Irregularities and falsifications

Background and suggested improvements

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Commissionner

ENSREG Conference, June 29 2017

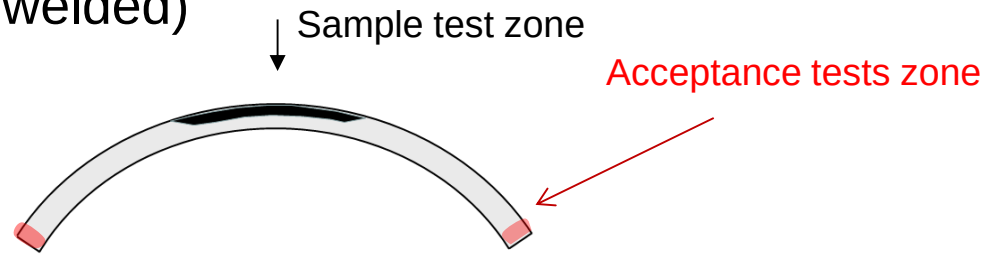
OUTLINE

1. **Background : Technical EPR vessel head anomaly**
2. **Irregularities and falsifications**
3. **What kind of improvements with regard to CSFI?**

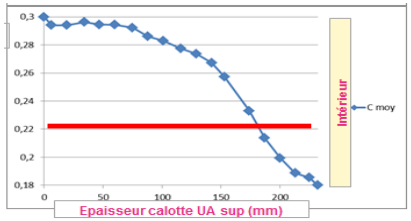
Background : Technical EPR vessel head anomaly

Flamanville 3 RPV anomalies

- Compliance with minimal mechanical properties required in acceptance tests zone (surface to be welded)



- Chemical and mechanical tests on a sample of the EPR reactor vessel head and bottom (late 2014, performed to address the risk of heterogeneity at ASN request)
  - Results of Charpy test (impact energy) lower than codes and regulation values
  - Attributed to the high carbon concentration in the sample resulting from the manufacturing process (large ingot)



Background : Technical EPR vessel head anomaly

Flamanville 3 RPV anomalies

New French regulation highlighted the risk of heterogeneities in the vessel heads

Technical anomaly

Identification of a zone with higher carbon content and lower mechanical properties than expected

Risk of brittle fracture

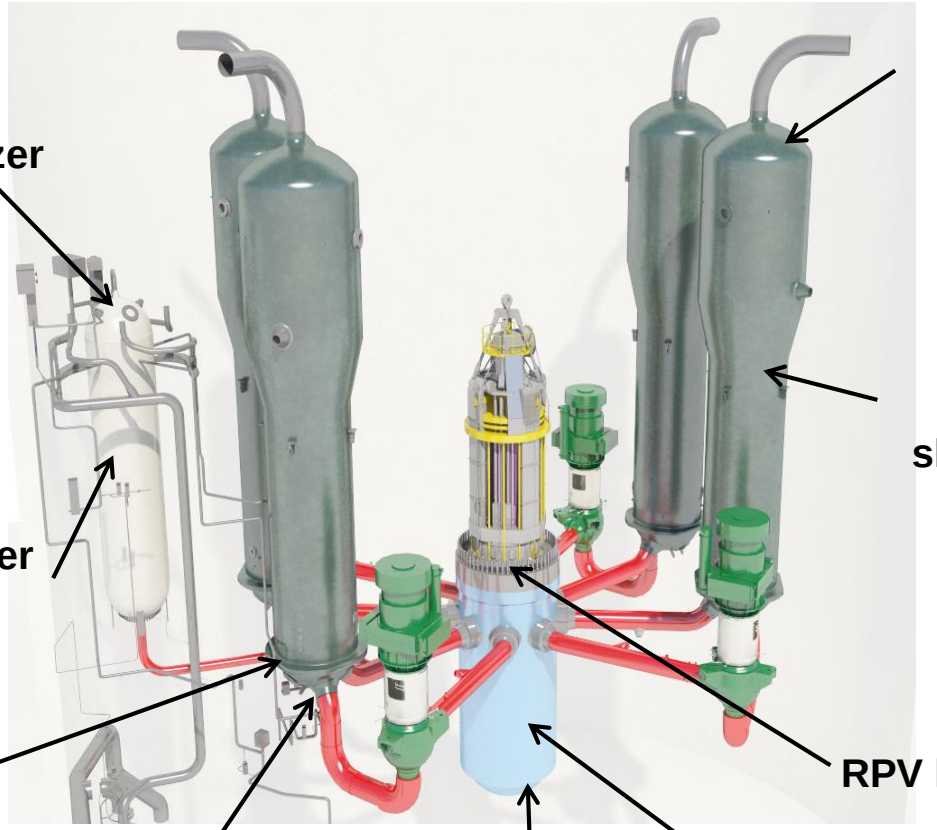
AREVA has to demonstrate the behavior of the vessel heads

