EDF MEASUREMENT PROGRAM FOR SOURCE TERM REDUCTION

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LEADING THE ENERGY CHANGE

French RP context

Collective Dose Reduction :
A constant challenge for all NPP operators

2 ways to reduce collective dose

Better organize the outage

Time spent in controled area
Biological shielding

Play directly on source term

Prediction tools and modelling (OSCAR code)
Chemical procedure improvement
Material improvement
Purification improvement

Measurement strategy to characterize
Dose rates AND Deposited activities

Determine and compare performances of each French units

Monitor the influence of new operational procedures
(zinc, boron/lithium management, optimized SG tubes pre-oxidation and cleaning)

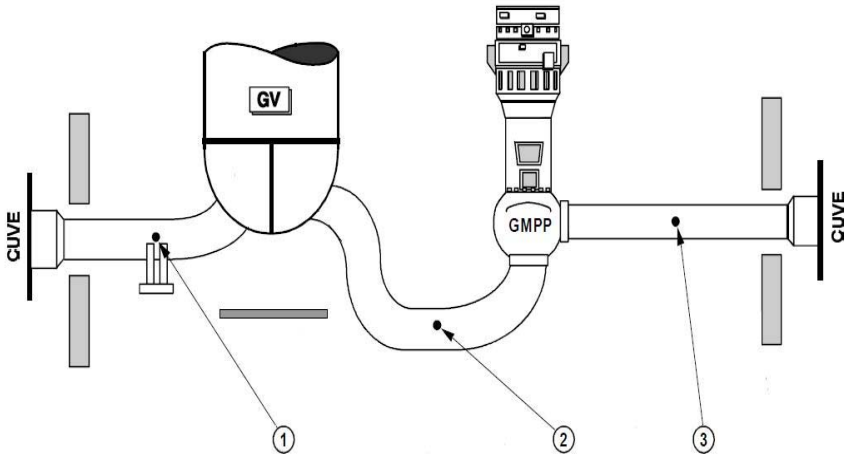
Measurement strategy in French fleet

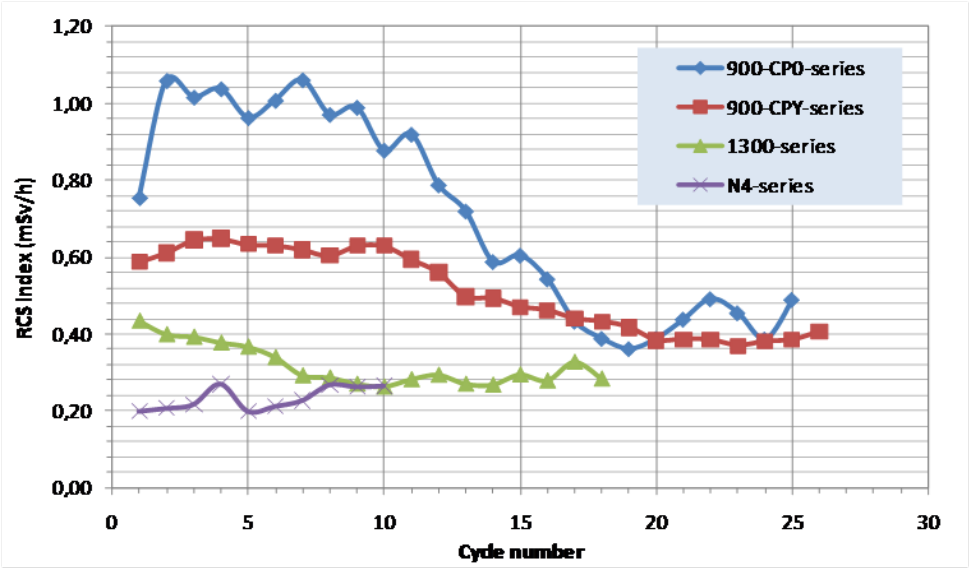
EDF Strategy

	ROUTINE DOSE RATE MEASUREMENTS	SPECIFIC CAMPAIGNS	ROUTINE CZT MEASUREMENTS
What	ROUTINE DOSE RATE MEASUREMENTS	SPECIFIC CAMPAIGNS	ROUTINE CZT MEASUREMENTS
Who	RP teams in each French units	CEA (EMECC)	RP teams in each French units
Why	• Calculation of RCS Index and RB index • Performance comparison • Good practices	• Accurate analysis • Specific experiments • Specific contamination	• DED contribution only • Less accurate than EMECC • Easier to handle

Dose Rates : RCS Index measurement

Localization of RCS index measurement points





Number of measurement points

3 points per loop	
900 series	*9 points*
1300-N4 series	*12 points*

Mandatory : Before oxygenation

If need be : After oxygenation

« Old » units closer and closer than « new » units

Continuous progress on source term

Optimized shutdown procedures to avoid over-contamination after oxygenation

Design improvements (690 alloy SG tubes)

Dose Rates : RB Index measurement

General description

RCS Index

- Useful to compare dose rates near primary pipes (Historic index followed since the first start-up)
- No information about the global radiological state of Reactor Building

