Analysis of Collective Dose Trends using the ISOE Database

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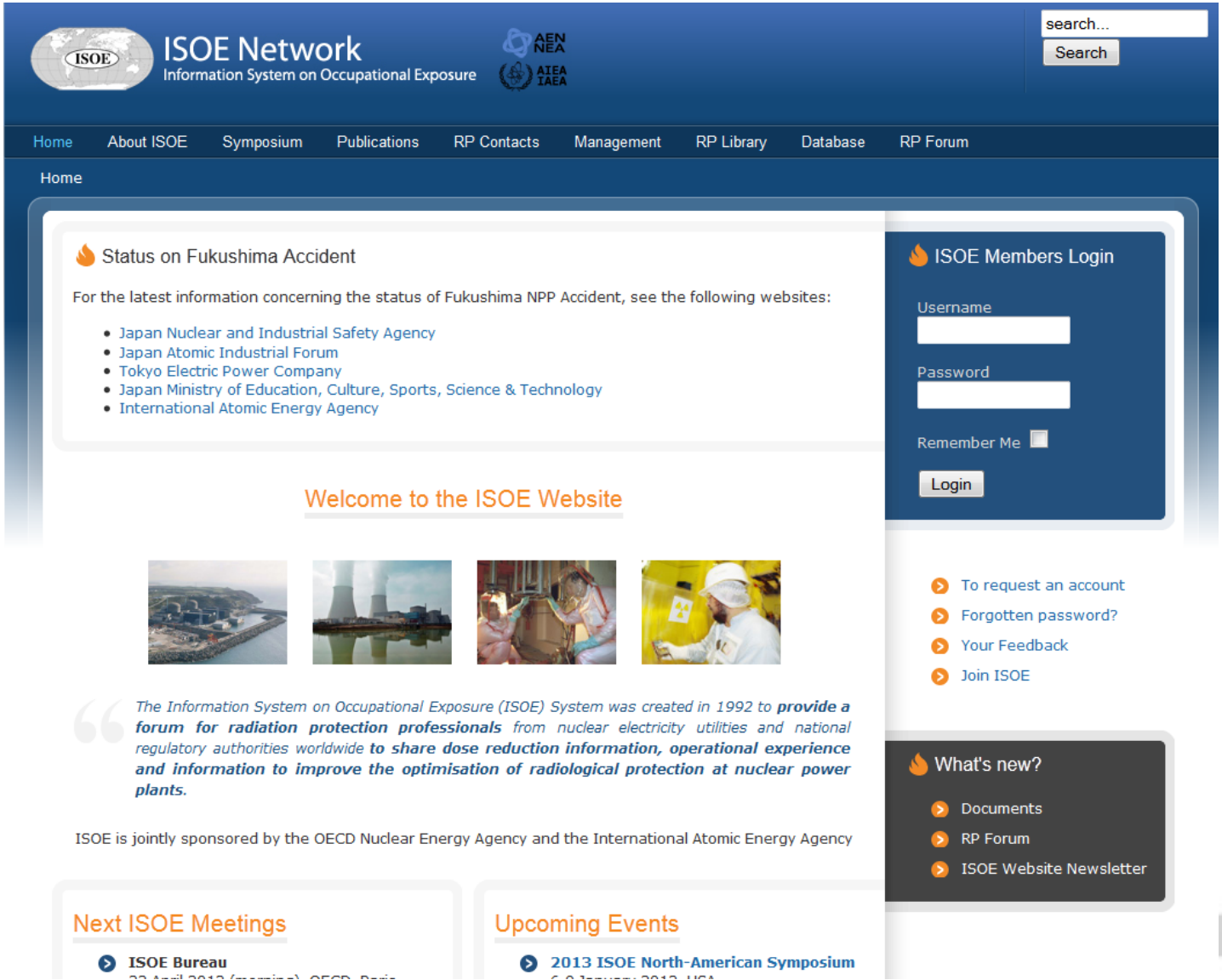
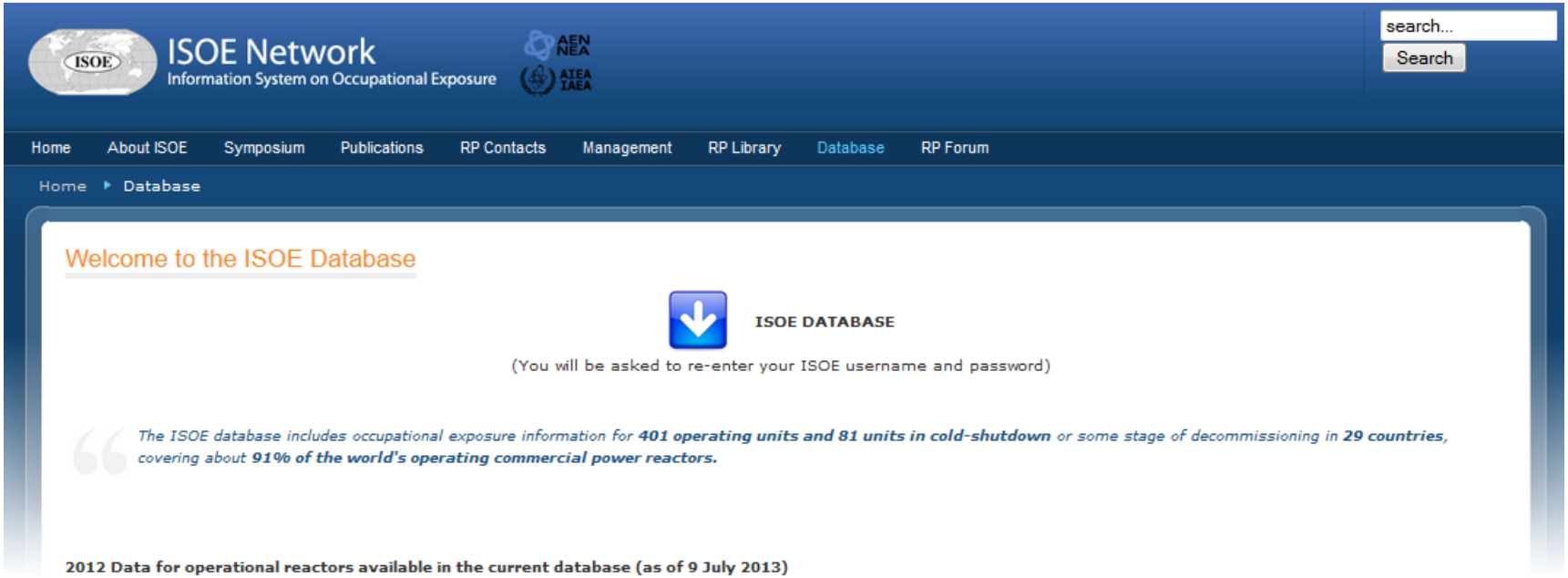
The ISOE Website (www.isoe-network.net)



