CZT technology application at EDF

for better radiation protection and nuclear plant surveillance

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EDF
LEADING THE ENERGY CHANGE

OUTLINE

- CZT position in the measurement strategy in French fleet
- CZT device description and CZT programme
- CZT data statistical analysis
- Developments: in progress or planned

Measurement strategy in French fleet

Curative objective :
Early detection of radiological state deterioration

- *To know the radiological state of circuits*
- *To eliminate the pollution source quickly « at the root »*
- *To plan decontamination operations at the next outage*

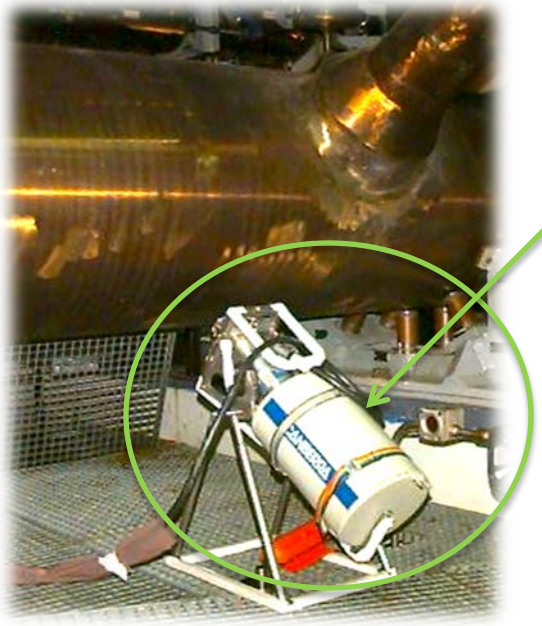
DOSE RATE MEASUREMENTS	CZT MEASUREMENTS	EMECC campaigns
RCS and RB Indexes	Routine analysis *Contributors to dose rates*	Accurate analysis for specific experiments *Contributors to deposited activity and dose rates*
Performance comparison between units	"Daily" contamination characterization	Reference at EDF

Preventive objective :
Source Term Reduction
Input data for engineering and R&D studies

- *To better understand contamination mechanisms*
- *-To develop innovative procedures*
- *- To follow their efficiency for a further roll out on the whole fleet*

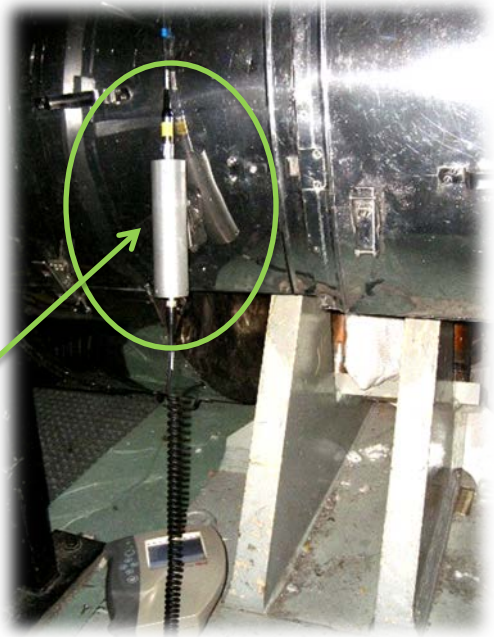
Why does EDF carry out CZT measurements ?