- **Demonstration that the thermal-mechanical loads can't initiate the propagation of the biggest potential defect, not detected by NDT**

Background : Technical EPR vessel head anomaly

Flamanville 3 RPV anomalies

Same anomaly in other components ?



Background : Technical EPR vessel head anomaly

Flamanville 3 RPV anomalies

Same anomaly in other components ?

Review identified several SG bottom channel heads (2015)

- Manufactured by **Creusot Forge** and **Japan Casting & Forging Corp.** (18 PWR units in France)
- Charpy V-notch tests results (approximately 30J at 0°C) : no compliance with French regulation on a qualification component

Generic anomaly in the composition of the steel of heavy components **:** a **technical anomaly despite compliance with industrial codes and standards**, highlighted by the French regulation

Potentially international issue

Background : Technical EPR vessel head anomaly

WENRA works on this issue (carbon heterogeneity) in order to consider a potential recommendation

1. **On related safety risks,**
   - **licensees should** be encouraged to **identify the components concerned by carbon positive macro-segregation issue**, among those equipping operating reactors
   - **licensees should** launch Investigations and **corrective actions to demonstrate** that components affected by carbon segregation are **safe** in operation

2. On manufacturing processes, licensees have to **monitor the manufacturing processes** that may cause a carbon segregation concern and therefore affect the mechanical properties of the products, especially the weight and type of ingots, the pouring process, the discard rate, the machining rate and the forging stages

3. On the codes and regulation, action should be taken on current **manufacturing codes or regulation** so that they **prevent** the risks due to residual carbon positive macro-segregation.

Background : Technical EPR vessel head anomaly

Flamanville 3 RPV anomalies

Audit of manufacturing quality in Areva Creusot Forge plant

(2015)

Same anomaly in other components ?

First audit limited in terms of period (between 2010-2014); out of the manufacturing period of FA3 vessel

At end of 2015, ASN requested to extend the period of the audit

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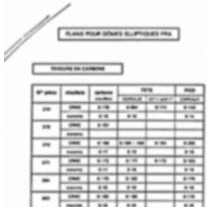
Irregularities and falsifications

- **Areva Creusot Forge (France) – 2016**

  - Irregularities detected concerning manufacturing parameters or test results

87 marked files

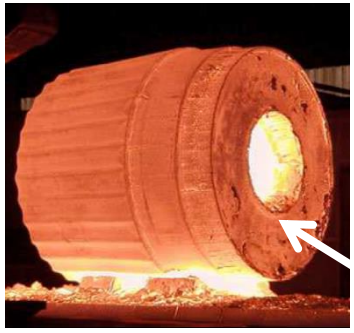
- inconsistencies
- modifications
- omissions in the production files



File archived by Le Creusot ≠ File transmitted to manufacturer, licensee, ASN

Irregularities of about 400 pieces among 10 000, since 1965
(around 100 for French nuclear industry: SG, primary branch, transport packages)

Main safety case for the lower shell of an SG in F



feedhead

CREUSOT FORGE

FICHE INCIDENT QUALITÉ
QUALITY NOTIFICATION

N° d'affaire	Document	Rev.	Page
88571001	FIQ 08 083	1	1/1

Emetteur *Issuing*

56, Rue Clémenceau – 71200 LE CREUSOT – Tél. : +33 3 85 80 73 00 – Fax. : +33 3 85 80 73 38