Access to the ISOE Database



2012 Data for operational reactors available in the current database (as of 9 July 2013)

Armenia *(missing)*	**Finland** *(complete)*	**Pakistan** *(missing)*	**Spain** *(2 NPPs missing)*
Belgium *(4 reactors missing)*	**France** *(complete)*	**Rep. of Korea** *(missing)*	**Sweden** *(complete)*
Brazil *(complete)*	**Germany** *(complete)*	**Romania** *(complete)*	**Switzerland** *(1 NPP missing)*
Bulgaria *(complete)*	**Hungary** *(complete)*	**Russian Federation** *(missing)*	**Ukraine** *(complete)*
Canada *(missing)*	**Japan** *(1st set of data available)*	**Slovak Rep.** *(complete)*	**United Kingdom** *(complete)*
China *(complete)*	**Mexico** *(missing)*	**Slovenia** *(complete)*	**USA** *(missing)*
Czech Rep. *(complete)*	**Netherlands** *(missing)*	**South Africa** *(complete)*	

Content of the ISOE Database

- ISOE 1: Dosimetric information from commercial NPPs in operation or in some stage of decommissioning, including:
  - annual collective dose for normal operation
  - maintenance/refuelling outage dose
  - forced outage dose
  - annual collective dose for certain tasks and worker categories

Who Can Access the Database?

- ISOE Participants can access the DB on-line (ISOE website) and on CD-ROM (Microsoft ACCESS)
  - Web version is routinely updated
  - CD-ROM is distributed annually after all data received[1]

➢ Participating Utilities:

- Full access to global database

➢ Participating Authorities:

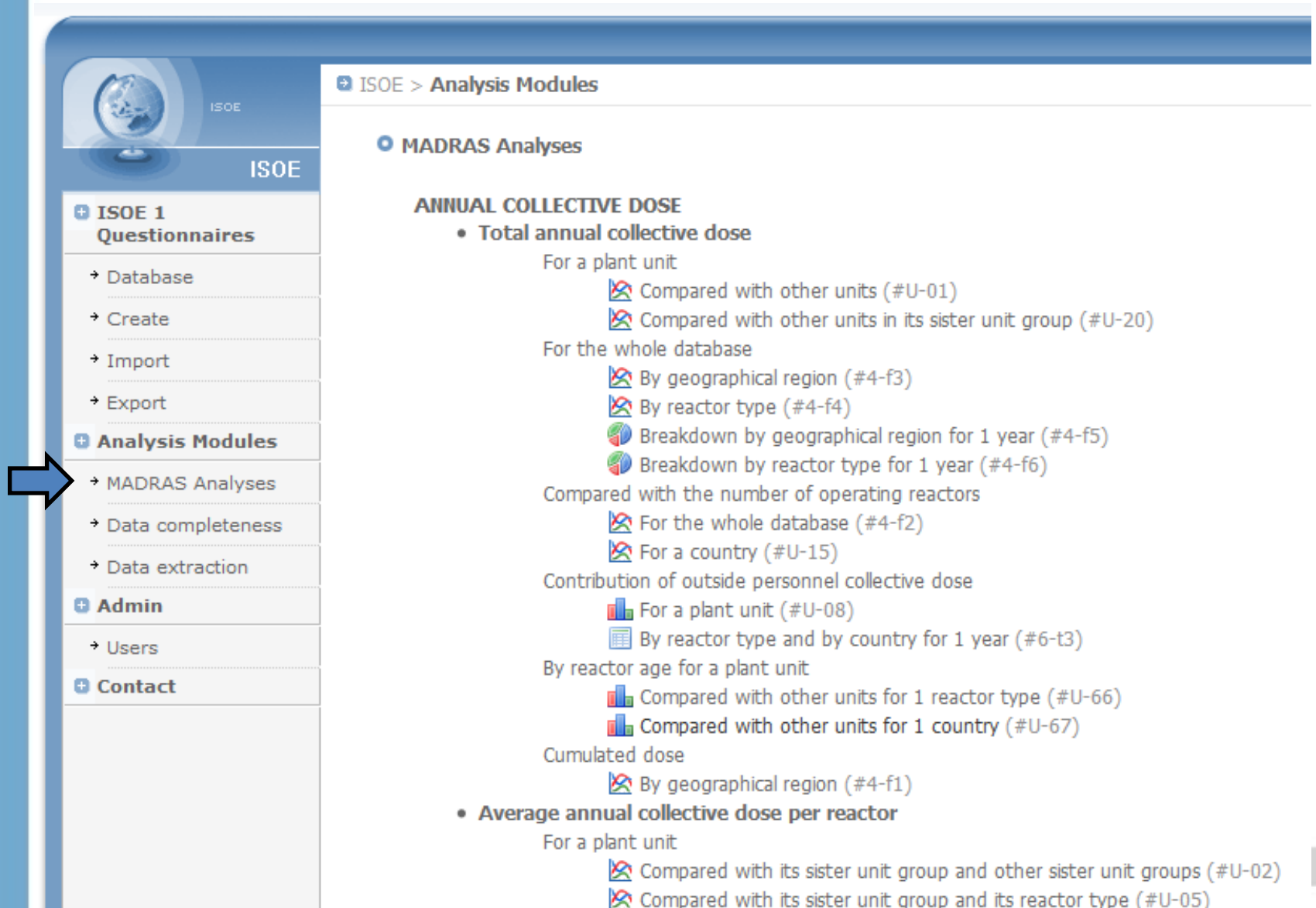
- Full access to ISOE 1 data from national licensees
- Limited access to ISOE 1 data from other countries
  - No access to dose per task and job, dose per occupational category and dose rates

[1] CD-Rom needed by 3 countries: Armenia, Russian Federation and by some German plants

