

The ISOE Global NPP Database Overview

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Overview of ISOE ALARA Network for Nuclear Power Plants

- Greetings from the 335 Operating Nuclear Power Plant
- Objective of Information System on Occupational Exposure (ISOE) is to reduce worker occupational radiation exposure
- Mission accomplished by global information exchange network to share ALARA lessons learned from maintenance or refueling radiological controls program to prevent reoccurrence at another NPP

Nuclear Power Challenges in the Future & ISOE

- This presentation discusses the largest global ALARA information exchange program and achievements/future directions
- News Flash: Illinois nuclear plants Byron 1,2 & Dresden 2,3 have been very active ISOE members since 1993
- However, the sites were threatened to be shut down permanently on September 18, 2021 due to economic challenges
- On September 16, 2021 the Illinois legislature passed the Clean Air legislation which allow the four units to continue operation
- This is good news for the future of safe nuclear operation globally.

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

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Information System on Occupational Exposure

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Welcome to the ISOE Website

The Information System on Occupational Exposure (ISOE) System was created in 1992 to **provide a forum for radiation protection professionals** from nuclear electricity utilities and national regulatory authorities worldwide to **share dose reduction information, operational experience and information to improve the optimisation of radiological protection at nuclear power plants**.

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ISOE Database

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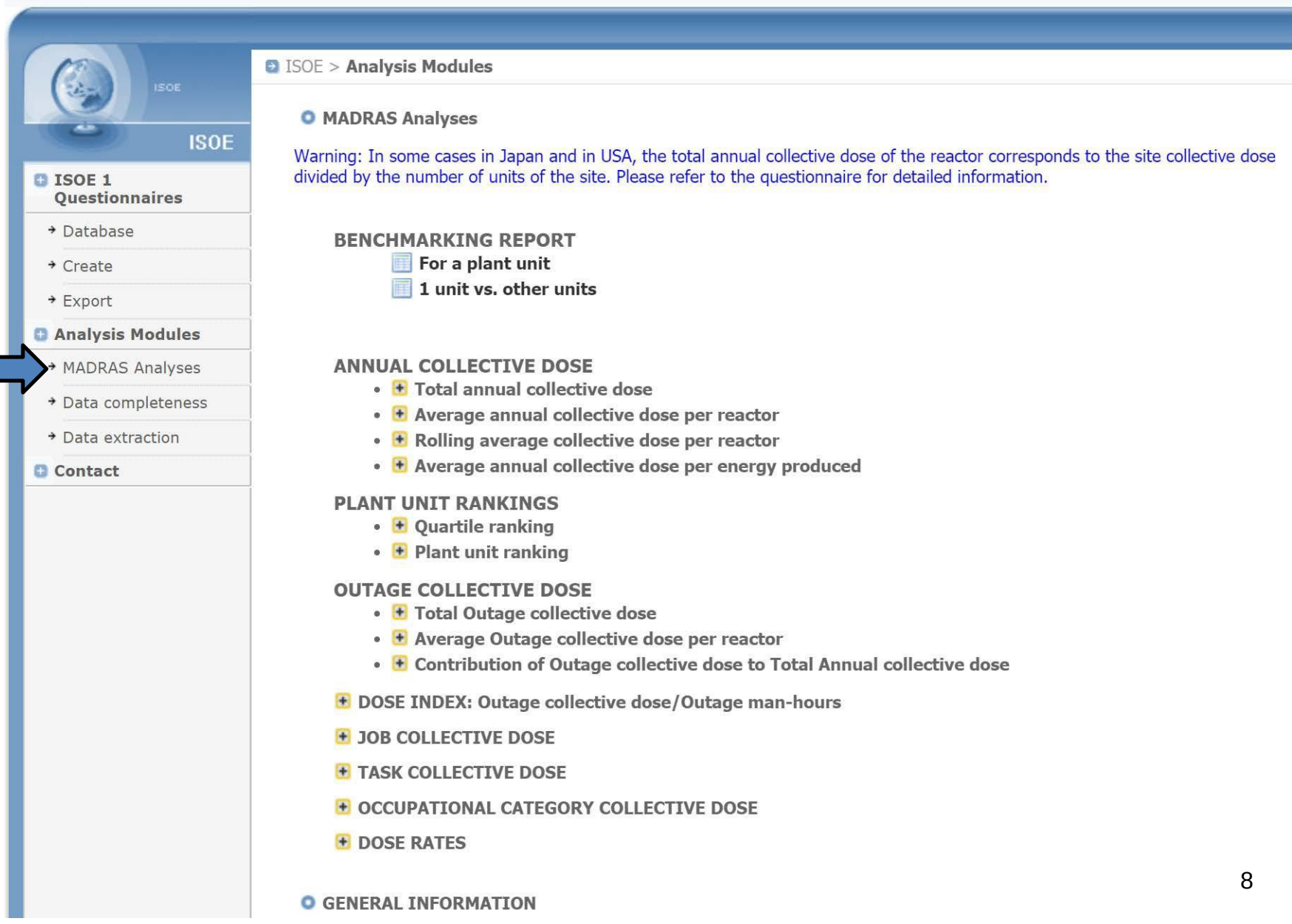
Content of the ISOE Database

