



IAEA

International Atomic Energy Agency

Coordinated Research Activities

Annual Report and Statistics for 2005

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<http://cra.iaea.org/>

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1. INTRODUCTION

Article III of the IAEA Statute authorises the Agency to encourage and assist research on, and development and practical application of, atomic energy for peaceful purposes throughout the world and to foster the exchange of scientific and technical information, as well as the exchange of scientists in the field of peaceful uses of atomic energy. The Agency's Coordinated Research Activities stimulate and coordinate the undertaking of research in selected nuclear fields by scientists in IAEA Member States.

The research supported by the Agency is within the framework of the Agency's programmes, sub-programmes and projects that are listed in the approved Programme and Budget of the Agency. These Coordinated Research Activities are normally implemented through Coordinated Research Projects (CRPs) that bring together research institutes in both developing and developed Member States to collaborate on the research topic of interest. The Agency may also respond to proposals from institutes for participation in the research activities by awarding individual research contracts not related to a CRP. A small portion of available funds is used to finance individual projects, which deal with topics covered by the Agency's scientific programme.

The Agency also supports Doctoral CRPs, which are designed to strengthen promotion of research on nuclear technologies in developing Member States through pair building between agreement holders and contract holders. These CRPs include a PhD training programme at the contract holders' institutions. Three doctoral CRPs currently implemented by the Human Health programme address the management of liver cancer using radionuclide methods, improvement of radiotherapy outcomes in AIDS cancer patients and isotopic and complementary tools for the study of micronutrient status and interactions in developing country populations exposed to multiple nutritional deficiencies.

Further information on the Agency's Coordinated Research Activities, including current information on CRPs and programme areas supported, information on policies and procedures and the administration of the activities is contained in the Agency's Coordinated Research Activities website at:

<http://cra.iaea.org/>

2. COORDINATED RESEARCH ACTIVITIES IN SUPPORT OF AGENCY PROGRAMMES AND SUBPROGRAMMES

The Coordinated Research Activities reported in this document are conducted in support of the following Agency programmes/subprogrammes (Ref: GC(48)/2 and 16 of August 2005).

Major Programme 1: Nuclear Power, Fuel Cycle and Nuclear Science

- Programme A.: Nuclear Power
- Programme B.: Nuclear Fuel Cycle and Materials Technologies
- Programme D.: Nuclear Science

Major Programme 2: Nuclear Techniques for Development and Environmental Protection

- Programme E.: Food and Agriculture
- Programme F.: Human Health
- Programme G.: Water Resources
- Programme H.: Protection of the Marine and Terrestrial Environments`
- Programme I.: Physical and Chemical Applications

Major Programme 3: Nuclear safety and Security

- Programme J.: Safety of Nuclear Installations
- Programme K.: Radiation and Transport Safety
- Programme L.: Management of Radioactive Waste
- Programme M.: Nuclear Security

The Sub-programmes supported by the CRPs are listed in Appendix C.

Results of research are available to all Member States and are disseminated through, national, international and Agency scientific and technical publications. The Coordinated Research Activities are complementary to its Technical Cooperation Projects, with the knowledge gained via coordinated research used to enhance the quality of Technical Cooperation Projects. Some research results are directly relevant to Technical Cooperation Projects and lead to successful implementation of these projects, while some Technical Projects lead to participation in Coordinated Research Activities. In addition, CRPs and TC Projects may also be carried out simultaneously.

3. COORDINATED RESEARCH ACTIVITIES IN 2005

In terms of benefits to Member States through their participating research institutions, number of awards and degree of funding, coordinated research activities constitute a significant component of the Agency's overall programme.

765 contracts and 142 agreements were awarded from the 1170 proposals (992 contract proposals and 178 agreement proposals) received by the Agency during 2005. Annex I lists, by country, the number of proposals received and awards made.

In 2005, \$7 223 923 from the regular budget, (\$166 566 thereof from 2004 unobligated funds), and \$169 590 of extra-budgetary contributions totaling \$7 393 513 were awarded to institutes under contractual arrangements and to fund Research Coordination Meetings (RCMs). The average award per contract was \$6 440, about 6% more than the 2004 average award level. Table 1 summarizes all awards by Programme in 2005.

TABLE 1. SUMMARY OF ALL AWARDS BY PROGRAMME IN 2005

Programme	Regular Budget \$				Extra Budgetary Funding \$				RB+EB
	Contracts	CRPs Purchases	RCMs Expenditures	Total by Programme	Contracts	CRPs Purchases	RCMs Expenditures	Total by Programme	Total by Programme
A: Nuclear power	111 538	0	228 311	339 849	0	0	10 660	10 660	350 509
B: Nuclear Fuel Cycle and Material Technologies	65 000	0	89 954	154 954	0	0	0	0	154 954
D: Nuclear Science	403 450	15 630	242 209	661 289	20 000	0	19 000	39 000	700 289
Total Major Programme 1	579 988	15 630	560 474	1 156 092	20 000	0	29 660	49 660	1 205 752
E: Food and Agriculture	2 132 577	0	819 720	2 952 297	0	0	0	0	2 952 297
F: Human Health	1 341 800	14 342	448 939	1 805 081	0	0	0	0	1 805 081
G: Water Resources	196 000	0	71 303	267 303	0	0	0	0	267 303
H: Protection of the Marine and Terrestrial Environment	28 500	0	32 272	60 772	0	0	0	0	60 772
I: Physical and Chemical Applications	301 000	48 472	187 918	537 390		0	0	0	537 390
Total Major Programme 2	3 999 877	62 814	1 560 152	5 622 843	0	0	0	0	5 622 843
J: Safety of Nuclear Applications	54 800	0	81 572	136 372	0	0	3 780	3 780	140 152
K: Radiation and Transport Safety	64 500	0	56 643	121 143	0	0	0	0	121 143
L: Management of Radioactive Waste	88 970	0	98 503	187 473	0	0	0	0	187 473
M: Nuclear Security	0	0	0	0	116 150	0	0	116 150	116 150
Total Major Programme 3	208 270	0	236 718	444 988	116 150	0	3 780	119 930	564 918
Grand Total	4 788 135	78 444	2 357 344	7 223 923	136 150	0	33 440	169 590	7 393 513
Total Contracts Awards: \$4 924 285									
Total CRP Expenditure: \$ 78 444									
Total RCM Expenditure: \$ 2 390 784									
Total Expenditure in 2005 \$7 393 513									

FIGURE 1 illustrates the proportion of regular budget and extra-budgetary funding in 2005

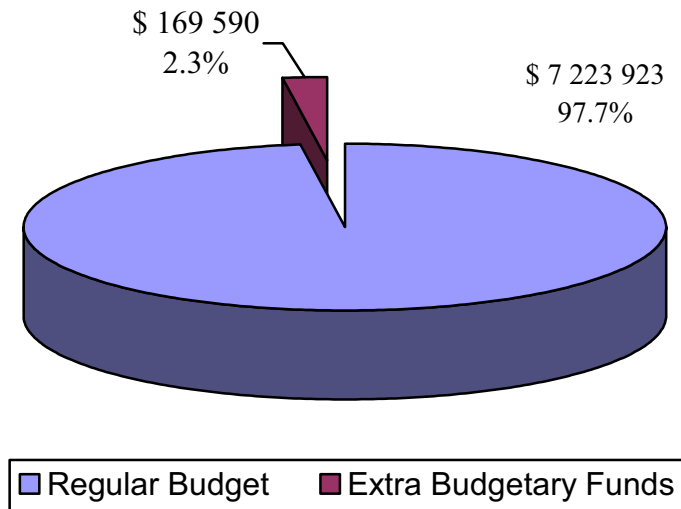
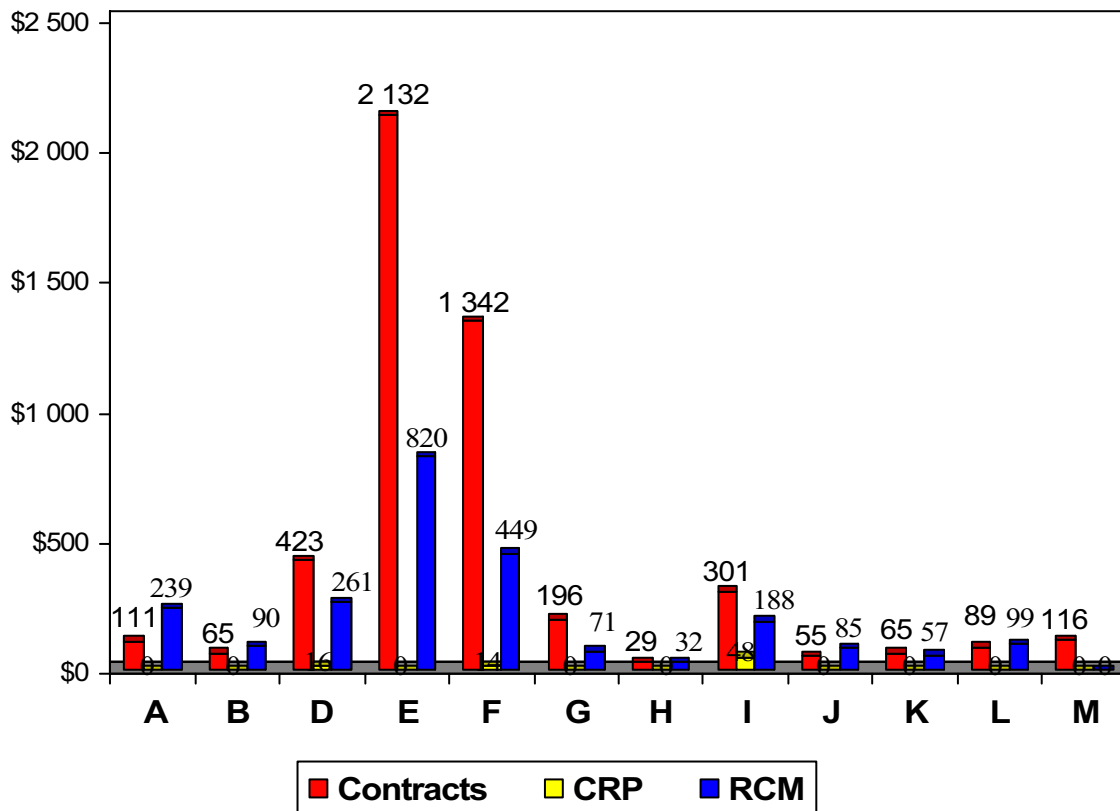


FIGURE 2. Distribution of all 2005 Awards by Programme and Type of Activity (in thousands)



Details of resources for 2005 awards by programme and sub-programme and type of award are provided in Table 2. Annex II lists awards by country and programme.

TABLE 2. DISTRIBUTION OF 2005 TOTAL FUNDS BY PROGRAMME

Programme	Research Contracts				Technical Contracts				Doctoral Contracts				CRP Expenses \$	Total contracts expenses \$	RCMs		Overall Total \$
	New		Renewal		New		Renewal		New		Renewal				#	\$	
	#	\$	#	\$	#	\$	#	\$	#	\$	#	\$					

A: Nuclear Power

A1	2	10 000	0	0	0	0	0	0	0	0	0	0	0	0	10 000	2	32 810	42 810
A3	2	6 000	2	4 038	0	0	0	0	0	0	0	0	0	0	10 038	1	44 146	54 184
A4	7	26 000	17	37 500	1	28 000	0	0	0	0	0	0	0	0	91 500	6	151 355	242 855
A4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10 660	10 660
Total A	11	42 000	19	41 538	1	28 000	0	0	0	0	0	0	0	0	111 538		238 971	350 509

B: Nuclear Fuel Cycle and Materials Technologies

B2	5	26 500	0	0	1	4 000	1	5 000	0	0	0	0	0	0	35 500	2	64 954	100 454
B3	2	7 000	1	5 000	0	0	1	5 000	0	0	0	0	0	0	17 000	1	25 000	42 000
B4	0	0	2	12 500	0	0	0	0	0	0	0	0	0	0	12 500	0	0	12 500
Total B	7	33 500	3	17 500	1	4 000	2	10 000	0	0	0	0	0	0	65 000	3	89 954	154 954

D: Nuclear Science

D1	18	85 000	15	75 000	2	10 000	0	0	0	0	0	0	0	0	170 000	6	117 251	287 251
D2	0	0	7	34 000	0	0	0	0	0	0	0	0	15 630	49 630	1	19 830	69 460	
D2	2	10 000	1	6 000	0	0	0	0	0	0	0	0	0	16 000	2	31 760	47 760	
D2	4	20 000	0	0	0	0	0	0	0	0	0	0	0	20 000	1	19 000	39 000	
D3	15	62 500	9	46 000	0	0	0	0	0	0	0	0	0	108 500	3	58 318	166 818	
D4	0	0	16	73 000	0	0	3	1 950	0	0	0	0	0	74 950	1	15 050	90 000	
Total D	39	177 500	48	234 000	2	10 000	3	1 950	0	0	0	0	15 630	439 080	14	261 209	700 289	

E: Food and Agriculture

E1	18	153 000	125	945 359	7	60 000	18	164 000	0	0	0	0	0	1 322 359	13	510 843	1 833 202
E2	12	133 000	62	504 057	5	45 000	2	17 000	0	0	0	0	0	699 057	8	240 844	939 901
E3	0	0	20	108 661	0	0	1	2 500	0	0	0	0	0	111 161	3	68 033	179 194
Total E	30	286 000	207	1 558 077	12	105 000	21	183 500	0	0	0	0	0	2 132 577	24	819 720	2 952 297

Programme	Research Contracts				Technical Contracts				Doctoral Contracts				CRP Expenses \$	Total contracts expenses \$	RCMs		Overall Total \$
	New		Renewal		New		Renewal		New		Renewal				#	\$	
	#	\$	#	\$	#	\$	#	\$	#	\$	#	\$					

F: Human Health

F1	5	34 000	0	0	0	0	0	0	0	0	0	0	0	34 000	1	15 467	49 467
F1	10	70 000	40	260 000	2	20 000	5	25 000	0	0	1	12 000	0	387 000	6	117 301	504 301
F2	18	86 000	25	105 500	0	0	5	43 300	0	0	1	8 000	0	242 800	4	66 647	309 447
F3	10	48 000	20	87 000	0	0	1	9 000	0	0	0	0	14 112	158 112	3	66 542	224 654
F4	28	258 000	23	196 000	4	57 500	1	10 000	0	0	1	12 500	230	534 230	7	182 982	717 212
Total F	71	496 000	108	648 500	6	77 500	12	87 300	0	0	3	32 500	14 342	1 356 142	21	448 939	1 805 081

G: Water Resources

G1	0	0	12	54 500	0	0	1	35 000	0	0	0	0	0	89 500	1	23 065	112 565
G2	0	0	8	36 500	3	70 000	0	0	0	0	0	0	0	106 500	2	48 238	154 738
Total G	0	0	20	91 000	3	70 000	1	35 000	0	0	0	0	0	196 000	3	71 303	267 303

H: Protection of the Marine and Terrestrial Environments

H1	0	0	2	10 000	0	0	0	0	0	0	0	0	0	10 000	1	5 579	15 579
H2	0	0	4	18 500	0	0	0	0	0	0	0	0	0	18 500	1	26 693	45 193
Total H	0	0	6	28 500	0	0	0	0	0	0	0	0	0	28 500	2	32 272	60 772

I: Physical and Chemical Applications

I1	5	23 000	27	106 000	2	9 000	0	0	0	0	0	0	39 472	177 472	3	77 450	254 922
I2	9	37 000	29	122 000	0	0	1	4 000	0	0	0	0	9 000	172 000	4	110 468	282 468
Total I	14	60 000	56	228 000	2	9 000	1	4 000	0	0	0	0	48 472	349 472	7	187 918	537 390

J: Safety of Nuclear Installations

J2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3 780	3 780
J3	0	0	6	29 800	0	0	0	0	0	0	0	0	0	29 800	1	24 430	54 230
J5	0	0	3	9 000	0	0	0	0	0	0	0	0	0	9 000	1	32 112	41 112
J7	0	0	2	8 000	0	0	0	0	0	0	0	0	0	8 000	1	25 030	33 030
J8	0	0	2	8 000	0	0	0	0	0	0	0	0	0	8 000	0	0	8 000
Total J	0	0	13	54 800	0	0	0	0	0	0	0	0	0	54 800	3	85 352	140 152

K: Radiation and Transport Safety

K1	0	0	0	0	0	0	2	40 000	0	0	0	0	0	40 000	0	0	40 000
K5	0	0	9	22 000	0	0	1	2 500	0	0	0	0	0	24 500	3	35 623	60 123
K7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	21 020	21 020
Total K	0	0	9	22 000	0	0	3	42 500	0	0	0	0	0	64 500	4	56 643	121 143

L: Management of Radioactive Waste

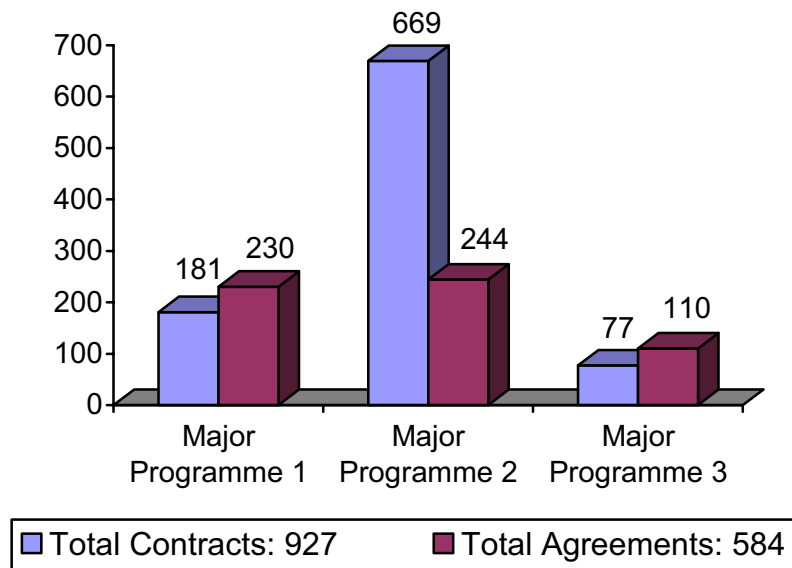
L4	6	29 000	10	44 970	0	0	0	0	0	0	0	0	0	73 970	2	68 339	142 309
L7	1	5 000	2	10 000	0	0	0	0	0	0	0	0	0	15 000	1	30 164	45 164
Total L	7	34 000	12	54 970	0	0	0	0	0	0	0	0	0	88 970	3	98 503	187 473

M: Nuclear Security

M3	0	0	12	116 150	0	0	0	0	0	0	0	0	0	116 150	0	0	116 150
Total M	0	0	12	116 150	0	0	0	0	0	0	0	0	0	116 150	0	0	116 150
Total	179	1 129 000	513	3 095 035	27	303 500	43	364 250	0	0	3	32 500	78 444	5 002 729	92	2 390 784	7 393 513

At the end of 2005, there were 1511 active research contracts and agreements supported by the Agency. 95 % of these represented participation in the 124 active CRPs shown in Appendix A and 5% were individual projects. 92 RCMs (see Annex III) were held in support of these CRPs and an amount of \$2 390 784 was spent in support of these meetings. Figure 3 shows the distribution by Major Programme of these contracts and agreements, and Figure 4 shows the distribution by programme of the CRPs and RCMs held during the year.

FIGURE 3. Active Contracts and Agreements by Major Programme at End 2005

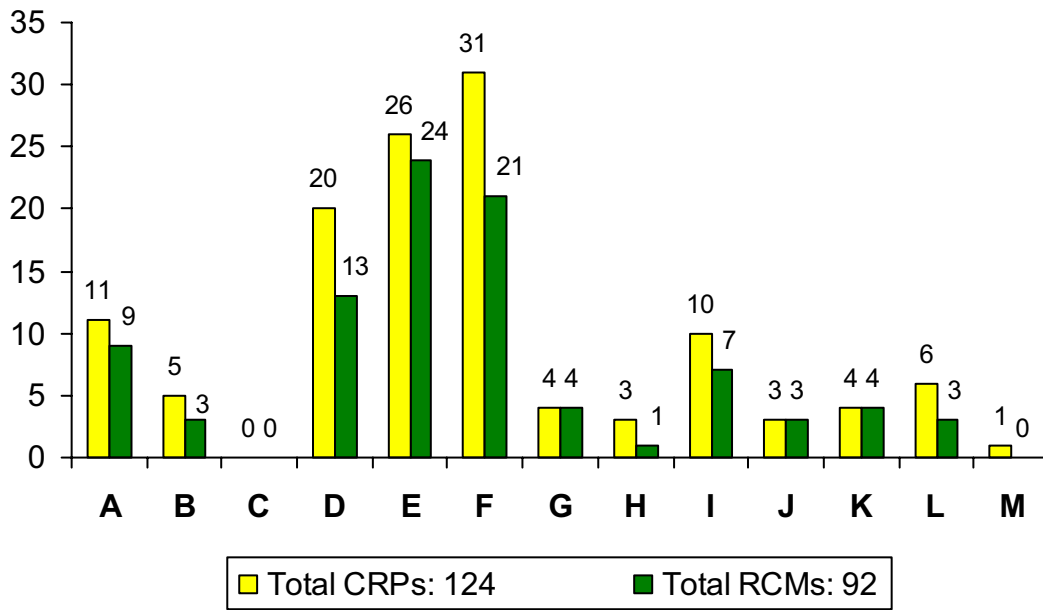


MP 1: A. Nuclear Power, B. Nuclear Fuel Cycle and Materials Technologies, D. Nuclear Science

MP 2: E. Food and Agriculture, F. Human Health, G. Water Resources, H. Protection of the Marine and Terrestrial Environments, I. Physical and Chemical Applications

MP3: J. Safety of Nuclear Installations, K. Radiation and Transport Safety, L. Management of Radioactive Waste, M. Nuclear Security

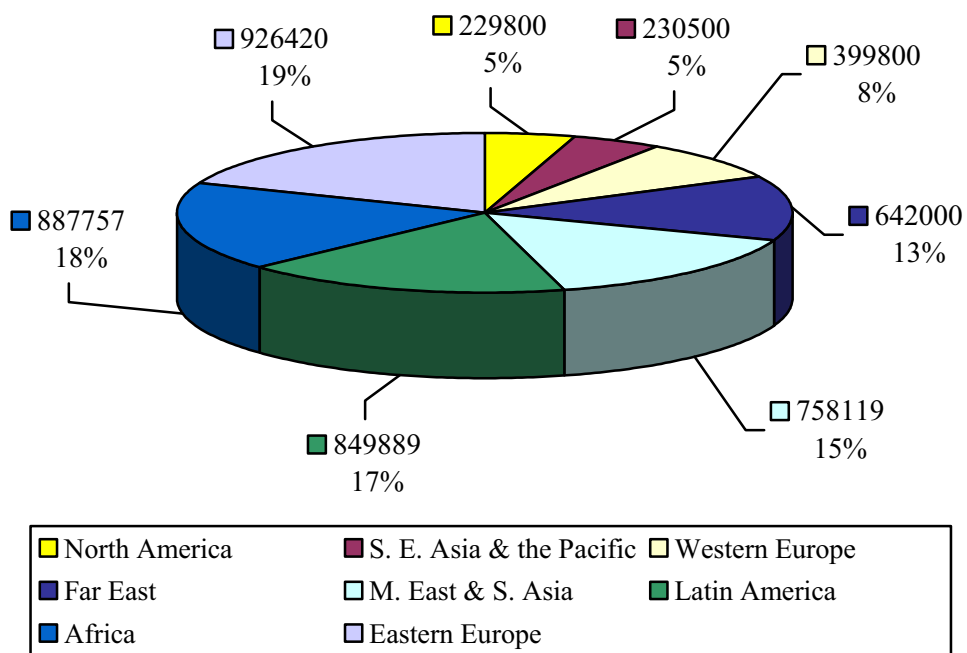
FIGURE 4. CRPs Active at End 2005 and RCMs Held During the Year



3.1. Member States Participation

The distribution of all contract awards in 2005 is shown by country in Annex IV. 70% of the funds awarded for contracts were made to institutes in developing countries. Figure 5 show the geographical distribution of all contract awards in 2005.