Database Analyses and Benchmarking

- The extensive data in ISOEDAT provides a solid basis for analyses on issues in operational RP such as dose trends, doses related to certain jobs and tasks, identification of good performance, etc.
- Several ways to use the database:
  a) MADRAS analysis package : Main trends in occupational exposure
  b) Direct access to ISOE 1 questionnaires, including contact information and complementary data
  c) Direct access to the whole database using the data extraction module

Database Analyses and Benchmarking



MADRAS Data Analysis Package

- A set of pre-defined data queries to facilitate analysis of main trends in occupational exposure, benchmarking between plants, sister units, etc.
  - Benchmarking at unit level
  - Total annual collective dose
  - Annual average collective dose per reactor
  - Rolling average collective dose per reactor
  - Total annual collective dose vs. number of operating reactors
  - Total annual collective dose by reactor age
  - Average annual collective dose per TWh
  - Contribution of outside personnel and outages to total collective dose
  - Dose rates

Using ISOEDAT as a Benchmarking Tool

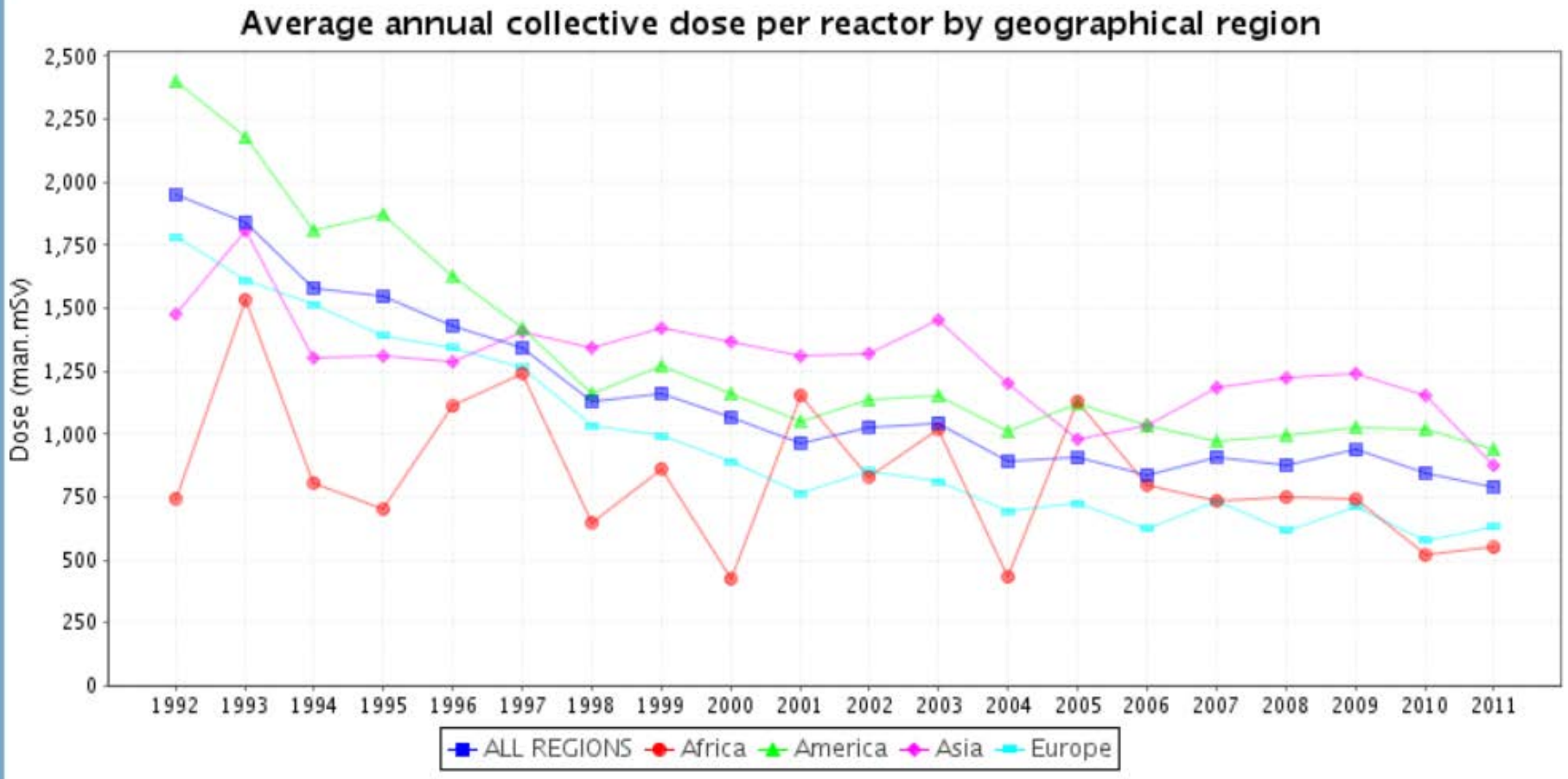
- Analyses at country or regional level:

  Trends in Annual average collective dose per reactor / Annual total collective dose

  - Between countries or regions: by country/region for a given reactor type, or all reactors, including rolling average over several years
  - Within a country: Specific unit against another unit or by type of reactor
- Analyses at utility level:
  - Specific utility against other utilities
  - Specific utility by reactor type
- Analyses at unit level
  - Specific unit against another unit / sister group / reactor type
  - Benchmarking at the job and task level