- 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
  - dose rates

Database Analyses and Benchmarking

- The extensive data in database 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
  - Annual collective dose
  - Outage collective dose
  - Plant unit ranking
  - Total annual collective dose vs. number of operating reactors
  - Total annual collective dose by reactor age
  - Job collective dose
  - Occupational category collective dose
  - Dose rates

Using ISOE Database as a Benchmarking Tool

- Analyses at country or regional level:

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

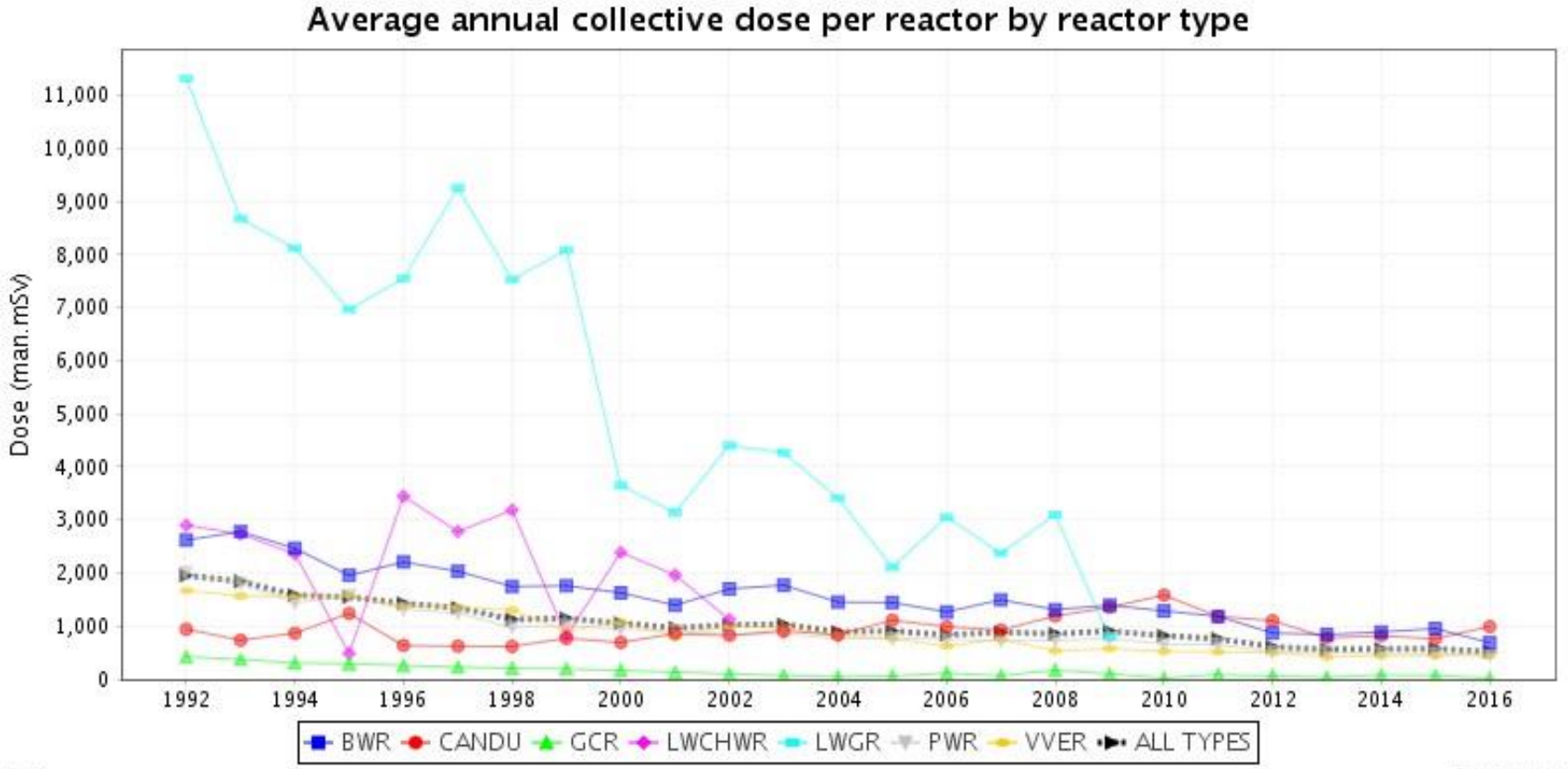
  - Between countries or regions: by country/region for a given reactor type, or all reactors, including rolling average over several years
  - Within a country: Specific unit vs. another unit or by type of reactor

- Analyses at utility level:
  - Specific utility vs. other utilities
  - Specific utility by reactor type

- Analyses at unit level
  - Specific unit vs. another unit / sister group / reactor type
  - Benchmarking at the job and task level

