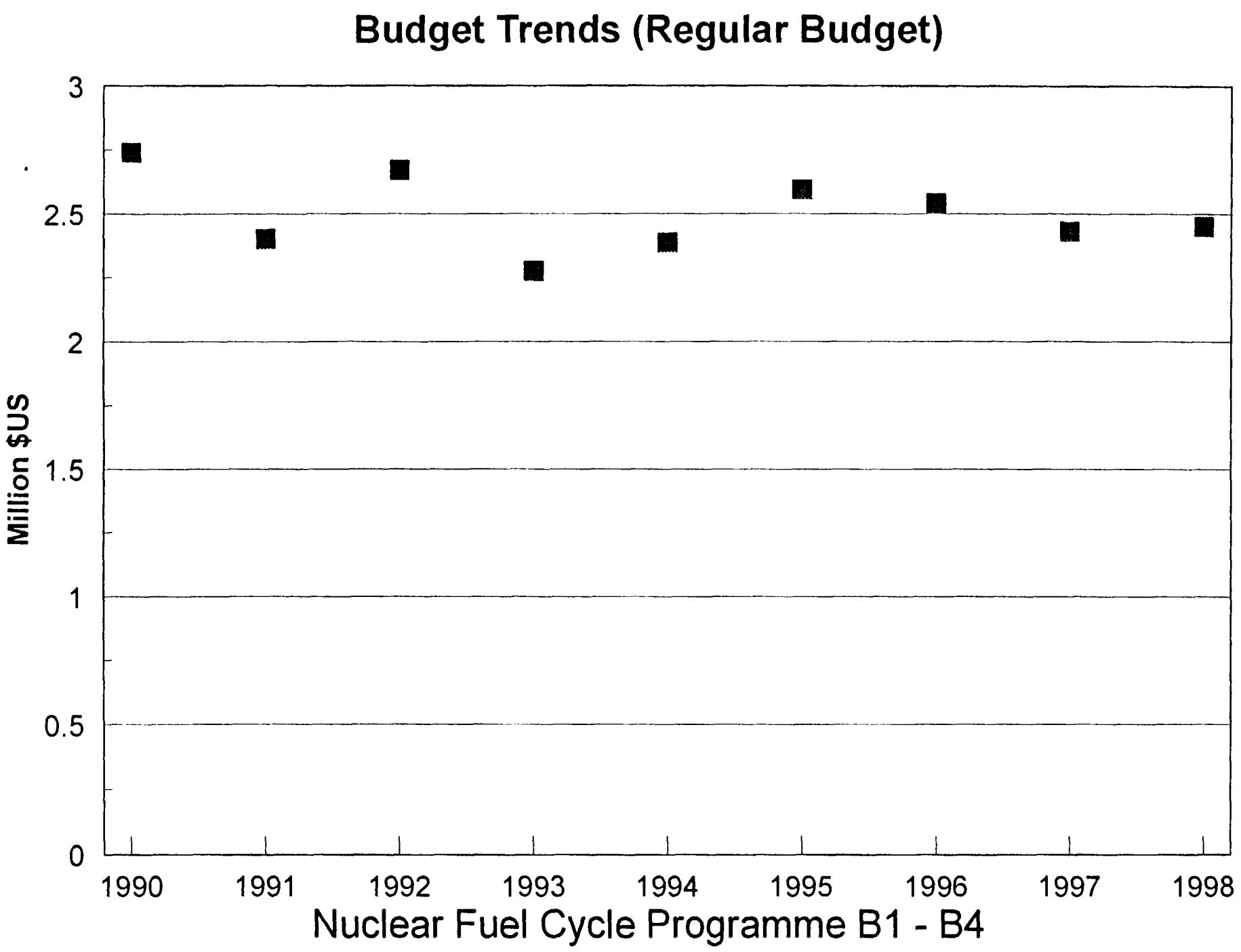
R. Thottakkara
C. Wild-Herrero
J.P. Nicolet
Raw Materials for Reactor Fuels
D. Underhill
Assesment of U Resources, Supply and Demand
J.P. Nicolet
D. Underhill
Management of U Explor., Deposit Development, Production and Closure
J.P. Nicolet
R. Shani
Preservation of U Geology and Exploration Data and Maintenance of Databases
V. Onoufriev
Reactor Fuel Technology and Performance
P. Menut
I.G. Ritchie
Reactor Fuel Materials
P. Menut
V. Onoufriev
Water Reactor Fuel Performance and Technology
V. Onoufriev
P. Menut
Advanced Fuel Technology and Performance
P. Dyck
Spent Fuel Management Technology and Safety
A. Grigoriev
Spent Nuclear Fuel Arissings, Storage Option and Practices
P. Dyck
Safety of Spent Fuel Storage
I. G. Ritchie
P. Dyck
Handling and Storage of Spent Fuel from Research and Test Reactors
A. Grigoriev
Technical Development in the Backend of Nuclear Fuel Cycle
J. Finucane
Pu Issues
Nuclear Fuel Cycle Strategy
R. Shani
Nuclear Fuel Cycle Databases
I. G. Ritchie
Nuclear Materials
Y. Orita
Nuclear Fuel Cycle System