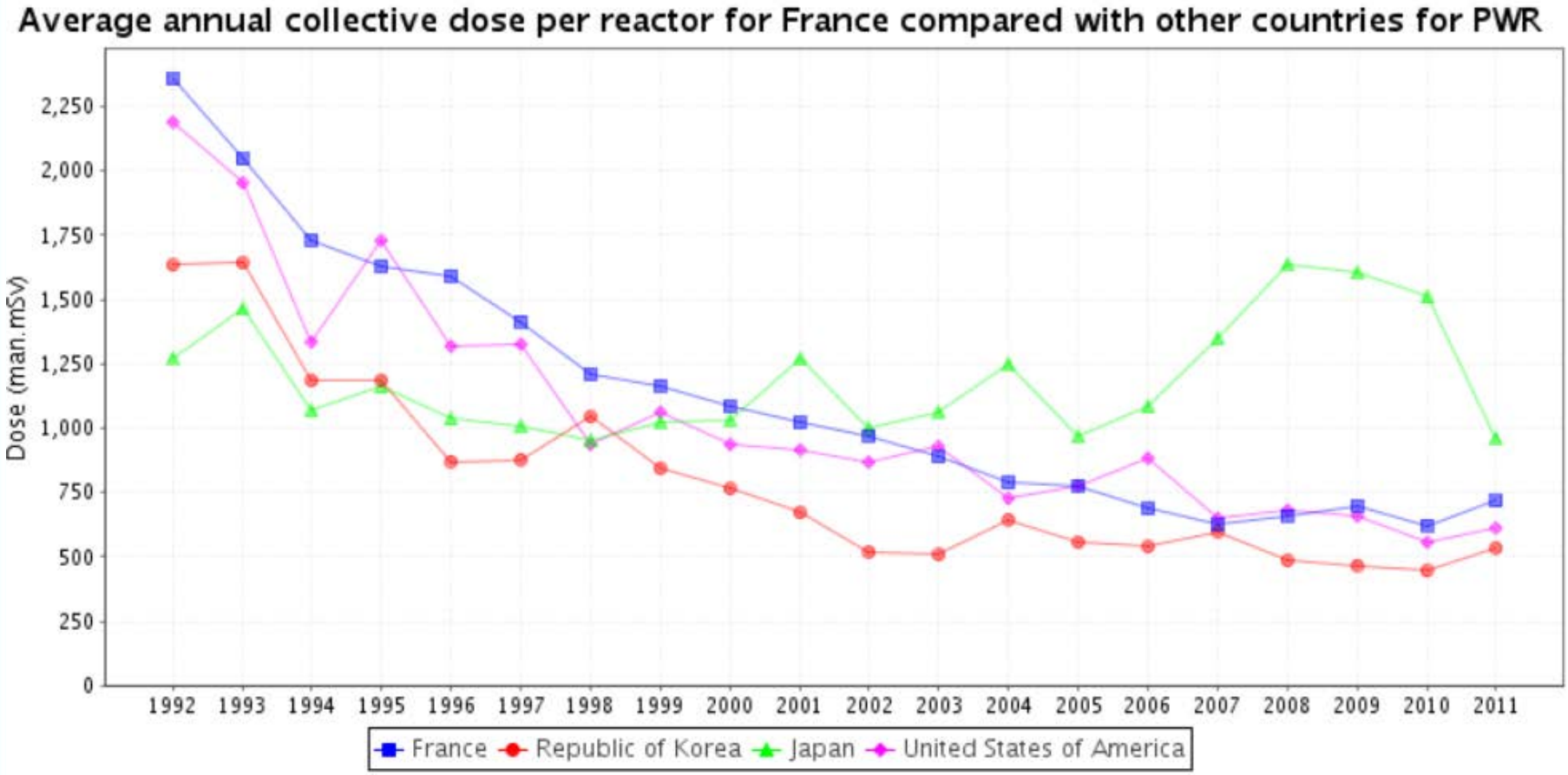
Global Dose Trends by Geographical Region

- The annual average collective dose per operating reactor has consistently decreased over the time period covered in by ISOE



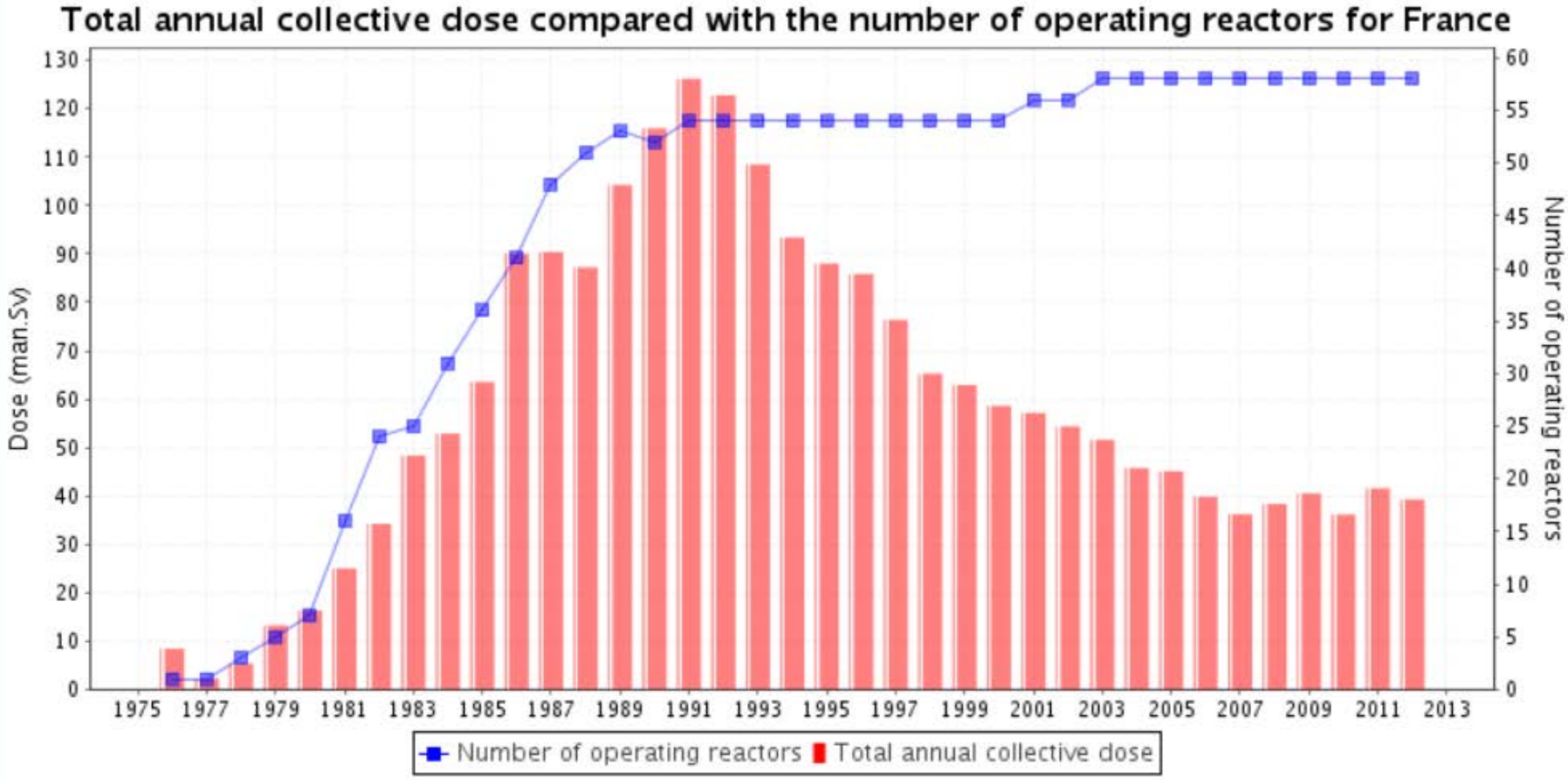
Country Dose Trends by Reactor Type (PWRs)