FIGURE 5. Geographical Distribution of Research Contract Awards in 2005



3.2. Extra-budgetary Funding

In 2005, extra-budgetary funds amounting to \$169 590 were used for financing contracts and RCMs. The funds used were from Japan, Nuclear Desalination Project (NDP), the Nuclear Security Multi-donors Fund, and United States of America as shown in Table 4.

TABLE 4. Summary of 2005 Extra-budgetary Funded Awards

Funds	CRP	Title	Type of expenditure and amount in \$			
			RCMs	Cost	Contracts	Cost
Japan	J7.10.10	Safety significance of postulated initiating events for different research reactor types and assessment of analytical tools	1	3 780	0	0
Nuclear Desalination Project (NDP)	I3.50.02	research on, and assessment of, selected nuclear desalination projects and case studies	1	10 660	0	0
Nuclear Security Multi-donors Fund	M2.20.06	Improvement of technical measures to detect and respond to illicit trafficking of nuclear material and other radioactive materials	0	0	12	116 150
United States of America	T1.20.18	Developing techniques for small scale indigenous Molybdenum 99 production using Low Enriched Uranium (LEU) fission or neutron activation	0	0	4	20 000
			1	19 000	0	0
Total			3	33 440	16	136 150

3.3. Coordinated Research Projects Completed in 2005

33 CRPs were completed in 2005, with 8 in Nuclear Power, Fuel Cycle and Nuclear Science, 21 of these CRPs concerning topics in Nuclear Techniques for Development and Environmental Protection, and 4 in Nuclear Safety and Security. A list of these CRPs is included in Appendix B. Evaluations of these CRPs will be completed by the end of 2006 and their accomplishments will be included in the next annual report.

4. ACCOMPLISHMENTS OF COORDINATED RESEARCH PROJECTS COMPLETED IN 2004

Coordinated Research Projects are fully evaluated one year after their completion. During 2004, 17 CRPs were successfully completed: 3 related to Nuclear Power, Fuel Cycle and Nuclear Science, 10 related to Nuclear Techniques for Development and Environmental Protection, and 4 to Nuclear Safety and Security.

Accomplishments of these CRPs such as publications, databases, software packages, websites, presentations at conferences, etc. are listed in Appendix D.

TOTAL NUMBER OF PROPOSALS RECEIVED AND AWARDS MADE IN 2005

Proposals Received				Awards*			
Country	Contracts	Agreements	Total	Regular	External	Agreements	Total
Algeria	11	0	11	5	0	0	5
Angola	2	0	2	1	0	0	1
Argentina	39	2	42	35	0	1	36
Armenia	2	0	2	2	0	0	2
Australia	3	6	9	3	0	4	7
Austria	3	1	4	3	0	2	5
Bangladesh	14	0	14	12	0	0	12
Barbados	1	0	1	1	0	0	1
Belarus	7	0	7	4	1	0	5
Belgium	2	6	8	2	0	4	6
Bolivia	0	0	0	1	0	0	1
Botswana	1	0	1	0	0	0	0
Brazil	57	4	61	39	0	1	40
Bulgaria	13	1	14	8	0	1	9
Burkina Faso	6	0	6	5	0	0	5
Cameroon	2	1	3	4	0	0	4
Canada	5	3	8	6	0	0	6
Chile	8	1	9	7	1	0	8
China	66	3	69	58	1	2	61
Colombia	5	1	6	7	0	1	8
Congo	1	0	1	0	0	0	0
Costa Rica	3	0	3	3	0	0	3
Côte d'Ivoire	3	0	3	1	0	0	1
Croatia	12	0	12	9	0	0	9
Cuba	17	0	17	16	0	0	16
Cyprus	1	0	1	1	0	0	1
Czech Republic	14	4	18	13	0	3	16
Democratic Rep. of the Congo	1	0	1	1	0	0	1
Denmark	0	2	2	0	0	2	2
Ecuador	1	0	1	1	0	0	1
Egypt	19	1	20	7	0	1	8
Eritrea	1	0	1	0	0	0	0
Estonia	2	0	2	3	0	0	3
Ethiopia	2	0	2	1	0	0	1
Finland	0	5	5	0	0	6	6
France	7	16	23	4	0	12	16
Gambia	1	0	1	1	0	0	1
Georgia	1	0	1	0	1	0	1
Germany	3	12	15	1	0	11	12
Ghana	12	0	12	6	0	0	6
Greece	15	2	17	6	0	2	8

* Also includes awards of approved proposals received in previous years

Proposals Received				Awards*			
Country	Contracts	Agreements	Total	Regular	External	Agreements	Total
Guatemala	2	0	2	1	0	0	1
Guinea	1	0	1	1	0	0	1
Hungary	17	3	20	16	0	4	20
India	53	6	59	48	0	4	52
Indonesia	12	1	13	12	0	1	13
Iran, Islamic Republic of	24	3	27	8	0	1	9
Israel	5	0	5	4	0	1	5
Italy	0	6	6	0	0	5	5
Jamaica	1	0	1	1	0	0	1
Japan	1	6	7	1	0	9	10
Jordan	5	0	5	1	0	0	1
Kazakhstan	4	0	4	3	1	0	4
Kenya	15	0	15	14	0	0	14
Korea, Republic of	14	11	25	15	0	10	25
Kuwait	1	0	1	0	0	0	0
Latvia	1	0	1	0	1	0	1
Lebanon	2	0	2	2	0	0	2
Libyan Arab Jamahiriya, Socialist People's	2	0	2	1	0	0	1
Lithuania	5	0	5	2	0	0	2
Malaysia	7	0	7	7	0	0	7
Mali	3	0	3	3	0	0	3
Malta	1	0	1	1	0	0	1
Mauritania	1	0	1	1	0	0	1
Mauritius	3	1	4	3	0	0	3
Mexico	12	2	14	13	0	2	15
Morocco	16	0	16	12	0	0	12
Myanmar	9	0	9	2	0	0	2
Namibia	1	0	1	1	0	0	1
Nepal	1	0	1	1	0	0	1
Netherlands	1	7	8	1	0	3	4
New Zealand	1	2	3	0	0	1	1
Nigeria	6	0	6	5	0	0	5
Norway	1	0	1	1	0	0	1
Pakistan	62	2	64	32	0	2	34
Paraguay	2	0	2	1	0	0	1
Peru	7	0	7	4	0	0	4
Philippines	16	0	16	11	0	0	11
Poland	20	1	21	16	1	1	18
Portugal	6	1	7	5	0	1	6
Romania	27	0	27	12	2	0	14
Russian Federation	45	8	53	34	6	4	44
Saudi Arabia	1	0	1	1	0	0	1
Senegal	3	1	4	2	0	0	2

* Also includes awards of approved proposals received in previous years

Annex I.2

Proposals Received				Awards*			
Country	Contracts	Agreements	Total	Regular	External	Agreements	Total
Serbia and Montenegro	2	0	2	2	0	0	2
Singapore	2	0	2	1	0	0	1
Slovakia	7	1	8	9	0	1	10
Slovenia	7	1	8	5	0	0	5
South Africa	29	2	31	25	0	1	26
Spain	0	3	3	0	0	4	4
Sri Lanka	4	0	4	4	0	0	4
Sudan	5	0	5	6	0	0	6
Sweden	0	5	5	0	0	4	4
Switzerland	4	0	4	2	0	0	2
Syrian Arab Republic	12	0	12	8	0	0	8
Thailand	26	0	26	17	0	0	17
The Former Yugoslav Republic of Macedonia	3	0	3	2	0	0	2
Tunisia	6	0	6	4	0	0	4
Turkey	16	0	16	14	0	1	15
Uganda	7	0	7	6	0	0	6
Ukraine	10	1	11	4	0	1	5
United Kingdom	11	11	22	10	0	10	20
United Republic of Tanzania	9	0	9	8	0	0	8
United States of America	10	21	31	11	0	18	29
Uruguay	7	0	7	11	0	0	11
Uzbekistan	4	1	5	4	1	0	5
Venezuela	2	0	2	3	0	0	3
Vietnam	24	0	24	14	0	0	14
Yemen	2	0	2	2	0	0	2
Zambia	1	0	1	0	0	0	0
Zimbabwe	2	0	2	1	0	0	1
Total	992	178	1 170	749	16	142	907

* Also includes awards of approved proposals received in previous years

DISTRIBUTION OF TOTAL 2005 CONTRACT AWARDS, BY COUNTRY AND PROGRAMME

Country	Contracts			Major Programme 1			MP1	Major Programme 2					MP2	Major Programme 3				Total	
	New	Ren.	Total	A	B	D		E	F	G	H	I		J	K	L	M		MP3
Algeria	0	5	5	0		0	0	8 000	15000	0	0	0	23 000	4 000	0	0	0	4 000	27 000
Angola	1	0	1	0			0	11 000	0		0		11 000	0	0		0	0	11 000
Argentina	6	29	35	8 500	6 000	31 500	46 000	84 500	25 000	9 000	0	9 000	127 500	0	0	5 000	0	5 000	178 500
Armenia	0	2	2	0			0	10 000	0		0		10 000	4 000	0		0	4 000	14 000
Australia	1	2	3	0			0	20 000	0		0		20 000	0	0		0	0	20 000
Austria	2	1	3	0			0	7 000	0	35 000	0	4 000	46 000	0	0		0	0	46 000
Bangladesh	4	8	12	0		5 000	5 000	46 000	51000	0	0	0	97 000	0	0		0	0	102 000
Barbados	0	1	1	0			0	6 000	0		0		6 000	0	0		0	0	6 000
Belarus	2	3	5	4 000		5 000	9 000	0	9000	0	0	0	9 000	0	0	5 000	4 000	9 000	27 000
Belgium	0	2	2	0		650	650	7 000	0	0	0	0	7 000	0	0		0	0	7 650
Bolivia	0	1	1	0			0	10 000	0		0		10 000	0	0		0	0	10 000
Brazil	8	31	39	5 038		20 650	25 688	90 000	52500	10 000	0	28 000	180 500	4 000	0	10 000	0	14 000	220 188
Bulgaria	1	7	8	0		5 000	5 000	34 000	5000	0	0	4 000	43 000	5 000	0		0	5 000	53 000
Burkina Faso	3	2	5	0			0	31 500	7000		0		38 500	0	0		0	0	38 500
Cameroon	2	2	4	0			0	8 000	23000		0		31 000	0	0		0	0	31 000
Canada	1	5	6	0	4 000		4 000	13 500	23300		0		36 800	0	0		0	0	40 800
Chile	2	6	8	0		5 000	5 000	33 500	14000		0		47 500	0	0		0	0	52 500
China	16	43	59	14 000		41 000	55 000	186 500	93000	9 000	0	20 000	308 500	0	0	14 000	4 000	18 000	381 500
Colombia	2	5	7	0		0	0	25 000	21000	5 000	0	0	51 000	0	0		0	0	51 000
Costa Rica	0	3	3	0			0	16 000	0		0		16 000	0	0		0	0	16 000
Côte d'Ivoire	0	1	1	0			0	10 000	0		0		10 000	0	0		0	0	10 000
Croatia	2	7	9	0		21 000	21 000	13 500	5500	0	0	4 000	23 000	0	0		0	0	44 000
Cuba	4	12	16	0		5 500	5 500	28 000	32000	0	5 000	10 000	75 000	0	0	5 000	0	5 000	85 500
Cyprus	0	1	1	0			0	6 000	0		0		6 000	0	0		0	0	6 000
Czech Republic	3	10	13	0	6 500	10 000	16 500	30 000	21000	0	0	5 000	56 000	5 000	0	9 000	0	14 000	86 500
Democratic Rep. of the Congo	1	0	1	0			0	12 000	0		0		12 000	0	0		0	0	12 000
Ecuador	0	1	1	0		0	0	0	0	0	0	4 000	4 000	0	0		0	0	4 000
Egypt	3	4	7	2 000		3 000	5 000	10 000	15000	0	0	8 000	33 000	0	0		0	0	38 000

DISTRIBUTION OF TOTAL 2005 CONTRACT AWARDS, BY COUNTRY AND PROGRAMME

Country	Contracts			Major Programme 1			MP1	Major Programme 2					MP2	Major Programme 3				MP3	Total
	New	Ren.	Total	A	B	D		E	F	G	H	I		J	K	L	M		
Estonia	0	3	3	0		6 000	6 000	0	5500	0	0	0	5 500	0	0		0	0	11 500
Ethiopia	0	1	1	0			0	10 000	0		0		10 000	0	0		0	0	10 000
France	3	1	4	0		0	0	17 500	5000	25 000	0	0	47 500	0	0		0	0	47 500
Gambia	1	0	1	0			0	12 000	0		0		12 000	0	0		0	0	12 000
Georgia	0	1	1	0			0	0	0		0		0	0	0		20 000	20 000	20 000
Germany	1	0	1	0		0	0	7 500	0	0	0	0	7 500	0	0		0	0	7 500
Ghana	2	4	6	0		0	0	18 000	11000	6 000	0	4 000	39 000	0	0		0	0	39 000
Greece	1	5	6	0			0	32 000	0	2 500	0	4 000	38 500	0	0		0	0	38 500
Guatemala	0	1	1	0			0	0	9000		0		9 000	0	0		0	0	9 000
Guinea	1	0	1	0			0	12 000	0		0		12 000	0	0		0	0	12 000
Hungary	5	11	16	0	5 000	18 000	23 000	24 000	13000	0	0	17 000	54 000	5 000	0		0	5 000	82 000
India	10	38	48	7 500	5 000	18 000	30 500	92 819	130000	0	0	8 000	230 819	4 000	5 500		0	9 500	270 819
Indonesia	2	10	12	0		0	0	54 000	12000	0	5 000	8 000	79 000	0	0		0	0	79 000
Iran, Islamic Republic of	3	5	8	0		0	0	26 000	24000	0	0	5 000	55 000	0	0		0	0	55 000
Israel	2	2	4	0			0	27 000	0		0		27 000	0	0		0	0	27 000
Jamaica	1	0	1	0			0	0	9000		0		9 000	0	0		0	0	9 000
Japan	0	1	1	0			0	0	8000		0		8 000	0	0		0	0	8 000
Jordan	0	1	1	0		0	0	0	0	0	0	4 000	4 000	0	0		0	0	4 000
Kazakhstan	2	2	4	0		10 000	10 000	8 000		0	0	4 000	12 000	0	0		0	0	22 000
Kenya	8	6	14	0			0	58 000	50200		0		108 200	0	0		0	0	108 200
Korea, Republic of	2	13	15	3 500		0	3 500	42 000	15000	0	0	14 000	71 000	4 000	0	4 000	0	8 000	82 500
Latvia	0	1	1	0			0	0	0		0		0	0	0		7 500	7 500	7 500
Lebanon	2	0	2	0		0	0	0	9000	0	0	3 000	12 000	0	0		0	0	12 000
Libyan Arab Jamahiriya, Socialist People's	1	0	1	0		5 000	5 000	0	0	0	0	0	0	0	0		0	0	5 000
Lithuania	2	0	2	0	5 000		5 000	0	0		0		0	0	0	5 000	0	5 000	10 000
Malaysia	2	5	7	0		0	0	5 000	5000	0	0	13 000	23 000	0	4 000		0	4 000	27 000
Mali	3	0	3	0			0	12 000	17000		0		29 000	0	0		0	0	29 000
Malta	0	1	1	0			0	6 000	0		0		6 000	0	0		0	0	6 000

DISTRIBUTION OF TOTAL 2005 CONTRACT AWARDS, BY COUNTRY AND PROGRAMME

Country	Contracts			Major Programme 1			MP1	Major Programme 2					MP2	Major Programme 3				MP3	Total
	New	Ren.	Total	A	B	D		E	F	G	H	I		J	K	L	M		
Mauritania	1	0	1	0			0	12 000	0		0		12 000	0	0		0	0	12 000
Mauritius	0	3	3	0			0	13 500	0		0		13 500	0	0		0	0	13 500
Mexico	3	10	13	0		3 500	3 500	50 200	31 500	0	0	8 000	89 700	0	0		0	0	93 200
Morocco	3	9	12	3 000		0	3 000	23 000	48 000	4 000	0	0	75 000	0	0		0	0	78 000
Myanmar	0	2	2	0			0	5 000	5 000		0		10 000	0	0		0	0	10 000
Namibia	0	1	1	0			0	6 000	0		0		6 000	0	0		0	0	6 000
Nepal	0	1	1	0			0	6 000	0		0		6 000	0	0		0	0	6 000
Netherlands	1	0	1	0		0	0	0	0	0	0	5 000	5 000	0	0		0	0	5 000
Nigeria	4	1	5	0		3 000	3 000	12 500	14 000	0	0	0	26 500	0	0		0	0	29 500
Norway	0	1	1	0	5 000		5 000	0	0		0		0	0	0		0	0	5 000
Pakistan	8	24	32	2 000	7 500	5 000	14 500	86 000	64 300	13 500	5 000	8 000	176 800	0	0		0	0	191 300
Paraguay	0	1	1	0			0	8 000	0		0		8 000	0	0		0	0	8 000
Peru	1	3	4	0		0	0	9 000	8 000	0	0	4 000	21 000	0	0		0	0	21 000
Philippines	1	10	11	0		0	0	54 000	17 000	0	6 000	4 000	81 000	0	0		0	0	81 000
Poland	3	14	17	3 000		13 500	16 500	35 000	9 000	0	0	21 000	65 000	0	3 000		9 500	12 500	94 000
Portugal	2	3	5	0		14 000	14 000	6 000	0	0	0	4 000	10 000	0	0		0	0	24 000
Romania	5	9	14	1 500	5 000	31 000	37 500	8 000	4 000	0	0	9 000	21 000	1 000	0	5 000	0	6 000	64 500
Russian Federation	14	26	40	23 500	11 000	79 000	113 500	8 000	9 000	0	5 000	8 000	30 000	13 800	0	9 000	63 150	85 950	229 450
Saudi Arabia	1	0	1	0		0	0	0	0	0	0	5 000	5 000	0	0		0	0	5 000
Senegal	1	1	2	0			0	12 000	9 000		0		21 000	0	0		0	0	21 000
Serbia and Montenegro	0	2	2	0		6 000	6 000	0	0	4 000	0	0	4 000	0	0		0	0	10 000
Singapore	0	1	1	0			0	0	6 000		0		6 000	0	0		0	0	6 000
Slovakia	1	8	9	1 000	5 000	5 000	11 000	22 000	8 000	5 000	0	0	35 000	5 000	0		0	5 000	51 000
Slovenia	3	2	5	0		9 000	9 000	0	17 000	4 000	0	0	21 000	0	0		0	0	30 000
South Africa	7	18	25	0		15 000	15 000	71 000	67 700	5 000	0	4 000	147 700	0	0	4 000	0	4 000	166 700
Sri Lanka	0	4	4	0			0	24 000	5 000		0		29 000	0	0		0	0	29 000
Sudan	2	4	6	0			0	0	37 800		0		37 800	0	0		0	0	37 800

DISTRIBUTION OF TOTAL 2005 CONTRACT AWARDS, BY COUNTRY AND PROGRAMME

Country	Contracts			Major Programme 1			MP1	Major Programme 2					MP2	Major Programme 3				MP3	Total
	New	Ren.	Total	A	B	D		E	F	G	H	I		J	K	L	M		
Switzerland	1	1	2	0			0	9 000	10000		0		19 000	0	0		0	0	19 000
Syrian Arab Republic	1	7	8	2 000		0	2 000	26 000	5000	0	0	9 000	40 000	0	0		0	0	42 000
Thailand	3	14	17	0		5 000	5 000	46 000	27000	0	0	4 000	77 000	0	6 500		0	6 500	88 500
The Former Yugoslav Republic of Macedonia	1	1	2	0		5 000	5 000	10 000	0	0	0	0	10 000	0	0		0	0	15 000
Tunisia	0	4	4	0			0	28 557	0		0		28 557	0	0		0	0	28 557
Turkey	1	13	14	0			0	43 000	23000	4 000	2 500	8 000	80 500	0	2 500		0	2 500	83 000
Uganda	1	5	6	0			0	46 000	5000		0		51 000	0	0		0	0	51 000
Ukraine	1	3	4	0		5 000	5 000	0	0	0	0	0	0	0	0	13 970	0	13 970	18 970
United Kingdom	4	6	10	0		5 650	5 650	55 000	14000	0	0	0	69 000	0	30 000		0	30 000	104 650
United Republic of Tanzania	3	5	8	0		3 500	3 500	21 000	33500	0	0	0	54 500	0	0		0	0	58 000
United States of America	6	5	11	28 000		0	28 000	37 000	69000	45 000	0	0	151 000	0	10 000		0	10 000	189 000
Uruguay	2	9	11	0		0	0	16 000	40000	0	0	8 000	64 000	0	3 000		0	3 000	67 000
Uzbekistan	0	5	5	0		5 000	5 000	16 000	7000	0	0	0	23 000	0	0		8 000	8 000	36 000
Venezuela	1	2	3	0			0	14 000	5000		0		19 000	0	0		0	0	19 000
Vietnam	1	13	14	3 000		0	3 000	53 001	5000	10 000	0	12 000	80 001	0	0		0	0	83 001
Yemen	1	1	2	0			0	20 000	0		0		20 000	0	0		0	0	20 000
Zimbabwe	0	1	1	0			0	0	3000		0		3 000	0	0		0	0	3 000
Total	206	559	765	111 538	65 000	423 450	599 988	2 132 577	1 341 800	196 000	28 500	301 000	3 999 877	54 800	64 500	88 970	116 150	324 420	4 924 285

RESEARCH COORDINATION MEETINGS HELD IN 2005

Regular Budget

Major Programme 1: Nuclear power, fuel cycle and nuclear science

A: Nuclear Power (NENP)			Expenditure \$
A1	I2.10.18	Master curve approach to monitor the fracture toughness of reactor pressure vessel in nuclear power plants	20 630
	I2.10.19	Review and benchmark of calculation methods for structural integrity assessment of reactor pressure vessels during pressurized thermal shocks	12 180
A3	I2.50.01	Small reactors without on-site refuelling	44 146
A4	I3.10.12	Evaluation of high temperature gas cooled reactor performance	27 140
	I3.10.13	Conservation and application of high temperature gas cooled reactor (HTGR) technology: Advances in HTGR fuel technology development	25 150
	I3.10.14	Natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation	39 840
	I3.20.06*	Analytical and experimental benchmark analyses of accelerator driven systems (ADS)	6 800
	I3.30.10	Intercomparison of techniques for pressure tube inspection and diagnostics	16 420
	I3.50.02*	Economic research on, and assessment of, selected nuclear desalination projects and case studies	15 000
B: Nuclear Fuel Cycle and Materials Technologies (NEFW)			
B2	T1.20.15	Improvement on the models used for fuel behaviour simulation (FUMEX II)	39 010
	T1.20.17	Delayed hydride cracking (DHC) of zirconium alloy fuel cladding	25 944
B3	T1.30.12	Spent fuel performance assessment and research (SPAR II)	25 000
D: Nuclear Science (NAPC + NEFW)			
D1	F4.10.22	Parameters for calculation of nuclear reactions of relevance to non-energy nuclear applications	26 849
	F4.10.23	Development of a reference database for ion beam analysis	17 079
	F4.20.05	Reference database for neutron activation analysis	13 894
	F4.20.06	Updated decay data library for actinides	13 014
	F4.30.14*	Atomic and molecular data for plasma modelling	23 277
	F4.30.15	Atomic data for heavy element impurities in fusion reactors	23 138
D2	F2.30.21	New applications of prompt gamma neutron activation analysis (PGNAA)	19 830
	T1.20.18*	Developing techniques for small scale indigenous Molybdenum 99 production using Low Enriched Uranium (LEU) fission or neutron activation	9 830
	T1.30.10	Corrosion of research reactor aluminium-clad spent fuel in water (Phase II)	21 930