1997 Budget Estimates

	Staff P	Staff GS	Regular Budget	Extra-budgetary resources	TACF
Nuclear Power and the Fuel Cycle (Division)	56	28	12.206,000	1.139,000	5.897,000
Nuclear Fuel Cycle and Materials (Section)	12	6	2.431,000	543,000	1.090,000
Safeguards (Department)	328	212	78.751,000	4.262,000	--
Agency Total	**787**	**995**	**221.952,000**	**13.042,000**	**23.920,000**

[US dollars]


Budget Trends (Regular Budget)
Million $US
3
2.5
2
1.5
1
0.5
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
Nuclear Fuel Cycle Programme B1 - B4

THE NUCLEAR FUEL CYCLE PROGRAMME:

MISSION STATEMENT

To plan, implement and support the Agency's activities in the field of nuclear fuel cycle and materials, aimed in particular at:

- **Assisting the decision making process in Member States by furnishing relevant information;**

- **Providing help in assuring the safety, reliability and economic viability of nuclear fuel cycle activity and minimizing their environmental and health impacts;**

- **Helping meet the needs in Member States for the safe management of spent fuel and plutonium;**

- **Assisting the development in Member States of fuel with improved performance.**

objnfc

HOW TO ACHIEVE THE OBJECTIVES

- **FORUM FOR EXCHANGE OF EXPERIENCE, IDEAS AND APPROACHES:**

  Meetings and Publications

- **PREPARATION OF INTERNATIONAL NORMS, GUIDELINES:**

  Safety Documents for Spent Fuel Storage, Pu handling, etc.

- **PREPARATION AND MAINTENANCE OF DATABASES:**

  Red Book, Nuclear Fuel Cycle Simulation (VISTA Code)

  NFCIS, INTURGEO, etc.

- **SUPPORT ACTIVITIES OF DEVELOPING COUNTRIES:**

  Research Contracts

  Technical Co-operation Projects

SUBPROGRAMME B.1
RAW MATERIALS FOR REACTOR FUELS

B.1.01 Assessment of Uranium Resources and Projections of Supply and Demand

B.1.02 Management of U Exploration, Deposit Development, Production and Facility Closure

B.1.03 Preservation of Uranium Geology and Exploration Data and Maintenance of Databases

PROJECT B 1.01

ASSESSMENT OF URANIUM RESOURCES AND PROJECTIONS OF SUPPLY AND DEMAND

OBJECTIVE:

To maintain and improve the quality and coverage of estimates of world nuclear fuel resources, supply and demand ensuring that all resources are reported on a comparable economic basis, and to make the information available to Member States

PROJECT B.1.02

MANAGEMENT OF URANIUM EXPLORATION, DEPOSIT DEVELOPMENT, PRODUCTION AND CLOSURE

OBJECTIVES:

To assist Member States in assessing the economics of mining a uranium deposit and planning uranium production, and through a series of guidebooks and reports addressing all aspects of development, mining, ore processing, environmental issues and closure

PROJECT B.1.03

PRESERVATION OF URANIUM GEOLOGY AND EXPLORATION DATA AND MAINTENANCE OF DATABASES

OBJECTIVE:

To keep up-to-date uranium geology, exploration and facility data through the maintenance of databases in order to assist Member States in resource, supply and environmental planning.