New RB Index

- Based upon a cartography including 40-50 points
- Main monitored systems (RHRS, CVCS, RCS, PZR, SIS, SG tubes, ...)
- Set up on the whole EDF fleet between 2010 and 2011

Not described in details because of a specific poster at that conference

« EDF new Reactor Building Index », P. Remy and al. (EDF/DIN/CIDEN)

Contamination : EMECC Campaigns (1/2)

EMECC

Ensemble de **M**esure et d'**E**tude de la **C**ontamination des **C**ircuits

(assembly of measuring and study of circuit contamination)

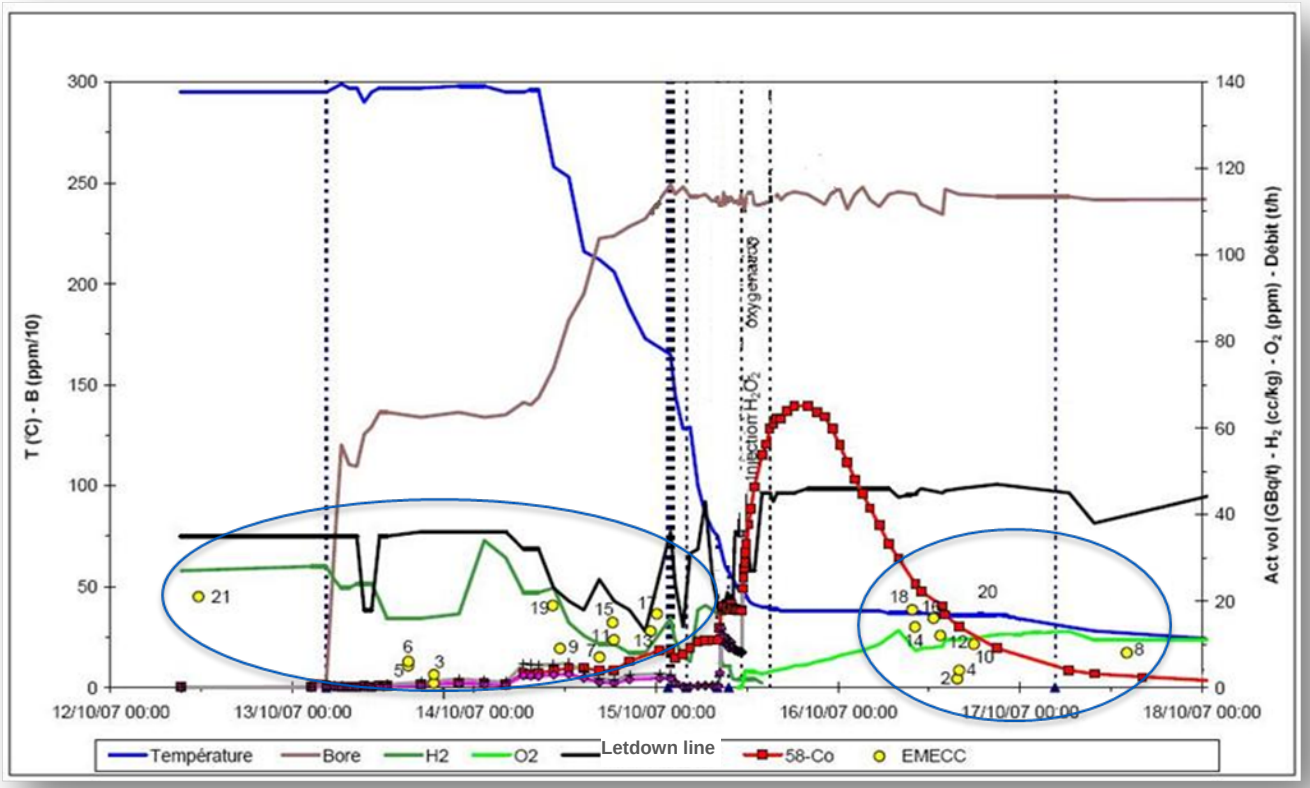
- **Non destructive activity measurements by gamma spectrometry**
- **General Method : Numerical calibration**
  - *Unique efficiency calibration of a detector : measurement of a photon flux (relation between count/s and photon flux rate)*
  - *Computed transfer functions (Mercure code) : calculation of a photon flux (relation between photon flux rate and activity)*
  - *Very large range of application (all geometries being able to be modelled).*

- **Detector** *: Germanium cooled by liquid nitrogen*

- **Full or empty** *(w. or wo. volumic activity contribution)*
- **Deposited activities in a range between 1 MBq/m² → 100 GBq/m²**
- **Radionuclides : ^{58}Co, ^{60}Co, ^{110m}Ag, ^{124}Sb ….**
- **300 campaigns for the last 40 years** *(mainly France but also foreign units)*

Contamination : EMECC Campaigns (2/2)