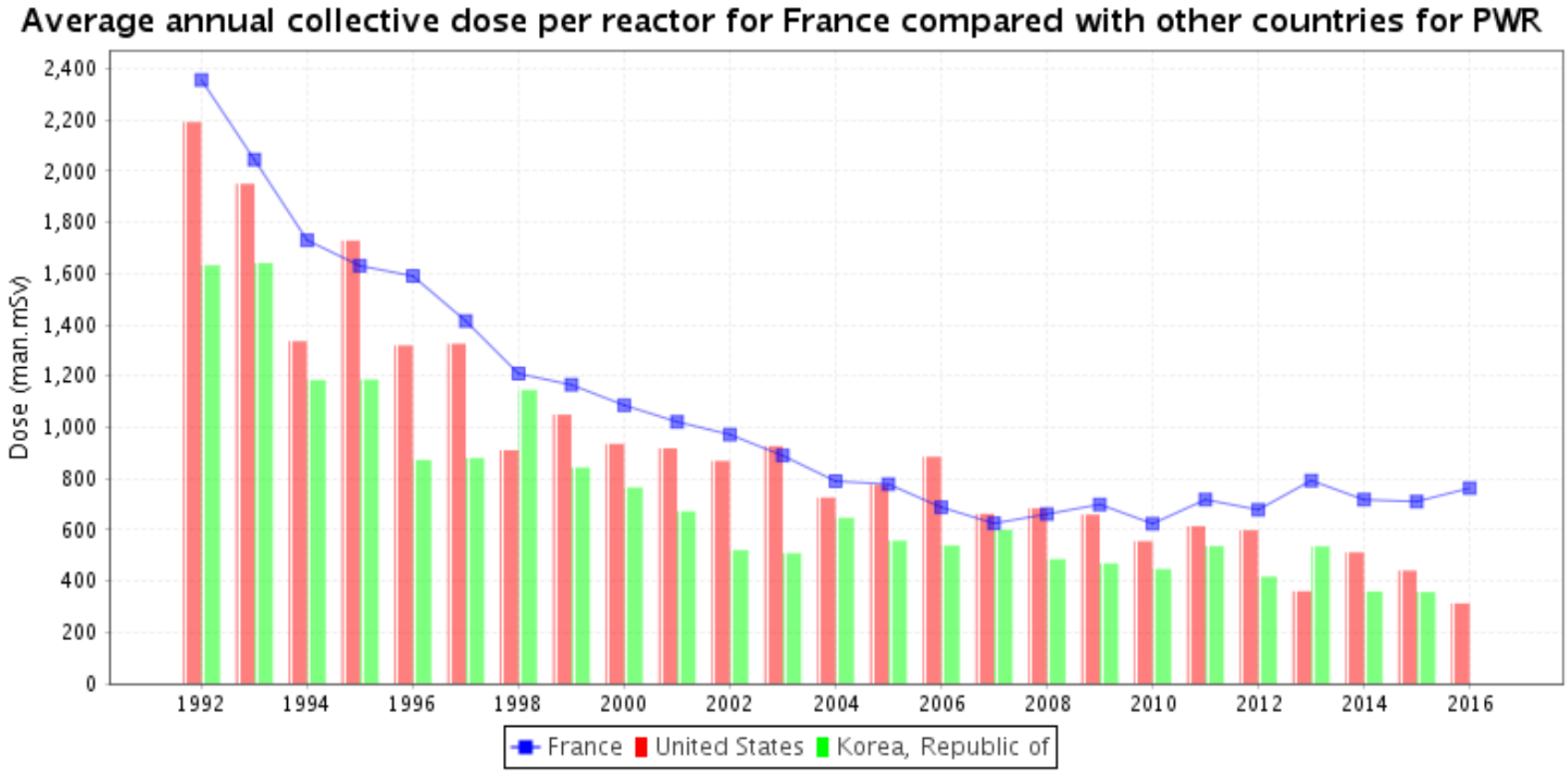
Global Dose Trends by Reactor Type

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



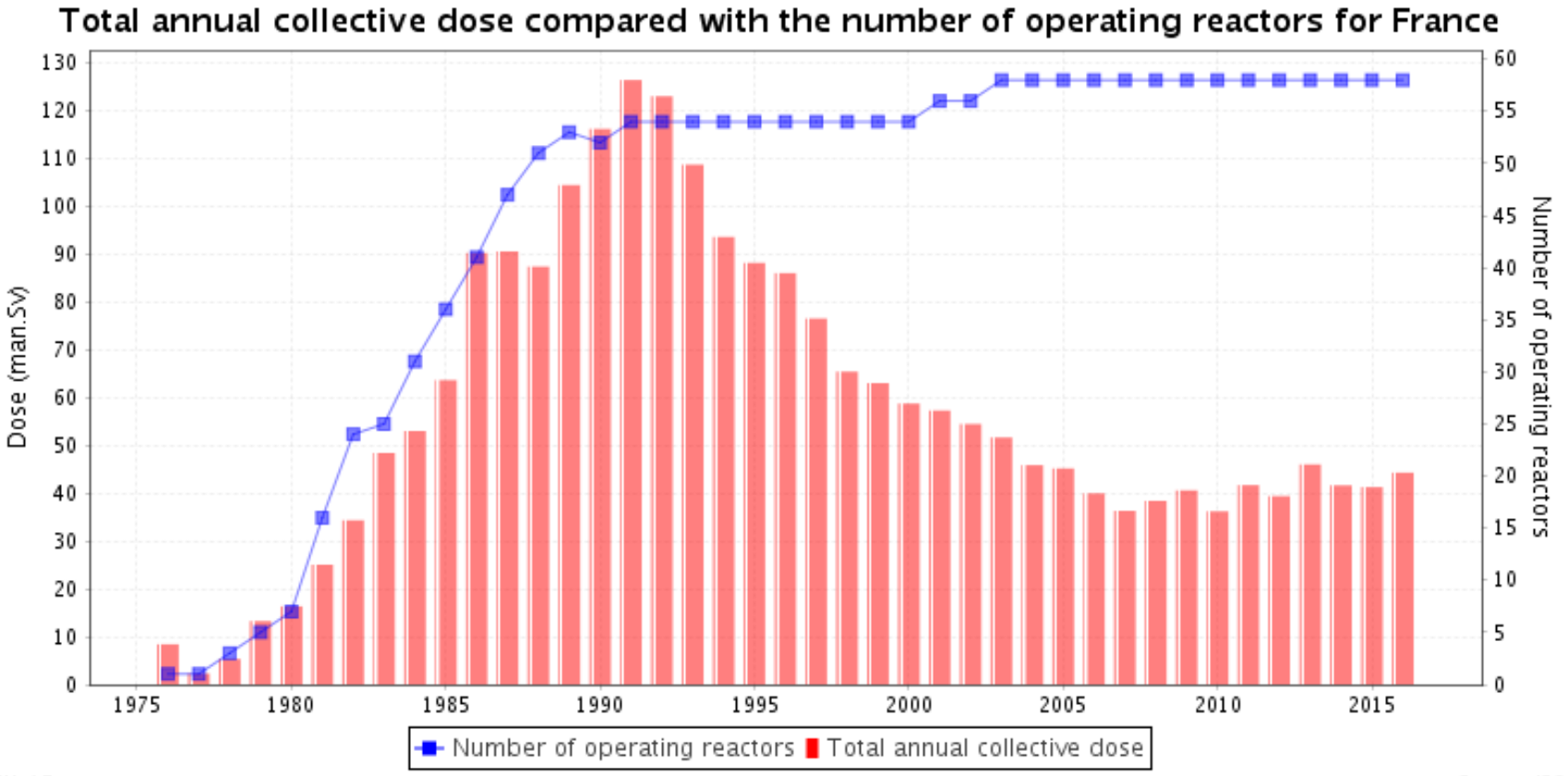
Country Dose Trends by Reactor Type (PWRs)

