AGEING MANAGEMENT PROGRAM

EDF methodology / GALL report

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SEPTEN

EDF

Content

- Introduction EDF Methodology
- Comparison EDF / GALL
- Conclusions

Introduction to EDF AMP

- Ageing management and remaining lifetime evaluation of nuclear plants continuous issue for EDF :
  - 58 PWRs with 34 3-loop , 20 4-loop 1300MW, 4 4-loop 1500MW
  - put in operation between 1977 and 1999
- 3 major steps :
  - daily routine maintenance
  - exceptional maintenance : operational or anticipative
    - large, normally unique, maintenance task (like SGR, baffle bolts replacements, vessel head replacements, alternators, condensors, transformers, turbine rotors…)
    - on a large number of similar plants
    - with large consequences on resources and plant availability
  - every 10 years periodic safety review of each plants, including AMP review
- Life management program at corporate level

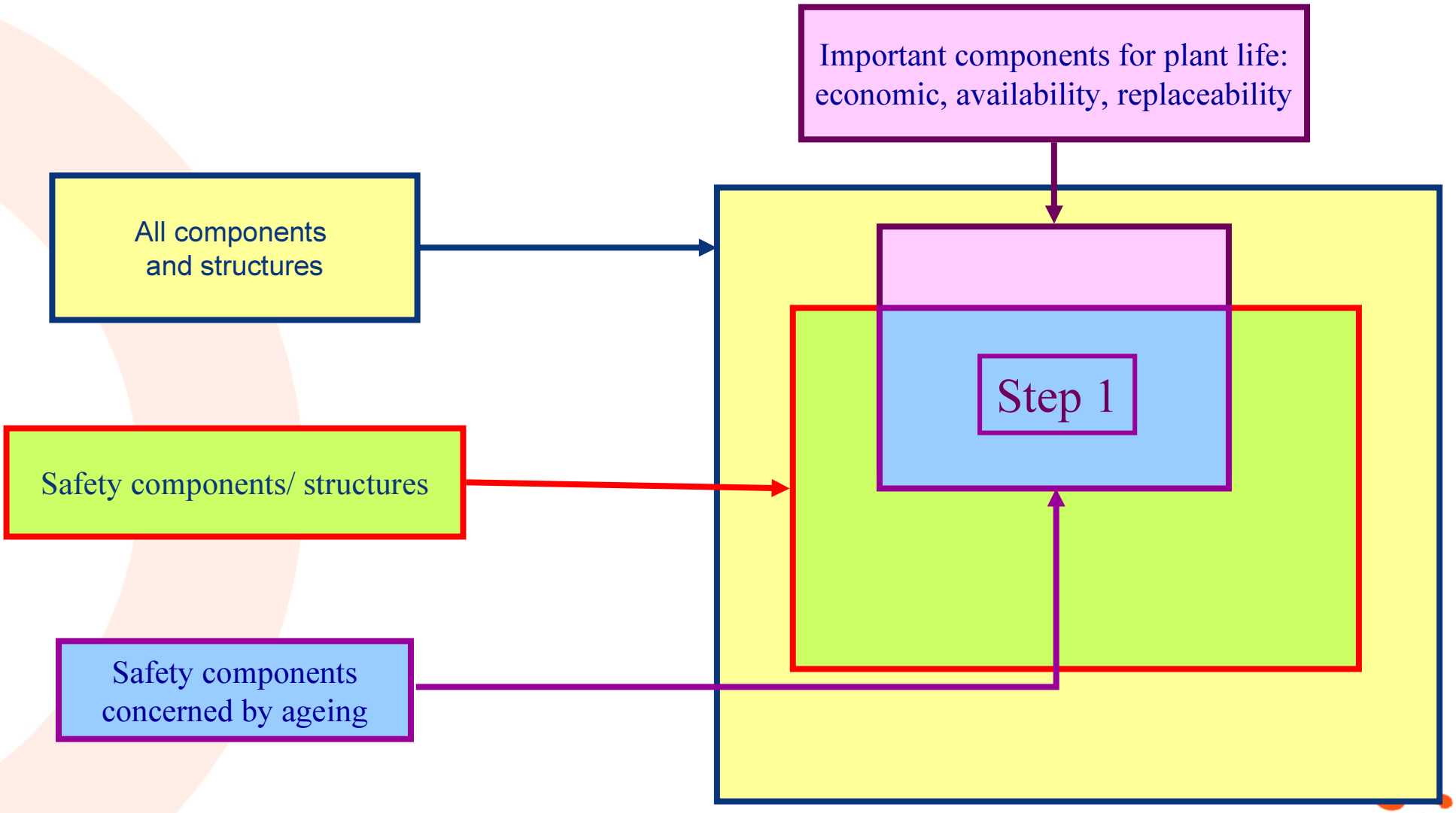
Introduction to EDF AMP review

- Major objectives:
  - confirm collection of relevant data : surveillance programs, monitoring, ISI…
  - anticipate repair-replacement strategy
  - survey industrial capacities and risk of obsolescence
  - include R&D state of the art
  - compare with international activities,
    like (IAEA, OECD, EPRI, NEI, NRC, INPO, EC…)
    and direct contacts with utilities
  - Consider consequences on human resources
  - And finally update documentation and practices, if necessary

EDF AMP of safety class components review

- 5 steps
  - step 1: selection of components
    - grid / datasheets
  - step 2: degradation mechanism analyses
    - ageing analysis report
  - step 3: comparison with existing maintenance practices
    - synthesis in "Doctrine de maintenance“ at central service level
    - PBMP: "Programme de Base de Maintenance Preventive" at plant level
  - Step 4: transfer and complete generic ageing analysis report at plant level
  - Step 5: yearly review of the datasheets
- all the consequences on the 3rd 10Y shutdown with minimum of 1Y delay

Step 1: Selection of components



Step 1: Selection of components