ORIGINE *Origin* ☐ Fournisseur *Supplier* ☐ Client *Customer*

Client *Customer* : AREVA

Projet *Project*: GV RB III

N° Cde Client *P. Order*: 8857 1001

Matière *Material*: 1.4 MDO

Identification / N° de coulée *Marking / Heat N°*: Z 5433

Désignation, pièce ou sous ensemble *Designation, part or subassembly*: VIROLE basse 335

Détection *detection*: Date : 09/12/2008

☐ Annexes *Annex*

Stade de fabrication *Operation manufacturing stage*: forgeage

Date : 09/12/2008 D1 CARACTERISTIQUE DE L'ECART *Description of the discrepancy*

Impossibilité de couper la chute tête longueur trop juste environ manque environ 400

Critères d'acceptation *Acceptance standard*

☐ SANS FNC *No NCR* D3 TRAITEMENT DE L'ECART / ACTIONS A ENTREPRENDRE *Treatment of the discrepancy / Actions to be performed*

SOLUTIONS / ACTIONS A ENTREPRENDRE *Resolution / Actions to be performed*

Resp. *Person(s) in charge*

- Poursuivre la fabrication
- Prevenir le CA lors du traçage pour déterminer les suites à donner.

S A

Diffusion *Distribution*
☐ AQ
☐ DT / MCQ
☐ CQ
☐ GP
☐ CTRL
☐ PROD

Irregularities and falsifications

New SG in Gravelines – ASN request to check files

- Irregularity discovered in a **unmarked** file
- Changes made to the results of mechanical tests on the upper shell

File archived by Le Creusot ≠ File transmitted to manufacturer, licensee, ASN

File archived by Le Creusot

REPERE	SENS PRELEVEMENT	TEMPE	ENERGIE de RUPTURE (IMPACT ENERGY) JOULES			FIBROSITE DUCTILE	EXPANSION LATERALE laterale
ITEM	ORIENTATION	RATURE °C	IMPOSEE REQUIRED	RESULTATS RESULTS	MOYENNE AVERAGE	FRACTURE VERFORMUNG	expansion seitliche ausdehnung
NR	PROBENLAGE	TEMP	SOLLWERT	ERMITTELT	MITTELWERT	%	mm
Z5887							
VD1	Circonférentiel (Longitudinal)	0°C	≥ 80 Moy.	170	} 159	80	2,2
VD2	"	"	≥ 60 Indi.	139		50	1,8
VD3	"	"	"	167		75	2,1
AD1	Axial (Travers)	0°C	≥ 80 Moy.	42	} 83	5	0,7
AD2	"	"	≥ 60 Indi.	42		5	0,7
AD3	"	"	"	165		70	2,2

File transmitted

REPERE	SENS PRELEVEMENT	TEMPE	ENERGIE de RUPTURE (IMPACT ENERGY) JOULES			FIBROSITE DUCTILE	EXPANSION LATERALE laterale
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VD2	"	"	≥ 60 Indi.	139		50	1.8
VD3	"	"	"	167		75	2.1
AD1	Axial (Travers)	0°C	≥ 80 Moy.	98	} 128	25	1.5
AD2	"	"	≥ 60 Indi.	120		40	1.7
AD3	"	"	"	165		70	2.2

Irregularities and falsifications

2015 :

- Several cases of **nonconformance** in the products manufactured at Le Creusot
- ASN requests **inspections of past manufacturing products**, which exhibit **noncompliant** results

2016 : New inspections launched by AREVA

2017 : **Full examination** decided : 10000 files, 6000 of them in the nuclear field, 150 people dedicated to examinations

April 2016

Discovery of « marked files »