* Entry appears under more than one Programme as a shared cost

D3	F1.20.17	Development of new techniques and applications of accelerator mass spectrometry	13 175
	F1.20.18	Development of harmonized QA/AC procedures for maintenance and repair of nuclear instruments	20 163
	F1.20.19	Development of nuclear microprobe techniques for the quantitative analysis of individual microparticles	24 980
D4	F1.30.09	Dense magnetized plasmas	15 050
Total Major Programme 1			518 908

Major programme 2: Nuclear techniques for development and environmental protection

E: Food and Agriculture (NAFA)

E1	D1.20.07	Use of nuclear techniques for developing integrated nutrient and water management practices for agroforestry systems	40 907
	D1.20.08	Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination	26 760
	D1.50.07	Integrated soil, water and nutrient management for sustainable rice-wheat cropping systems in Asia	15 368
	D1.50.09	Integrated soil, water and nutrient management in conservation agriculture	34 658
	D2.30.24	Physical mapping technologies for the identification and characterization of mutated genes contributing to crop quality	42 903
	D2.30.26	Identification and pyramiding of mutated genes: novel approaches for improving crop tolerance to salinity and drought	49 171
	D2.30.27	Molecular tools for quality improvement in vegetatively propagated crops including banana and cassava	51 181
	D2.40.11	Effects of mutagenic agents on the DNA sequence in plants	45 322
	D4.10.17	Development of improved attractants and their integration into fruit fly SIT management programmes	54 353
	D4.10.18	Improvement of codling moth SIT to facilitate expansion of field application	29 585
	D4.10.19	Molecular technologies to improve the effectiveness of SIT	42 345
	D4.10.21	Development of mass rearing for New World (<i>Anastrepha</i>) and Asian (<i>Bactrocera</i>) fruit fly pest in support of SIT	44 706
	D4.30.02	Evaluating the use of nuclear techniques for the colonization and production of natural enemies of agricultural insect pests	33 584
E2	D3.10.23	Integrated approach for improving small scale market oriented dairy systems	32 459
	D3.10.24	Development and use of rumen molecular techniques for predicting and enhancing livestock productivity	50 178
	D3.10.25	Gene-based technologies in livestock breeding: Characterization of small ruminant genetic resources in Asia	14 210
	D3.20.21	Developing, validating and standardizing methodologies for the use of PCR and PCR-ELISA in the diagnosis and monitoring of control and eradication programmes for trypanosomiasis	37 036
	D3.20.22	The development of strategies for the effective monitoring of veterinary drug residues in livestock and livestock products in developing countries	37 630
	D3.20.23	Veterinary surveillance of Rift Valley Fever	21 495
	D4.20.09	Enabling technologies for the expansion of SIT for old and new world screwworm	13 030

	D4.20.10	Improved and harmonized quality control for expanded tsetse production, sterilization and field application	34 806
E3	D5.40.03	Quality control of pesticide products	17 825
	D6.10.22	Use of irradiation to ensure hygienic quality of fresh, pre-cut fruits and vegetables and other minimally processed food of plant origin	28 160
	D6.10.23	Testing the efficiency and uncertainty of sample processing for analysis of food contaminants	22 048

F: Human Health (NAHU)

F1	G3.40.01	Development of standardised mass rearing systems for male <i>Anopheles arabiensis</i> mosquitoes (formerly D4.20.11)	15 467
F1	E1.30.19	Doctoral CRP on Management of liver cancer using radionuclide methods with special emphasis on trans-arterial radioconjugate therapy and internal dosimetry	11 321
	E1.30.22	Harmonization of radionuclide procedures and protocols in the management of neonatal hydronephrosis	11 025
	E1.30.23	Radiopharmaceutical imaging to predict and evaluate the response of breast cancer to neoadjuvant chemotherapy	13 232
	E1.30.26	Comparative evaluation of radiopharmaceuticals for radiosynovectomy	29 046
	E1.30.30	Development and quality control of hospital prepared radiopharmaceuticals for infection imaging for use in HIV/AIDS positive patients	24 183
	E1.50.19	Improved accuracy of molecular and immunological markers for prediction of efficacy of antimalarial drugs	28 494
F2	E3.30.18	Aspects of radiobiology applicable in clinical radiotherapy - Increase of the number of fractions per week	16 053
	E3.30.22	Doctoral CRP on clinical and experimental studies to improve radiotherapy outcome in AIDS cancer patients	21 877
	E3.30.23	Resource sparing treatment of head and neck cancer	9 786
	E3.30.24	Radiobiological and clinical study on viral-induced cancers response to radiotherapy	18 931
F3	E2.10.05	Harmonization of quality practices for nuclear medicine radioactivity measurements	15 782
	E2.10.06	Testing of the implementation of the code of practice for dosimetry in X-ray diagnostic radiology	26 142
	E2.40.14	Development of procedures for in vivo dosimetry in radiotherapy	24 618
F4	E4.10.13	Use of nuclear and related analytical techniques in studying human exposure to toxic elements consumed through foodstuffs contaminated by industrial activities	40 946
	E4.10.14	Exposure to toxic and potentially toxic elements in women of childbearing age in developing countries	24 443
	E4.30.13	Doctoral CRP on Isotopic and complementary tools for the study of micronutrient status and interactions in developing country populations exposed to multiple nutritional deficiencies	18 036
	E4.30.14	Application of isotopic and nuclear techniques in the study of nutrition-pollution interactions and their impact on the nutritional status of human subjects in developing country populations	29 163
	E4.30.15	The application of isotopic and nuclear techniques in studies related to intrauterine growth restriction (IUGR) issues in populations from developing countries	29 200
	E4.30.16	Assessment of total energy expenditure and body composition for older adult subjects with different lifestyles	26 597
	E4.30.18	Zinc nutrition during early life	14 597

G: Water Resources (NAPC)

G1	F3.30.13	Application of isotopes to the assessment of pollutant behaviour in the unsaturated zone for groundwater protection	17 486
	F3.30.14*	Nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones	5 579
G2	F3.20.03	Design criteria for a network to monitor isotope compositions of runoff in large rivers	42 010
	F3.40.10	Isotope methods for the study of water and carbon cycle dynamics in the atmosphere and biosphere	6 228

H: Protection of the Marine and Terrestrial Environment (NAML)

H1	F3.30.14*	Nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones	5 579
H2	K4.10.08	Nuclear applications to determine bioaccumulation parameters and processes used for establishing coastal zone monitoring and management criteria	26 693

I: Physical and Chemical Applications (NAPC)

I1	F2.20.36	Development of radioactive sources for emerging therapeutic and industrial applications	17 781
	F2.20.37	Comparative laboratory evaluation of therapeutic radiopharmaceuticals	32 273
	F2.30.23	Applications of nuclear analytical techniques to investigate the authenticity of art objects	27 396
I2	F2.10.09	Industrial process gamma tomography	18 508
	F2.20.39	Controlling of degradation effects in radiation processing of polymers	33 653
	F2.30.20	Corrosion and deposit determination in large diameter pipes, with and without insulation by radiography testing	29 466
	F2.30.24	Electron beam treatment of organic pollutants contained in gaseous streams	28 841

Total Major Programme 2**1 560 152****Major programme 3: Nuclear Safety and Security****J: Safety of Nuclear Installation (NSNI)**

J3	J4.20.04	Assessment of the interfaces between neutronic, thermal-hydraulic, structural and radiological aspects in accident analyses	24 430
J5	J4.10.05	Safety significance of near field earthquakes	32 112
J7	J7.10.10*	Safety significance of postulated initiating events for different research reactor types and assessment of analytical tools	25 030

K: Radiation and Transportation Safety

K5	J1.70.06	Exploring the possibility of establishing guidance levels for interventional radiology	15 592
	J1.70.08	Evaluate quantitatively and promote patient dose reduction approaches in interventional radiology	9 724
	J1.70.09	Dose reduction in computed tomography (CT) while maintaining diagnostic confidence	10 307
K7	J1.30.09	Accident severity during air transport of radioactive material	21 020

* Entry appears under more than one Programme as a shared cost

L: Management of Radioactive Waste

L4	T2.10.22	Characterization and performance studies and demonstration in underground research laboratories of swelling clays as engineered barriers of geological repositories	35 880
	T2.10.23	New development and improvements in processing of "problematic" radioactive waste streams	32 459
L7	T2.40.07	Innovative and adaptive technologies in decommissioning of nuclear facilities	30 164
Total Major Programme 3			236 718

2004 Unobligated Funds**A: Nuclear Power (NENP)**

A4	I3.20.06*	Analytical and experimental benchmark analyses of accelerator driven systems (ADS)	21 005
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I: Physical and Chemical Applications (NAPC)

D1	F4.30.14*	Atomic and molecular data for plasma modeling	20 561
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Total Regular Funds **2 357 344**

External Funds**A: Nuclear Power (NENP)**

A4	I3.50.02*	Economic research on, and assessment of, selected nuclear desalination projects and case studies	10 660
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D: Nuclear Science (NEFW)

D2	T1.20.18*	Developing techniques for small scale indigenous Molybdenum 99 production using Low Enriched Uranium (LEU) fission or neutron activation	19 000
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J: NSSC

J2	J7.10.10*	Safety significance of postulated initiating events for different research reactor types and assessment of analytical tools	3 780
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Total External Budget Funds **33 440**

Total Funds **2 390 784**

* Entry appears under more than one Programme as a shared cost

LOCATIONS OF RESEARCH COORDINATION MEETINGS HELD IN 2005

<i>Country</i>	<i>Number of meetings</i>
Argentina	2
Austria	51
Bangladesh	1
Belarus	1
Brazil	1
Canada	1
Egypt	1
France	1
Germany	1
Greece	1
Guatemala	1
Hungary	1
Iceland	1
Indonesia	1
Italy	1
India	1
Monaco	1
Morocco	1
Myanmar	1
Norway	1
Pakistan	1
Philippines	1
Poland	1
Republic of Korea	1
Senegal	1
South Africa	4
Spain	1
Sweden	1
Switzerland	1
Syria	1
Thailand	3
Ukraine	1
Uruguay	1
USA	2
Vietnam	1
Total	92

TOTAL 2005 CONTRACT AWARDS, BY COUNTRY

<i>Country</i>	<i>Total \$</i>
China	381 500
India	270 819
Russian Federation	229 450
Brazil	220 187
Pakistan	191 300
United States of America	189 000
Argentina	178 500
South Africa	166 700
Kenya	108 200
United Kingdom	104 650
Bangladesh	102 000
Poland	94 000
Mexico	93 200
Thailand	88 500
Czech Republic	86 500
Cuba	85 500
Vietnam	83 001
Turkey	83 000
Korea, Republic of	82 500
Hungary	82 000
Philippines	81 000
Indonesia	79 000
Morocco	78 000
Uruguay	67 000
Romania	64 500
United Republic of Tanzania	58 000
Iran, Islamic Republic of	55 000
Bulgaria	53 000
Chile	52 500
Colombia	51 000
Slovakia	51 000
Uganda	51 000
France	47 500
Austria	46 000
Croatia	44 000
Syrian Arab Republic	42 000
Canada	40 800
Ghana	39 000

<i>Country</i>	<i>Total \$</i>
Burkina Faso	38 500
Greece	38 500
Egypt	38 000
Sudan	37 800
Uzbekistan	36 000
Cameroon	31 000
Slovenia	30 000
Nigeria	29 500
Mali	29 000
Sri Lanka	29 000
Tunisia	28 557
Algeria	27 000
Belarus	27 000
Israel	27 000
Malaysia	27 000
Portugal	24 000
Kazakhstan	22 000
Peru	21 000
Senegal	21 000
Australia	20 000
Georgia	20 000
Yemen	20 000
Switzerland	19 000
Venezuela	19 000
Ukraine	18 970
Costa Rica	16 000
The Former Yugoslav Republic of Macedonia	15 000
Armenia	14 000
Mauritius	13 500
Democratic Rep. of the Congo	12 000
Gambia	12 000
Guinea	12 000
Lebanon	12 000
Mauritania	12 000
Estonia	11 500
Angola	11 000
Bolivia	10 000
Côte d'Ivoire	10 000
Ethiopia	10 000
Lithuania	10 000

<i>Country</i>	<i>Total \$</i>
Myanmar	10 000
Serbia and Montenegro	10 000
Guatemala	9 000
Jamaica	9 000
Japan	8 000
Paraguay	8 000
Belgium	7 650
Germany	7 500
Latvia	7 500
Barbados	6 000
Cyprus	6 000
Malta	6 000
Namibia	6 000
Nepal	6 000
Singapore	6 000
Libyan Arab Jamahiriya, Socialist People's	5 000
Netherlands	5 000
Norway	5 000
Saudi Arabia	5 000
Ecuador	4 000
Jordan	4 000
Zimbabwe	3 000
Total	4 924 285

ACTIVE COORDINATED RESEARCH PROJECTS AT END 2005

A. NUCLEAR POWER

A.1. Nuclear Power Plant Operating Performance and Life Cycle Management

I2.10.18 Master curve approach to monitor the fracture toughness of reactor pressure vessel in nuclear power plants
 13 Agreements 05/3/1 08/12/31
 Belgium(A)¹, Bulgaria(A), Czech Republic(A), Finland(A), Germany(A), Hungary(A), Japan(A), Korea, Republic of(A), Mexico(A), Russian Federation(A), Spain(A), United States of America(A) (2)

I2.10.19 Review and benchmark of calculation methods for structural integrity assessment of reactor pressure vessels during pressurized thermal shocks
 2 Contracts 7 Agreements 05/9/15 08/12/31
 China(C)², Czech Republic(A), Finland(A), Germany(A), Hungary(A), Korea, Republic of(A), Netherlands(A), Russian Federation(C), Slovakia(A)

A.3. Coordination of International Collaboration for the Development of Innovative Nuclear Technologies

I2.50.01 Small reactors without on-site refuelling
 12 Contracts 6 Agreements 04/12/1 08/12/31
 Brazil(C) (2), Croatia(C), India(C), Indonesia(C), Italy(A), Japan(A) (2), Lithuania(C), Morocco(C), Russian Federation(C) (4), United States of America(A) (3), Vietnam(C)

A.4. Technology Developments and Applications for Advanced Reactors

I3.10.12 Evaluation of high temperature gas cooled reactor performance
 10 Agreements 97/11/1 06/12/31
 China(A), France(A), Germany(A), Japan(A), Korea, Republic of(A), Netherlands(A), Russian Federation(A), South Africa(A), Turkey(A), United States of America(A)

I3.10.13 Conservation and application of high temperature gas cooled reactor (HTGR) technology: Advances in HTGR fuel technology development
 10 Agreements 00/11/1 08/12/31
 China(A), France(A), Germany(A), Japan(A), Korea, Republic of(A), Netherlands(A), Russian Federation(A), South Africa(A), Turkey(A), United States of America(A)

I3.10.14 Natural circulation phenomena, modelling and reliability of passive systems that utilize natural circulation
 5 Contracts 13 Agreements 04/3/1 08/2/29
 Argentina(C), Czech Republic(C), France(A), Germany(A), India(C), Italy(A) (2), Japan(A), Korea, Republic of(A), Netherlands(A), Russian Federation(A), Slovakia(C), Spain(A), Switzerland(A), United States of America(A) (3)United States of America(C)

I3.20.04 Studies of innovative reactor technology options for effective incineration of radioactive waste
 4 Contracts 18 Agreements 01/12/15 05/12/31
 Belgium(A) (2), China(A)China(C), Czech Republic(C), France(A) (2), Germany(A) (2), Hungary(A) (2), India(C), Italy(A), Japan(A), Korea, Republic of(A), Netherlands(A) (2), Poland(A), Russian Federation(A) (2)Russian Federation(C), United States of America(A)

I3.20.05 Updated codes and methods to reduce the calculational uncertainties of the LMFR reactivity effects
 2 Contracts 7 Agreements 99/10/1 06/5/31
 China(C), France(A), Germany(A), India(A), Japan(A), Korea, Republic of(A), Russian Federation(C), United Kingdom(A), United States of America(A)

¹ (A) Research Agreement

² (C) Research Contract

I3.20.06	Analytical and Experimental Benchmark Analyses of Accelerator Driven Systems (ADS) 7 Contracts 17 Agreements 05/10/1 10/9/30 Argentina(C), Belarus(C), Belgium(A), Brazil(C), China(C), France(A) (2), Germany(A) (2), Hungary(A), Italy(A), Japan(A), Pakistan(A), Poland(A)Poland(C), Russian Federation(A) (2) Russian Federation(C) (2), Spain(A) (2), Sweden(A), Ukraine(A), United States of America(A)
I3.30.10	Intercomparison of techniques for pressure tube inspection and diagnostics 5 Contracts 2 Agreements 98/12/15 05/12/31 Argentina(C), Canada(A), India(C), Korea, Republic of(A) Korea, Republic of(C), Romania(C) (2)
I3.50.02	Economic research on, and assessment of, selected nuclear desalination projects and case studies 8 Contracts 3 Agreements 01/12/15 06/12/31 Argentina(C), Canada(A), China(C), Egypt(C), France(A), India(C), Korea, Republic of(C), Pakistan(C), Russian Federation(C), Syrian Arab Republic(C), United States of America(A)

B. NUCLEAR FUEL CYCLE AND MATERIALS TECHNOLOGIES

B.2. Nuclear Fuel Performance and Technology

T1.20.14	Data processing technologies and diagnostics for water chemistry and corrosion control in nuclear power plants (DAWAC) 2 Contracts 13 Agreements 01/3/1 06/3/31 Bulgaria(A), Canada(A), China(A), Czech Republic(C), Finland(A), France(A), Germany(A), Hungary(A), India(A), Japan(A), Slovakia(C), Sweden(A), Ukraine(A), United States of America(A) (2)
T1.20.15	Improvement on the models used for fuel behaviour simulation (FUMEX II) 5 Contracts 11 Agreements 02/9/1 05/12/31 Argentina(A), Belgium(A), Bulgaria(C) (2), Canada(A), China(A), Czech Republic(C), Finland(A), Germany(A) (2), India(A), Japan(A), Korea, Republic of(A), Norway(C), Romania(A), Russian Federation(C)
T1.20.17	Delayed hydride cracking (DHC) of zirconium alloy fuel cladding 6 Contracts 4 Agreements 05/3/1 09/12/31 Argentina(C), Brazil(A), Canada(C), India(C), Korea, Republic of(A), Lithuania(C), Pakistan(C), Romania(C), Russian Federation(A), Sweden(A)

B.3. Management of Spent Fuel from Power Reactors

T1.30.12	Spent fuel performance assessment and research (SPAR II) 3 Contracts 9 Agreements 04/12/1 09/12/31 Canada(A), Germany(A) (2), Hungary(C), Japan(A) (2), Korea, Republic of(A), Russian Federation(C), Slovakia(C), Spain(A), United Kingdom(A), United States of America(A)
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B.4. Topical Nuclear Fuel Cycle Issues and Information Systems

T1.30.11	Study of process-losses in separation processes in Partitioning and Transmutation (P&T) systems in view of minimizing long term environmental impacts 3 Contracts 6 Agreements 03/9/1 08/9/30 China(A), Czech Republic(C), Germany(A), India(A)India(C), Japan(A), Korea, Republic of(A), Russian Federation(C), United States of America(A)
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D. NUCLEAR SCIENCE

D.1. Atomic and Nuclear Data

F4.10.19	Improvement of the standard neutron cross sections for light elements 4 Contracts 5 Agreements 02/4/1 06/6/30 Austria(A), China(C), Germany(A), Korea, Republic of(C), Russian Federation(C) (2), United States of America(A) (3)
F4.10.20	Evaluated nuclear data for the Thorium-Uranium fuel cycle 6 Contracts 4 Agreements 02/11/1 06/2/28 Austria(A), Belarus(C), Bulgaria(C), China(C), India(C), Japan(A), Romania(C), Russian Federation(C), United States of America(A) (2)

D.3. Utilization of Accelerators and Instrumentation

F1.20.16	Ion beam modification of insulators 4 Contracts	3 Agreements	04/8/1	08/7/31
	Bulgaria(C), Croatia(C), Germany(A), Portugal(A), South Africa(C), Thailand(C), United Kingdom(A)			
F1.20.17	Development of new techniques and applications of accelerator mass spectrometry 5 Contracts		04/12/15	08/12/14
	Argentina(C) (2), China(C), Croatia(C), Kazakhstan(C)			
F1.20.19	Development of nuclear microprobe techniques for the quantitative analysis of individual microparticles 8 Contracts	1 Agreement	05/7/1	08/6/30
	Argentina(C), Croatia(C), France(A), Hungary(C) (2), India(C), Portugal(C), Slovenia(C), South Africa(C)			
F1.20.18	Development of harmonized QA/AC procedures for maintenance and repair of nuclear instruments 7 Contracts	1 Agreement	05/9/15	08/9/14
	Argentina(C), Cuba(C) (2), India(C), Mexico(C), Netherlands(A), Poland(C), United Republic of Tanzania(C)			

D.4. Nuclear Fusion Research

F1.30.09	Dense magnetized plasmas 8 Contracts	2 Agreements	01/12/15	07/4/30
	China(C), Estonia(C), Italy(A), Korea, Republic of(A), Poland(C) (2), Romania(C), Russian Federation(C) (2), Singapore(C)			
F1.30.10	Joint research using small tokamaks 11 Contracts	1 Agreement	04/9/1	08/8/31
	Belgium(C), Brazil(C) (3), Canada(A), China(C), Czech Republic(C), Egypt(C), Portugal(C), Russian Federation(C) (2), United Kingdom(C)			

E. FOOD AND AGRICULTURE

E.1. Sustainable Intensification of Crop Production Systems

D1.20.08	Selection for greater agronomic water-use efficiency in wheat and rice using carbon isotope discrimination 12 Contracts	1 Agreement	03/11/1	08/10/31
	Algeria(C), Australia(C), Bangladesh(C), China(C) (2), France(C), India(C), Morocco(C), Pakistan(C), Philippines(C), Syrian Arab Republic(C), United States of America(A), Yemen(C)			
D1.50.07	Integrated soil, water and nutrient management for sustainable rice-wheat cropping systems in Asia 8 Contracts	2 Agreements	01/10/1	06/10/31
	Australia(A)Australia(C), Bangladesh(C), China(C) (2), India(A)India(C), Nepal(C), Pakistan(C), Philippines(C)			
D1.50.08*	Assess the effectiveness of soil conservation techniques for sustainable watershed management using fallout radionuclides 14 Contracts	5 Agreements	02/11/1	07/12/31
	Argentina(C), Australia(A), Austria(C), Brazil(C), Canada(A), Chile(C), China(C) (2), Japan(A), Morocco(C), Pakistan(C), Poland(C), Romania(C), Russian Federation(C), Switzerland(A), Turkey(C), United Kingdom(C), United States of America(A), Vietnam(C)			
D1.50.09	Integrated soil, water and nutrient management in conservation agriculture 10 Contracts	1 Agreement	04/12/1	09/11/30
	Argentina(C), Australia(C), Brazil(C), Chile(C), India(C), Kenya(A), Morocco(C), Pakistan(C), Turkey(C), Uganda(C), Uzbekistan(C)			

* Jointly with Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources (G.1.)