1. Maintenance of International Uranium Geology Information System (INTURGEO) and related databases and update of World Atlas of Uranium Deposits
2. Radioelement mapping using uranium exploration data

This information can be used as a baseline for environmental studies and monitoring and for the assessment of other mineral resources

B103

SPECIAL FEATURES OF B1 UNIT

- For many years the Unit has been the centre of information on raw materials for reactor fuels and is expected to continue to carry out this important function. The IAEA is the sole UN organization responsible for U resources related activities.
- U Resources, Production and Demand (Red Book), an authoritative publication on U, is prepared biennially by the Joint IAEA/NEA Uranium Group.
- In recent years the data on U resources and production have become more global and comprehensive, but additional effort is required to obtain harmonization and complete reporting.

- As the world now produces only 55% of U demand, a more reliable database is essential for planners and decision makers.
- A series of guidebooks are being prepared especially for developing Member States to assure the safety, reliability and economic viability while minimizing environmental/health impacts of U mining/milling operations:
  - Good practice in the management of U mining and milling operation
  - In-situ leaching of U
  - Environmental impact assessment for uranium project development.

Activities of B1 Unit in 1997

2 Technical Committee Meetings

- Uranium Resources, Production and Demand - Joint IAEA/NEA Uranium Group, Vienna, May

- Recent Developments in Uranium Resources, Production and Demand - May, Vienna

9 Consultancies are planned

SUBPROGRAMME B.2
REACTOR FUEL TECHNOLOGY AND PERFORMANCE

B.2.01 Reactor Fuel Materials

B.2.02 Water Reactor Fuel Performance and Technology

B.2.03 Advanced Reactor Fuel Technology and Performance

PROJECT B2.01
REACTOR FUEL MATERIALS

Objective:

To collect, evaluate and disseminate information on fuel assembly materials, including control materials, which are continually being tuned to meet more stringent requirements (increased burn-up, load following, MOX fuel exploitation), and to maintain a watching brief on any problems or concerns with old, new or improved materials, both normal and accident conditions being considered, to help ensure continued improvement in the safety, reliability and economic viability of nuclear power reactors.

PROJECT B2.02
WATER REACTOR FUEL PERFORMANCE AND TECHNOLOGY

Objective:

To collect, evaluate and disseminate information on the developments in fuel performance and technology, to meet more stringent requirements (increasing burnup, load follow, higher temperatures), and to maintain a watching brief on any problems or concerns with old, new or improved fuel or water chemistry so as to ensure continued improvement in the safety, reliability and economic viability of nuclear power reactors, especially in developing countries. The project covers fuel performance in normal and accident conditions.

PROJECT B2.03
ADVANCED FUEL TECHNOLOGY AND PERFORMANCE

Objective:

To provide a forum for the exchange of experience, ideas and approaches on advanced fuel rather than conventional oxide fuels with the objective of improving safety, reliability and economic viability.

SPECIAL FEATURES OF B.2 UNIT

The International Working Group on Water Reactor Fuel Performance and Technology (IWGFPT), which comprises fuel experts from 25 countries and 3 international organizations has been advising the Agency and supported activities since 1977. The IWGFPT plays a key role in co-ordinating activities in the world with regard to water reactor fuel performance.

Emphasis in 1997 will be given to:

i) Fuel Database and Modelling,

ii) On-Line Water Chemistry Monitoring and Activity Transport,

iii) Degradation of Zr-alloys - Corrosion and Hydriding,

iv) Poolside Inspection, Repair and Reconstitution of LWR Fuel,

v) Reliability, Performance and Safety Aspects of WWER Fuel in the former Soviet Union and East European countries

Activities of B2 Unit in 1997

3 Technical Committee Meetings

- Review Status and Trends in the Area of Water Reactor Fuel Performance and Technology, (Plenary Meeting of IWGFPT), Vienna, May,
- Poolside Inspection, Repair and Reconstitution of LWR Fuel, Switzerland, September
- Review status and Trends on the Fast Reactor Fuels and Core materials, Obninsk, Russia, June

13 Consultancies are planned

SUBPROGRAMME B.3
SPENT FUEL MANAGEMENT

B.3.01 Spent Nuclear Fuel Arising, Storage Options and Practice

B.3.02 Safety of Spent Fuel Storage

B.3.03 Handling and Storage of Spent Fuel from Research and Test Reactors

B.3.04 Technical Developments in the Back End of the Nuclear Fuel Cycle

REGULAR ADVISORY GROUP ON SPENT FUEL MANAGEMENT

Members:

The Group presently consists of nominated experts from 13 Member States and OECD/NEA

CAN, CZE, FRA, GER, HUN, IND, JPN, ROK, RUS, SAF, SWE, UKR, UK, USA (1997)