- 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

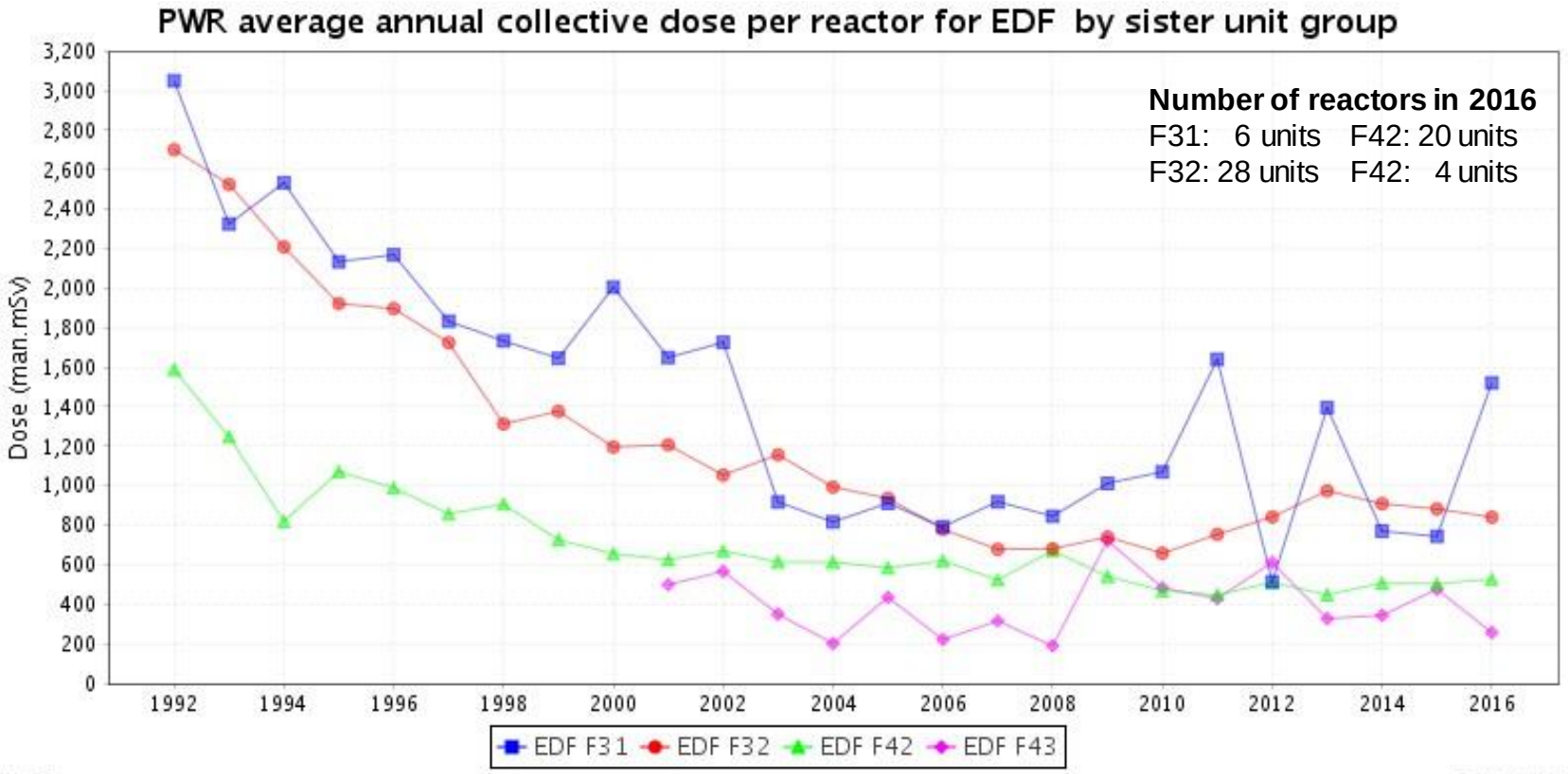


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Source: ISOE

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
2014-2016 Average Collective Dose for France