Example of EMECC program performed in 2009



Measurement points
RCS – Hot leg – Loop 1
RCS – Hot leg – Loop 2
RCS – Crossover leg – Loop 1
RCS – Crossover leg – Loop 2
RCS – Cold leg – Loop 1
RCS – Cold leg – Loop 2
RCS – SG hot side – Loop 1
RCS – GG cold side – Loop 1
RCS – SG hot side – Loop 2
RCS – SG cold side – Loop 2
RCS – Bypass line – Loop 1
CVCS – NRHE

21 points

Measurements all along the outage

Before and after oxygenation

Contamination : CZT program (1/2)

Complementarity of CZT with EMECC device

EMECC Campaigns : Very accurate way to characterize contamination

Not possible to perform EMECC campaign on each unit

CEA staff restricted capacity (10 campaigns per year)

Significant cost of each campaign

CZT Device

Since 2006

Provided to each EDF RP department in each unit

Sensor : Cadmium / Zinc / Tellurium

Energy range : 300 keV → 1.8 MeV

Sensitivity : 0.1 to 10 mSv/h

Allows to characterize the radionuclide contribution to dose rates

Contamination : CZT program (2/2)

Program description

CZT optimized program			
P1a P1b	CVCS	Before purification system	Power operation After fuel download
P2a P2b	**CVCS**	**After purification system**	**Power operation** **After fuel download**
P3a P3b	CVCS	Exchanger	Power operation After fuel download
P4a P4b	**RCS**	**Crossover leg**	**Hot shutdown** **Pool flooding beginning**
P5a P5b	RCS	Hot leg	Hot shutdown Pool flooding beginning
P6a P6b	**RCS**	**Cold leg**	**Hot shutdown** **Pool flooding beginning**
P7a P7b	SIS	Valve	Hot shutdown Pool flooding beginning
P8a P8b	**RHRS**	**Exchanger**	**Hot shutdown** **Pool flooding beginning**

16 points

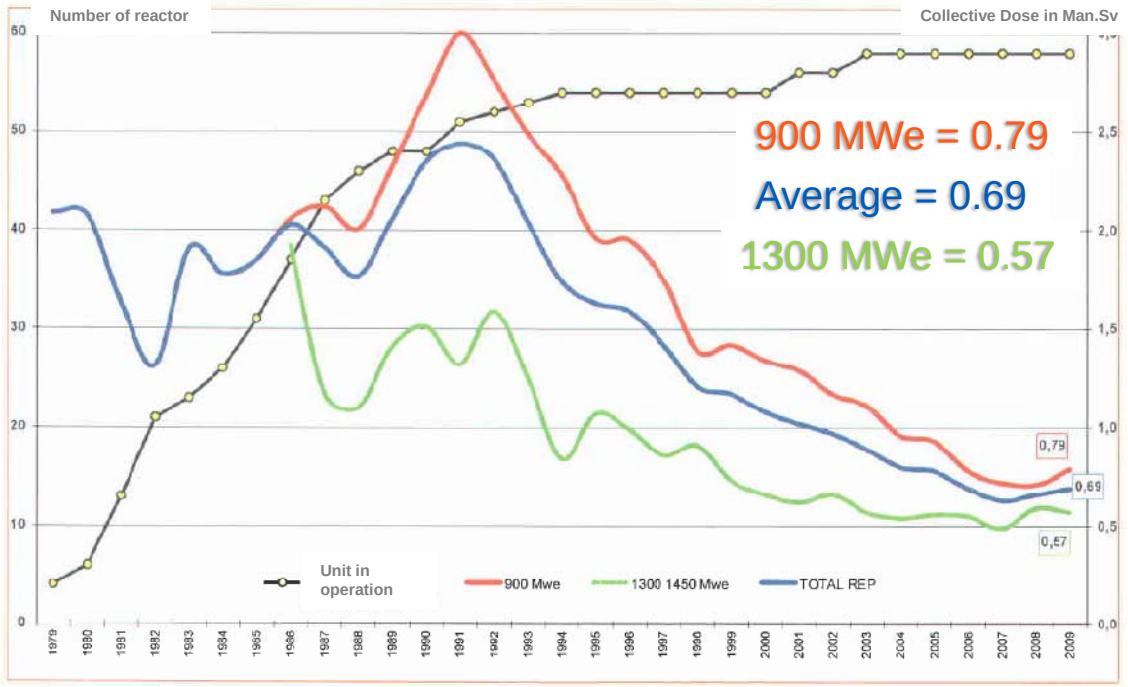
Located on RCS, CVCS and SIS

Efficient basis for contamination mechanism understanding

Characterize unknown and unexpected contamination

French RP context

EDF dose performances in 2009



2010 objective
0.65 Man.Sv

In a good way to be reached

Country	France	USA	Japan	Germany	Belgium	Spain	Sweden	Switzerland
Collective dose (Man.sv)	0.69	0.70	1.49	1.05	0.37	0.72	0.92	0.36
Unit number	58	69	23	11	7	6	3	3

In 2009, EDF shows one of the lowest collective dose compared to others european operator

Conclusion

Source term reduction is an important matter of concern for EDF fleet performances

S.T.R. project has launched a significant measurement program aimed to reduce contamination levels and dose rates

Routine measurements

Specific campaigns

Thanks for your attention !

At your disposal for some questions !