July 2016

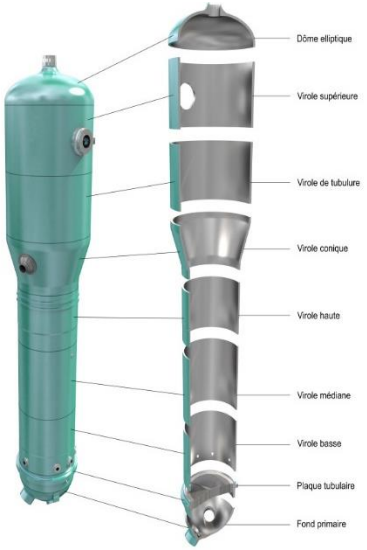
Discovery of irregularities in « unmarked files »

From September 2016

Full examination process

Irregularities and falsifications

Meanwhile, other CSFI cases

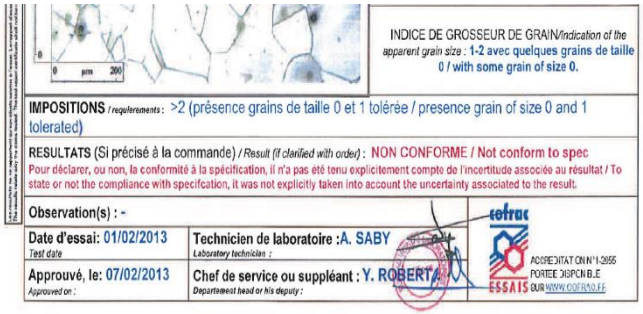


➢ Westinghouse - Mangiarotti (Italy) – November 2015

- Manufacture of heavy components (steam generators for EDF, AP1000…):
  - Concealment of the absence of the heat treatment on a gage block and attempt to transmit a falsified certificate on this block

➢ SBS Forge (France) – November 2015

- Forge specialized in ring rolling products: Metallurgical reports had been falsified


INDICE DE GROSSEUR DE GRAIN/*Indication of the apparent grain size* : 1-2 avec quelques grains de taille 0 / with some grain of size 0.

IMPOSITIONS /*requirements* : >2 (présence grains de taille 0 et 1 tolérée / presence grain of size 0 and 1 tolerated)

RESULTATS (Si précisé à la commande) / *Result (if clarified with order)* : NON CONFORME / Not conform to spec

Pour déclarer, ou non, la conformité à la spécification, il n'a pas été tenu explicitement compte de l'incertitude associée au résultat / To state or not the compliance with specifcation, it was not explicitly taken into account the uncertainty associated to the result.

Observation(s) : -

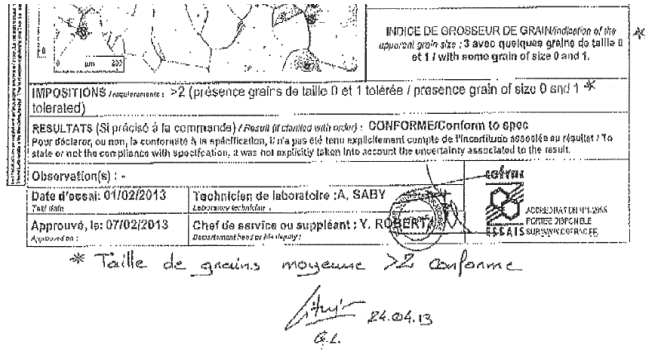
Date d'essai: 01/02/2013 *Test date*

Technicien de laboratoire :A. SABY *Laboratory technician :*

Approuvé, le: 07/02/2013 *Approved on :*

Chef de service ou suppléant : Y. ROBERT *Department head or his deputy :*

cofrac ACCREDITATION N°1-2955 PORTEE DISPONIBLE ESSAIS SUR WWW.COFRAC.FR


INDICE DE GROSSEUR DE GRAIN/*Indication of the apparent grain size* : 3 avec quelques grains de taille 0 et 1 / with some grain of size 0 and 1. *

IMPOSITIONS /*requirements* : >2 (présence grains de taille 0 et 1 tolérée / presence grain of size 0 and 1 * tolerated)

RESULTATS (Si précisé à la commande) / *Result (if clarified with order)* : CONFORME/Conform to spec

Pour déclarer, ou non, la conformité à la spécification, il n'a pas été tenu explicitement compte de l'incertitude associée au résultat / To state or not the compliance with specifcation, it was not explicitly taken into account the uncertainty associated to the result.