EMECC device



Liquid Nitrogen cooling *(heavy tank)*

CZT device



Easier to handle *(no tank)*

Gamma spectrometry expert team at CEA

SPECIFIC EXPERIMENTS

Performed by

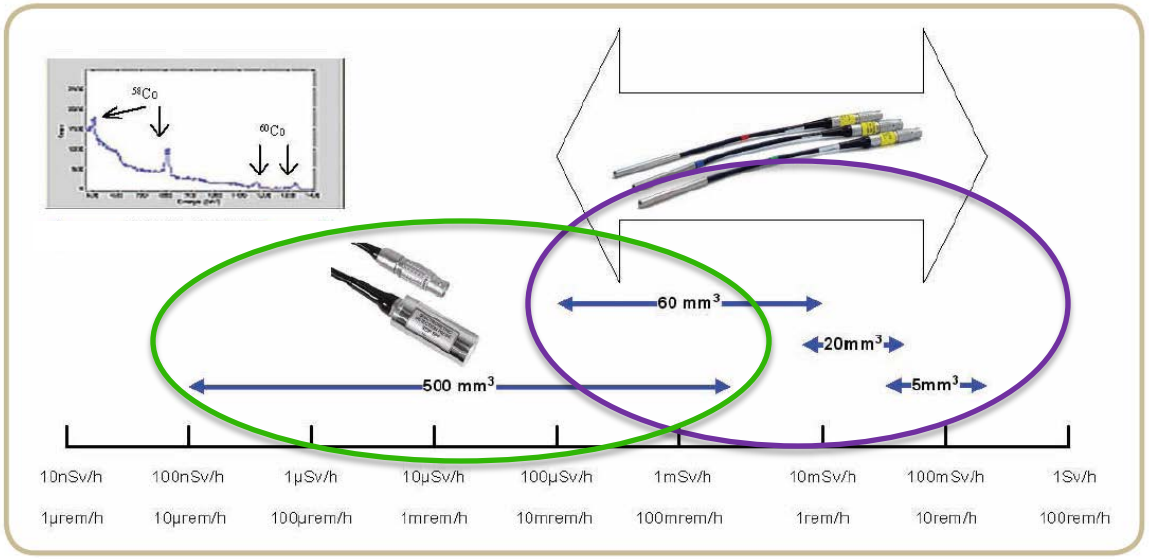
Radiation Protection team of each unit

ROUTINE MEASUREMENTS

CZT device description

Main technical characteristics

Sensor : Cadmium / Zinc / Tellurium



Sensitivity : 0.1 to 200 mSv/h with current probes :
5 mm³
20 mm³
60 mm³

Sensitivity : less than 0.1 µSv/h with optional probe : 500 mm³ (8 available at EDF)

Energy range : 30 keV → 1900 keV

Typical acquisition time : 15 min (w.o. collimator)

Resolution sufficient for main RN : ^{58}Co, ^{60}Co, ^{110m}Ag, ^{124}Sb, etc.

RADMAP software

CZT probe in its briefcase

Optimised programme for CZT gamma measurements

Measuring points in the NAB (Nuclear Auxiliary Building) *1 series before oxygenation: in operation the week before uncoupling* *1 series after oxygenation: in refuelling mode when the pool is being filled*		
P1:	CVCS	Upstream from purification
P2:	CVCS	Downstream from purification
P3:	CVCS	Non regenerative heat exchanger
Measuring points in the RB (Reactor Building) *1 series before oxygenation: in hot standby conditions* *1 series after oxygenation: in refuelling mode when the pool is being filled*		
P4:	RCS	Crossover Leg
P5:	RCS	Hot Leg
P6:	RCS	Cold Leg
P7:	RCS/SIS	Injection check valve of the SIS accumulator
P8:	RHRS	Heat exchanger