xxx	yy	zz	Sheet N°	Indice	date	Component / Structure	Classement sûreté (1/2/3/NC/1E/GC/Aut)	Location	Mechanism	Mechanism acronym	Encountered damage (Y/N)	Design life (xx years)	Operation measures (Adapted /Adaptable /Difficult to adapt)	Repair difficulty (L/M/H/N)	Replacement difficulties (L/M/H/N)	Comment- Action planned	Previous Status	Status end 2008
001			**001**			**CUVE**												
001	01	01	001-01-01	G	27/01/09	RPV	1	Core shell and welds	Fraglr	FSI01	O	40	adapted	H	H	Revised TLAA needed after Regulator remarks	2	2
001	01	02	001-01-02	F	27/01/09	RPV	1	Core shell and welds	Fat	FAT01	N	40	adapted	H	H	to be justified for 60Y operation	0	0
001	03	01	001-03-01	E	14/12/06	RPV	1	Vessel head	CBor	COR01	O	N	Adaptées	H	M		0	0
001	04	01	001-04-01	F	27/01/09	RPV	1	Welds outside core region	VieilTh	VTH01	N	-	-	-	-	Non pertinent damage	SO	SO
001	05	01	001-05-01	F	27/01/09	RPV	1	Bolted flange	VieilTh	VTH01	N	-	-	-	-	Mécanisme non pertinent	SO	SO
001	05	02	001-05-02	F	27/01/09	RPV	1	Bolted flange	Fat	FAT01	N	40	Adaptées	H	H	to be justified for 60Y operation	0	0
001	06	01	001-06-01	F	27/01/09	RPV	1	Nozzle shell	VieilTh	VTH01	N	-	-	-	-	Non pertinent damage	SO	SO
001	07	01	001-07-01	F	27/01/09	RPV	1	Outlet nozzle	VieilTh	VTH01	O	40	Adaptées	H	H	to be justified for 60Y operation	2	2
001	07	02	001-07-02	F	27/01/09	RPV	1	Outlet-Inlet nozzle	Fat	FAT01	N	40	Adaptées	H	H	to be justified for 60Y operation	0	0
001	08	01	001-08-01	C	27/01/09	RPV	1	DMW	CAtm	COR06	O	N	Adaptées	M	H	project review	0	0
001	08	02	001-08-02	C	27/01/09	Cuve, GV, Pressuriseur	1	DMW	VieilTh	VTH04	N	-	-	-	-	Non pertinent damage	SO	SO
001	12	01	001-12-01	E	27/01/08	Cuve	1	Radial keys	VieilTha	VTH01	N	-	-	-	-	Non pertinent damage	SO	SO
001	12	02	001-12-02	B	09/12/08	cuve	1	Radial keys	CSC	CSC01-CSC03	N		adaptéés	H	H	to be justified for 60Y operation	0	0
001	13	01	001-13-01	F	27/01/09	Cuve	1	BMI	CSCP	CSC01-CSC03	N	N	Adaptées	M	H	to be justified for 60Y operation	0	0
001	16	01	001-16-01	F	09/12/08	Cuve	1	Vessel head penetrations	CSCP	CSC01-CSC03	O	N	Adaptées	H	M	to be justified for 60Y operation	0	0
001	17	01	001-17-01	D	15/12/06	Cuve	1	Lifting lug	CBor	COR01	-	-	-	-	-	refer to 001-03-1	SO	SO
001	21	01	001-21-01	F	27/11/08	Cuve	1	Alloy 182 UCC repair in nozzle bore	CSCP	CSC03	N	N	Adaptées	M	H		0	0
001	22	01	001-22-01	B	15/12/06	Cuve	1	CANOPY and OMEGA Joints	CSC	CSC04	O	N	Adaptées	M	M	by comparison with TRACTEBEL	0	0