Meetings held biannually:

1984, 1996, 1988, 1990, 1991, 1993, 1995, 1997

Objectives:

To provide technical advice to the Secretariat;

Exchange of information on national programmes;

Coordination of international activities

PROJECT B 3.01

SPENT NUCLEAR FUEL ARISINGS, STORAGE OPTIONS AND PRACTICES

OBJECTIVE:

To collect, evaluate and disseminate information on spent fuel discharge, storage capacity requirements, storage options and practices world-wide and to provide Member States with information on the development of safe and economical technical solutions. To provide advisory services, mainly to developing countries, to assist with the implementation of the best suitable internationally agreed method for storing and handling spent nuclear fuel from both power and research reactors.

B301

PROJECT B.3.02

STANDARDS FOR SPENT FUEL STORAGE

OBJECTIVE:

To develop a set of internationally agreed guidelines to assist Member States in establishing national standards, criteria and regulations for the safe long term storage of spent nuclear fuel from power and research reactors

PROJECT B3.03

HANDLING AND STORAGE OF SPENT FUEL FROM RESEARCH REACTORS

OBJECTIVE:

To collect, evaluate and disseminate information on the safe and reliable handling, management and storage, or preparation for shipment, of spent fuel from research and test reactors. To disseminate information on technical solutions to these problems and to provide Member States with advice and assistance on the successful implementation of such technical solutions

PROJECT B 3.04

TECHNICAL DEVELOPMENTS IN THE BACK END OF THE NUCLEAR FUEL CYCLE

OBJECTIVE:

To collect, evaluate, analyse and disseminate information on overall developments and trends in the back end of the nuclear fuel cycle and related areas and to provide Member States with information on the development of safe technical solutions

B304

19

Extrabudgetary Project on the Storage of WWER Spent Fuel

1. To collect data on mechanistic properties of irradiated Zr-1% Nb cladding material under long-term storage conditions: VNIPIET/Hot cell at Novo Voronesh NPP

2. Modification/bench mark of COBRA-SFS for WWER-440 fuel/KFKI, HUN

3. Modification/bench mark of the SCALE 4.3 for WWER-440 fuel

4. Workshop/TCM on the Commissioning of Dry Storage Technologies for WWER operating countries: at CZE, 1997

SPECIAL FEATURES OF B 3 UNIT

- The Regular Advisory Group on Spent Fuel Management which comprises 13 countries has advised and promoted the activities continuously since 1984.

- Long Term Spent Fuel Storage has been identified as a high priority activity in the Agency's Medium Term Plan.

- Safety Series documents on Long Term Storage for Power Reactor Fuels were completed in 1994, one document on Research Reactor Fuels and one document on Spent Fuel Storage at NPPs are under preparation.

- Support of the RERTR (Reduced Enrichment for Research and Test Reactors) Programme and its implications for long term storage of spent fuel, especially for developing Member States.

- Support of the take-back of spent fuel of US-origin from developing Member States through advice on training in the preparation of spent fuel for shipment.

- Compilation of information on the behaviour of WWER/RBMK spent fuel during long-term storage is in progress.

Activities of B3 Unit in 1997

4 Advisory Group Meetings

- Technical documents on remote technology in Spent Fuel Management, Vienna, June
- Collect and Evaluate Information on Current Status and Prospects on Spent Fuel Management, Vienna, September
- Procedures and Techniques for the Management of Experimental and Exotic Fuels from Research and Test Reactors, Vienna, October
- Evaluate and Review the Implementation of Burnup Credit in Spent Fuel Management Systems, Vienna, October

3 Technical Committee Meetings

- Technologies and Safety Aspects of a Regional Spent Storage Facility, Vienna, June
- Workshop on Spent Fuel Management for WWER/RBMK Reactors
- Update a Safety Guide on Fuel Handling and Storage Systems in Nuclear Power Plants and Develop a Safety Guide on the Design of Modifications of Spent Fuel Storage Facilities

20 Consultancies are planned

SUBPROGRAMME B.4

NUCLEAR FUEL CYCLE: ISSUES AND DATABASES

B.4.01 NUCLEAR FUEL CYCLE ISSUES

B.4.02 PLUTONIUM INVENTORY AND EMERGING PROBLEMS

B.4.03 NUCLEAR FUEL CYCLE DATABASES

PROJECT B4.01

NUCLEAR FUEL CYCLE

ISSUES

OBJECTIVE:

To collect, evaluate and disseminate information that covers the whole field of the nuclear fuel cycle, including technology, safety, public acceptance and nuclear non-proliferation

PROJECT B.4.02

PLUTONIUM ACCUMULATION AND EMERGING PROBLEMS

OBJECTIVE:

To provide a forum for the exchange of information concerning various issues on plutonium

- **Inventory of Pu, both, current and projected**
- **Safe Handling and Storage**
- **Technology Associated with Disposition of Pu**
- **Support for "International Arrangement to Manage Pu"**
- **Preparation for the Symposium on "Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Realities", Vienna, June 1997**

PROJECT B.4.03

NUCLEAR FUEL CYCLE DATABASES

OBJECTIVE:

To develop and maintain databases concerning the world-wide nuclear fuel cycle activities and facilities, and to elaborate country nuclear fuel cycle profiles

REGISTERED DATABASES AT NESI

VISTA, INTURGEO AND NFCIS

THE NUCLEAR FUEL CYCLE INFORMATION SYSTEM

(NFCIS)

An international directory of civilian nuclear fuel cycle facilities.
It includes information on:

- U mining and milling,
- U refining and conversion,
- enrichment,
- fuel fabrication,
- away from reactor spent fuel storage,
- spent fuel reprocessing
- heavy water production
- zircalloy metal and tubing fabrication.

The information was obtained through questionnaires sent to Member States and also from literature (>400 records).

NFCIS is a computerized database. The book was published in 1996. It will be offered as an computerized on-line service to Member States.

NUCLEAR FUEL CYCLE SIMULATION SYSTEM

(VISTA) A PC Computer Code being Developed by the Agency

INPUT:

- Nuclear Capacity, Burnup, Enrichment and the Trends

OUTPUT:

- Spent Fuel Discharge
- Fissile and Total Pu Generation
- Actinides Generation
- U Resource Requirement
- SWU Requirement
- Others

on country, reactor type and yearly basis

INTERNATIONAL URANIUM GEOLOGY INFORMATION SYSTEM (INTURGEO)

A PC Database being maintained by the Agency

- A compilation of worldwide data on U deposits and occurrences
- Collection of data through questionnaire sent to Member States and from literature
- Number of records: 4 900
- The World Uranium Atlas was published in 1995 based on INTURGEO

SPECIAL FEATURES OF B.4 ACTIVITIES

- The project will look through the whole nuclear fuel cycle from the standpoint of economics, environment, non-proliferation and safety.

- The issue of the "Accumulation of Separated Plutonium" is a serious international concern and the activities reflect the interest of Member States. The Symposium on Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Realities (June 1997) will examine all aspects of the problems concerning plutonium.

- Preparation of computerized information sources is one of the key activities of the Section.

Activities of B4 Unit in 1997

Symposium

- Nuclear Fuel Cycle and Reactor Strategies - Adjusting to New Realities, Vienna, June

3 Advisory Group Meetings

- Technical Problems Concerning the Utilization of Plutonium from Nuclear Weapons in the Various Disposition Options, Vienna, March
- Maintenance of a Database on Separated Civil Plutonium Inventories, Vienna, April
- Seismic Safety of Nuclear Fuel Cycle Facilities, Vienna, November

9 Consultancies are planned

COORDINATED RESEARCH PROGRAMMES

- Treatment of liquid effluents from Mines and Mills during and after the operation (1996 - 2000)

4 Agreements	AUL, CAN, GER, FRA
8 Contracts	CPR, HUN, IND, KAZ, POR, TUR, UKR

- On-line Monitoring of Water Chemistry related to Fuel Behaviour and Activity Transport (WACOL) (1995 - 2000)

13 Agreements	CAN(2), FIN, FRA, GER, ITA, JPN, NOR, SWE(2) SWI, UK, USA(1)
4 Contracts	CPR, CZE, POL, RUS

- Hydrogen pick-up and hydrogen/hydride induced degradation of the physical and mechanical properties of Zirconium based alloys (1997 - 2002)

- Modelling of the Activity Transport in Primary Circuit of Water Cooled Reactors (1996 - 2000)

11 Agreements	ARG, CAN(2), FRA, GER, HUN, JPN, ROK, NOR, RUS, USA
4 Contracts	BUL, CZE, SLR

- Corrosion of Research Reactor Fuel Cladding during Storage (1995-1998)