D2.30.23	Improvement of tropical and subtropical fruit trees through induced mutations and biotechnology 10 Contracts China(C), Cuba(C), India(C), Indonesia(C), Iran, Islamic Republic of(C), Israel(A), Malaysia(C) (2), Pakistan(C), Philippines(C), South Africa(C), United Kingdom(A), United States of America(A)	3 Agreements	00/8/1	05/12/31
D2.30.24	Physical mapping technologies for the identification and characterization of mutated genes contributing to crop quality 9 Contracts Argentina(C), Bulgaria(C), China(C) (2), Czech Republic(C), Germany(A), Iceland(A), Pakistan(C) (2), Poland(C), United Kingdom(A), United States of America(A), Vietnam(C)	4 Agreements	02/9/2	07/12/31
D2.30.25	Pyramiding of mutated genes contributing to crop quality and resistance to stress affecting quality 12 Contracts Australia(A), Bulgaria(C), China(C) (2), Colombia(A), Cuba(C), France(A), India(C), Indonesia(C), Iran, Islamic Republic of(C), Japan(A), Korea, Republic of(C), Pakistan(C), Poland(C), Thailand(C), The Frmr. Yug.Rep. of Macedonia(C), United Kingdom(A)	5 Agreements	04/7/1	09/6/30
D2.30.26	Identification and pyramiding of mutated genes: novel approaches for improving crop tolerance to salinity and drought 15 Contracts Bulgaria(C), China(C) (2), Cuba(C), Egypt(C), Ghana(C), India(C) (2), Indonesia(C), Israel(A), Italy(A), Pakistan(C), Thailand(C), Tunisia(C) (2), Turkey(C), United States of America(A) (3), Vietnam(C)	5 Agreements	04/12/1	09/11/30
D2.30.27	Molecular tools for quality improvement in vegetatively propagated crops including banana and cassava 12 Contracts Bangladesh(C), Brazil(C) (2), China(C), Colombia(A), Cuba(C), Czech Republic(A), France(A), Ghana(C), India(C), Indonesia(C), Kenya(C), Mexico(C), Nigeria(C), Philippines(C), United Kingdom(A) (2)	5 Agreements	05/5/1	10/4/30
D2.40.11	Effects of mutagenic agents on the DNA sequence in plants 11 Contracts Bulgaria(C), China(C) (2), Colombia(C), India(C), Kazakhstan(C), Korea, Republic of(C) (2), Philippines(C), Poland(C), South Africa(C), United Kingdom(A), United States of America(A) (2)	3 Agreements	03/9/15	08/9/14
D4.10.18	Improvement of codling moth SIT to facilitate expansion of field application 10 Contracts Argentina(C) (2), Armenia(C), Brazil(C), Canada(A)Canada(C), Chile(C), Czech Republic(C), South Africa(A), Switzerland(A), Syrian Arab Republic(C) (2), United States of America(A)United States of America(C)	4 Agreements	02/5/1	07/4/30
D4.10.19	Molecular technologies to improve the effectiveness of SIT 3 Contracts Australia(A), China(C), Germany(A), Greece(A) (3), India(C), Italy(A) (2), New Zealand(A), Thailand(C), United Kingdom(A) (2), United States of America(A) (2)	12 Agreements	03/6/12	08/6/11
D4.10.20	Improving sterile male performance in fruit fly SIT programmes 11 Contracts Argentina(C), Australia(A) (2), Brazil(C), Croatia(C), France(A), Greece(C), Israel(C), Mauritius(C), Mexico(C) (2), Philippines(C), Portugal(C), Spain(A), Thailand(C), United States of America(A) (2)	6 Agreements	04/7/1	09/6/30
D4.10.21	Development of mass rearing for New World (Anastrepha) and Asian (Bactrocera) fruit fly pest in support of SIT 15 Contracts Argentina(C) (2), Australia(A), Bangladesh(C), Brazil(C) (2), Costa Rica(C), Greece(C), Israel(C), Italy(A), Kenya(C), Mauritius(C), Mexico(C) (2), Philippines(C), Thailand(C), United States of America(A), Vietnam(C)	3 Agreements	04/11/15	09/11/14
D4.30.02	Evaluating the use of nuclear techniques for the colonization and production of natural enemies of agricultural insect pests 3 Contracts Argentina(C), Austria(A) (2), Pakistan(C), United States of America(A)United States of America(C)	3 Agreements	99/8/1	05/5/31

E.2. Sustainable Intensification of Livestock Production Systems

D3.10.23	Integrated approach for improving small scale market oriented dairy systems 11 Contracts Bangladesh(C), Cameroon(C), Malaysia(A), Pakistan(C), Paraguay(C), Peru(C) (2), South Africa(C), Sri Lanka(C), Tunisia(C), United Kingdom(A), United Republic of Tanzania(C), United States of America(A), Uruguay(A), Venezuela(C)	4 Agreements	01/11/1	06/12/31
D3.20.21	Developing, validating and standardising methodologies for the use of PCR and PCR-ELISA in the diagnosis and monitoring of control and eradication programmes for trypanosomosis 10 Contracts Belgium(A), Bolivia(C), Brazil(C), Burkina Faso(C), Chile(C), Côte D'ivoire(C), Germany(A), Kenya(C), Netherlands(A) (2), South Africa(C), Thailand(C), Uganda(C), United Kingdom(A), Vietnam(C)	5 Agreements	00/11/15	06/2/28
D3.20.22	The development of strategies for the effective monitoring of veterinary drug residues in livestock and livestock products in developing countries 15 Contracts Argentina(C), Barbados(C), Brazil(C), Cyprus(C), Germany(A)Germany(C), Indonesia(C), Kenya(C), Korea, Republic of(C), Malta(C), Namibia(C), South Africa(C), Sri Lanka(C), Sweden(A), Thailand(C), Turkey(C), United Kingdom(A)United Kingdom(C)	3 Agreements	02/1/1	06/12/31
D3.20.23	Veterinary surveillance of Rift Valley Fever 13 Contracts Burkina Faso(C), Democratic Rep. of the Congo(C), France(A)France(C), Gambia(C), Germany(A)Germany(C), Guinea(C), Kenya(C), Mali(C), Mauritania(C), Senegal(C), South Africa(C), Uganda(C), Yemen(C)	2 Agreements	05/5/1	10/4/30
D3.10.24	Development and use of rumen molecular techniques for predicting and enhancing livestock productivity 9 Contracts Australia(A), Brazil(C), China(C) (2), Colombia(C), Cuba(C), Ethiopia(C), India(C), Japan(A), New Zealand(A), Switzerland(A)Switzerland(C), Thailand(C), United Kingdom(A), United States of America(A)	6 Agreements	03/11/15	09/11/14
D3.10.25	Gene-based technologies in livestock breeding: Characterization of small ruminant genetic resources in Asia 9 Contracts Bangladesh(C), China(C) (2), Indonesia(C), Iran, Islamic Republic of(C), Italy(A), Kenya(C), Pakistan(C), Sri Lanka(C), Vietnam(C)	1 Agreement	04/12/1	09/11/30
D4.20.09	Enabling technologies for the expansion of SIT for old and new world screwworm 7 Contracts Brazil(C), Indonesia(C), Iran, Islamic Republic of(C), Sweden(A), United Kingdom(C) (2), United States of America(A) (2), Uruguay(C), Venezuela(C)	3 Agreements	01/8/1	07/3/31
D4.20.10	Improved and harmonized quality control for expanded tsetse production, sterilization and field application 13 Contracts Austria(A) (2), Belgium(C), Burkina Faso(C), Costa Rica(C), Czech Republic(C), Ethiopia(C), Kenya(C) (2), Mali(C), Slovakia(C) (2), South Africa(C), Uganda(C), United Republic of Tanzania(C)	2 Agreements	03/6/12	08/6/11

E.3. Risk Analysis Methodologies and Capacity Building for Compliance with Food Safety Standards

D6.10.23	Testing the efficiency and uncertainty of sample processing for analysis of food contaminants 9 Contracts Argentina(C), Australia(A), China(C), Colombia(C), Costa Rica(C), Croatia(C), Hungary(C), India(A)India(C) (2), Netherlands(A), Thailand(C), United Kingdom(A)	4 Agreements	02/4/1	07/12/31
D6.20.07	Irradiation to ensure the safety and quality of prepared meals 11 Contracts Argentina(C), China(C), Ghana(C), Greece(C), Hungary(C), India(C), Indonesia(C), Israel(A), Korea, Republic of(C), South Africa(C), Syrian Arab Republic(C), Thailand(C), United Kingdom(A), United States of America(A)	3 Agreements	02/1/1	06/5/31

D5.40.03 Quality control of pesticide products
6 Contracts 1 Agreement 00/12/1 06/9/30
China(C), Greece(A), India(C), Myanmar(C), Nigeria(C), Philippines(C), Vietnam(C)

F. HUMAN HEALTH

F.1. Nuclear Medicine

G3.40.01 Development of standardised mass rearing systems for male Anopheles arabiensis mosquitoes (formerly D4.20.11)
5 Contracts 05/9/15 10/12/31
Kenya(C), Pakistan(C), Sudan(C), United Kingdom(C), United Republic of Tanzania(C)

E1.30.19 Doctoral CRP on Management of liver cancer using radionuclide methods with special emphasis on trans-arterial radioconjugate therapy and internal dosimetry
7 Contracts 7 Agreements 00/9/1 05/12/31
Australia(A), Austria(A), China(C), Colombia(C), France(A), India(A), Mongolia(C), Philippines(C), Singapore(C), Thailand(C), United Kingdom(A), United States of America(A) (2), Vietnam(C)

E1.30.22 Harmonization of radionuclide procedures and protocols in the management of neonatal hydronephrosis
5 Contracts 2 Agreements 01/8/1 05/12/31
Algeria(C), Chile(A), Estonia(C), India(C), Iran, Islamic Republic of(C), Pakistan(C), Spain(A)

E1.30.23 Radiopharmaceutical imaging to predict and evaluate the response of breast cancer to neoadjuvant chemotherapy
6 Contracts 1 Agreement 01/8/1 05/11/30
Argentina(C), Chile(C), Colombia(C), Cuba(C), Italy(A), Poland(C), Thailand(C)

E1.30.24 Improvement in the treatment of acute lymphoblastic leukemia (ALL) by the detection of minimal residual disease (MRD)
6 Contracts 1 Agreement 02/10/24 06/12/31
Chile(C), France(C), India(C), Myanmar(C), Pakistan(C), Sudan(C), United Kingdom(A)

E1.30.25 Nitrate augmented myocardial imaging for assessment of myocardial viability
5 Contracts 3 Agreements 02/9/1 05/12/31
Australia(A), Bulgaria(C), China(A), India(A), Philippines(C), Singapore(C), South Africa(C), Uruguay(C)

E1.30.26 Comparative evaluation of radiopharmaceuticals for radiosynovectomy
8 Contracts 3 Agreements 02/10/15 05/12/31
Argentina(C), Colombia(C), Germany(A), India(C), Korea, Republic of(C), Philippines(C), Slovakia(C), Thailand(C), United States of America(A), Uruguay(C), Venezuela(A)

E1.30.27 Role of radionuclide techniques in the diagnosis of early dementia
8 Contracts 3 Agreements 03/7/1 08/6/30
Bangladesh(C), China(C), Cuba(C), Czech Republic(C), Hungary(C), India(A)India(C), Italy(A), Japan(C), Korea, Republic of(C), Norway(A)

E1.30.28 Standardisation and quality control of in-house prepared radiopharmaceuticals for nuclear oncology
10 Contracts 1 Agreement 04/6/1 08/5/31
Algeria(C), China(C), Costa Rica(C), Cuba(C), India(C), Mongolia(C), Singapore(C), The Frmr.Yug.Rep. of Macedonia(C), Turkey(C), United States of America(A), Uruguay(C)

E1.30.29 Evaluation of a single utilization of pulmonary perfusion scintigraphy in patients with suspected pulmonary embolism
8 Contracts 1 Agreement 04/9/1 07/8/31
Czech Republic(C), India(C) (2), Japan(A), Pakistan(C), Philippines(C), Slovenia(C), Turkey(C), Uruguay(C)

E1.30.30 Development and quality control of hospital prepared radiopharmaceuticals for infection imaging for use in HIV/AIDS positive patients
8 Contracts 1 Agreement 04/11/15 07/11/14
Argentina(C), India(C), Indonesia(C), Iran, Islamic Republic of(C), Netherlands(A), South Africa(C), Syrian Arab Republic(C), Uruguay(C), Vietnam(C)

E1.50.19 Improved accuracy of molecular and immunological markers for prediction of efficacy of antimalarial drugs
 11 Contracts 05/6/15 09/6/14
 Burkina Faso(C), Cameroon(C) (2), Colombia(C), Indonesia(C), Kenya(C) (2), Mali(C) (2), Sudan(C), United Kingdom(C)

F.2. Applied Radiation Biology and Radiotherapy

E3.30.18 Aspects of radiobiology applicable in clinical radiotherapy - Increase of the number of fractions per week
 6 Contracts 1 Agreement 98/9/15 06/5/31
 Denmark(A)Denmark(C), Estonia(C), India(C) (2), Pakistan(C) (2)

E3.30.21 The role of teletherapy (TT) supplementary to intraluminal high dose rate (ILHDR) brachytherapy (BT) in the palliation of advanced oesophageal cancer
 7 Contracts 1 Agreement 02/9/1 06/8/31
 Brazil(C), Canada(C), China(C), Croatia(C), India(C), South Africa(C), Sudan(C), United States of America(A)

E3.30.22 Doctoral CRP on clinical and experimental studies to improve radiotherapy outcome in AIDS cancer patients
 7 Contracts 2 Agreements 03/6/15 09/6/14
 Canada(C), China(C), India(C), South Africa(C), Uganda(C), United Kingdom(A), United Republic of Tanzania(C), United States of America(A), Zimbabwe(C)

E3.30.23 Resource sparing treatment of head and neck cancer
 6 Contracts 03/9/15 09/9/15
 Algeria(C), Egypt(C), Malaysia(C), Morocco(C), Pakistan(C), Thailand(C)

E3.30.24 Radiobiological and clinical study on viral-induced cancers response to radiotherapy
 7 Contracts 1 Agreement 04/8/1 10/7/31
 Brazil(C), Canada(C), India(C), Korea, Republic of(A), Morocco(C), Pakistan(C), Peru(C), South Africa(C)

E3.30.25 Resource sparing curative treatment in breast cancer
 7 Contracts 5 Agreements 05/10/1 11/9/30
 Egypt(A)Egypt(C), Finland(A), Ghana(C), India(A), Japan(A), Morocco(C), Nigeria(C), Pakistan(A)Pakistan(C), Peru(C), Turkey(C)

F.3. Dosimetry and Medical Radiation Physics

E2.10.05 Harmonization of quality practices for nuclear medicine radioactivity measurements
 5 Contracts 3 Agreements 04/12/15 08/12/14
 Brazil(C), Cuba(C), Czech Republic(A), India(A), Iran, Islamic Republic of(C), Korea, Republic of(A), Romania(C), Turkey(C)

E2.10.06 Testing of the implementation of the code of practice for dosimetry in X-ray diagnostic radiology
 8 Contracts 3 Agreements 05/11/15 07/11/14
 Austria(A), Brazil(C), China(C), Cuba(C), Czech Republic(C), Finland(A), Greece(A), Hungary(C), South Africa(C), Thailand(C), Vietnam(C)

E2.40.12 Development of TLD-based quality audits for radiotherapy dosimetry in non-reference conditions
 7 Contracts 2 Agreements 01/12/15 07/2/28
 Algeria(C), Argentina(C), Austria(A), Belgium(A), Bulgaria(C), China(C), Cuba(C), India(C), Poland(C)

E2.40.13 Development of procedures for quality assurance for dosimetry calculations in radiotherapy
 5 Contracts 2 Agreements 04/4/1 08/3/31
 Argentina(C), Cuba(C), Estonia(C), Germany(A), South Africa(C), Thailand(C), United States of America(A)

E2.40.14 Development of procedures for in vivo dosimetry in radiotherapy
 6 Contracts 2 Agreements 04/12/15 07/12/14
 Brazil(C), Canada(A), China(C), Colombia(C), Croatia(C), Pakistan(C), Poland(C), United Kingdom(A)

F.4. Nutrition and Effects of Contaminants on Human Health

- E4.10.14** Exposure to toxic and potentially toxic elements in women of childbearing age in developing countries
7 Contracts 2 Agreements 05/7/1 08/6/30
Australia(A), Bangladesh(C), Belarus(C), Chile(C), China(C), Japan(A), Nigeria(C), Russian Federation(C), Slovenia(C)
- E4.30.13** Doctoral CRP on Isotopic and complementary tools for the study of micronutrient status and interactions in developing country populations exposed to multiple nutritional deficiencies
10 Contracts 3 Agreements 01/12/15 06/05/31
Ghana(C), India(A)India(C), Mexico(C), Pakistan(C), Sri Lanka(C), Switzerland(C) (2), Thailand(C), United Kingdom(A), United States of America(A)United States of America(C) (2)
- E4.30.15** The application of isotopic and nuclear techniques in studies related to intrauterine growth restriction (IUGR) issues in populations from developing countries
10 Contracts 2 Agreements 03/9/15 07/9/14
Bangladesh(C), Brazil(C), Cameroon(C), India(C) (2), Morocco(C), Pakistan(C), South Africa(C), Sudan(C), United Kingdom(A), United Republic of Tanzania(C), United States of America(A)
- E4.30.16** Assessment of total energy expenditure and body composition for older adult subjects with different lifestyles
9 Contracts 3 Agreements 03/11/1 07/10/31
Brazil(C), China(C), Guatemala(C), India(C), Mexico(C), Morocco(C), New Zealand(A), Philippines(C), Senegal(C), South Africa(C), United States of America(A) (2)
- E4.30.17*** Assessment of nutrients uptake from biofortified crops in populations from developing countries
6 Contracts 05/7/1 08/6/30
Bangladesh(C), China(C), Mexico(C), United Kingdom(C), United States of America(C) (2)
- E4.30.18** Zinc nutrition during early life
6 Contracts 3 Agreements 05/9/15 08/9/14
Bangladesh(C), France(A), India(C), Iran, Islamic Republic of(C), Kenya(C), Morocco(C), Pakistan(C), United Kingdom(A), United States of America(A)
- E4.30.19** Body fat and its relationship with metabolic syndrome indicators in overweight pre-adolescents and adolescents
6 Contracts 2 Agreements 05/12/15 10/12/14
Brazil(C), China(C), India(C), Iran, Islamic Republic of(C), Jamaica(C), Lebanon(C), Mexico(A), United States of America(A)
- E4.30.20** Nutrition and HIV/AIDS: The efficacy of food based interventions evaluated by stable isotope techniques
6 Contracts 2 Agreements 05/12/15 10/12/14
Denmark(A), India(C), Kenya(C), South Africa(C) (2), Thailand(C), United Kingdom(A), United Republic of Tanzania(C)

G. WATER RESOURCES

G.1. Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources

- F3.30.14†** Nuclear and isotopic techniques for the characterization of submarine groundwater discharge (SGD) in coastal zones
5 Contracts 4 Agreements 02/8/1 06/7/31
Brazil(C), India(A), Italy(C), Japan(A), Russian Federation(C), Slovenia(C), Turkey(C), United States of America(A) (2)
- F3.30.15** Isotopic age and composition of streamflow as indicators of groundwater sustainability
13 Contracts 3 Agreements 04/7/1 10/6/30
Argentina(C), Austria(A), Brazil(C), China(C), Colombia(C), Germany(A), Ghana(C), Greece(C), India(C), Morocco(C), Pakistan(C), Portugal(A), Serbia and Montenegro(C), Slovakia(C), Turkey(C), Vietnam(C)

* Jointly with Sustainable Intensification of Crop Production Systems (E.1.)

† Jointly with Measurement and Assessment of Radionuclides in the Marine Environment (H.1.)

G.2. Reference Isotope Data and Analysis for Hydrological Applications

F3.20.03 Design criteria for a network to monitor isotope compositions of runoff in large rivers
10 Contracts 8 Agreements 02/4/1 06/10/31
Argentina(C), Australia(A), Austria(A), Brazil(C), Canada(C), China(C), France(A), Germany(A),
India(C), Israel(A), Japan(A), Pakistan(C), Slovenia(C), South Africa(C), Syrian Arab Republic(C),
United States of America(A) (2), Vietnam(C)

F3.40.10 Isotope methods for the study of water and carbon cycle dynamics in the atmosphere and biosphere
5 Contracts 6 Agreements 04/11/15 08/11/14
Australia(C), Canada(C), China(C), Iran, Islamic Republic of(A), Pakistan(C), Switzerland(A) (2),
United States of America(A) (3)United States of America(C)

H. PROTECTION OF THE MARINE AND TERRESTRIAL ENVIRONMENT

H.1. Measurement and Assessment of Radionuclides in the Marine Environment

K4.10.09 Nuclear and isotopic studies of the El Niño phenomenon in the ocean
4 Contracts 8 Agreements 04/3/1 09/2/28
Australia(A) (2), France(A), Indonesia(C), Israel(C), Jordan(C), Monaco(A), New Zealand(A), Peru(C),
United States of America(A) (3)

H.2. Radioecological Approaches to Coastal Contaminant Problems

K4.10.08 Nuclear applications to determine bioaccumulation parameters and processes used for establishing
coastal zone monitoring and management criteria
6 Contracts 3 Agreements 02/12/15 05/12/14
Australia(A), Brazil(C), Cuba(C), Indonesia(C), Korea, Republic of(A), Pakistan(C), Philippines(C),
Thailand(C), United States of America(A)

H.4. Measurement and Assessment of Radionuclides and Non-redoactive Pollutants in the Terrestrial Environment

G4.10.03 Radiochemical, chemical and physical characterisation of radioactive particles in the environment
4 Contracts 7 Agreements 00/12/1 07/12/31
Denmark(A), Finland(A), Germany(A), Hungary(C), Israel(A), Kazakhstan(C), Norway(A), Russian
Federation(C), Spain(A), Ukraine(C), United States of America(A)

I. PHYSICAL AND CHEMICAL APPLICATIONS

I.1. Radiochemical Application

F2.30.23 Applications of nuclear analytical techniques to investigate the authenticity of art objects
12 Contracts 4 Agreements 04/11/15 08/11/14
Brazil(C), China(C), Croatia(C), Cuba(C), France(A), Germany(A), Ghana(C), Greece(A), Hungary(C),
Kazakhstan(C), Lebanon(C), Malaysia(C), Mexico(C), Peru(C), Poland(A), Syrian Arab Republic(C)

F2.20.38 Development of ^{99m}Tc based small bio molecules using novel ^{99m}Tc cores
6 Contracts 7 Agreements 03/3/15 06/3/14
Austria(A), Brazil(C), China(C), Germany(A), Greece(C), Hungary(C), India(C), Italy(A), Portugal(A),
Russian Federation(A), Switzerland(A), United States of America(A), Uruguay(C)

F2.20.40 Development of generator technologies for therapeutic radionuclides
8 Contracts 5 Agreements 04/7/1 08/6/30
Brazil(C), China(C), Cuba(C), Germany(A), India(C), Indonesia(C), Italy(A), Korea, Republic of(A),
Mexico(C), Poland(C), Russian Federation(A), United States of America(A), Vietnam(C)

F2.20.41 Improved high current liquid and gas targets for cyclotron produced radioisotopes
4 Contracts 4 Agreements 05/12/15 09/12/31
Denmark(A), Finland(A), Hungary(A), Iran, Islamic Republic of(C), Korea, Republic of(C), Saudi
Arabia(C), Syrian Arab Republic(C), United States of America(A)