408 couples (location – potential degradation)

Step 1: Selection of components

sigle	mechanism	domain
ABR01	General abrasion	
CAR01	Carbonatation	Concrete
CER01	Erosion-Corrosion (Flow accelerated corrosion)	Carbon and low alloy steels
CIC01	Intercristallin corrosion secondary water	Alloy 600 tubes
CIC02	Intercrystalline corrosion	Austenitic Stainless Steels
COR01	Boric acid corrosion	Carbon and low alloy steels
COR03	Boric acid corrosion	Stainless steels
COR02	Corrosion	Reinforced concrete
COR04	Waterline corrosion	All Steels
COR05	General corrosion	
COR06	Atmospheric corrosion	Ferritic/ austenitic Dissimilar metal weld interface
CPI01	Pitting corrosion	Carbon and low alloy steels
CPI02	Pitting corrosion	Stainless steels
CSC01	PWR stress corrosion	Ni-based alloys type 600
CSC03	PWR stress corrosion	Nickel based alloy welds 82-182
CSC04	PWR polluted water stress corrosion	Austenitic Stainless Steels
CSC05	PWR stress corrosion	Cold worked Austenitic Stainless Steels
CSC06	Nominal PWR water stress corrosion	Carbon and low alloy steels
CSC07	Nominal PWR water stress corrosion	Austenitic Stainless Steels
CSC02	Secondary stress corrosion	Austenitic Stainless Steels
CSC08	PWR stress corrosion	Ni-based alloys type 750
CSC09	Irradiated Stress Corrosion cracking (IASCC)	Austenitic Stainless Steels of RVI
DEC01	Ductile tearing	Ductile alloy steel
DEC02	Ductile tearing	Cast austenitic duplex stainless steel
DEC03	Ductile tearing	Austenitic Stainless Steels of RVI

50 degradation mechanisms

Step 1: Selection of components

100	Primary system
101	CUVE
102	INTERNES DE CUVE
103	MCG
104	PRESSURISEUR ET LIGNE D'EXPANSION
105	SOUPAPES SEBIM PRESSURISEUR
106	GV
107	GMPP
108	TUYAUTERIES PRIMAIRES
109	TUYAUTERIES AUXILIAIRES DU CPP
110	ROBINETTERIE
200	Secondary system
201	VANNES D'ARRÊT VAPEUR
202	SOUPAPES GV
203	TUYAUTERIES CSP
300	Other nuclear components
301	TUYAUTERIES AUXILIAIRES NUCLEAIRE
302	TUYAUTERIES INCENDIE
303	POMPES
304	TURBINE ASG
305	TURBOALTERNATEUR LLS
306	ECHANGEURS AUXILIAIRES NUCLEAIRES
400	Non nuclear components
401	BÂCHES ET RESERVOIRS
402	TUYAUTERIES AUXILIAIRES
403	VENTILATIONS
404	MANUTENTION
405	FILTRATION EAU BRUTE
500	cables
501	CÂBLES ELECTRIQUES
502	CHEMINS DE CÂBLES
503	CÂBLES MINERAUX ET CONNECTEURS COAXIAUX