- For most countries, the annual average collective dose per operating reactor decreased over the time period



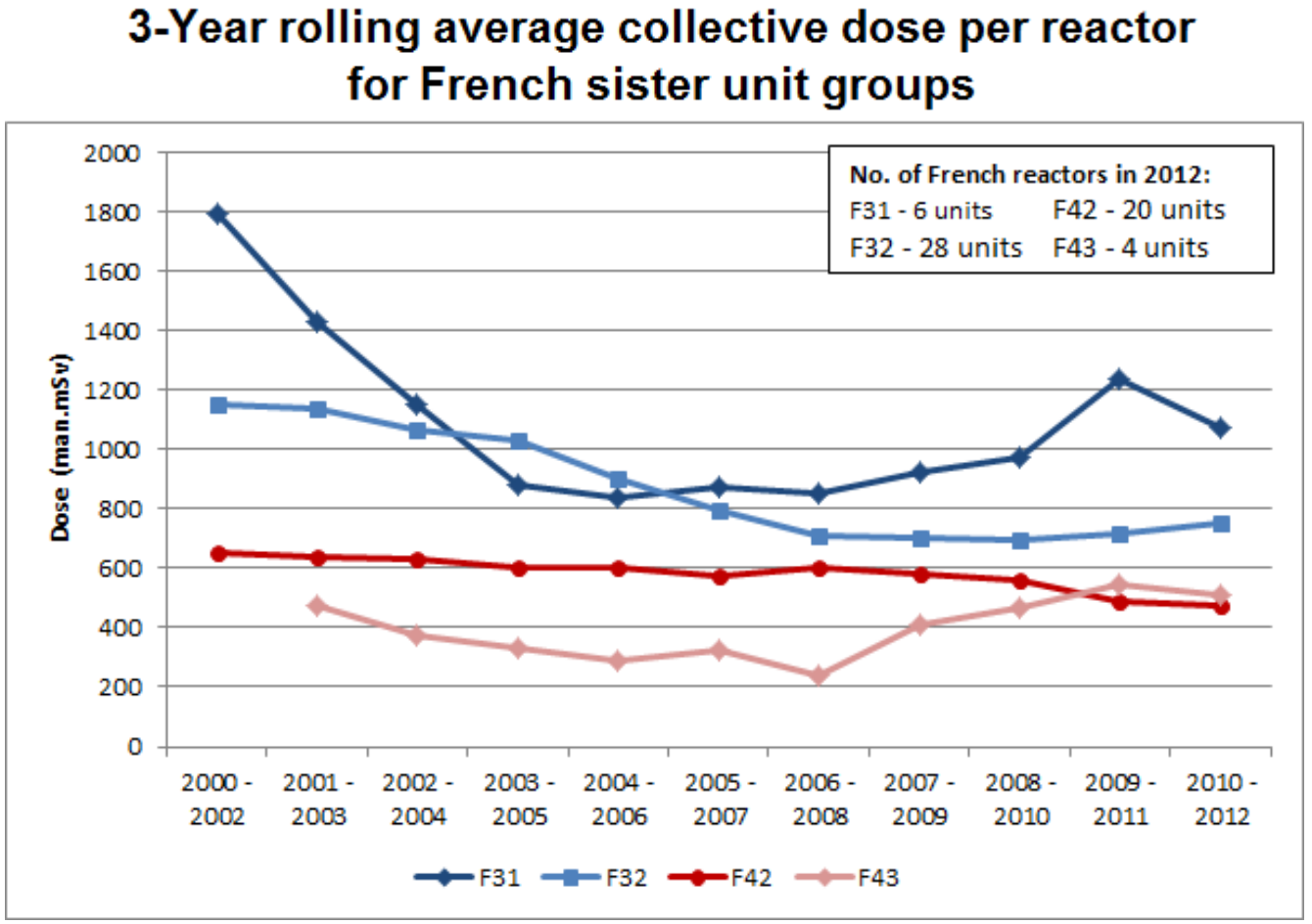
Focus on France
Total Dose vs. Number of Operating Reactors

- Decrease of total collective dose despite an ageing fleet and an increase of maintenance programme



France: Trends by Sister Unit Groups

- **Impact of the Design**: Clear decrease of average collective dose per reactor by sister unit group from F31 (oldest generation) to F43 (newest generation)



Quartile Ranking
2010-2012 Average Collective Dose for France

Quartile ranking for France

Quartile	Plant unit	2010 - 2012 (man.mSv)	2009 - 2011 (man.mSv)	Percent change from 2009 - 2011	2009 - 2011 Quartile (if changed)	
1	Penly 2	338.20	419.09	-19%		
	Chooz B2	342.89	511.17	-33%	2	
	Paluel 4	343.88	354.33	-3%		
	Saint Alban 2	363.21	354.06	3%		
	Nogent 1	375.09	573.95	-35%	2	
	Flamanville 2	379.93	388.35	-2%		
	Cattenom 4	380.10	388.27	-2%		
	Golfech 2	388.52	311.66	25%		
	Cattenom 2	394.37	366.06	8%		
	Belleville 2	401.43	684.57	-41%	3	
	Saint Alban 1	402.83	510.33	-21%		
	Paluel 3	426.60	417.76	2%		
	Chinon B3	431.50	897.08	-52%	4	
	Chinon B1	459.30	618.06	-26%	2	
	Penly 1	497.62	638.46	-22%	3	