I.2. Industrial Applications and Nuclear Techniques for Demining

F1.10.12	Neutron based techniques for the detection of illicit materials and explosives 5 Contracts Australia(A), Egypt(C), France(A), Italy(A), New Zealand(A), Poland(C), Russian Federation(C), South Africa(C), Thailand(C)	4 Agreements	05/12/15	10/12/14
F2.10.09	Industrial process gamma tomography 6 Contracts Argentina(C), Brazil(C), Czech Republic(C), France(A), Korea, Republic of(C), Malaysia(C), Norway(A), Poland(C), United Kingdom(A), United States of America(A)	4 Agreements	03/3/15	06/3/14
F2.10.10	Validation of tracers and software for inter-well investigations 7 Contracts Argentina(C), Australia(A), Brazil(C), China(C), France(A), Indonesia(C), Norway(A), Pakistan(C), Philippines(C), Vietnam(C)	3 Agreements	04/7/1	08/6/30
F2.20.39	Controlling of degradation effects in radiation processing of polymers 6 Contracts Brazil(C), Bulgaria(A), Czech Republic(A), Egypt(C), Korea, Republic of(A), Pakistan(C), Poland(A), Romania(C), Spain(A), Turkey(C), United States of America(A), Vietnam(C)	6 Agreements	03/11/15	06/11/30
F2.30.22	Remediation of polluted waters and wastewater by radiation processing 7 Contracts Austria(A), Brazil(C), Ecuador(C), Hungary(C), Jordan(C), Korea, Republic of(A), Poland(C), Portugal(C), Turkey(C), United States of America(A)	3 Agreements	02/5/1	06/4/30
F2.30.24	Electron beam treatment of organic pollutants contained in gaseous streams 8 Contracts Austria(A), Belarus(C), Bulgaria(C), China(A)China(C), Japan(A), Korea, Republic of(C), Malaysia(C), Poland(C), Romania(C), Russian Federation(C), Saudi Arabia(A), Spain(A), United States of America(A)	6 Agreements	04/12/15	08/12/14

J. SAFETY OF NUCLEAR INSTALLATIONS

J.3. Use of Advanced Tools for Safety Assessment

J4.20.04	Assessment of the interfaces between neutronic, thermal-hydraulic, structural and radiological aspects in accident analyses 6 Contracts Bulgaria(C), Croatia(A), Czech Republic(C), Finland(A), Hungary(A)Hungary(C), Italy(A), Russian Federation(C) (2), Slovakia(A) (2)Slovakia(C), United States of America(A)	7 Agreements	02/12/1	05/11/30
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J.5. Engineering Safety of Existing Nuclear Installations and Site Evaluation

J4.10.05	Safety significance of near field earthquakes 10 Contracts Armenia(C), Bulgaria(C), Canada(A), Finland(A), France(A) (3), India(C), Italy(A), Japan(A), Korea, Republic of(C) (2), Romania(C), Russian Federation(C), Slovakia(C), Spain(A), Turkey(C) (2), United Kingdom(A), United States of America(A)	10 Agreements	02/7/1	05/12/31
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J.7. Research Reactor Safety

J7.10.10	Safety significance of postulated initiating events for different research reactor types and assessment of analytical tools 6 Contracts Algeria(C), Argentina(A)Argentina(C), Brazil(C), Germany(A), Indonesia(C), Italy(A), Korea, Republic of(A), Romania(C), Syrian Arab Republic(C)	4 Agreements	02/9/1	06/8/31
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K.5. Radiological Protection of Patients

J1.70.07	Avoidance of unnecessary dose to patients while transitioning from analogue to digital radiology 5 Contracts Australia(C), Austria(C), India(C), Malaysia(C), Thailand(C), United Kingdom(A)	1 Agreement	02/11/15	06/12/31
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J1.70.08	Evaluate quantitatively and promote patient dose reduction approaches in interventional radiology 4 Contracts India(C), Italy(A), Japan(A), Malaysia(C), Thailand(C), Turkey(C)	2 Agreements	02/11/15	06/2/28
J1.70.09	Dose reduction in computed tomography (CT) while maintaining diagnostic confidence 3 Contracts Germany(A), Greece(A), India(C), Poland(C), Thailand(C), United Kingdom(A)	3 Agreements	02/11/15	06/2/28
K.7. Safety of the Transport of Radioactive Material				
J1.30.09	Accident severity during air transport of radioactive material Canada(A) (2), France(A), Germany(A), Ireland(A), Sweden(A), United Kingdom(A), United States of America(8 Agreements	98/6/1	05/9/30
L. MANAGEMENT OF RADIOACTIVE WASTE				
L.3. Safety Policies and Approaches for Disposable Radioactive Waste Safety				
J9.10.06	Application of safety assessment methodologies for near surface waste disposal facilities (ASAM) Belarus(A), Belgium(A) (3), Brazil(A), Bulgaria(A), China(A), Cuba(A), France(A), Hungary(A), Kazakhstan(A), Korea, Republic of(A), Lithuania(A) (2), Peru(A), Romania(A) (2), Russian Federation(A) (3), South Africa(A), Spain(A), Ukraine(A), Vietnam(A)	24 Agreements	02/8/27	06/3/27
L.4. Technologies for Disposable Radioactive Waste Management				
T2.10.22	Characterization and performance studies and demonstration in underground research laboratories of swelling clays as engineered barriers of geological repositories 6 Contracts Canada(A), China(C), Czech Republic(C), India(A), Japan(A), Korea, Republic of(C), Russian Federation(C), South Africa(C), Sweden(A), Ukraine(C)	4 Agreements	04/3/1	08/2/29
T2.10.23	New development and improvements in processing of "problematic" radioactive waste streams 5 Contracts Argentina(C), Australia(A), Belarus(C), Belgium(A), China(C), Czech Republic(A)Czech Republic(C), Finland(A), India(A), Korea, Republic of(A) (2), Russian Federation(A) (2), South Africa(A), Ukraine(C), United States of America(A)	11 Agreements	03/3/15	07/3/31
T2.10.24	The use of numerical models in support of site characterization and performance assessment studies of geologic repositories 5 Contracts Belgium(A), Brazil(C), China(C), India(A), Korea, Republic of(A), Lithuania(C), Romania(C), Ukraine(C), United Kingdom(A), United States of America(A)	5 Agreements	05/10/1	10/9/30
T2.40.06	Disposal aspects of low and intermediate level decommissioning waste 6 Contracts Argentina(C), Canada(A), China(C), Germany(A), Hungary(C), India(A), Korea, Republic of(A), Lithuania(C), Russian Federation(C), Slovakia(A), Sweden(A), Ukraine(C), United States of America(A)	7 Agreements	02/9/1	06/8/31
L.7. Technologies for the Decommissioning of Installations and Restoration of Sites				
T2.40.07	Innovative and adaptive technologies in decommissioning of nuclear facilities 3 Contracts Argentina(A), Austria(A), Belgium(A), Brazil(C), Cuba(C), Czech Republic(A), Denmark(A), Korea, Republic of(A) (2), Norway(A), Russian Federation(C), Slovakia(A), Ukraine(A), United Kingdom(A)	11 Agreements	04/5/1	09/4/30
M. NUCLEAR SECURITY				
M.3. Detection of and Response of Mlicious Activities Involving Nuclear and other Radioactive Materials				
M2.20.06	Improvement of technical measures to detect and respond to illicit trafficking of nuclear material and other radioactive materials 16 Contracts Australia(A), Austria(A) (2), Belarus(C), China(C), Croatia(C), France(A), Georgia(C), Germany(A) (3), Indonesia(C), Italy(A) (2), Korea, Republic of(A), Latvia(C), Poland(C), Russian Federation(C) (6), Slovakia(A), Turkey(C), Ukraine(C), United States of America(A) (2), Uzbekistan(C)	13 Agreements	03/3/15	06/6/30

CRPs Approved, but not yet initiated

A. NUCLEAR POWER

A.1. Nuclear Power Plant Operating Performance and Life Cycle Management

I2.10.17 Influence of synergism of nickel and other alloying elements on RPV materials irradiation embrittlement

A.4. Technology Developments and Applications for Advanced Reactors

I3.10.15 Potential of high temperature gas cooled reactors for process heat applications

I3.20.07 Analyses of and lessons learned from the operational experience with fast reactor equipment and systems

B. NUCLEAR FUEL CYCLE AND MATERIALS TECHNOLOGIES

B.4. Topical Nuclear Fuel Cycle Issues and Information Systems

T1.40.01 Analysis of material flow for advanced and innovative reactors and fuel cycles

C. CAPACITY BUILDING AND NUCLEAR KNOWLEDGE MAINTENANCE FOR SUSTAINABLE ENERGY DEVELOPMENT

C.2. Energy Economics Environment (3E) Analysis

I1.10.05 Greenhouse gas (GHG) mitigation strategies and energy options

L5.30.01 Comparative analysis of methods and tools for nuclear knowledge preservation

E. FOOD AND AGRICULTURE

E.1. Sustainable Intensification of Crop Production Systems

D1.50.10 Selection and evaluation of food (cereal and legume) crop genotypes tolerant to low nitrogen and phosphorus soils through the use of isotopic and nuclear-related techniques

J. SAFETY OF NUCLEAR INSTALLATIONS

J.3. Use of Advanced Tools for Safety Assessment

J7.20.05 Evaluation of uncertainties in best estimate accident analysis

J.5. Engineering Safety of Existing Nuclear Installations and Site Evaluation

J7.20.04 Probabilistic safety assessment of nuclear facilities in relation to external events

J.6. Safety of Research Reactors and Fuel Cycle Facilities*

J7.10.11 Assessment of source term, radionuclides transport within containment/confinement and release to the environment, for research reactors

J7.20.06 Operational safety performance indicators for nuclear fuel cycle facilities

* Approved for Programme and Budget 2006/2007

K. RADIATION AND TRANSPORT SAFETY

K.7. Safety of the Transport of Radioactive Material

J1.30.11 The appropriate level of regulatory control for the safe transport of naturally-occurring radioactive material (NORM)

M. NUCLEAR SECURITY

M.3. Detection of and Response to Malicious Activities involving Nuclear and other Radioactive Materials

J0.20.01 Application of nuclear forensics in illicit trafficking of nuclear and other radioactive materials

CRPs COMPLETED IN 2005

A. NUCLEAR POWER

A.1. Nuclear Power Plant Operating Performance and Life Cycle Management

- I2.10.14 Verification of WWER steam generator tube integrity
- I2.10.16 Evaluation of radiation damage of WWER reactor pressure vessels using the IAEA database on reactor pressure vessel

C. CAPACITY BUILDING AND NUCLEAR KNOWLEDGE MAINTENANCE FOR SUSTAINABLE ENERGY DEVELOPMENT

C.1. Energy Modelling, Databanks and Capacity Building

- I1.40.04 Cost effectiveness of nuclear power compared to CO₂ capture and sequestration from fossil fuel power plants

C.2. Energy Economics Environment (3E) Analysis

- I1.10.04 Historical evolution of indicators of sustainable energy development (ISED) and the use of this information for designing guidelines for future energy strategies in conformity with the objectives of sustainable development

D. NUCLEAR SCIENCE

D.1. Atomic and Nuclear Data

- F4.30.11 Atomic and molecular data for fusion plasma diagnostics
- F4.30.12 Data for molecular processes in edge plasmas

D.3. Utilization of Accelerators and Instrumentation

- F1.10.10 Development of distance learning (DL) modules on troubleshooting of nuclear instruments

D.4. Nuclear Fusion Research

- F1.30.08 Elements of power plant design for inertial fusion energy

E. FOOD AND AGRICULTURE

E.1. Sustainable Intensification of Crop Production Systems

- D1.20.07 Use of nuclear techniques for developing integrated nutrient and water management practices for agroforestry systems
- D1.50.06 Development of management practices for sustainable crop production systems on tropical acid soils through the use of nuclear and related techniques
- D2.30.21 Molecular characterization of mutated genes controlling important traits for seed crop improvement
- D4.10.16 Quality assurance of mass produced and released fruit flies for SIT programmes
- D4.10.17 Development of improved attractants and their integration into fruit fly SIT management programmes

E.2. Sustainable Intensification of Livestock Production Systems

- D3.10.22 Use of nuclear and related techniques to develop simple tannin assays for predicting and improving the safety and efficiency of feeding ruminants on tanniniferous tree foliage
- D3.20.20 The use of non-structural protein of foot-and-mouth disease virus (FMDV) to differentiate between vaccinated and infected animals

E.3. Risk Analysis Methodologies and Capacity Building for Compliance with Food Safety Standards

- D5.50.01 The classification of soil systems on the basis of transfer factors of radionuclides from soil to reference plants
- D6.10.22 Use of irradiation to ensure hygienic quality of fresh, pre-cut fruits and vegetables and other minimally processed food of plant origin

F. HUMAN HEALTH

F.1. Nuclear Medicine

- E1.10.13 Development and validation of an Internet based clinical and technical study communication system for nuclear medicine
- E1.20.16 Radioimmunoassay of advanced glycation end products (AGEs) in the long term management of diabetes mellitus
- E1.30.20 Intravascular radionuclide therapy (IVRNT) using liquid beta-emitting radiopharmaceuticals to prevent restenosis following percutaneous transluminal coronary angioplasty

F.4. Nutrition and Effects of Contaminants on Human Health

- E4.10.13 Use of nuclear and related analytical techniques in studying human exposure to toxic elements consumed through foodstuffs contaminated by industrial activities
- E4.30.14 Application of isotopic and nuclear techniques in the study of nutrition-pollution interactions and their impact on the nutritional status of human subjects in developing country populations

G. WATER RESOURCES

G.1. Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources

- F3.30.12 Origins of salinity and impacts on fresh groundwater resources: Optimization of isotopic techniques
- F3.30.13 Application of isotopes to the assessment of pollutant behaviour in the unsaturated zone for groundwater protection

I. PHYSICAL AND CHEMICAL APPLICATIONS

I.1. Radiochemical Applications

- F2.20.35 Development of radioimmunometric assays and kits for non clinical applications
- F2.20.36 Development of radioactive sources for emerging therapeutic and industrial applications
- F2.20.37 Comparative laboratory evaluation of therapeutic radiopharmaceuticals

I.2. Industrial Applications and Nuclear Techniques for Demining

F2.20.34 Radiation synthesis of stimuli-responsive membranes, hydrogels and adsorbents for separation purposes

F2.30.20 Corrosion and deposit determination in large diameter pipes, with and without insulation by radiography testing

K. RADIATION AND TRANSPORT SAFETY

K.2. Information and Communication Networks for Radiation and Transport Safety

J1.30.10 Radiological aspects of package and conveyance non-fixed radioactive contamination

K.5. Radiological Protection of Patients

J1.70.06 Exploring the possibility of establishing guidance levels for interventional radiology

L. MANAGEMENT OF RADIOACTIVE WASTE

L.2. Information and Communication Networks on Radioactive Waste Management

J9.10.05 The use of selected safety indicators (concentrations; fluxes) in the assessment of radioactive waste disposal

L.4. Technologies for Disposable Radioactive Waste Management

T2.10.21 Chemical durability and performance assessment of spent fuel and high level waste forms under simulated repository conditions

IAEA 2005 PROGRAMME/SUB-PROGRAMME AND CRP CODES

MAJOR PROGRAMME 1: NUCLEAR POWER, FUEL CYCLE AND NUCLEAR SCIENCE

		<u>CRP Code</u>
Programme A: Nuclear Power		
A1	Nuclear Power Plant Operating Performance and Life Cycle Management	I2
A3	Coordination of International Collaboration for the Development of Innovative Nuclear Technologies	I2
A4	Technology Developments and Applications for Advanced Reactors	I3
Programme B: Nuclear Fuel Cycle and Materials Technologies		
B1	Uranium Production Cycle and Environment	T1
B2	Nuclear Fuel Performance and Technology	T1
B3	Management of Spent Fuel from Power Reactors	T1
B4	Topical Nuclear Fuel Cycle Issues and Information Systems	T1
Programme C: Capacity Building and Nuclear Knowledge Maintenance for Sustainable Energy Development		
C1	Energy Modelling, Databanks and Capacity Building	I1
C2	Energy Economics Environment (3E) Analysis	I1
C3	Nuclear Knowledge Management	I1
Programme D: Nuclear Science		
D1	Atomic and Nuclear Data	F4
D2	Research Reactors	F1, F2, T1
D3	Utilization of Accelerators and Instrumentation	F1
D4	Nuclear Fusion Research	F1

MAJOR PROGRAMME 2: NUCLEAR TECHNIQUES FOR DEVELOPMENT AND ENVIRONMENTAL PROTECTION

Programme E: Food and Agriculture		
E1	Sustainable Intensification of Crop Production Systems	D1, D2, D4
E2	Sustainable Intensification of Livestock Production Systems	D3, D4
E3	Risk Analysis Methodologies and Capacity Building for Compliance with Food Safety Standards	D5, D6
Programme F: Human Health		
F1	Nuclear Medicine	E1
F2	Applied Radiation Biology and Radiotherapy	E3
F3	Dosimetry and Medical Radiation Physics	E2
F4	Nutrition and Effects of Contaminants on Human Health	E4
Programme G: Water Resources		
G1	Isotope Methodologies for the Protection and Management of Surface Water, Groundwater and Geothermal Resources	F3
G2	Reference Isotope Data and Analysis for Hydrologic Applications	F3
Programme H: Protection of the Marine and Terrestrial Environments		
H1	Measurement and Assessment of Radionuclides in the Marine Environment	K4
H2	Radioecological Approaches to Coastal Contaminant Problems	K4
H4	Measurement and Assessment of Radionuclides and Non-radioactive Pollutants in the Terrestrial Environment	G4

IAEA 2005 PROGRAMME/SUB-PROGRAMME AND CRP CODES

CRP Code

Programme I: Physical and Chemical Applications

I1	Radiochemical Applications	F2
I2	Industrial Applications and Nuclear Techniques for Demining	F1, F2

MAJOR PROGRAMME 3: NUCLEAR SAFETY AND SECURITY

Programme J: Safety of Nuclear Installations

J2	Information and Communication Networks and Global Infrastructure for Nuclear Installation Safety	J7
J3	Use of Advanced Tools for Safety Assessment	J4
J5	Engineering Safety of Existing Nuclear Installations and Site Evaluation	J4
J7	Research Reactor Safety	J7

Programme K: Radiation and Transport Safety

K1	National and Global Infrastructure Enhancement for Radiation and Transport Safety	J1
K5	Radiological Protection of Patients	J1

Programme L: Management of Radioactive Waste

L3	Safety Policies and Approaches for Disposable Radioactive Waste Safety	J9, T2
L7	Technologies for the Decommissioning of Installations and Restoration of Sites	T2

Programme M: Nuclear Security

M3	Detection of and Response to Malicious Activities Involving Nuclear and other Radioactive Materials	M2
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Accomplishments of CRPs Completed in 2004

CRP Number and Title:	D23022 Mutational analysis of root characters in annual food plants related to plant performance
Participating Countries:	Argentina(C), Australia(A), Australia(A), Belgium(A), Brazil(C), Brazil(C), China(C), China(C), Cuba(C), Germany(A), India(C), Israel(A), Mexico(C), Peru(A), Poland(C), South Africa(C), Switzerland(A), Turkey(C), United Kingdom(A), United Republic of Tanzania(C), United States of America(A), United States of America(A)
Total Cost:	\$512,765
Duration:	1999-09-01 — 2004-08-31

CRP Overall Objectives

To assist Member States in the application of mutation techniques and related biotechnology to generate and utilise mutants for the identification of root properties and genes for improvement of productivity and sustainability of crop plants.

CRP Specific Objectives

1. To make mutational analysis of some of the essential characters related to root formation and function.
2. To assess the impact of specific root traits on yield potential under field conditions leading to the exploitation of these traits in future breeding programmes.

Research Outputs

1. More than 20 new mutant lines have been developed with altered root characters.
2. Mutant and genetics populations in various crops have been developed and genetic analysis performed.
3. Mutants for root traits have been used in production of new cultivars suitable for stressed environments (drought, salinity and water-logging).
4. Mutational analysis has shown that changes in root architecture are correlated with crop plant response to stress.
5. New specific root mutations provided a means to identify genes important for root traits, several genes and QTLs were identified contributing to root architecture or development.
6. New methods in phenotyping root architecture have been developed.

CRP Outcome (Effectiveness; Impact; Relevance)

Many root mutants were induced and analysed, extensive research was performed on the physiological response of these mutants to abiotic stresses, i.e., salinity, drought, and water-logging, and on the physiological, anatomical and developmental changes caused by the mutations. Some mutant lines, i.e. drought and Al tolerant wheat, drought and water-logging tolerant barley, drought tolerant cowpea, have been already integrated into breeding programs.

The increased availability of mutant lines, new knowledge generated and new techniques developed, and the network on root research established through and outlived this CRP, all contributed to the Agency's program of E.1.03-Induced Biodiversity for Breeding Crops with Increased Adaptability to Drought, Salinity and other Constraints.

The output generated through this CRP has significant impact on the developing of new crop varieties, particularly for harsh environments, the deepening of knowledge on root development and their interaction with environment, and the advocating of use of induced mutations in crop improvement and basic researches.

1. A number of induced mutants have already been used in crop improvement programs for increasing tolerance to abiotic stresses, e.g. the drought stress in wheat and barley production and the salinity problem in rice production. It is expected that this will produce substantial impact on crop improvement. As an example, the research conducted in South Africa on cowpea is now further evolved into a national TC project on mutational improvement of drought tolerance in cowpea.
2. Mutants and mutational analysis proved unique and powerful in research that seeks to clarify ways that root structure and function respond to environmental cues and alleviate the stress. The knowledge generated has far reaching impact on our future research for developing new crop varieties.
3. The publications derived from the CRP, some in internationally leading journals, also had world wide impact on crop root research.
4. The research consortium and its website, www.crop-roots.org, fostered by this CRP to outlive its initiation, are already considered important research platforms on crop roots.

Recommended Future Action by Agency

1. Outcomes from this CRP should be integrated into ongoing and new CRP's and TCP's in related areas.
2. IAEA should establish a new CRP in root functional genomics using mutations and extend the conceptual basis of this CRP to perennial crop species.

Accomplishments of CRPs Completed in 2004

3. Interdisciplinary collaborations between root biologists, plant breeders and soil scientists should be fostered.
4. Mutant germplasm analyzed in this programme should be made available to national and regional breeding programmes as well as to collaborating scientists through the IAEA mutant repository database (establish links for access to mutant populations for different crops).
5. IAEA should disseminate newly developed methods and software packages for assessing root traits to member states, through continued support of the root consortium that was established during this CRP.

Resulting Publications

1. IAEA TECDOC Series No. 1493 "Mutational analysis of root characters in food plants" (2006).
2. The participants have already published two book chapters, 10 papers in international and six in national peer-reviewed journals or presented at international conferences.
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22. Gutierrez , L.; Cabrera L.M.Y colaboradores: El cultivo del trigo en Cuba, un siglo de trabajos. En: *Convención Trópico* (2004, Abril 4-8, La Habana). Memoria CD-ROM, ISBN 959-7167-02-6.
23. Gutierrez , L. ; Cabrera L. M. Y colaboradores: Comportamiento de la variedad de trigo RM-26, frente a la aplicación de bioproductos. En: *Fitogen* (2003, La Habana).