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* Taille de grains moyenne >2 conforme

24.04.13

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3. **What kind of improvements with regard to CSFI?**

What kind of improvements with regard to CSFI?

Findings

CSFI as well observed abroad

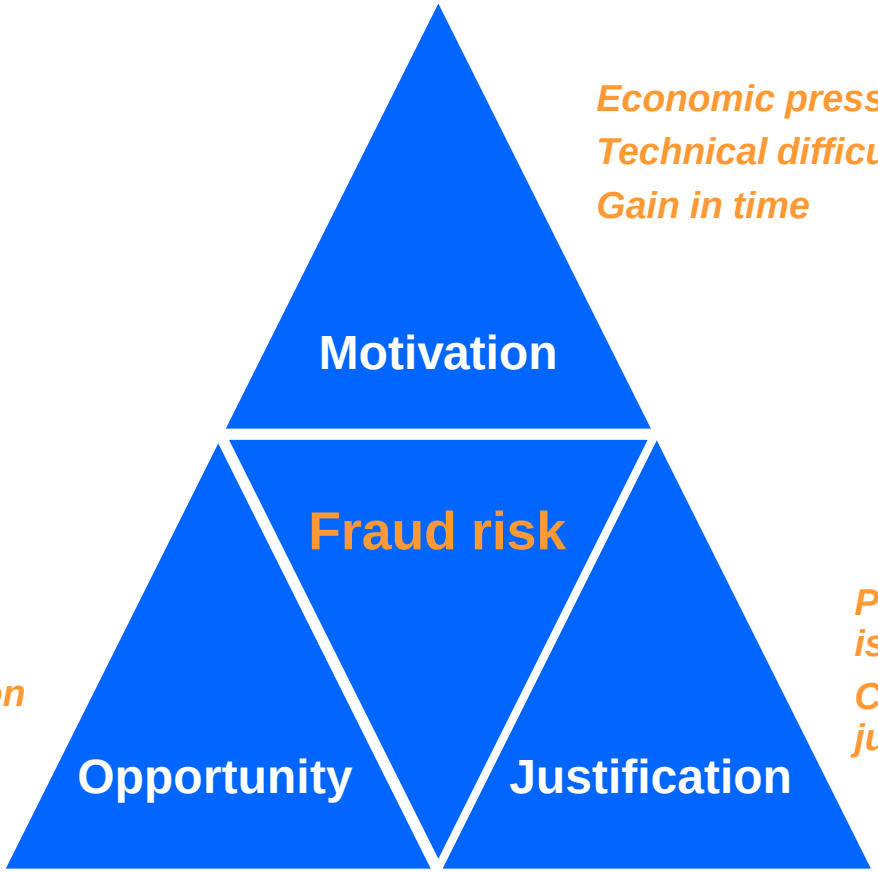
Controls based on trust and openness put into question

In 2015 and 2016, falsifications especially in pressure equipments

- Need to adapt the **oversight processes** (internal and external)
- Need for an analysis of the **reasons for irregularities** in order to **adapt the monitoring system**

What kind of improvements with regard to CSFI?

Analysis of the reasons for irregularities system



Economic pressure
Technical difficulties
Gain in time

Ineffective controls
Inappropriate organization
Handwriting documents

Poor appraisal of safety issues and requirements
Culture of deviation justifications

Dr Donald R. Cressey – Triangle fraud (1950)

➡ Actions to adapt the monitoring system

What kind of improvements with regard to CSFI?

Information and notification

- Protection of whistle-blowers
- Encouraging the information to Regulatory bodies when knowing case of falsification
- Systematic analysis of alerts

Controls and tests

- Promoting automatic data transmission to foster integrity
- Increasing the controls and tests monitoring by agreed third party
- Requiring independent tests on samples coming from the manufacturer

Oversight and Inspections

- Suppliers inspections (whatever the level, abroad)
- Methodology to identify sensitive suppliers
- Making inspectors aware of the risk of fraud

Applicable to all actors (suppliers, customers, licensees, safety authorities)