Rolling average collective dose quartile ranking for France

Quartile	Plant unit	2014 - 2016 (man.mSv)	2013 - 2015 (man.mSv)	Percent change from 2013 - 2015	2013 - 2015 Quartile (if changed)
1	Golfech 1	267.64	285.34	-6%	
	Civaux 1	314.64	340.96	-8%	
	Chooz B1	322.11	408.39	-21%	
	Nogent 2	322.70	367.80	-12%	
	Cattenom 4	344.01	602.60	-43%	2
	Belleville 2	381.28	392.87	-3%	
	Chooz B2	382.23	373.37	2%	
	Saint Alban 2	382.36	423.80	-10%	
	Cattenom 2	386.24	384.90	0%	
	Penly 1	392.51	405.54	-3%	
	Saint Alban 1	394.50	376.88	5%	
	Chinon B3	404.22	528.67	-24%	2
	Paluel 3	413.41	496.35	-17%	2
	Civaux 2	416.14	406.95	2%	
	Flamanville 2	421.72	680.12	-38%	2
2	Cattenom 3	423.26	342.81	23%	1

International Benchmarking
2016 Outage Collective Dose Ranking

Outage collective dose - Top 20 plant units for PWR

Plant unit	Country	2016 (man.mSv)
Dampierre 1	France	144.99
Chinon B3	France	149.94
Golfech 1	France	157.27
Paloverde 3	United States	157.91
Nogent 1	France	196.93
Oconee 1	United States	199.00
Chooz B2	France	199.35
Penly 1	France	202.98
Cruas 1	France	208.52
Tihange 3	Belgium	218.16
Cruas 2	France	220.52
Ringhals 4	Sweden	223.00
Tricastin 2	France	225.88
Cook 1	United States	230.68
Blayais 4	France	233.97
Chinon B1	France	235.42
Dampierre 3	France	244.83
Angra 2	Brazil	245.76
Qinshan 1	China	247.86
Civaux 1	France	249.26

Plant unit ranking for a reactor type

Top 20 for PWRs

International Benchmarking
2016 Outage Collective Dose Ranking

Outage collective dose - Top 20 plant units for PWR 3-Loop reactors

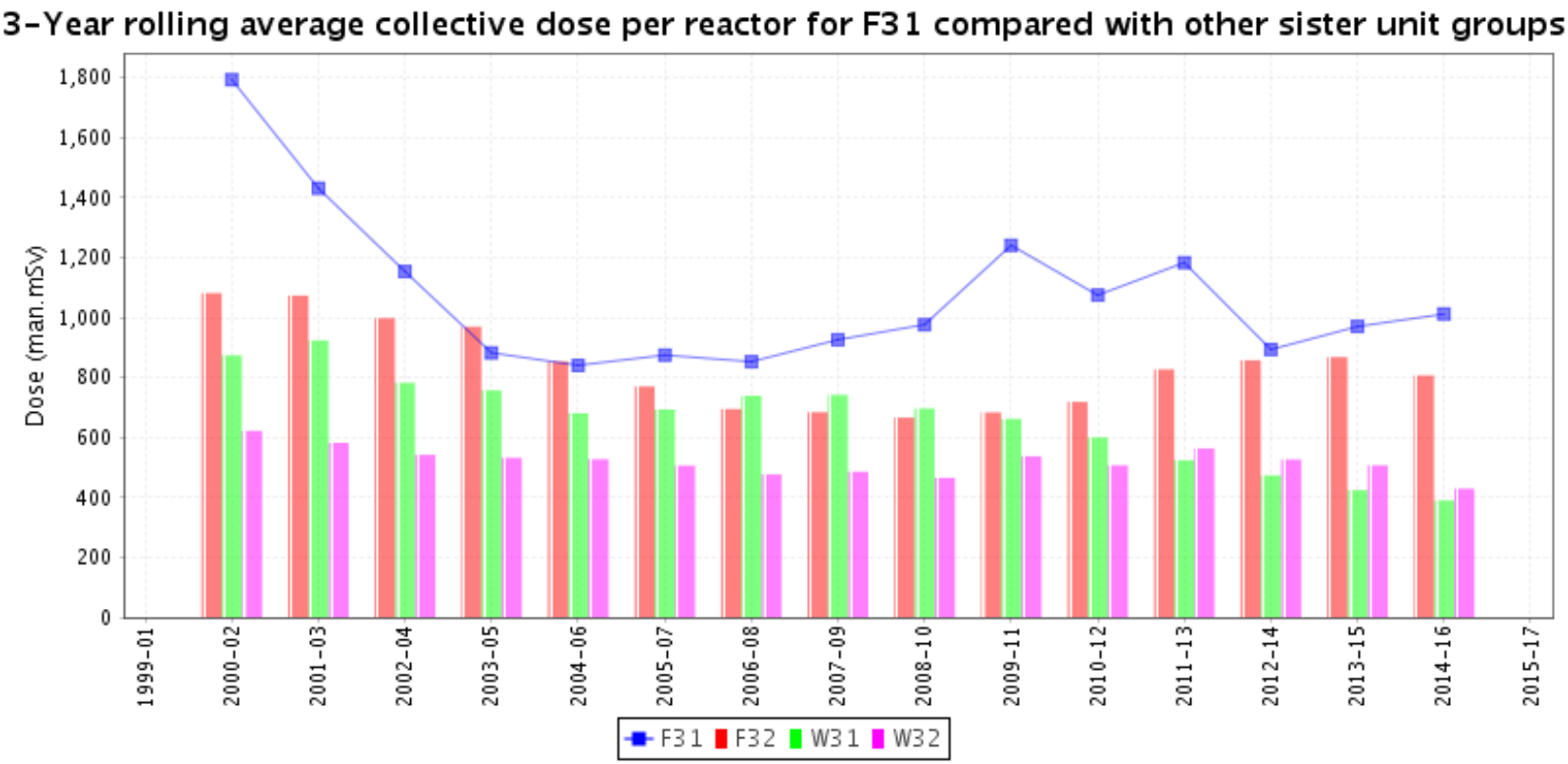
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Cruas 1	France	208.52
Tihange 3	Belgium	218.16
Cruas 2	France	220.52
Ringhals 4	Sweden	223.00
Tricastin 2	France	225.88
Blayais 4	France	233.97
Chinon B1	France	235.42
Dampierre 3	France	244.83
Saint Laurent B1	France	249.55
Gravelines 4	France	253.07
Farley 2	United States	266.29
North Anna 2	United States	269.59
Ling Ao 3	China	270.07
Surry 1	United States	283.00
Farley 1	United States	297.19
Tricastin 1	France	312.91
Blayais 2	France	350.23
Koeberg 1	South Africa	366.66