4 Agreements	RUS(2), IND, US
4 Contracts	ARG, CPR, PAK, THA

- SCC of Zr Alloys (1993-1998)

1 Agreement	UK
4 Contracts	ARG, CPR, IND, ROK
Supervisory Group	FRA, RUS, UK

- Spent Fuel Performance Assessment and Research (SPAR) (1997 - 2003)

- **Irradiation Enhanced Degradation of Materials in Spent Fuel Storage Facilities (1993 - 1998)**

5 Agreements	CAN, GER, JPN, UK, USA
2 Contracts	IND, RUS

- **Safety, Environmental and Non-Proliferation Aspects of Partitioning and Transmutation of Actinides and Fission Products (1995-1999)**

7 Agreements	BEL, FRA, IND, JPN, ROK, UK, EU
2 Contracts	IND, RUS

TECHNICAL ASSISTANCE AND CO-OPERATION PROGRAMME OF THE NFC&MS AS OF JANUARY 1997

Number of Projects	18
(B1: 12, B2: 3, B3: 3 projects)	
Number of Member States involved	12
Budget (outside the control of NFC&MS)	$ 1,87 Million

Model Projects (2)

KAZ/3/002: Modern Technologies for In-situ Leaching of U Mining

RER/4/019: Licensing Fuel and Fuel Modelling Codes for WWER

B1 Area: ALG, EGY, INS, IRA, KAZ, NAM, PHI, SYR

B2 Area: BUL, BYL, CPR, CZE, BUL, SVO, ROM, SLO, TUR

B3 Area: ARM, BUL, CZE, HUN, LIT, ROM, SLO, SVK, UKR

Technical Assistance in the form of

i) Provision of Experts,

ii) Fellowship/Scientific Visits,

iii) Provision of Equipment,

iv) Training Courses

Training Courses:

Interregional Training Course on *Interim Storage and Preparation of Research Reactor Spent Fuel for Return to Its Country of Origin,* January, ANL, USA;

Regional Training Course on *U Resource Inventories and Ore Reserve Calculations,* October, Changsha, China

MEDIUM TERM PERSPECTIVE 1998-2003

Special emphasis

- **Spent fuel management from power and research reactors**
- **Plutonium issues: both civilian and ex-wPu**
- **Performance and safety of high burnup water reactor fuels**

(Note by the Secretariat - 1997/NOTE 2 of 4 April 1997)

mtp

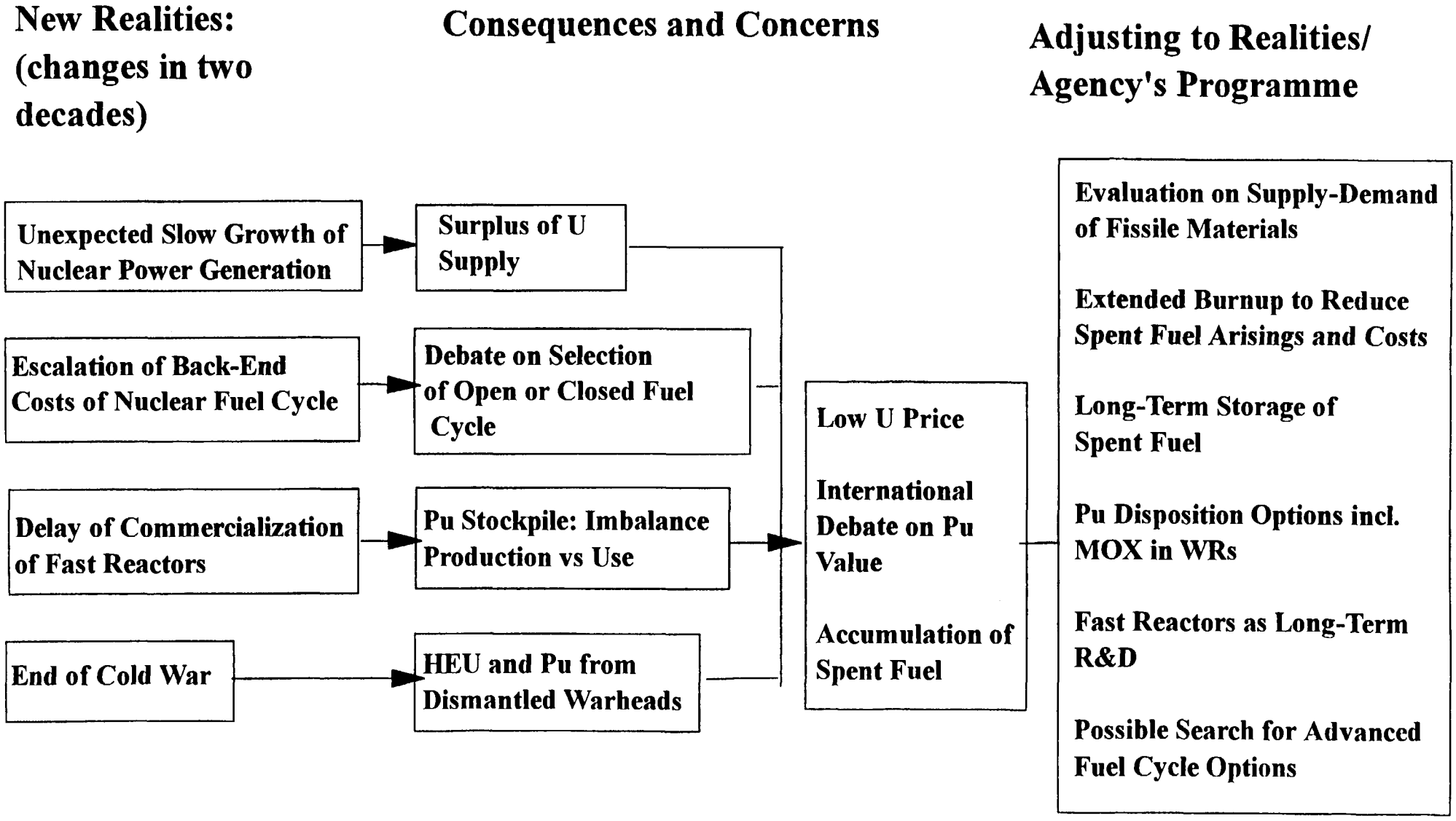
MEETING STATISTICS: NFC&MS in 1996 (1995)