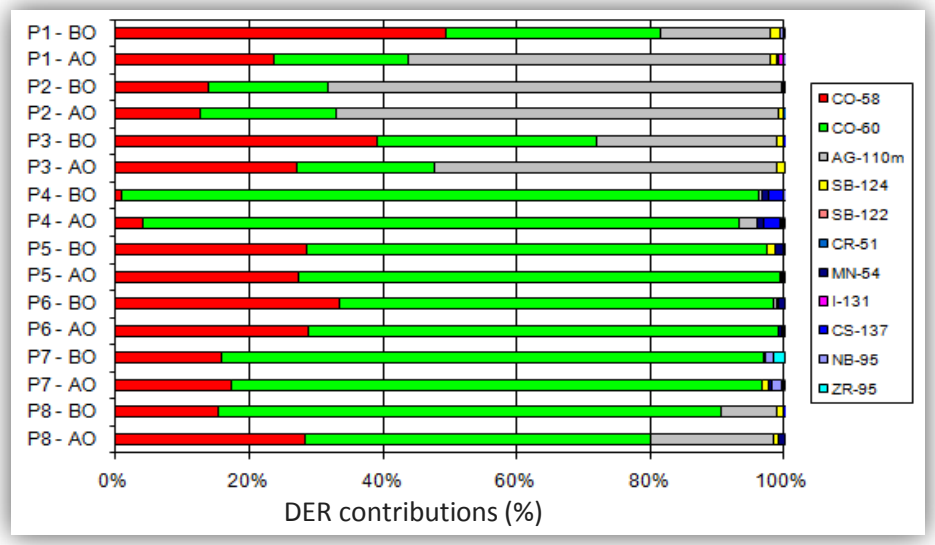
Point 5
RCS – Hot Leg

16 points

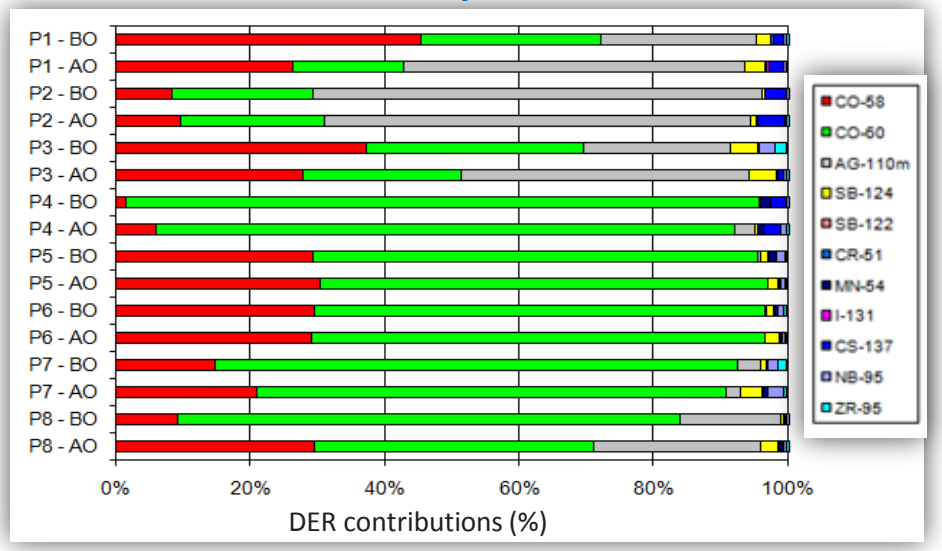
- Located on RCS, CVCS, RHRS and SIS
- Efficient basis for contamination mechanism understanding
- Characterize unknown and unexpected contamination

CZT data statistical analysis (1/2)

2006-2007 synthesis



2008-2011 synthesis



DER contribution (%)	2006 – 2007 (410 spectra)	2008 – 2011 (405 spectra)
^{58}Co	23.1	22.1
^{60}Co	55.7	52.4
^{110m}Ag	19.3	20.7
^{124}Sb	0.7	1.7

2007 and 2011syntheses are very similar which shows the **reproducibility** and the **robustness** of the CZT measurements