Plant unit ranking by number of loops

Top 20 for PWRs

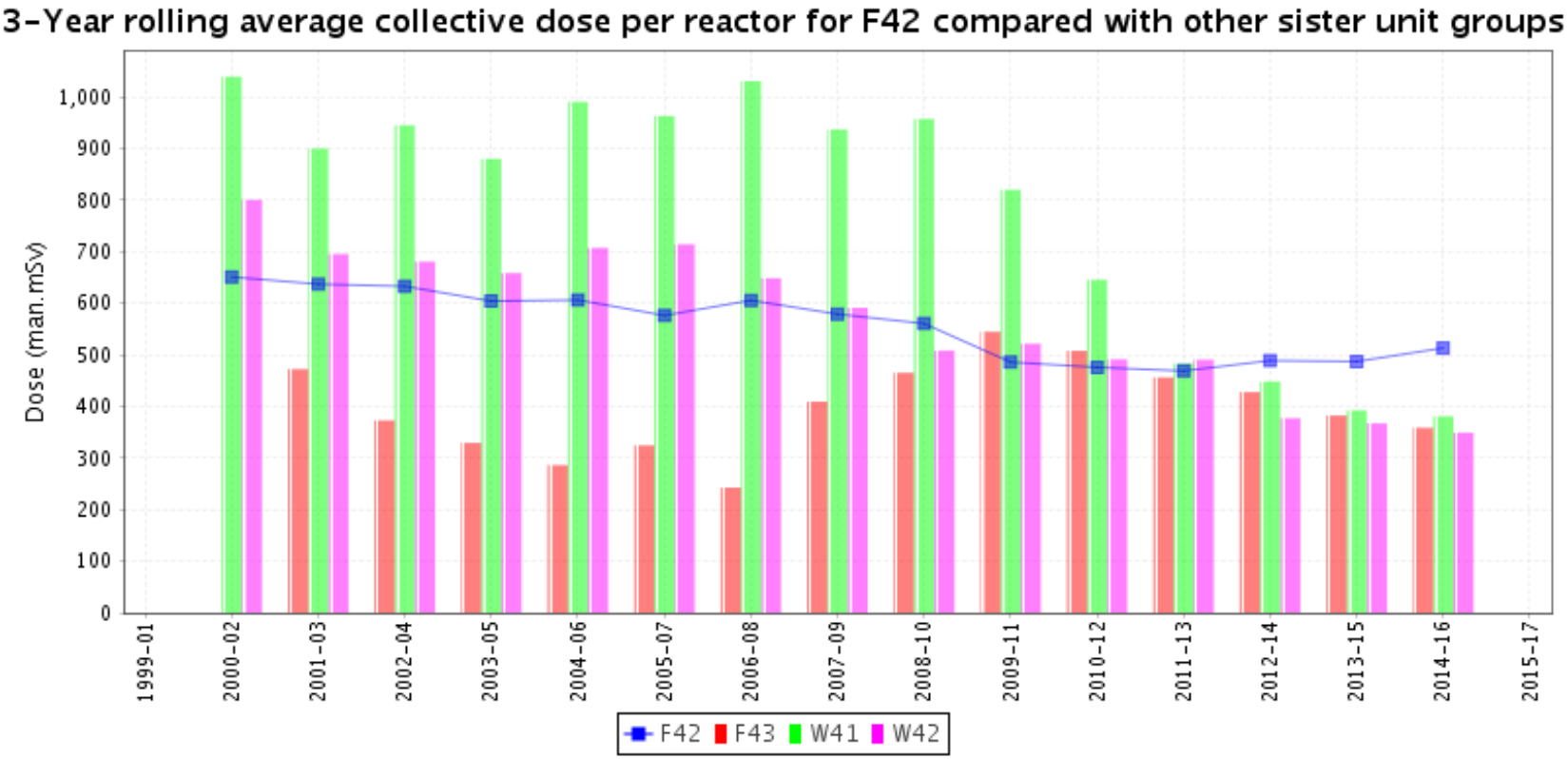
Collective Dose Trends by Sister Unit Group Comparison Framatome – Westinghouse reactors