Accomplishments of CRPs Completed in 2004

CRP Number and Title: D32017 To develop and validate standardised methods for using polymerase chain reaction (PCR) and related molecular technologies for rapid and improved animal disease diagnosis

Participating Countries: Cameroon(C), Côte d'Ivoire(C), Ethiopia(C), France(A), Kenya(C), Korea, Republic of(C), Mali(C), Namibia(C), Pakistan(C), South Africa(A), Sweden(A), Turkey(C), United Kingdom(A), United Republic of Tanzania(C)

Total Cost: \$381,531

Duration: 1997-01-01 — 2004-02-29

CRP Overall Objectives

To develop methods involving PCR to aid in the diagnosis control of livestock diseases.

CRP Specific Objectives

To develop protocols for a number of devastating diseases of livestock; to validate methods and examine the factors involved in technology transfer of a modern molecular technique.

Research Outputs

Methods were developed and validated for the use of conventional PCR in the diagnosis and differentiation of FMD, rinderpest, and PPR viruses.

CRP Outcome (Effectiveness; Impact; Relevance)

The CRP facilitated technology transfer, training and research in developing countries, and so contributed to the overall current status of the PCR technology and its use in control programmes in developing countries.

When the CRP began there were very few examples of the transfer of PCR technology in developing countries. The true potential of the PCR in diagnosis of livestock diseases was not known and there was a large element of doubt in the International arena that such a technology could be effectively used. The CRP illustrated that this was not true and many of the parameters now accepted as standard in the setting and use of PCR in many livestock diseases were developed. Many lessons in how to transfer the PCR were learned. Contract holders went on in the main to supervise others and lead laboratories involved in research as well as applied uses of PCR in routine work. Several assays validated in the CRP form the basis of current systems for surveillance of livestock diseases.

The CRP was highly relevant and timely in the context of the push towards nuclear based molecular technologies. This technology was proved. Later CRPs and TC projects involved PCR in diagnosis using methods developed here.

Recommended Future Action by Agency

Continued support for the development and validation of molecular techniques in member states through technology transfer, training and provision of quality guidelines and management to laboratories in developing countries.

Resulting Publications

Overall publication of textbook developed by CRP holders and experience in CRP entitled "Molecular Diagnostic PCR Handbook", edited by Gerrit J. Viljoen, Louis H. Nel and John R. Crowther, Springer Publishers.

Accomplishments of CRPs Completed in 2004

CRP Number and Title: D32019 **Assessment of the effectiveness of vaccination strategies against Newcastle Disease and Gumboro Disease using immunoassay-based technologies for increasing farmyard poultry production in Africa**

Participating Countries: Cameroon(C), Côte d'Ivoire(C), Denmark(A), Egypt(C), Ghana(C), Kenya(C), Madagascar(C), Mauritius(C), Morocco(A), Morocco(C), Morocco(C), Mozambique(C), Netherlands(A), Netherlands(A), Netherlands(C), Nigeria(A), Sudan(C), Uganda(C), United Republic of Tanzania(A), United Republic of Tanzania(C), United States of America(A), United States of America(C), Zimbabwe(C)

Total Cost: \$471,238

Duration: 1998-04-01 — 2004-03-31

CRP Overall Objectives

To improve village poultry production through the introduction of cost effective and sustainable interventions.

CRP Specific Objectives

To introduce a control strategy for Newcastle Disease (ND) based on vaccination and study its impact in different poultry management systems with specific focus on supplemented feeding and Gambaro Disease (IBD) control in the final two years extension period.

Research Outputs

Systematic vaccination against ND and/or IBD showed an 80% decrease in chicken losses due to disease in all the participating countries. Feed supplementation, anti-parasitic treatment and improved housing showed an increased survival of young chicks (85% as against 53% without) and added value in adults (+80% weight) only when introduced together with a vaccination programme.

CRP Outcome (Effectiveness; Impact; Relevance)

Clear guidelines for the use, distribution and application of poultry vaccines at the village level were established and documented. Supplemented feeding, application of anti parasitic drugs and housing for young chicks in any form reduced mortality by up to 80%. The CRP showed the feasibility of these small scale interventions and it's positive economic impact and return of value.

Village poultry production was doubled in general with return on investment by a factor of 2,5 -7 depending on the market situation. All participating farmers introduced and adopted the integrated and comprehensive approach of vaccination together with supplemented feeding, housing and basic poultry management.

The CRP was introduced in 13 countries which created the basis for an improved small scale poultry production system demonstrating that minimal intervention(s) are needed from external sources provided veterinary services (vaccine supply) and improved poultry production management is in place. The thermo-stable I-2 ND vaccine proved especially useful administered by the eye-drop method once every four months. The eye-drop administration of the vaccine proved to be the most cost effective vaccination procedure and conferred protection to chicken against ND infection and reduce mortality by up to 80%. Feed supplementation and antiparasitic treatment in chicks nearly doubled the survival of chicks. A new employment opportunity "village vaccinator" was created.

The CRP evaluated and demonstrated that an integrated and holistic approach to small scale poultry production improved the livelihood of small scale farmers by improving their subsistence and increasing their income from local trade as well as strengthening the food security of the village as a whole. One additional benefit of the control of ND in village chickens was the subsequent reduction of infections in the growing commercial sector.

Recommended Future Action by Agency

No further input is necessary as the guidelines published contain all factors and financial calculations for a sustainable and profitable small scale poultry production. The preparation and distribution of the I-2 vaccine is a task for the national veterinary laboratories and authorities.

Resulting Publications

IAEA TECDOC Series No. 1489 "Improving farmyard poultry production in Africa: Interventions and their economic assessment" (2006).

Accomplishments of CRPs Completed in 2004

CRP Number and Title: E11014 To compare clinical application software between nuclear medicine laboratories by software phantoms developed by the Agency and COST B2 project.

Participating Countries: Argentina(C), Austria(A), Chile(C), China(C), Cuba(C), Hungary(C), India(C), South Africa(C), Thailand(C), United Kingdom(A)

Total Cost: \$133,319

Duration: 1999-12-15 — 2004-01-30

CRP Overall Objectives

To establish feasible and useful methods for quality assurance of nuclear medicine softwares with software phantoms.

CRP Specific Objectives

1. To investigate the reliability of software phantoms for measuring left ventricular ejection fraction (LVEF) of heart and tracer mean transit time (MTT) through kidneys using gamma cameras.
2. To collect information on quality control of gamma cameras.

Research Outputs

1. The software phantoms were tested using 20 different gamma cameras in five countries and one in 1999-2003, and the inter-laboratory comparison was performed.
2. Not all of the software phantoms could be applied to the gamma cameras due to the limitation of interfile function. It is recommended that a universal interface should be developed.
3. Different gamma cameras demonstrated different figures of LVEF and MTT. It is also recommended that normal range of LVEF and MTT should be fixed in each gamma camera but not each institute.
4. Information on QC of gamma camera was collected beyond this group.

CRP Outcome (Effectiveness; Impact; Relevance)

1. Evidence from the outputs of #2 and 3 could be useful for the users in Member States (MSs).
2. The publication of "IAEA quality control atlas for scintillation camera systems" is widely accepted among the MSs.

E1 10 13: CRP on the development and validation of an Internet based clinical and technical study communication system for nuclear medicine.

Recommended Future Action by Agency

For more effective monitoring and reviewing of the scientific activity performed by research contract holders, an audit system should be established as follows: 1) Teleconference between Project Officer (PO) and Research Contract Holder, 2) Duty Travel of PO to review the quality of activity in selected cases.

Resulting Publications

IAEA quality control atlas for scintillation camera systems. IAEA (2003) STI/PUB/1141.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	E13018 Study of the relationship between recurrent lower respiratory tract infection, gastroesophageal reflux (GER) and bronchial asthma in children
Participating Countries:	Chile(C), China(C), Colombia(C), India(A), Pakistan(C), Philippines(C), Poland(C), Poland(C), South Africa(C), Thailand(C), Turkey(C)
Total Cost:	\$201,907
Duration:	1999-12-15 — 2004-01-31

CRP Overall Objectives

The overall objective of the CRP was to render the health care of children with respiratory disorders associated with GER more rational and cost effective both in short term as well as long term perspectives by providing a clearer understanding of the relationship between GER, lower respiratory tract infections, wheezing in infancy and bronchial asthma. Such an understanding will help to institute appropriate and timely treatment leading to effective management of such patients.

CRP Specific Objectives

To determine the prevalence of GER in asthmatic children with recurrent lower respiratory tract infection; to determine the prevalence of GER in asthmatic children and adolescents; to probe the relationship between GER and Asthma; to determine the effectiveness of anti-reflux pharmacotherapy and surgery in the clinical control of asthma and effects of symptomatic and asymptomatic reflux on lung function; to develop a diagnostic algorithm and management strategy in patients suffering from gastroesophageal reflux and/or respiratory disorders; to compare the sensitivity, specificity and accuracy of various diagnostic modalities (like pH probe; barium studies and radionuclide imaging) in the detection of gastroesophageal reflux.

Research Outputs

1. Protocol for the study of GER in children developed, tested and standardised.
2. Results of study conducted on a total number of more than 1000 infants and children.
3. Database of results obtained in 680 patients, which were accepted for consideration of final data analysis.
4. Presentation of interim results at several important International scientific meetings like SNM, EANM and Congress of WFNMB.
5. Demonstration of an association between Bronchial Asthma (BA), Recurrent lower respiratory tract infection (rLRTI) and Gastro-esophageal reflux (GER) [The scintigraphic study was positive for GER in 52% of the total number of patients studied. An abnormal oesophageal transit was observed in 13.5% and Lung Aspiration scintigraphy positive for aspiration of gastric contents in 4% of the patients studied. The interim results also revealed 75% of children with Bronchial asthma had GE reflux and 31% had recurrent lower respiratory tract infection (rLRTI). Follow up studies done in a sub-set of patients after treatment of GER revealed normalization of the scintigraphic study, associated with clinical improvement in 69% cases].
6. Confirmation of the relevance of recognizing gastric abnormalities for dealing with therapeutic problems in bronchial asthma when GER is in a sub-clinical stage (The results obtained in the CRP have shown GER prevalence in children with bronchial asthma and recurrent LRTI to be significantly higher than the reported normal prevalence in infancy or childhood).
7. Formulation of a diagnostic algorithm and management strategy in children suffering from gastroesophageal reflux, recurrent respiratory tract infection and/or bronchial asthma.
8. Publication of results in the supplementary issues of Journal of Nuclear Medicine, European Journal of Nuclear Medicine as well as World J Nuclear Medicine.

CRP Outcome (Effectiveness; Impact; Relevance)

This systematic, large scale multi-centric clinical study has investigated the relationship between GER, rLRTI and Bronchial Asthma in a prospective manner. Based on the results of the study it has been possible to recommend a diagnostic algorithm and management strategy which would help in rationalising management of infants and children suffering from these disorders.

The CRP has helped the participating centres in various IAEA Member States to standardize the various in vivo diagnostic radionuclide procedures used in the multi-centre study and use them on a day to day basis. This has resulted in more appropriate and scientific management of patients suffering from bronchial asthma and gastro-esophageal reflux. Presentation of the work resulting out of the CRP at various International meetings has increased the image of IAEA as an international

Accomplishments of CRPs Completed in 2004

organization engaged in peaceful application of nuclear energy for human health. The CRP has also further strengthened and widened the already existing net-work of professionals, scientists and doctors working in the field of nuclear medicine around the world, leading to increasing exchange of knowledge and ideas among people from developed and developing countries.

Gastro-esophageal reflux (GER) has been described as "the most important" disorder of the oesophagus and the lower oesophageal sphincter. It has been reported that one in 500 children requiring hospital consultation suffer from GER. It has been recently shown that the incidence of GER pathology evaluated by pH monitoring in an unselected population (healthy infants screened for sudden infant death risk) was about 8%. GER usually becomes apparent by the age of 2 months. In majority of these patients the process is self limiting and spontaneously resolves by the end of infancy. Some children, however, continue to have problems and progress from functional GER to pathologic GER. It has also been reported that in a group of infants with GER, 60% became symptom free by the age of 18 months, with the greatest improvement occurring by 8-10 months; 30% continue to have symptoms by until the age of four years (at least). In the absence of treatment, 10% develop complications. GER can cause failure to thrive related to vomiting, esophagitis and esophageal stricture. Anemia can occur as a consequence of chronic blood loss.

GER has been implicated as a cause of recurrent respiratory infection, asthma, and sudden death syndrome. Pulmonary symptoms of cystic fibrosis are often aggravated by concomitant GER.

It is now well recognised that vomiting is not necessarily present in severe GER; this symptom may even be completely missing in recurrent lung infection directly related to GER. Therefore it is mandatory to investigate a possible GER in case of chronic or recurrent lung pathology without any other clear explanation. Surprisingly only a few studies addressing the relationship between GER and respiratory symptoms have been reported in infants and young children in literature.

There is no clear cut explanation of mechanisms responsible for the respiratory symptoms in children with recurrent GER, and these could be multi-factorial. Possible mechanisms are as follows: 1. Highly tuned vagal reflex with an exaggerated effector response to a normal receptor stimulus, leading to excessive broncho-constriction, 2. Lung aspiration of gastric material and 3. Pharyngeal dysfunction.

On the other hand bronchial asthma is a disease that has been recognised for centuries, which is influenced mainly by genetic and environmental factors. The current interest of bronchial asthma is focused to ascertain the causes and mechanisms that induce bronchoconstriction.

In asthmatic patients the recognition of gastric abnormalities is highly relevant for addressing therapeutic problems when GER is in a sub-clinical stage. In fact, many drugs used in the treatment of bronchial asthma can promote or enhance GER and subsequently they may worsen the symptoms of "gastric asthma".

The medical literature has been deluged with articles on the relation between gastroesophageal reflux (GER) and asthma. Epidemiological evidence for a GER/asthma association suggests that about three fourths of asthmatics, independent of the use of bronchodilators, have acid GER, increased frequency of reflux episodes, or heart burn; and 40% have reflux esophagitis. In any given patient, however, there is no acceptable diagnostic method available to confirm the presence or absence of GER-induced asthma. Clinical trials, using antireflux medical therapy and antireflux surgery have begun to provide some clues about GER-related pulmonary symptoms. The trials of medical therapy using acid suppressing drugs (e.g., histamine-2 receptor antagonists) have ranged from no benefit to modest improvement of only nocturnal asthma symptoms. In some uncontrolled surgical studies, antireflux surgery has resulted in partial or complete remission of asthma symptoms in a large proportion of patients. Despite the uncontrolled nature of these studies, many patients have had dramatic subjective improvement in pulmonary symptoms. It appears for now that clinical trials are the only available means to assess whether medical or surgical treatment of GER in patients with both GER and asthma improves the symptoms of asthma and decreases the need for pulmonary medication. To this extent the IAEA CRP has been extremely relevant and timely, and would contribute significantly to existing literature.

Recommended Future Action by Agency

The CRP has gathered probably the largest volume of data in patients in a multi-centre, multi national study conducted by any Agency or organization in this field in the world. These data must be given final shape in the form of publications in peer reviewed journals. It is therefore essential to have a final meeting of at least a few (if not all) active members of the CRP group to finalize the results and the three scientific papers as proposed in the last RCM of the CRP in Bogota, Colombia, e.g., one paper based on recurrent lower respiratory tract infection, one paper based on bronchial Asthma and another paper based on the results of the overall longitudinal study.

Accomplishments of CRPs Completed in 2004

Resulting Publications

1. Ciofetta G, Bernal P, Birkenfeld B, Boonyaprapa S, Chen S, Ellmann A, Fatima S, Orellana P, Rondain JE, Padhy AK. Relationship between gastroesophageal reflux, lower respiratory infection and asthma in children: Preliminary report of a coordinated research project. *Eur J Nucl Med* 2001; 28: 965.
2. Chen SL, Bernal P, Rondain JE, Birkenfeld B, Ellmann A, Boonyaprapa S, Padhy AK. Study of the relationship between recurrent lower respiratory tract infection, bronchial asthma and gastro-esophageal reflux in children. *J Nucl Med* 2002; 43: 85p.
3. Chen SL, Zeng JH, Zhao RF, Padhy AK. The evaluation of GER in children with chronic respiratory disease. *J Nucl Med* 2003; 44: 351p.
4. Orellana P, Bernal P, Birkenfeld B, Boonyaprapa S, Chen SL, Cioffeta GC, Ellmann A, Kavasakal L, Shazia F, Rondain P, Padhy A. Relationship between recurrent lower respiratory tract infection, bronchial asthma and gastroesophageal reflux in children. *World J Nucl Med* 2002; 1: S-145.
5. Fatima S, Saeed MA, Raza M, Kundi ZU, Hyder SW, Jafri SRA. Gastro-esophageal reflux and respiratory diseases in children. *World J Nucl Med* 2002; 1: S-141.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	E21004	Development of techniques at SSDLs for the dissemination of absorbed dose to water standards
Participating Countries:	Algeria(C), Argentina(C), France(A), India(C), Norway(A), Thailand(C)	
Total Cost:	\$65,098	
Duration:	2001-04-01 — 2004-03-31	

CRP Overall Objectives

To assist Secondary Standards dosimetry Laboratories (SSDLs) of Member States develop techniques for the realization and dissemination of absorbed dose to water standards needed for the implementation of the new international Code of Practice TRS 398.

CRP Specific Objectives

To test practical implementation of TRS 398 at SSDLs and provide guidance on the calibration and dissemination of calibration coefficients to hospitals, based on absorbed dose to water standards. The guidance, to be published in a TECDOC, will include recommendations on:

- Instrumentation needed and procedures used by SSDLs for in water measurements for Co-60 gamma beam;
- Calibration and dissemination of calibration coefficients for high energy photon beams;
- Uncertainties achievable at SSDLs.

Research Outputs

As an output of the CRP, the following results were obtained:

- Development of standardized procedures for absorbed dose to water calibration by SSDLs;
- Estimation of calibration uncertainty and validation through international comparisons;
- Publication of TECDOC: Implementation of International Code of Practice on Dosimetry in Radiotherapy (TRS 398): Review of Testing Results.

CRP Outcome (Effectiveness; Impact; Relevance)

The calibration procedures implemented by the SSDLs in terms of absorbed dose to water for Co-60 gamma beam was verified in a comparison programme. Specific guidance on the expression of measurement uncertainty for absorbed dose to water calibrations was developed. Recommendations on calibration and dissemination of calibration coefficients for high energy photon beams were prepared.

The use of TRS 398 will improve radiotherapy dosimetry. The guidance developed under the CRP will assist the SSDLs in its implementation.

The guidance developed under the CRP will be disseminated to all IAEA/WHO SSDL network members. For Member States, it will yield a unified and consistent framework for the implementation of the International Code of Practice TRS 398.

The use of TRS 398 and the practical guidance developed under this CRP for SSDLs will improve radiotherapy dosimetry in the Member States.

Recommended Future Action by Agency

The IAEA should review the guidance developed under this CRP when a second edition of TRS 398 is prepared.

Resulting Publications

IAEA TECDOC Series No. 1455 "Implementation of the International Code of Practice on Dosimetry in Radiotherapy (TRS 398): Review of testing results" (2005).

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	E41012	Health impacts of mercury cycling in contaminated environments studied by nuclear techniques
Participating Countries:	Brazil(C), Canada(A), China(C), Germany(A), India(C), Japan(A), Philippines(C), Slovenia(C), Sweden(A), United Republic of Tanzania(C), Venezuela(C)	
Total Cost:	\$256,191	
Duration:	1999-10-01 — 2004-02-24	

CRP Overall Objectives

To establish in Member States capability to evaluate the fate of key non-radioactive environmental contaminants and selected long-lived radioactive contaminants that affect human health by using nuclear analytical techniques (mainly NAA, PIXE, XRF and ICP-MS).

CRP Specific Objectives

To study and assess the factors influencing the dynamics of mercury cycling and its impact on human health in mercury contaminated aquatic ecosystems, especially in tropical environments, using radioisotopes and enriched stable isotope tracers and complementary analytical techniques. Research activities should include at least one of the following studies, using isotope and complementary techniques:

1. Evaluation of the relevant environmental factors influencing mercury transformations, transport and partitioning in aquatic ecosystems and assessment of the health effects of the exposed human subjects;
2. Validation and application of appropriate methodologies for the measurements of mercury methylation and demethylation rates in various environmental compartments;
3. Validation and application of appropriate methodologies for the measurements of mercury fluxes at sediment/water/air interfaces;
4. Evaluation of relative toxicity (e.g. as reflected in selected human specimens such as hair and urine), and the biokinetics of uptake and release of the different forms of mercury in key aquatic species with the view of better understanding the key pathways of its harmful supply to man;
5. Formulation of an appropriate sediment reference sample for comparability studies.

Research Outputs

Five countries out of 11 participants reported results on methylation, demethylation and reduction studies. Methods used included the use of radioactive isotopes ^{203}Hg (Japan, Slovenia, Tanzania, Brazil) and $^{14}\text{CH}_3\text{Hg}$ (Slovenia). Enriched stable isotopes were only used by one member (Canada) and the expertise to use these tracers in the future was transferred to Slovenian and Brazilian partners. Some laboratories (Japan and Tanzania) developed techniques based on the addition of known quantities of non-radioactive mercury. Significant improvements were done on methods already available, and successful experiments on mercury transformation and partitioning were conducted in laboratory conditions. Validated protocols and comparative analysis on the use of stable and radioactive isotopes was provided by Brazil.

Three participating laboratories conducted flux measurements at different boundary conditions. Slovenia studied fluxes from coastal sediment to water using benthic chambers and compared benthic fluxes with diffusive fluxes for total Hg and MeHg. They also used flux chambers to estimate flux of elemental Hg from contaminated soils to the air. Experiments in the laboratory conditions were developed to study the effect of different factors, such as moisture, Hg concentration, and organic matter content on the volatilization of $\text{Hg}(0)$. German participant developed very sophisticated laboratory chamber experiments to study factors influencing mercury flux from soil to air. The Chinese partner developed a technique that can be used under the field conditions to estimate fluxes of mercury from contaminated soil to water. He also developed a methodology to quantify mercury flux from soil to selected vegetables and transfer of Hg from the air to plants.

Mercury transformation experiments and factors influencing these processes were obtained from contaminated areas in tropical forests (Amazon, Brazil), polluted areas due to past mining activity in Slovenia (soil, river and marine sediments), gold mine tailings in Tanzania, contaminated soils in China, and Swedish waste water treatment pond. Information on fluxes and factors influencing these fluxes in the environmental conditions were only reported from China and Slovenia, while Germany mainly conducted laboratory experiments.

Contaminated sites in different participating countries were carefully investigated in terms of factors influencing Hg transformation, transport and partitioning. Comparison of case studies in each individual country showed that these processes

Accomplishments of CRPs Completed in 2004

depend on different factors such as pollution source, change of the land and water use, type of water bodies, type of soil, climate, hydro meteorological conditions, topography. The results are reported in country reports and other publications.

The initial plan of the CRP participants was to prepare a reference sediment sample from a tropical region for comparability studies. One of the potential areas for sampling was Lake Guri in Venezuela, but the results of total and MeHg revealed that sediment samples collected contained low concentrations of total Hg, and would, therefore, not be appropriate. The second possibility was to prepare river sediment from the Amazon region, which would be more appropriate as regards the concentration ranges. However, the amount of the sample (about 2 kg) sent to the Jožef Stefan Institute in Ljubljana would not be sufficient to prepare a reference material for all the CRP participants. Therefore, it was decided to prepare a soil sample from an area close to Idrija mercury mine, Slovenia that is contaminated with Hg due to continuous deposition of particles enriched with Hg during flood events. Such a sample is representative of areas where mercury transport and deposition is governed by river hydrology, which is typical in a number of mercury-contaminated environments. Over 270 bottles of SOIL-1 sample were prepared in compliance with ISO/REMCO Guides for the preparation of reference materials. Each participant received 6 - 10 bottles of the sample for various purposes. One of them is to compare the results for total and MeHg obtained in laboratories participating in the CRP and to perform fractionation studies. The second objective was to use this material for methylation and demethylation studies using different methodologies and compare the results obtained. The material can also be used as a reference material for continuous monitoring of laboratory's analytical performance. In addition, a sediment sample from the Amazon was collected by Canada and was distributed to the participants during the last RCM.