600	Electrical components
601	DIESELS DE SECOURS
602	TABLEAUX ELECTRIQUES
603	MOTEURS MT ET BT
604	CONVERTISSEURS (ONDULEURS ET CHARGEURS)
605	BATTERIES ELECTRIQUES
606	TRANSFORMATEURS PRINCIPAUX
607	RELAIS D'AUTOMATISME
608	ELECTROVANNES ASCO-JOUCOMATIC
609	CONNECTEURS AIR-LB
610	CONNECTIQUE RAYCHEM
611	CONNECTEURS K1
700	Instrumentation
701	EX CORE NEUTRONIC MEASUREMENT
702	POSITION DETECTOR
703	ON-OFF CAPTOR
704	TEMPERATURE PROBE
705	CORE THERMOCOUPLE
706	HYDROGEN-METER
707	FLOW METER
708	UT FLOW METER
709	ANALOG PRESSURE TRANSMITTER
710	UT TRANSMITTERS
711	KRT PROTECTION CHANNEL
712	REGUL ROD POSITION MEASUREMENT
713	TIME INDEPENDANT PROTECTION RELAY
714	COUNTER
715	RPV LEVEL MEASUREMENT
716	AUTOMATIC SCRAM INSTRUMENTATION
800	Control components
801	CONTRÔLE ROOM / EMERGENCY PANNEL
802	OTHER CONTROL COMPONENTS
900	Civil engineering structures
901	CONFINEMENT BUILDING
902	FLUID PENETRATION
903	ELECTRICAL PENETRATION
904	MATERIAL and PERSONAL HATCH
905	NUCLEAR CIVIL ENGINEERING STRUCTURES
906	BUILDINGS and STRUCTURES
907	REACTOR BUILDING and FUEL POOLS
908	FIRE PROTECTION
909	SITE STRUCTURES
910	BONA CONCRETE PIPINGS
911	COOLING TOWERS

70 components or group of components

Step 1: Selection of components

Status principle

	Encountered degradation			Potential degradation		
Maintenance program	adapted	easy to be adapted	difficult to adapt	adapted	easy to be adapted	difficult to adapt
Repair and replacement difficult	2	2	2	0	1	2
Repair or replacement difficult	0	1	2	0	1	1

15 000 components/structures **50 degradation mechanisms**	500 sheets	70 components	12 TLAA

Step 1: Selection of components

Consequences

- 0: no particular modification or action
- 1: transform in 0 or 2, as soon as possible
- 2: complementary "Ageing Analysis Report" of Comp. or Struct.

408 couples = 336 status 0 + 16 status 1 + 12 status 2

Step 1: Selection of components

Ageing Analysis Sheet						Sheet N° :	001-01-01	
						Indice :	F	
						Date :	18/01/2008	
						CAPCOV Reference	FSI01	

DIN	Author	H. CCCCCCC	Unit	SEPTEN	Verification	H. NNN	Unit	SEPTEN
DPN	Author	C. PPPPPPP	Unit	UNIE	Verification	N. FFF	Unit	UNIE

Type(s) / Plant(s)	CP0, CPY			
Component / Structure	RPV			
Location / Area	Core shell and welds			
Mechanism	Acronym	Fraglr	Mechanism name	Radiation embrittlement

Cross if new methodology used

Last 3 indice changes

Cross if new data used

Indice	Date	Indice change reason	Modifications		
D	15/03/2004				
E	01/12/2006				X
F	18/01/2008				

General Ageing Analasys	Answer / Justification / Comment	References
Safety class		
Mechanism description		
Design or regulatory life		
Encountered damage (Y, N)		
Operation condition or maintenance adaptation (adapted, easy to adapt, difficult to adapt)		
Repair difficulties (L, M, H) and obsolescence (Y, N)		
Replacement difficulties (L, M, H) and obsolescence (Y, N)		

Sheet status	2	Justification	
Following action	RPV TLAA revision		

Complementary questions	date	Answer / Justification / Comment	References

datasheet

Documentation:

- all references used

Consistency of the results with:

- PRA results

- reliability studies

- initial list of sensitive components

- all the field experience analysis

Step 2: Ageing Analysis Report

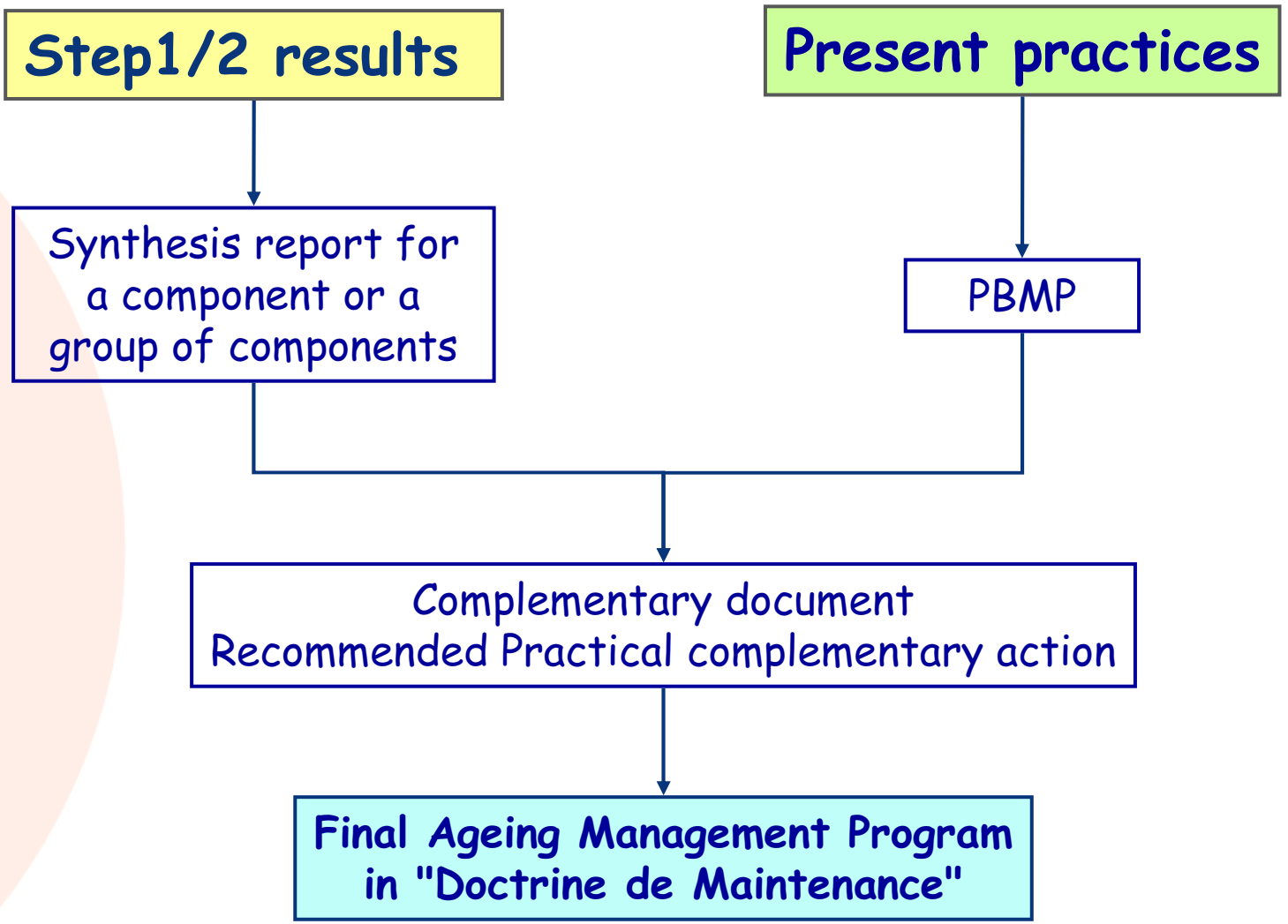
- Detailed reports:
  - collect all design / fabrication / modification / regulation / Code & Standards
  - national and international field experience
  - all the knowledge available on degradation mechanism: material, stressors, threshold, kinetic
  - fitness for service criteria
  - monitoring and ISI
  - repair / replacement
  - industrial considerations: obsolescence