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



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

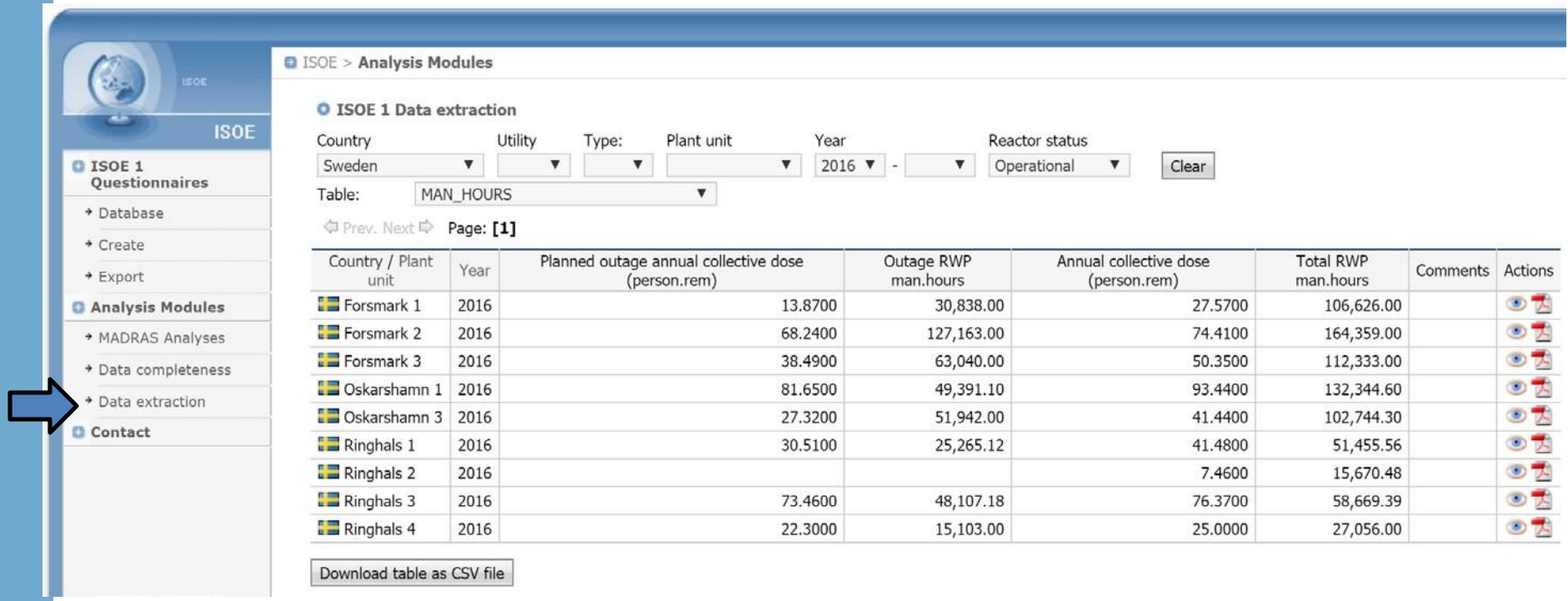


New Analyses

- Analysis module is improved every year with new developments based on user feedback and requests
- New dose analysis include 10-year comparisons of major refueling tasks, e.g, reactor disassembly/reassembly, BWR reactor water pump motor replacement
- Estimated vs actual Radiation Work Permit outage dose and manhours

  Life of plant major refueling task dose trends for BWRs, PWRs and CANDU

Data Extraction



Country / Plant unit	Year	Planned outage annual collective dose (person.rem)	Outage RWP man.hours	Annual collective dose (person.rem)	Total RWP man.hours	Comments	Actions
Forsmark 1	2016	13.8700	30,838.00	27.5700	106,626.00		
Forsmark 2	2016	68.2400	127,163.00	74.4100	164,359.00		
Forsmark 3	2016	38.4900	63,040.00	50.3500	112,333.00		
Oskarshamn 1	2016	81.6500	49,391.10	93.4400	132,344.60		
Oskarshamn 3	2016	27.3200	51,942.00	41.4400	102,744.30		
Ringhals 1	2016	30.5100	25,265.12	41.4800	51,455.56		
Ringhals 2	2016			7.4600	15,670.48		
Ringhals 3	2016	73.4600	48,107.18	76.3700	58,669.39		
Ringhals 4	2016	22.3000	15,103.00	25.0000	27,056.00		

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

NATC Data

- Unique to NATC is a library of PWR and BWR post-outage reports.

- This allows for planners to review post-outage reports for unique as well as routine work for beneficial practices and potential pit falls.