Eight countries performed measurements and provided data in bio-indicators of contamination at different levels, representing human exposure, water and terrestrial environment, and air. The measured data confirmed the suitability of Hg measurements in urine and blood in population exposed to mercury vapor and inorganic mercury in food, while blood and hair were successfully used in population exposed to MeHg through consumption of fish and other food. Mercury levels in fish were used to indicate the availability of mercury for methylation and uptake in various water environments including fishponds, lakes, rivers and coastal environment. Mercury levels in fish were used for the evaluation of potential risk in human exposure. In contaminated soils, the suitability of terrestrial isopods was investigated to assess the availability of mercury to the lower levels of food chains. Studies on the uptake of mercury from plants to herbivore roe deer in contaminated sites in Slovenia showed that roe deer might be a suitable early warning system for humans living in contaminated sites. In China several vegetables grown in contaminated soil were analysed for the content of Hg. The results confirmed that the major uptake in vegetables is through the air. In Slovenia and Tanzania studies on the suitability of lichens as indicators of air mercury pollution were carried out by using two species of lichens: *Hypogimnia physodes* and *Parmelia sulcata*. The CRP provided numerous data on total mercury measurements in bio-indicators. In order to assess the risk, in particular in humans, it is of paramount importance to distinguish between total mercury and MeHg in bio-indicators, as it is well known that these Hg species have different metabolic pathways and effects. The participants in the CRP actively exchanged their expertise in mercury speciation in order to transfer the knowledge and improve capacities to analyse total and MeHg in biological and environmental samples.

In order to address various possibilities for remediation of contaminated sites, research coordination meetings took place in three different places, each representing different scenario. In Idrija, Slovenia that is contaminated due to the past mercury mining the remediation will be based on integrated modeling combining natural sciences and socio-economic development of the region. In Minamata, Japan, polluted coastal environment was remediated by sediment dredging and permanent burial of polluted sediment. In Sweden, remediation of contaminated lake Turingen due to industrial discharge was presented. This included dredging of contaminated sediments and subsequent isolation of Hg containing sediment by artificial Al polymers. Also, the results of successful removal of mercury in stack gas of the Uppsala incineration plant were presented.

CRP Outcome (Effectiveness; Impact; Relevance)

The CRP's outputs have contributed considerably to better understand factors influencing the dynamics of mercury cycling and its impact on human health (Venezuela, Brazil, Tanzania, China, Philippines and Slovenia). The combination of nuclear and non-nuclear techniques has proven to be the most appropriate approach to study mercury cycling in the environment and to address human exposure issues. The diversity of expertise available and the variety of mercury problems in selected case studies have provided excellent opportunity to address specific objectives of the CRP and assured successful implementation of the work programme. The CRP addressed the most important questions in Hg research related to mobility, reactivity, uptake and consequent toxicity to man and ecosystems. The emphasis was put on the methodological issues, which still represent the largest uncertainties in quantification of Hg adverse effects. Results of this CRP will therefore have wider community benefit, which is evidenced by the number of open literature publications of the CRP participants.

Developed and improved methodologies enhanced current knowledge of mercury cycle in selected case studies. The results were disseminated to wider scientific communities as well as to the wider public and policy makers, which improved the perception for mercury pollution problems. This was achieved through the publications of journal articles, books, conference contributions and the organization of worldwide, regional and local conferences, workshops and forum:

Accomplishments of CRPs Completed in 2004

1. 6th International Conference on Mercury as Global Pollutant, October, 2001 (Japan) (600 participants);
2. The International Workshop on Health and Environmental Effects of mercury - Impact of Mercury from Artisanal Gold Mining in Africa, (19-20 November, 2002) (Japan, Tanzania) (50 participants);
3. SEAMIC Workshop on Chemical Warfare, Manila, Philippines, 25-29. March, 2003 (JICA, Japan) (20 participants);
4. SEAMIC Workshop on the Analytical Procedures and Techniques in the Determination of Metals, 19-23 May, Manila, Philippines (JICA, Japan) (20 participants);
5. 1st International Forum on the mercury problem in reservoirs: the case of reservoir Guri, May, 2001, Bolivar City, Venezuela (Venezuela) (100 participants);
6. Workshop on Mercury in the Wider Idrija Region and the Gulf of Trieste, May, 2000. Portoroz, Slovenia (Slovenia) (73 participants).

Recommended Future Action by Agency

The present CRP significantly improved the knowledge of mercury cycling in contaminated sites and provided some information on factors influencing mercury behavior in investigated case studies. Significant differences in mercury cycling were observed that were not fully explained due to the lack of expertise in the field of biology, biochemistry, microbiology and genetics. Nuclear techniques and methodologies in these fields could complement "chemical" approaches to study mercury cycling in the environment and biological systems. In order to improve the knowledge on health effects of populations exposed to mercury in contaminated sites it would be necessary to introduce biomarkers of functional damage of target organs (central nervous system, kidney and endocrine glands) and effects on lipid peroxidation responsible for cardiovascular disorders.

One of the objectives of this CRP was also related to the countermeasures. The participants were acquainted with various options currently in place in selected member states case studies. Globally, there are no generally accepted methodologies to manage contaminated sites and the area of research is also widely opened for further actions. The potential role of nuclear techniques is very high in terms of technological development in this area. Therefore, the Agency is also recommended to consider coordinated research in this topic.

The CRP established a network of participating laboratories in 11 Member States that have encountered serious mercury pollution problems. It is strongly suggested that the IAEA establish a liaison with other specialized Agencies and programmes in the UN family in particular with UNEP and WHO as well UNIDO in order to further strengthen the role of the network in the implementation of actions to abate mercury pollution at the global level.

Resulting Publications

The participants have published numerous scientific papers produced in the framework of this CRP: 25 articles in peer reviewed international scientific journals, 30 papers in not peer reviewed journals or proceedings, 61 abstracts, and more than 10 publications in local journals. The results, therefore, reached wider community interested in the subject and the visibility of the IAEA CRP was also high. Based on these facts the participants suggested to publish a special issue in one of the scientific journal dealing with environmental issues, which will include summary papers of the research conducted in Member States laboratories. The Special issue will highly acknowledge the support of the IAEA.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	F12013	Development and practical utilization of small angle neutron scattering (SANS) applications
Participating Countries:	Austria(A), Brazil(C), France(A), France(A), Germany(A), Greece(C), Hungary(C), India(C), Korea, Republic of(C), Portugal(C), Russian Federation(C), South Africa(C)	
Total Cost:	\$164,399	
Duration:	2000-08-25 — 2004-03-25	

CRP Overall Objectives

The objective of the IAEA's project D 2.01 is to enhance the Utilization of Research Reactors, promote research and development in specific applications of research reactors, help development of trained manpower and encourage collaboration.

CRP Specific Objectives

The Specific purpose is to solve current problems hindering the use of SANS in under-utilized facilities to be achieved by:

1. Developing SANS related equipment which will be useful for many applications, but easily maintainable in developing countries;
2. Forging long term supportive relationships between type A and Type B pairs of institutions and the scientists working at those institutions;
3. Transferring ships research to other facilities involved in the CRP.

Research Outputs

1. Neutron position sensitive detectors were developed and tested individually and in specific configuration required for effective use in SANS;
2. Data acquisition systems were designed and tested;
3. Multichannel collimators were configured;
4. Feasibility of SANS on a medium flux reactor was done using simulation;
5. Ultra SANS was designed and is under fabrication;
6. Measurements on various metallurgical samples were carried out on MSANS;
7. Components for Neutron Velocity Selector were developed and tested.

Some of these are contributions of teamwork.

CRP Outcome (Effectiveness; Impact; Relevance)

Development, fabrication and testing of instruments were carried out in different centres based on the available facilities. The discussion and exchange of knowledge during the CRP helped improving the facilities and using them effectively.

The development of new facilities is a significant contribution to meet the overall objective of project "enhancement of research reactor utilization".

The participants of the CRP gained experience in developing instruments. It is proposed that this facility will be open to users from national universities and industries and subsequently to international community.

SANS is an important technique in materials research and development. The team work among different facilities has shown that the concept adopted in this CRP works and is expected to go a long way. Equipment were developed and tested. There has been exchange of scientists, fellows to fulfill the commitments.

Recommended Future Action by Agency

The developing of equipment and techniques for research reactor utilization is a continuous process; thus the Agency should continue with this development work.

Accomplishments of CRPs Completed in 2004

Resulting Publications

1. FALCÃO, A.N., MARGAÇA, F.M.A., and CARVALHO, F.G., "The Use of Multichannel Collimation in Small Angle Neutron Scattering: A Computer Simulation Study", *Appl. Phys. A* 74 (Suppl.), S1462-S1464 (2002)
2. FALCÃO, A.N., MARGAÇA, F.M.A., CARVALHO, F.G., "Intensity and Resolution Effects in Converging Multichannel Collimators for SANS by Monte Carlo Simulation", *J. Appl. Cryst.*, (2003), 36, 1262-1265
3. FALCÃO, A.N., MARGAÇA, F.M.A., CARVALHO, F.G., "A Contribution to the Practical Implementation of a Variable Geometry Converging Multichannel Collimator for SANS", *J. Appl. Cryst.*, (2003), 36, 1266-1269
4. MARGAÇA, F.M.A., FALCÃO, A. N., CARVALHO, F.G., "Guidelines for the Implementation of Converging Multichannel Collimation in a Specific SANS Facility", *J. Appl. Cryst.* (2004) (in press)
5. MARGAÇA, F.M.A., FALCÃO, A.N., SALGADO, J.F., CARVALHO, F.G., "Wavelength Dependence of the Performance of a SANS Instrument Installed at a Steady Source" (2003) (to be submitted)
6. Dynamical scaling of structure factor for some non-Euclidian systems: S. Mazumder, D. Sen, A.K. Patra, S.A. Khadilker, R.M. Cursetji, R. Loidl, M. Baron and H. Rauch; *Phys. Rev. Lett.* in press (2004)
7. Manifestation of the statistical nature of a medium in multiple Small-angle scattering: S. Mazumder, D. Sen, S.K. Roy, M. Hainbuchner, M. Baron and H. Rauch, *J. Phys.: Condens. Matter*, vol 13, 5089-5102 (2001)
8. Pore morphology in sintered ZrO₂-8 mol%Y₂O₃: A Small-angle neutron scattering investigation: D. Sen, A.K. Patra, S. Mazumder and S. Ramanathan; *J. Alloys and compounds*, vol 340, 236-241(2002)
9. L.Rosta, L.Cser, Zs.Révay: Gain factors with the new supermirror guide system at the Budapest Neutron Centre, *Appl. Phys A* 74 S292-294 (2002)
10. L.Almásy, G.Jancsó, L.Cser: Application of SANS to the determination of Kirkwood-Buff integrals in liquid mixtures, *Appl. Phys. A* 74 S1376-1378 (2002)
11. L.Cser, J.Füzi, L. Riecsánszky, Gy.Török: Polarized neutron reflectometer at the Budapest Research Reactor *Appl. Phys. A* 74 (Suppl.), pp S213-214 (2002)
12. Füzi J, Török Gy, Rosta L; Neutron focusing with permanent magnet hexapole lenses; *Physica B*; 350, 169-172, 2004
13. Len A, Pépy G, Rosta L; Multibeam focussing in SANS technique; *Physica B*; 350, E771-E773, 2004 Conference Proceedings
14. Füzi J; Magnetic Lenses for Neutron Beams; In: Proceedings CD of the 11th IGTE Symposium on Numerical Field Calculation in Electrical Engineering, 13-15 September, Graz; Ed: Bíró O; pp 371-375 (2004)

Book Chapter

15. L.Cser, I.Salma, G.Molnár: Anyagvizsgálatok Neutronokkal (Materials Studies by Neutrons, in Hungarian), *Nukleáris tudomány és a 20. Század: Műhelytanulmányok sorozat* (Strategic Research at the Hungarian Academy of Sciences), Eds. Glatz F, Vértes A.: MTA ISSN 1419-1822, pp 75-90 (2002)
16. Report of second RCM F1-RC-830 (Working Material) Reproduced by the IAEA, 2003

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	F23018	Development and validation of speciation analysis using nuclear techniques
Participating Countries:	Argentina(C), Austria(A), Belgium(A), Brazil(C), China(C), Ghana(C), India(A), Slovenia(C)	
Total Cost:	\$98,910	
Duration:	2001-03-01 — 2004-03-31	

CRP Overall Objectives

To assist Member State laboratories to adopt validated methods for speciation analysis of arsenic (As), chromium (Cr) and selenium (Se) in aqueous media.

CRP Specific Objectives

- To improve separation and determination techniques for speciation of As, Cr and Se in water.
- To improve reliability of results obtained with validated techniques and, hence, more accurate data base for decisions on legal limits.
- To disseminate information on speciation techniques to Member States being effected by impaired element concentrations in drinking water, soil or nutrition to monitor the toxic potential to their population.

Research Outputs

- A cost effective hydride generation module for AAS determination of As species was developed and is ready for being distributed to other laboratories. TOs will try to promote this module.
- Several low-tech speciation methods for As, Cr, and Se were developed that can be easily adopted by laboratories without access of ICP-MS and other expensive equipment.

CRP Outcome (Effectiveness; Impact; Relevance)

The CRP was efficient in developing validated speciation methodology which was easy to adopt in developing Member States' laboratories.

A TECDOC is currently in preparation summarizing the experience of the participants, including many case studies for As, Cr and Se speciation. Validation of speciation methods using radioisotopes will also be described.

In view of a large proportion of the population suffering from As poisoning in South Asia and Latin America, information on reliable analytical procedures to assess the impact of chemical species on human health is required and appreciated. This CRP helped to develop validated methods for As, Cr and Se species in aqueous matrices.

Recommended Future Action by Agency

As a general conclusion the participants stressed the growing need to improve speciation analysis capabilities and urged the Agency to continue its support for enhancing awareness and to improve capabilities for speciation analysis.

Resulting Publications

1. VAN ELTEREN, J.T., STIBILJ, V., ŠLEJKOVEC, Z., "Speciation of inorganic arsenic in some bottled Slovene mineral waters using HPLC-HGAFS and selective coprecipitation combined with FI-HGAFS", Water Res., 36 (2002) 2967-2974
2. P. Smichowski, L. Valiente, A. Ledesma: Simple method for the selective determination of As(III) and As(V) by ETAAS after separation with anion exchange mini-column. Atom. Spectroscopy, Vol. 23 (3) (2002) 92-97
3. Van Hulle M, Zhang C, Schotte B, Mees L, Vanhaecke F, Vanholder R, Zhang XR, Cornelis R. Identification of some arsenic species in human urine and blood after ingestion of Chinese seaweed Laminaria, JOURNAL OF ANALYTICAL ATOMIC SPECTROMETRY 19 (1): 58-64 JAN 2004

Accomplishments of CRPs Completed in 2004

4. Wei C, Li WH, Zhang C, Van Hulle M, Cornelis R, Zhang XR. Safety evaluation of organoarsenical species in edible porphyra from the China Sea, *JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY* 51 (17): 5176-5182 AUG 13 2003
5. Li WH, Wei C, Zhang C, Van Hulle M, Cornelis R, Zhang XR. A survey of arsenic species in chinese seafood, *FOOD AND CHEMICAL TOXICOLOGY* 41 (8): 1103-1110 AUG 2003
6. Van Hulle M, Zhang C, Zhang XR, Cornelis R. Arsenic speciation in chinese seaweeds using HPLC-ICP-MS and HPLC-ES-MS, *ANALYST* 127 (5): 634-640 2002
7. ŠCANCAR, Janez, MILACIC, Radmila. A novel approach for speciation of airborne chromium by convective-interaction media fast-monolithic chromatography with electrothermal atomic-absorption spectrometric detection. *Analyst (Lond.)*, 2002, vol. 127, str. 629-633. [COBISS.SI-ID 16715815] JCR IF: 2.292; SE, x: 1.5 (12/68), chemistry, analytical
8. FALNOGA, Ingrid, KOBAL, Alfred Bogomir, STIBILJ, Vekoslava, HORVAT, Milena. Selenoprotein P in subjects exposed to mercury and other stress situations such as physical load or metal chelation treatment. *Biol. trace elem. res.*, 2002, vol. 89, str. 25-33. [COBISS.SI-ID 16936743]
9. MAZEJ, Darja, STIBILJ, Vekoslava. Measurement uncertainty of selenium determination in the reference material Seronorm Trace Element Serum by hydride generation atomic fluorescence spectrometry. *Accredit. qual. assur.*, 2003, vol. 8, str. 117-123. [COBISS.SI-ID 17426215]
10. MAZEJ, Darja, FALNOGA, Ingrid, STIBILJ, Vekoslava. Selenium determination in whole blood, plasma and selenoprotein P by hydride generation atomic fluorescence spectrometry. *Acta chim. slov.* [Tiskana izd.], 2003, vol. 50, str. 185-198 [COBISS.SI-ID 17565735]
11. STIBILJ, Vekoslava, MAZEJ, Darja, FALNOGA, Ingrid. A study of low level selenium determination by hydride generation atomic fluorescence spectrometry in water soluble protein and peptide fractions. *Anal. bioanal. chem.*, 2003, vol. 377, str. 1175-1183. [COBISS.SI-ID 17905447]
12. MAZEJ, Darja, HORVAT, Milena, BARBONE, Fabio, STIBILJ, Vekoslava. Simple and rapid method for determination of selenium in breast milk by HG-AFS. *Mikrochim. acta (1966)*. [Print ed.], 2004, vol. 147, str. 73-79. [COBISS.SI-ID 18285095]

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	F23019	Integration of residence time distribution (RTD) tracing with computational fluid dynamics (CFD) simulation for industrial process visualization and optimization
Participating Countries:	Australia(A), Brazil(C), Cuba(C), Czech Republic(C), France(A), Germany(A), India(C), Korea, Republic of(C), Norway(A), Poland(C), United States of America(A)	
Total Cost:	\$149,993	
Duration:	2001-03-01 — 2004-03-31	

CRP Overall Objectives

To develop and validate an integrated methodology for application of residence time distribution (RTD) tracing and computational fluid dynamics (CFD) modeling in investigation of engineering processes selected from chemical and petrochemical industries, energy production, mineral ore processing and waste-water treatment sectors.

CRP Specific Objectives

- To develop radiotracer experimental techniques for CFD model verification and validation in several processing units.
- To develop, test and compare simple software packages for prediction of RTD by CFD tools.
- To develop combined RTD and CFD protocols for flow patterns characterization.

Research Outputs

- CRP participants developed several CFD models of commonly used industrial processes, and radiotracer tests were performed for the validation of such CFD models in copper ore enrichment hydrocyclone, wastewater treatment plant, wastewater purification photo reactor, sludge hygienization irradiator, direct ohmic heater, sugar crystalliser and mini oil reservoir.
- Through the subgroup activity of the CRP, a CFD-RTD educational package, which includes lecture notes, tutorials and software for both CFD and RTD, was produced. As the user-friendly web-based interface allows users more easily learning the CFD and RTD knowledge and practicing the software, it is suitable for the training of both tracer personnel and modellers on the integrated CFD-RTD methods.
- The CRP produced the IAEA-TECDOC-1412 "Integration of tracing with computational fluid dynamics for industrial process investigation" and the reports of three research coordination meetings. The TECDOC was prepared based on the work performed during this CRP to help radiotracer groups and their end users to establish a working partnership to develop further and make operational the RTD-CFD method for problem solving.

CRP Outcome (Effectiveness; Impact; Relevance)

- The CRP demonstrated that radiotracer techniques could play a key role in validation of CFD models through experimental RTD analysis. Some participating groups generated the RTD functions from CFD simulations, and compared them with experimental tracing RTD curves from tracer tests to validate the models. The validated models were used for interpretation of radiotracer data and visualization of the flows.
- A CFD & RTD Educational Package was developed to provide knowledge on CFD and RTD techniques and their interactions to both tracer and CFD specialists.
- A TECDOC was prepared to help radiotracer groups and their end users in utilizing the RTD-CFD method for problem solving in industry.

The participants demonstrated the beneficial role of RTD-CFD integrated method in analyzing and optimizing industrial processes with many case studies from chemical and petrochemical industries, from mineral ore processing and waste water treatment plants.

The main achievements of the CRP were summarized the TECDOC, which provides basic information about the RTD-CFD integrated method and illustrates its use through many case studies. It will help the radiotracer specialists in introducing modern modeling methods to industry and in transferring the technology to developing countries.

The CRP developed a new approach in investigating industrial processes. Tracer specialists learned how to validate CFD models and CFD specialists understood the need and role of tracer RTD tests for verification of their CFD models. The RTD-CFD method is the best approach for obtaining reliable and accurate results for process insight. The method developed

Accomplishments of CRPs Completed in 2004

in this CRP serves as a bridge for working partnership between tracer specialists, CFD modelers and end users. It will open the door for further investigation and problem solving of many complex processes in industry and environment.

Both experimental radiotracer RTD technique and theoretical CFD simulation method can be used for investigation and optimization of industrial processes. The RTD tracing experiment provides important hydrodynamic parameters, but cannot localize and visualize flow pattern inside the systems. The CFD provides localize information and pictures of flow pattern, but it provides qualitative results only due to lack of experimental data. The RTD results of tracer experiments can be used for validation of the CFD model. Then, the validated model can be used for optimization of the process as well as visualization of tracer experimental results. One can obtain synergy effect by using both RTD and CFD technique. In most cases, however, experts on one technology have not enough knowledge on the other technology. The results of this CRP will help the specialists in understanding of each other's technology.

Recommended Future Action by Agency

It is recommended that the Agency follow up on the progress made in this CRP by starting a new one that concentrates on the use of radiotracers and modeling for the investigation of multi-phase flow.

Resulting Publications

IAEA TECDOC Series No. 1412 "Integration of tracing with computational fluid dynamics for industrial process investigation" (2004).

The TECDOC was published and distributed together with the CFD-RTD Educational Package to the participants and tracer groups all over the world.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	F31002 Isotopic composition of precipitation in the Mediterranean Basin in relation to air circulation patterns and climate
Participating Countries:	Algeria(C), Austria(A), Croatia(C), Egypt(C), France(A), Greece(C), Greece(C), Israel(A), Italy(A), Lebanon(C), Morocco(C), Portugal(C), Portugal(C), Slovenia(C), Spain(A), Turkey(C)
Total Cost:	\$218,547
Duration:	2000-06-15 — 2004-12-14

CRP Overall Objectives

To improve understanding of variations of air circulation patterns and climate using isotopic composition of precipitation.

CRP Specific Objectives

The specific objectives of the CRP are:

- the assessment of the variation of the isotopic values along the main directions west-east and south-north;
- the correlation between these variations and the main climatic and meteorological parameters;
- the comparison between the isotopic composition of the precipitation and the shallow groundwater and surface waters;
- the determination of physical phenomena in compliant place, and
- the refinement of a process-based understanding to fully realise the value of isotopic data in hydrological and climate studies.

Research Outputs

Comparison with data obtained by the various countries allows the improvement of the understanding of local and regional isotope hydrological features.

The use of d-excess in addition to absolute values O-18 and H-2 in precipitation is useful for seasonal tracing. The contrast between winter and summer data is very important.

In the Mediterranean region, high d-excess should not be systematically associated to Mediterranean Sea effect.

The 3H data has turned out to be a good tracer for different origins of moisture (e.g. Atlantic, Mediterranean, continentality...). This could be important where stable isotopes signal is masked by other physical parameters.