Step 2 : Ageing Analysis Report to continue operation

12 reports

7 mechanical components	5 Non mechanical components
RPV	containment
RPV internals	containment electrical penetration
pressurizer	nuclear civil engineering structures
main coolant pump	cables
main coolant loop	I&C
auxiliary primay pipings	
steam generator	
	no IAEA TECDOC

Step 3: Comparison with existing practices "PBMP"



Comparison EDF – GALL report

EDF 2005	GALL Rev. 0
◉ Included in periodic safety review, but regularly updated (every years)	◉ Mainly for license renewal
◉ Mainly Safety Class components and structures	◉ Enlarged over the Safety class components like BOP
◉ Generic analysis + plant by plant complementary reports	◉ Generic analysis + plant by plant reports

List of components is similar with some small differences, like BOP for GALL or cranes for EDF

Comparison EDF – GALL report

EDF	GALL
◉ Tables in the paper	◉ Tables in the paper

Locations on components are similar with some minor differences, like RCP shaft, wheel and thermal barrier, SG internal, RPV radial keys

Comparison EDF – GALL report

EDF	GALL
◉ List in the paper	◉ List in the paper

Degradation mechanism list is similar
with some minor differences in the threshold or degradation rate,
like thermal ageing of LAS and CS, environmental effects in fatigue,
ratcheting, fouling of HX, creep relaxation of baffle bolts

Comparison EDF – GALL report

EDF	GALL
◉ US regulation	◉ French reglementation
◉ ASME III + XI	◉ RCCM + RSEM
◉ Specific AMP	◉ Specific AMP

Regulation, Codes & Standards :
- are similar for design with some differences like fatigue evaluation in piping systems
- are different for operation and surveillance
- specific countermeasures have to be compared in detail

Comparison EDF – GALL report

Finally, few examples of differences

EDF

- RPV sensitive location for forged rings are underclad cracks
- Alloy 600 locations, including SG divided plate and RPV radial keys
- Thermal ageing of duplex cast SS components
- Environmental effect for fatigue : mainly CS with high DO, included in FWS, not for Stainless Steels and Ni based alloys

GALL

- RPV more work on probabilistic approaches on fabrication defects in axial welds
- Alloy 600, "*late consideration*", under consolidation
- Just threshold on ferrite content (over 20%)
- Environmental effect for fatigue : all steels mainly for LR

Comparison EDF – GALL report

EDF	GALL
High cycle fatigue in mixing tees : specific AMP	No mixing tee consideration
Fatigue in valve inner surface	Not consider
Thermal ageing of LAS / CS under analysis for 60 years	No thermal ageing of LAS/CS up to 60 years of operation
DMW and dilution / corrosion	Not consider
RPV internals : surveillance program + large amount of R&D on the different degradation mechanisms (IASCC, swelling, creep, lost of ductility)	RPV internals : Limited surveillance program, with active R&D

Conclusions (1/3)

- Plant life management is a very important issue
- Some systematic procedures have been developed in different countries
- A "simple" comparison between GALL rev. 0 report and EDF 2005 approaches has been done
- It's important to share :
  - Basic knowledge on degradation mechanisms
  - Location where degradation is expected
  - Consequences on component safety function
  - Field experience
  - Mitigation, monitoring, countermeasure
  - Fitness for service criteria
  - Codes & Standard consequences

Conclusions (2/3)

- Different objectives : LR / PSR
- Similar scope in GALL/EDF report
- Similar, but not identical list of components, locations, degradation mechanisms for PWR
- But, for mechanical components
  - different regulation (LR/PSR), SRP, C&S
  - Different understanding of some degradation mechanisms
  - Limited “potential” areas based on R&D knowledge and models
  - More based on USA experience with limited International field experience considered
  - More international cross check in EDF approach

Conclusion (3/3)

- To assure safety and competitiveness of NPP's, it's important to share :
  - Basic knowledge on degradation mechanisms
  - Potential location concerned, including field experience
  - Understanding of consequences : safety function affected
  - Mitigation, monitoring, surveillance, ISI, all countermeasures
  - Fitness for service criteria
- To include lessons learned :
  - in the new plant design specification (including replacement parts)
  - and Codes & Standards
- To transfer knowledge to new people in these areas (KM)

To prepare our future discussion…

International knowledge contents on AMP...