International Benchmarking
2010-2011 Average Collective Dose Ranking

Top 20 plant units for PWR

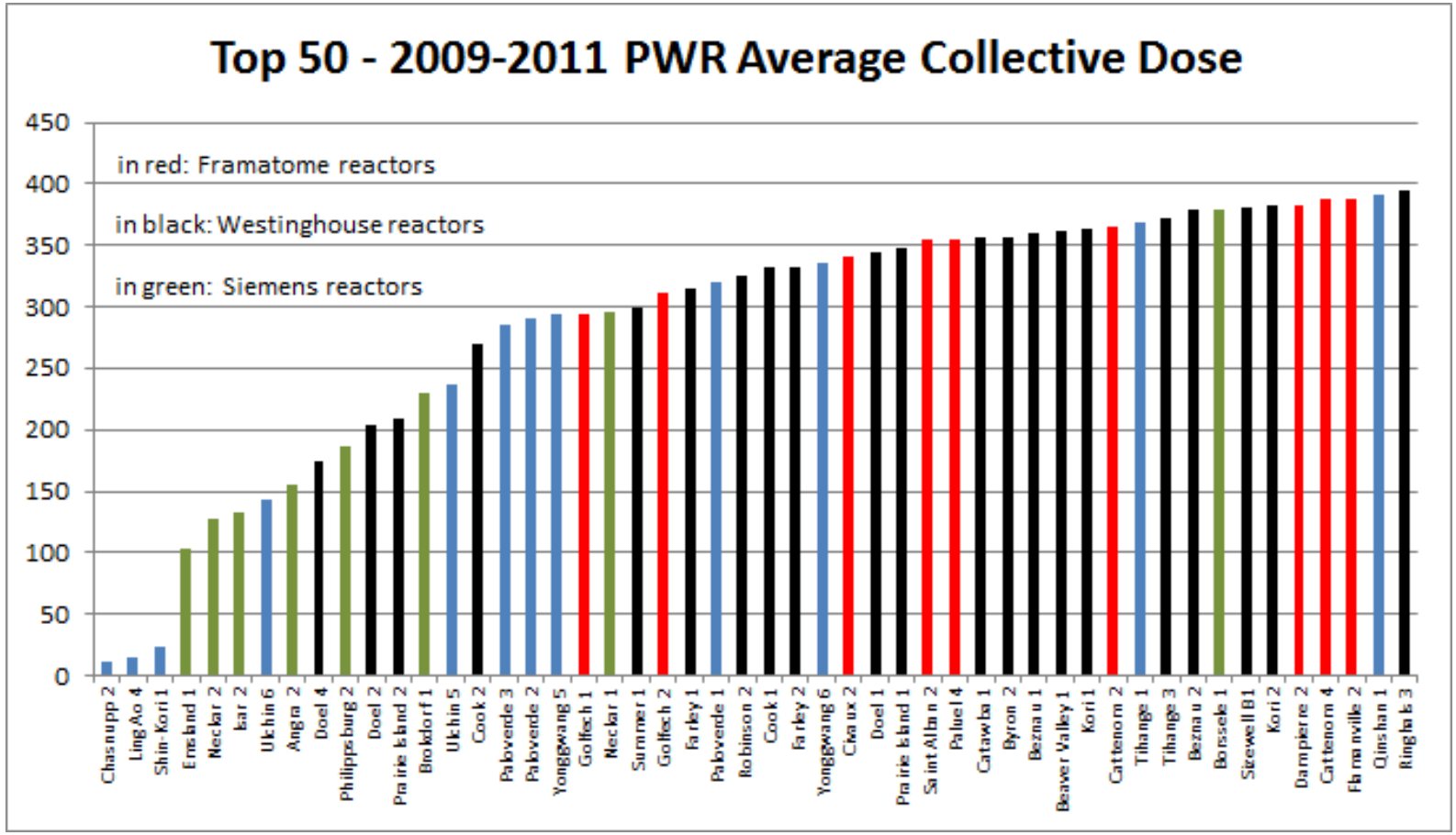
Plant unit	2009 - 2011 (man.mSv)
Chasnupp 2	11.03
Ling Ao 4	14.26
Shin-Kori 1	23.06
Emsland 1	103.08
Neckar 2	127.05
Isar 2	132.94
Ulchin 6	142.97
Angra 2	156.13
Doel 4	173.68
Philippsburg 2	187.03
Doel 2	203.15
Prairie Island 2	209.82
Brokdorf 1	229.14
Ulchin 5	237.51
Cook 2	269.03
Paloverde 3	285.57
Paloverde 2	291.48
Yonggwang 5	293.85
Golfech 1	294.72
Neckar 1	295.04