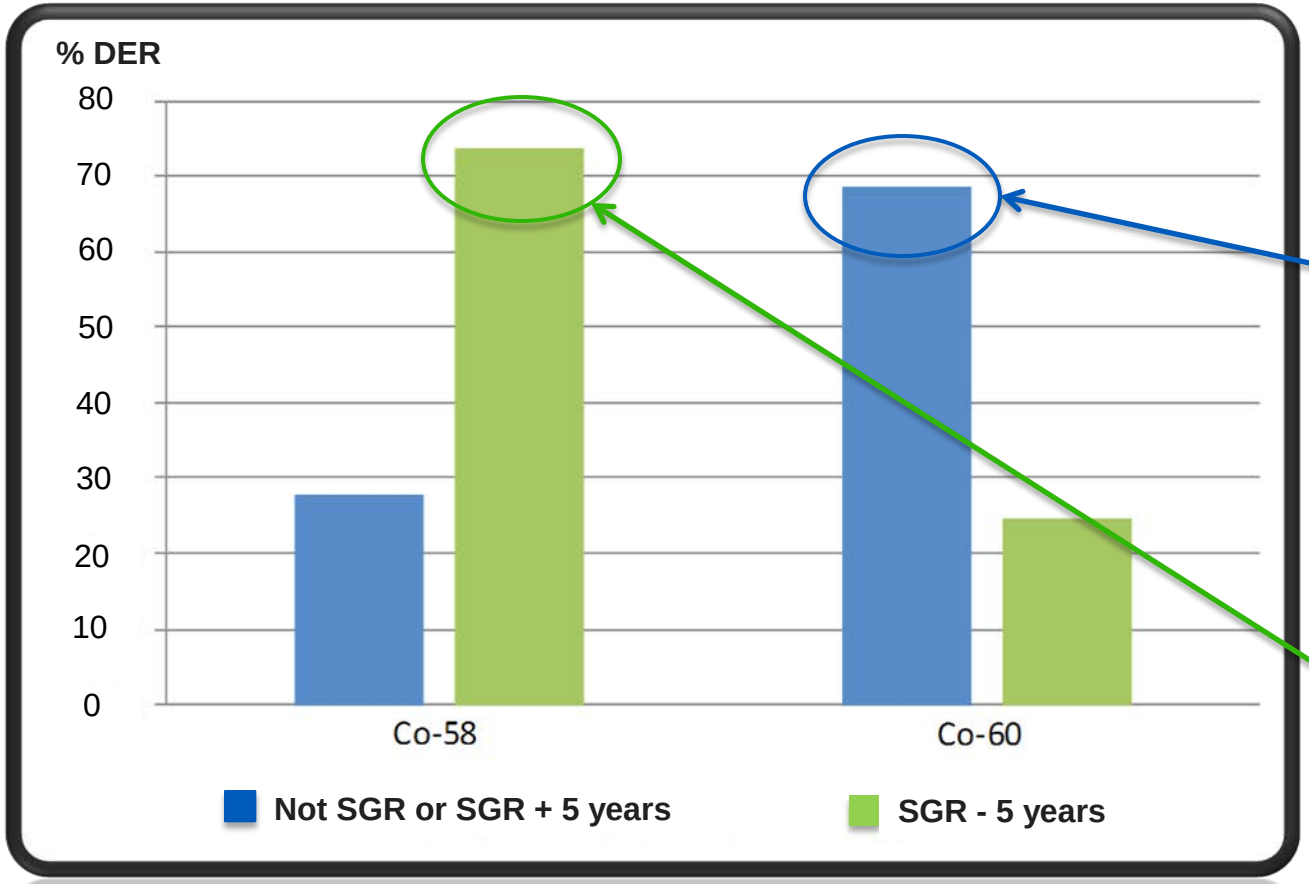
3 major radionuclides:

RCS: ^{60}Co and ^{58}Co
CVCS: ^{110m}Ag

BO: Before oxygenation
AO: After oxygenation

CZT data statistical analysis (2/2)

Steam Generator Replacement impact



"OLD" S.G.

^{60}Co is the main contributor to dose rates

"YOUNG" S.G.

^{58}Co is the main contributor to dose rates

Developments: in progress or planned

Recent results and further developments (2012)

Global results analysis in relation to other types of measurements

- *Comparison between all units and "series effect" identification*
- *Early detection of penalizing polutants*
- *Determination of units where a cleaning process is necessary*

Objective : Supply of 500 mm^3 probes for all EDF NPPs

Feasibility study of surface activity measurement with CZT

- *Development of a collimator for the 500 mm^3 probe*
- *Transfer functions calculation for different geometries and circuits*
- *Experimentation on site and comparison to HP Germanium*

Characterization of filter retention performances with CZT

Conclusion

CZT device is now currently used in EDF NPPs

Measurement programme has been optimized to be complementary to Dose Rates Indexes as a part of the global EDF strategy for radiological state characterization

New developments are in progress

To ensure a reliable analysis, EDF has put in place training for every shutdown : analyse and interpret the spectra produced by the CZT, use these results to propose solutions to improve radiological state, etc.

CZT is able to satisfactorily identify and quantify the contribution of the dominant radionuclides to the total DER

Thanks for your attention !

At your disposal for some questions !