1.	Total Number of Meeting Participants	758	(549)
2.	Total Number of Participating Countries	52	(36)
3.	Total Number of Meetings	68	(57)
	Advisory Group Meetings	3	(5)
	Technical Committee Meetings	13	(8)
	Research Coordination Meetings	5	(5)
	Consultancies	47	(39)

NUMBER OF PUBLICATIONS
NFC&M SECTION

	1996	1990 - 1995
Technical Report Series (Sales Publications)	3	20
TECDOC	9	44
Safety Series Document	-	3
Working Material	5	20
IAEA Yearbook Part C	1	5
Newsletter	-	2
IAEA Bulletin	-	1
Pamphlet	1	1

NUCLEAR FUEL CYCLE OVERVIEW



SUMMARY

The IAEA's activities in the field of the nuclear fuel cycle reflect new realities facing the international community today. These are geared towards the reliability, safety and economic viability of nuclear power.

The IAEA's role as a forum for the exchange of information on fuel performance, failure mechanisms, and the modelling of behaviour under normal, transient and accident conditions is becoming more important for maintaining safe and reliable operation of nuclear fuel as the current worldwide increase in operating demands on fuel (e.g. higher burnups, the use of MOX, etc.)

Spent fuel management from both power and research reactors continues to be a high priority issue. The IAEA is particularly involved in providing assistance to developing Member States for the selection of management options and licensing.

The use and disposition of Pu, including Ex-WPu, has become a matter of international concern. The IAEA, in cooperation with Member States, is taking steps to more effectively tailor its activities and experiences in this field to the emerging needs.

The Symposium on Nuclear Fuel Cycle and Reactor Strategy: Adjusting to New Realities to be held in June 1997 will offer good opportunity to raise international awareness and increased global understanding of the many important issues associated with the nuclear fuel cycle.

Closer communication between Member States and the Agency has proved to be highly valuable and we are looking forward to continued suggestion and advice.

Sum

ISSUES CONCERNING ACTIVITIES OF THE IWGFPT

1. The 20 years anniversary: Care should be taken not to become stereotyped
2. Needs more visibility and impact!
3. Needs timely response: move from traditional 1.5 year cycle?
4. Message: 'Mature technology, leave it to industry' still persists!
5. Activities should center around key issues: High burnup, MOX fuel, Assistance to Developing Member States (incl. East European countries), etc.
6. OECD/NEA's WG and the new dimensions through the co-operation with the Department of Nuclear Safety