Plant unit ranking for a reactor type

Top 20 for PWRs

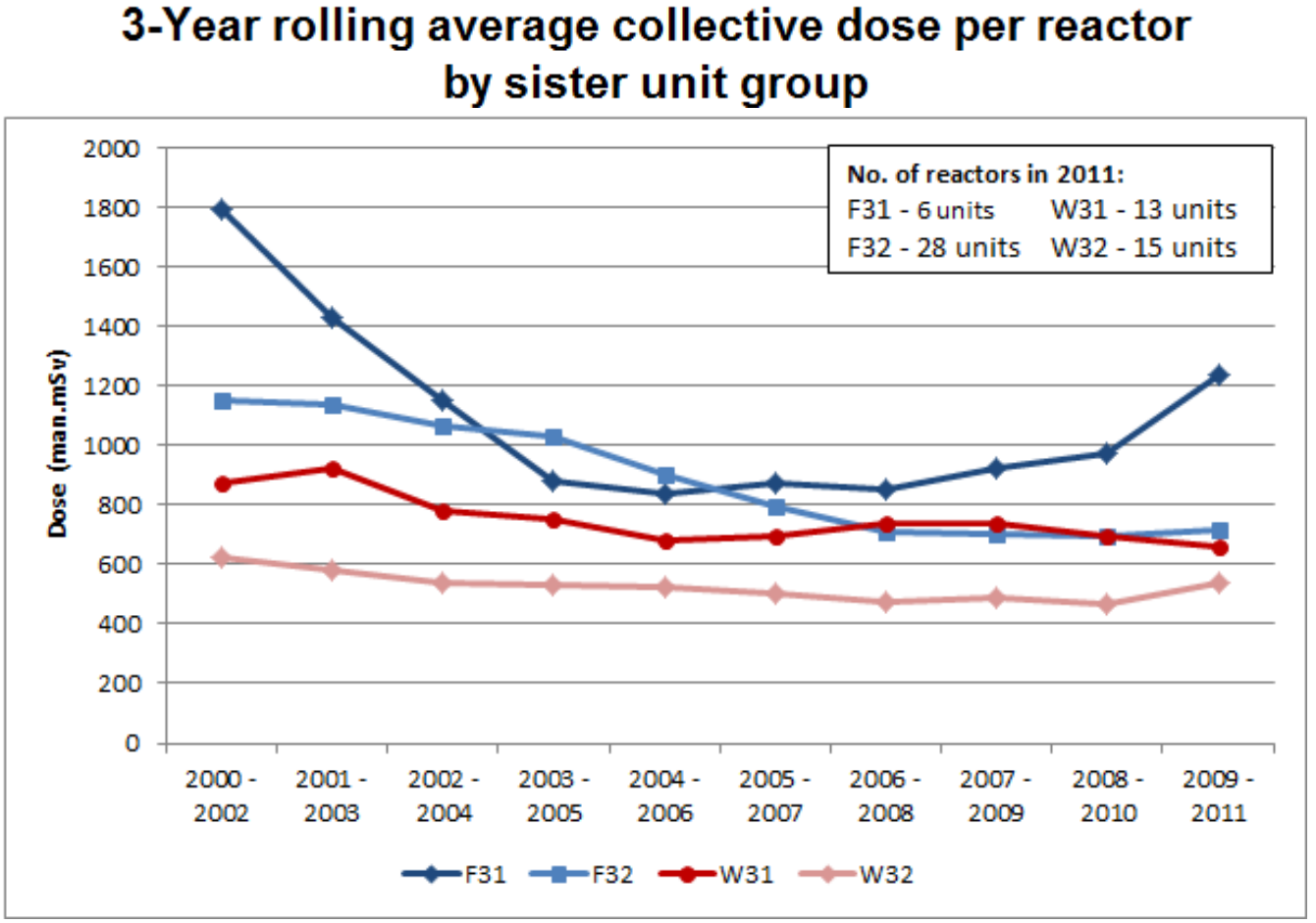
> German & Westinghouse reactors at top 20
if we exclude from the ranking units without outage refueling

International Benchmarking



Collective Dose Trends by Sister Unit Group Comparison Framatome – Westinghouse reactors

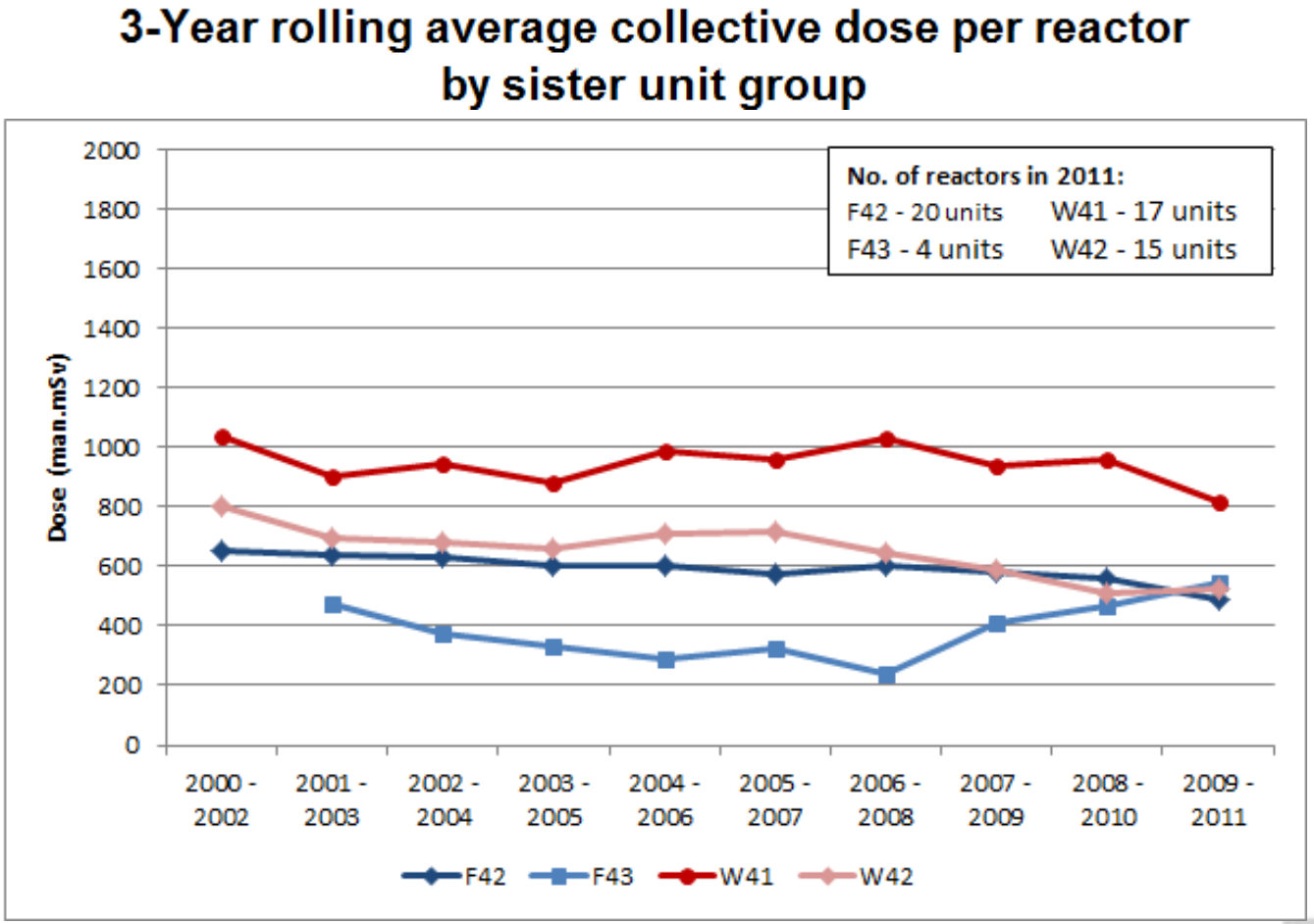
- **3-Loops reactors**: 1st and 2nd generation of Westinghouse reactors shows lower dose than respective generations of Framatome reactors