The origin and trajectory of air masses can be better-assessed using data from daily basis sampling.

The studies carried out since 2001 permitted to define better the possible role of isotopes in climate studies. Stable isotope composition of precipitation may be an additional parameter to monitor changes in circulation patterns.

It was possible to follow air masses (moisture) transport at least in some parts of the Mediterranean Basin using back trajectories.

Isotopes help to assess the magnitude of interaction with vapor generated over the Mediterranean. Air masses with high humidity deficit are more affected when crossing the Mediterranean, especially in the Eastern Mediterranean region.

There is a good connection between isotope ratios in water vapour and precipitation samples collected at the same time. This allows the study of the condensation and/or evaporation processes.

CRP Outcome (Effectiveness; Impact; Relevance)

The overall objectives and improvement in the understanding of isotope variation related to air masses trajectories were achieved.

The major findings obtained within the CRP are:

- A clear relation was observed in most of the Mediterranean countries between the air masses origins and trajectories and the isotope contents in precipitation and water vapor.

Accomplishments of CRPs Completed in 2004

- The daily-based sampling is giving additional information than the monthly one. Isotope content variations are driven by other parameters. The origin and trajectory of air masses can be better-assessed using data from daily basis sampling.
- Major changes in deuterium excess in precipitation samples occur from one day to another. These abrupt changes in d-excess were attributed in some cases to the rapid variation of the position of the inversion layer.
- Coastal stations are showing enriched stable isotopes and lower tritium values.

Hydrologist, hydrogeologist, and meteorologists were involved in the project and collaborate on a national and regional level. This was essential for the real integration of isotopes in climate studies.

Recommended Future Action by Agency

For a better understanding of the rainfall formation processes, a sequential sampling of precipitation at defined stations would be necessary. Other research could be conducted within the framework of a Coordinated Research Programme using chronological sampling of precipitation to investigate the changes and Rayleigh distillation in the source of humidity during selected events.

Climate modellers should make great use of the database built during the CRP and available at isohis.iaea.org.

Isotope data in vapour and precipitation might be of relevance for the study of climate variability and climate change. It should be envisaged to include such measurements into the GNIP network.

Resulting Publications

IAEA TECDOC Series No. 1453 "Isotopic composition of precipitation in the Mediterranean Basin in relation to air circulation patterns and climate" (2005).

4 papers presented at the International Workshop on the Application of Isotope Techniques in Hydrological and Environmental Studies UNESCO, Paris, France, September 6-8, 2004.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	I33011	Establishment of a thermophysical properties data base for LWRs and HWRs
Participating Countries:	Canada(A), China(C), Czech Republic(C), France(A), Germany(C), India(C), Korea, Republic of(C), Korea, Republic of(C), Russian Federation(C), Russian Federation(C), Ukraine(C)	
Total Cost:	\$118,450	
Duration:	1998-10-22 — 2004-01-30	

CRP Overall Objectives

This CRP was included in the IAEA's Nuclear Power Programme following endorsement in 1997 by the IAEA NE Department's International (now: Technical) Working Groups on Advanced Technologies for Light Water Reactors and Heavy Water Reactors (the TWG-LWR and the TWG-HWRs) with the support of the International Working Group on Fuel Performance and Technology. This project fostered the exchange of non-proprietary information on thermophysical properties of LWRs and HWRs materials to achieve improvements in design and safety.

IAEA's Nuclear Power Programme includes a Sub-programme on Nuclear Power Reactor Technology Development. The Sub-programme's objective is to increase the exchange of non-commercial information and to foster co-operative research in nuclear power technology development and its applications. A project on technology development for advanced water-cooled nuclear power plants was carried out within this Sub-programme to foster international information exchange and collaboration in achieving technology advances for improving reliability, economics and safety. The activities were formulated with the advice, and carried out with the support, of the TWG-LWR and TWG-HWR.

CRP Specific Objectives

The specific objective of the CRP was to collect and systemize an internationally available, peer reviewed data base of thermo-physical properties data base for light and heavy water reactor materials under normal operating, transient and accident conditions and to foster the exchange of non-proprietary information on thermo-physical properties of LWR and HWR materials.

Research Outputs

Nine institutes from seven countries participated in this CRP: Atomic Energy of Canada Ltd. (Canada); the Nuclear Power Institute of China (China); the University of West Bohemia (Czech Republic); the Institute of Physics and Power Engineering, and the Institute of High Temperatures of the Russian Academy of Sciences (Russia); Bhabha Atomic Research Centre (India); Commissariat à l'Energie Atomique, Grenoble (France); Hanyang University and Seoul National University (Rep. of Korea). Significant contributions have also been made by the Argonne National Laboratory, USA, through its work in establishing a thermo-physical properties database within the International Nuclear Safety Programme. Participants collaborated to establish an internationally available, peer reviewed database of properties at normal and severe accident conditions on the Internet. New measurements of thermo-physical properties of Zirconium liquid, Hf, Zr-2.5%Nb and UO₂-Gd₂O₃ were completed. Assessments of thermo-physical properties of materials including Zircaloy, Zr-2.5% Nb, Zr-1% Nb, Zr liquid, ThO₂-UO₂, ThO₂, UO₂-Gd₂O₃, UO₂, Russian steels, Hafnium, Hafnium Dioxide, Corium and Inconel were carried out by the participants, and these assessments were peer reviewed by designated institutes for each material. This CRP established the recommended data base with known uncertainties through an international peer review process.

Assessments of Thermo-physical properties of materials have been carried out by the participants and have been described in the TECDOC. Also, the selected new experimental data on the specified material have been collected and the experimental methods and equipments used to determine the material properties have been included in the TECDOC which will be published by the end of 2005.

To support this effort, the THERSYST system from the University of Stuttgart in Germany was obtained by the IAEA in December 2000 and the properties data were initially stored in this data system. This system was converted to a web-based system for data storage and retrieval by Hanyang University of Republic of Korea, which was the database manager. Also, the THERSYST data base was converted by IPPE into plain text format, which IAEA used as the reserve data archive. The data base contains over 13,000 data files containing properties data, descriptions of the experiments, and bibliographic information. IAEA established an initial version of the web page with an overview of the CRP and its objectives, which also reported on the status of the data collection, assessments and peer reviews, ultimately with links to the individual institutes' web sites which contained the actual data that they contributed to the CRP. Subsequently, this web page was developed into an

Accomplishments of CRPs Completed in 2004

internationally available internet database named THERPRO which is under development in IAEA web page <http://www.iaea.org/OurWork/ST/NE/NENP/NPTDS/Projects/Therpro/index.html>. This work initially concentrated on the analysis of the data base structure and means for the revitalization of the old database. Based on this analysis complete redesign and reconstruction into a modern one on the web-internet was conducted using the contemporary information technologies. In the mean time, Hanyang University was designated as IAEA's centre for data-base management with the financial assistance of the Republic of Korea.

CRP Outcome (Effectiveness; Impact; Relevance)

The Specific Objective of the CRP has been met. The CRP participants successfully collaborated to establish an internationally available, peer reviewed database of properties on the Internet . They also accomplished their purposes to foster international information exchange and collaboration in achieving technology advances for improving reliability, economics and safety. The new measurements and data collections of thermophysical properties were completed through this CRP. All materials collected within this CRP will be presented in the TECDOC. The web-based data base has been established excellently and it is available on the Internet (see Outputs-Research).

The CRP contributed to the overall objective of the project (i.e. to achieve improvements in design and safety) by collecting and systemizing a thermo-physical properties data base for light water reactor and heavy water reactor materials under normal operating, transient and accident conditions. Evaluation of reactor performance under normal operation, and severe accident conditions are important for current and future water cooled reactors and require accurate representations of thermo-physical properties under relevant temperature and neutron fluence conditions. Assuring that the needed thermo-physical properties are sufficiently accurate requires evaluation, documentation, peer review of existing data and selective measurements to obtain new data at conditions for which data is currently lacking, or highly inadequate. Improving the technology base through better databases can contribute to improved economics of future plants by helping to remove the need for large design margins simply to account for limitations of data and methods. Accurate representations of thermo-physical properties under relevant temperature and neutron fluence conditions are necessary for evaluating reactor performance under normal operation and accident conditions.

Establishment of Thermophysical Properties Data Base for Materials of LWRs and HWRs can provide more accurate predictions of reactor behaviour during normal operating and accident conditions and can provide the accurate representations of properties under relevant temperature and neutron fluence conditions. This can facilitate more economic designs for future reactors by removing the need to incorporate excessively large margins into the design simply for the purpose of allowing for limitations of calculation methodology and uncertain data.

Recommended Future Action by Agency

A TECDOC is presenting the data assessments and new measurements contributed by the participating organizations.

The THERPRO data base will be supervised by IAEA and maintained by the IAEA Designated Centre for nuclear material properties data base management located at Hanyang University with financial support from the Korean government. Whereas data review and assessment for the update and upgrade of THERPRO will be performed through IAEA the on-line data base system will be operated and updated by the Centre under supervision of IAEA. Useful new data will be added as this information becomes available. And in order to improve the quality of the data base, to upgrade the data management system and to expand the data base, Agency will collaborate with Technical Working Group of Advanced Technologies for LWRs and HWRs.

Resulting Publications

IAEA TECDOC Series No. 1496 "Thermophysical properties database of materials for light water reactors and heavy water reactors" (2006).

The web-based data base, THERPRO, which was an internationally available, peer reviewed data base of thermo physical properties for LWRs and HWRs, is under development.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	I35001 Optimization of the coupling of nuclear reactors and desalination systems
Participating Countries:	Argentina(C), Canada(C), China(C), Egypt(C), India(C), Indonesia(C), Korea, Republic of(C), Libyan Arab Jamahiriya(C), Morocco(A), Russian Federation(C), Tunisia(C)
Total Cost:	\$181,201
Duration:	1998-05-15 — 2004-01-30

CRP Overall Objectives

To share relevant information and resources in research activities with respect to those features which have major impact on performance, economic competitiveness and reliability of nuclear desalination concepts.

CRP Specific Objectives

To produce the best coupling configurations of nuclear and desalination systems.

CRP Outcome (Effectiveness; Impact; Relevance)

The CRP has enabled the IAEA and participating institutes to accumulate relevant information on the latest research and development of nuclear desalination and share it with interested Member States.

The CRP has produced optimum coupling configurations of nuclear and desalination systems, evaluated their performance and identified technical features, which may require further assessment for detailed specifications of large-scale nuclear desalination plants.

The CRP has catalysed the Member States to consider feasibility studies, design & development and deployment of nuclear desalination projects in the water scarce areas.

The CRP was initiated as a step forward for facilitating an early deployment in developing countries, where nuclear desalination is being considered as an option to cope with fresh water deficit as well as energy in the coming decade. It is the first CRP on the specific subject of nuclear desalination in order to bring together those research institutes, which have ongoing activities on the subject to share relevant information and resources in research activities with respect to those technical features, which have a major impact on performance, economic competitiveness and reliability of nuclear desalination plant concepts.

Recommended Future Action by Agency

A new CRP on potential of high temperature gas cooled reactors in process heat applications will be launched in 2006-07 for studying the coupling of hydrogen and desalination systems and their economics.

Resulting Publications

IAEA TECDOC Series No. 1444 "Optimization of the Coupling of Nuclear Reactors and Desalination Systems" (2005).

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	J46001 Round-robin exercise on WWER (water-cooled and -moderated reactor pressure vessel)-440 RPV weld metal irradiation embrittlement and annealing
Participating Countries:	Belgium(A), Finland(A), France(A), Hungary(C), Norway(A), Russian Federation(C), Russian Federation(C), Russian Federation(C), Slovakia(C)
Total Cost:	\$113,235
Duration:	1996-10-01 — 2004-01-30

CRP Overall Objectives

The overall objective of the related Agency Programme was to develop safety criteria for judging the safety of operating NPPs which do not conform to current safety standards and to assist in performing safety re-assessment as well as continuous issue based assessment, provide guidance on reviewing of safety analysis reports and to assist in prioritizing of safety modifications.

CRP Specific Objectives

The objective of the CRP was to verify the reliability of the WWER-440/230 material data used in the reactor pressure vessel integrity assessments with respect to annealing efficiency and irradiation re-embrittlement rate model used, in particular. The results extend existing database on material behaviour after annealing and thus provide a basis for the judgment on the representativeness of the material data and consequently strengthen the confidence of this part of the vessel integrity assessment.

Research Outputs

The CRP was initiated as a spin-off of the IAEA Extrabudgetary Programme (EBP) on the Safety of WWER NPPs. The EBP activities identified the RPV embrittlement, annealing recovery, and assessment of these as safety issues of highest concern. The CRP was initiated following a proposal from Prometey Institute, Russia, to provide a representative WWER-440 weld metal for such purpose. Eight organizations participated in the CRP: SCK-CEN Belgium, FORTUM Finland, EDF France, AEKI Hungary, Halden Reactor Project Norway, Kurchatov Institute Russian Federation, Prometey Institute Russian Federation, VUJE Slovak Republic. Each participant received a section of the circumferential model weld sufficient for cutting out of specimen needed to fulfill the agreed scope of experimental work (testing). The experimental work scope agreed includes all standard testing required to be performed to evaluate RPV embrittlement respectively annealing efficiency and re-embrittlement behaviour. Further, non-standard testing methods used in different laboratories/plants were also included, mainly subsize specimen testing used after vessel sampling, such as used in the case of Kozloduy 1. The CRP was designed to facilitate comparison of the reliability of the various testing methods used for assessing the RPV material degradation as well as to compare reliability of results obtained by the individual participants and identify any systematic deviations.

The work performed included:

- experimental programme;
- assessment of results.

The experimental programme main results/data of the CRP are results of material testing in terms of respective transition temperatures and their shifts due to irradiation embrittlement, annealing, re-embrittlement. These data were obtained as a result of testing of distributed material in reference unirradiated condition (R), irradiated condition (I) to evaluate irradiation embrittlement, irradiated and annealed condition (IA) to evaluate annealing recovery, irradiated, annealed and re-irradiated condition (IAI) to evaluate irradiation re-embrittlement (some participants also performed second annealing (IAIA) followed by re-irradiation, others re-irradiation to higher fluence-these were supplementary activities but of high interest). Irradiation of samples was performed both in material test research reactors as well as in power reactors empty surveillance channels.

The assessment of results included analysis of data obtained by individual participants, identification of root causes of discrepancies observed, and assessment of safety implications.

The results/data obtained in the course of the activities were included to the IAEA International database on reactor pressure vessel materials.

Accomplishments of CRPs Completed in 2004

CRP Outcome (Effectiveness; Impact; Relevance)

The specific objective of the CRP has been met. The work was performed as planned and the results obtained transferred to the related IAEA database.

The results of the CRP contribute to achieving the overall objective of the Project by providing guidance elements in addressing one of the most important safety issue identified for the WWER NPP s of the first generation.

The results obtained support reliability of the WWER-440/230 material data used in the reactor pressure vessel integrity assessments with respect to annealing efficiency and irradiation re-embrittlement rate model used, in particular. The results obtained also extend the existing database on material behaviour after annealing and thus provide a basis for the judgment on the reliability of the material data and consequently strengthen the confidence of this part of the vessel integrity assessment. Further, the results obtained contribute to establishing the basis for comparison of the reliability of the various testing methods used for assessing the RPV material degradation as well as to compare reliability of results obtained by different laboratories.

The CRP results are recognized as a significant contribution in achieving the Project objectives.

Recommended Future Action by Agency

The results obtained in the frame of this NS CRP were provided to the related database maintained by NE. The intent to continue maintaining this database for use by MS is strongly supported.

Resulting Publications

The report summarizing the results of the CRP has been drafted, reviewed by all participants and finalized. It will be proposed for publication e.g. as TECDOC.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	J71009 To update and expand the IAEA reliability data for research reactor PSAs
Participating Countries:	Argentina(C), Australia(A), Austria(A), Brazil(C), Canada(A), Czech Republic(C), India(C), Indonesia(C), Korea, Republic of(A), Romania(C), Vietnam(C)
Total Cost:	\$181,982
Duration:	2001-03-15 — 2004-03-14

CRP Overall Objectives

The CRP was initiated from the IAEA program H.4.02 to promote activities, encourage co-operation and foster exchange of information in the area of research reactor safety, among all the countries and organizations that operate research reactors. One way to achieve this objective is by coordinating the reliability data collection efforts and compiling new data in order to update and expand IAEA reliability database for research reactors.

CRP Specific Objectives

The objective of the CRP is to promote the development and use of PSA to improve the safety of research reactors. It is intended that observed component failures at the participants research reactors be recorded and analyzed to provide failure rate estimates for use in PSA type studies. Activities are to be undertaken that will improve both the quantity and quality of data provided in TECDOC-930. The issues of initiating event selection and quantification, dependent failures and human errors are to be covered as well. The research on these further issues will cover compilation of data where available, comparison of approaches taken and guidance on the treatment of these issues in research reactor PSA studies.

Research Outputs

In order to update and expand the IAEA reliability database for research reactor safety, series of data collection and compiling effort for 15 different type of research reactors in 11 MSs. In the frame of this CRP, a computerized data entry system was developed and applied to collect and compile data for 15 target facilities in the first phase between 2001-2002. According to the first RCM results, each participating organization studied the research reactor specific quantification methodologies for following topics during the second phase between 2002-2003:

- Initiating event frequency;
- Human reliability;
- PSA applications;
- Common Cause Failure;
- Digital I&C reliability.

CRP Outcome (Effectiveness; Impact; Relevance)

The CRP has fully reached its specific objectives. All target research goals were achieved; the reliability data for the target facilities were collected and compiled; all 12 researches on the detailed methodologies for conducting research reactor specific PSA were made.

The CRP has fully met the overall objective of establishing the generic reliability data base for supporting Member States to conduct research reactor PSA. It has collected and compiled failure events including human error and common cause failure for the various type of research reactors among the MSs. Sharing information, experience and knowledge on reliability data and research reactor specific PSA methodology can contribute to the established desirable safety performance of research reactor and towards enhancing operational safety through identifying the vulnerability of research reactor to overall safety.

The CRP has achieved data collection of initiating events, human errors and component & system failures for 15 different research reactor facilities of 11 participating Member States. It has advanced the establishment of the generic reliability database for the practical application of PSA to research reactors.

The results of the CRP in the second phase shown that there is remarkable achievement for updating and expanding the existing IAEA reliability database reflecting research reactor specific initiating events, human reliability and common cause failures which would be fundamental entities of PSA. This achievement offers a promising near future PSA applications including risk-centered maintenance(RCM) and risk based regulations for research reactor in Member States. PSA applications for research reactors provide the capability to optimize facility configuration and effective resources management

Accomplishments of CRPs Completed in 2004

without down-grading safety level of research reactors. This CRP results can establish a platform to mobilize PSA application for research reactors.

Recommended Future Action by Agency

It is recommended to maintain activities to upgrade and expand the generic reliability database for research reactor PSA periodically. It is also recommended to initiate a CRP on developing a detailed guideline for evaluation human reliability and common cause failures in research reactors.

Resulting Publications

IAEA TECDOC Series: Reliability database for research reactor PSA.

Proceedings Series "Research Reactor Utilization, Safety, Decommissioning, Fuel and Waste Management", Proceedings of an International Conference held in Santiago, Chile, 10-14 November 2003, STI/PUB/1212, ISBN 92-0-113904-7 (2005).

Restricted web page : <http://200.9.147.91/iaea>.

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	T21020 Anthropogenic analogues for geological disposal of high-level and long lived radioactive waste
Participating Countries:	Argentina(C), China(C), China(C), Czech Republic(C), Egypt(C), Korea, Republic of(A), Russian Federation(A), Ukraine(C), United States of America(A)
Total Cost:	\$126,100
Duration:	1999-07-15 — 2004-03-14

CRP Overall Objectives

To enhance understanding of the long term behavior of the geologic system.

CRP Specific Objectives

To find out to what extent anthropogenic analogues can provide scientific information and data to support the geological disposal option, its concepts and, in particular, employment of different barrier materials.

Research Outputs

Generating scientific information and data regarding long the term performance of different types of barrier materials (metals, concrete, glass).

CRP Outcome (Effectiveness; Impact; Relevance)

Scientific studies were completed allowing for the application of achieved results in repository performance and safety assessments.

Degradation processes were analysed and evaluated bringing new, practically verified views on long term behavior of selected materials in natural conditions.

The CRP generated data extending the existing databases of inputs for safety and performance analysis of geological disposal facilities. They may be used to select materials for container design, namely for defining the thickness of container walls. Quantification of long term mobilization and transport of uranium and his daughters from glass in contact with soil provides practically verified inputs for assessing the functionality of the disposal system.

The CRP has concentrated on issues which have not been mapped yet, such as:

- evaluation of degradation of metals of specific composition and manufacturing method,
- performance of glass containing uranium in direct contact with soil, and
- interaction of different geochemical systems with materials considered for the use within the engineered barrier system of a geological repository.

Recommended Future Action by Agency

The problem of anthropogenic analogue studies is specific and regards rather basic than applied research. Thus, the relevant projects are only exceptionally initiated in Member States. Therefore, the Agency shall not follow the issue in medium term.

Resulting Publications

IAEA TECDOC Series No. 1481 "Anthropogenic analogues for geological disposal of high level and long lived waste" (2005).

Accomplishments of CRPs Completed in 2004

CRP Number and Title:	T23014 Technologies and methods for long term stabilization and isolation of uranium mill tailings
Participating Countries:	Brazil(A), Canada(A), China(C), Czech Republic(A), France(A), Germany(A), Kazakhstan(C), Korea, Republic of(A), Poland(A), Poland(A), Russian Federation(C), Slovenia(A), Ukraine(C), United States of America(A)
Total Cost:	\$135,200
Duration:	2000-02-15 — 2004-02-18

CRP Overall Objectives

To raise in the Member States the awareness of potential problems with the long-term stability of historical uranium mine waste and mill tailings disposal sites, to assist Member States in the development of efficient procedures and processes for their sustainable long-term management and, if deemed appropriate, their remediation, and to encourage a harmonized and systematic approach where feasible.

CRP Specific Objectives

To contribute to the exchange of knowledge of current tailings disposal techniques, capping and liner designs, and new materials for use in such. The relevant techniques as such have reached a certain stage of maturity, but their applicability needs to be confirmed for different climatic conditions and they need to be adjusted to local requirements. As technical solutions alone will not suffice, the integration of management aspects in the overall approach needs to be demonstrated.

Research Outputs

A comprehensive review of uranium mill tailings legacy management strategies and techniques was carried out, supported by specific problem solving techniques.

CRP Outcome (Effectiveness; Impact; Relevance)

The main outcome of the CRP was to bring together researchers from different backgrounds and different countries, allowing them to exchange views and experience. Thus participants learnt about different approaches and became aware of problems and features associated with uranium mill tailings they might have otherwise overlooked.

Research and exchange of experience has been made available to planners and decision makers in the area of legacy mill tailings management, and up-to-date comprehensive information on the subject area thus enables them to make sustainable decisions.

All participants expressed their appreciation of having had this forum for exchange of ideas. While the long term management of legacy uranium mill tailings is a problem to be faced by many countries, the actual technical challenges are rather diverse, leading to parallel, rather than 'coordinated' research activities.

Recommended Future Action by Agency

CRPs are to be efficient instruments where a relatively well-defined problem can be tackled in a complementary fashion by different research groups.

Instruments to provide a regular forum for exchange between practitioners and decision makers in uranium mill tailings legacy management in addition to the usual Consultants' Meetings and Technical Meetings could be investigated.

Resulting Publications

IAEA TECDOC Series No. 1403 "The long term stabilisation of uranium mill tailings" (2004).