Fall 2021 NRC Data Request

Category	Original Estimate	OTD Actual	OTD Delta
Turbine Building			
Turbine Building - All Activities	1.561	1.950	0.389
Drywell			
Ops Tagging/Surveillances	0.934	2.166	1.232
DRYWELL - MINOR MTCE	2.132	5.631	3.499
Undervessel / SRM A	2.739	3.114	0.375
DW Cooler Maintenance	3.262	0.232	-3.030
Sump Work	0.226	0.258	0.032
MSIV's	0.813	1.032	0.219
SRV's (11 pilots, 7 bodies)	5.233	12.203	6.970
Nozzle Exams	18.876	11.202	-7.674
B Rx Recirc Pump	0.363	0.107	-0.256
A Rx Recirc Pump	0.654	0.172	-0.482
Walkdowns / Initial Entry/Final Entry	1.177	0.579	-0.598
Decontamination / Housekeeping	0.609	0.507	-0.102
CRD Maintenance	8.945	5.714	-3.231
RP Job Coverage (DW)	6.101	5.445	-0.656
Steam Tunnel Maint / MSIV's	0.699	1.279	0.580
Refuel Floor			
Reactor Dissassembly	3.035	1.879	-1.156
Internal Component Moves	1.277	2.368	1.091
Fuel Movement / Blades / LPRM's	3.683	5.884	2.201
Jet Pump Wedge	0.341	0.442	0.101
Reactor Reassembly	6.794	9.850	3.056
Cavity Decon	2.000	4.038	2.038
I V V I	1.674	4.611	2.937
ILRT	2.075	1.556	-0.519
Torus / Torus Room & GS Valves	1.484	1.999	0.515
ISI Exams	6.593	5.945	-0.648
LLRT's	6.610	5.526	-1.084
Insulation Activites	5.024	4.153	-0.871
Scaffold Activities	7.810	6.028	-1.782
TP&L Activites	2.411	0.549	-1.862
Snubbers	2.454	3.231	0.777
Shielding Activites	4.247	3.453	-0.794
All Other Reactor Building Activites	2.856	5.478	2.622
General Entry SRW	0.256	0.190	-0.066
TOTAL	114.948	118.771	3.823

Excerpt from Post–Outage Report

Main Steam Isolation Valves (MSIVs):
CRE: 1.946 Rem (97% of estimate)
Duration: 1,969 Hrs (94% of estimate)
EDR: 0.99 mrem/hr (104% of estimate)

2B21F028A outboard MSIV failed as well. The failure was due to a packing leak.
Maintenance wanted to replace 2 rings of packing, but could not get the packing follower up enough to get
packing out due to a piece of angle iron being welded to the coupling. They recovered a torque of 115 ft
lbs, and turned the nuts approximately 1 flat. Then they increased the torque to a maximum of 143 ft. lbs.
The plan then called for LLRT to pressurize to see if the packing leak is stopped. If so, they would complete
diagnostic testing to see if seat leakage was present as well.

Excerpt from Post–Outage Report

Good Practices:

- The 3M Air-mate (Versa-hoods) worked well in providing protection from facial contaminations. (See Job weaknesses)
- CASI suits were very effective in contamination control. CASI suits are lightweight, water-resistant, breathable and inexpensive.

Problems Encountered:

- A total of 187 mRem was received removing/installing the duct work above the 1D MSIV (63 mRem to remove and 124 mRem to install). This exposure was not accounted for in the original estimate. Scaffolding was also required to support this work.
- The Drywell coolers remained off for the vast majority of the outage which increased the temperaturesin the Drywell.
- The SDC line above the 1D MSIV was identified as the contributing source of the dose rates in the area. There was no lead package analyzed/prepared to shield the SDC line

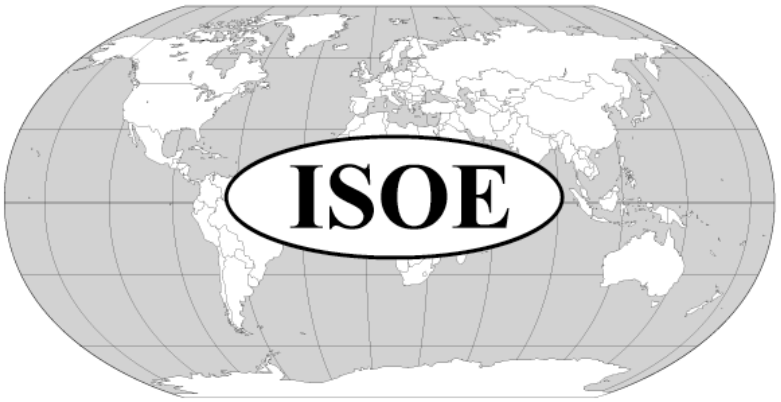
ISOE Bureau Note of Appreciation

- Brad Boyer, ISOE Bureau Chair & Watts Bar 1,2 Radiation Protection Manager wishes to express the appreciation of ISOE RPMs and regulators for the support provided by the ISOE co-secretariats at OECD NEA & IAEA
- Burcin has previously ably served as the ISOE Co-Secretariat
- J. Ma is the current IAEA co-secretariat
- The mission of the global ISOE ALARA Information Exchange Network could not be successful without their exceptional leadership and progam coordination

The ISOE Website and Database

Thank you for your attention!

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INFORMATION SYSTEM ON OCCUPATIONAL EXPOSURE

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