The reactors from South-Africa, China and South Korea have been excluded from F32

Collective Dose Trends by Sister Unit Group Comparison Framatome – Westinghouse reactors

- **4-Loops reactors**: 2nd generation of Framatome reactors shows lower dose than Westinghouse reactors except for recent periods

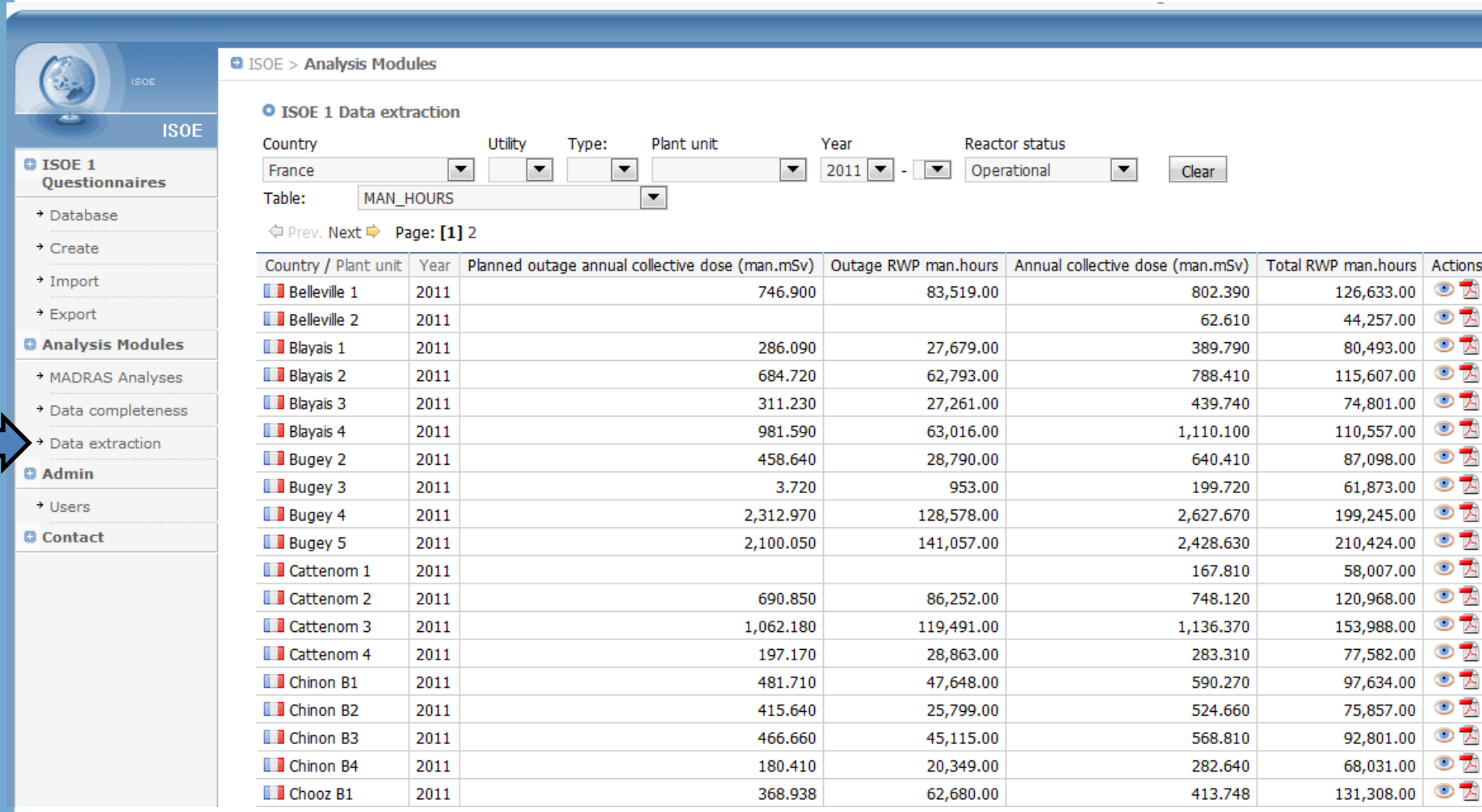


New MADRAS Analyses

- MADRAS Analysis module is improved every year with new developments based on user feedback and requests

- New analyses planned for 2013:
  A set of new queries to improve outage benchmarking

Data Extraction



Country / Plant unit	Year	Planned outage annual collective dose (man.mSv)	Outage RWP man.hours	Annual collective dose (man.mSv)	Total RWP man.hours	Actions
Belleville 1	2011	746.900	83,519.00	802.390	126,633.00	
Belleville 2	2011			62.610	44,257.00	
Blayais 1	2011	286.090	27,679.00	389.790	80,493.00	
Blayais 2	2011	684.720	62,793.00	788.410	115,607.00	
Blayais 3	2011	311.230	27,261.00	439.740	74,801.00	
Blayais 4	2011	981.590	63,016.00	1,110.100	110,557.00	
Bugey 2	2011	458.640	28,790.00	640.410	87,098.00	
Bugey 3	2011	3.720	953.00	199.720	61,873.00	
Bugey 4	2011	2,312.970	128,578.00	2,627.670	199,245.00	
Bugey 5	2011	2,100.050	141,057.00	2,428.630	210,424.00	
Cattenom 1	2011			167.810	58,007.00	
Cattenom 2	2011	690.850	86,252.00	748.120	120,968.00	
Cattenom 3	2011	1,062.180	119,491.00	1,136.370	153,988.00	
Cattenom 4	2011	197.170	28,863.00	283.310	77,582.00	
Chinon B1	2011	481.710	47,648.00	590.270	97,634.00	
Chinon B2	2011	415.640	25,799.00	524.660	75,857.00	
Chinon B3	2011	466.660	45,115.00	568.810	92,801.00	
Chinon B4	2011	180.410	20,349.00	282.640	68,031.00	
Chooz B1	2011	368.938	62,680.00	413.748	131,308.00	

Possibility to extract any type of data of the ISOE 1 Questionnaire in order to perform your own analyses

The ISOE Website and Database

Thank you for your attention!

OECD Nuclear Energy Agency
International Atomic Energy Agency

ISOE

INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

For more information, please visit:

www.isoe-network.net