



Sizewell Site Stakeholder Group Meeting

Creusot Forge Anomalies

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Creusot Forge France

Long established manufacturer of heavy steel forgings

Plant located in the town of Le Creusot central-eastern France

Currently owned by the AREVA group but previously part of Creusot-Loire Industries

Identified concerns:

Pre 2016 Sizewell B reactor outage 14:

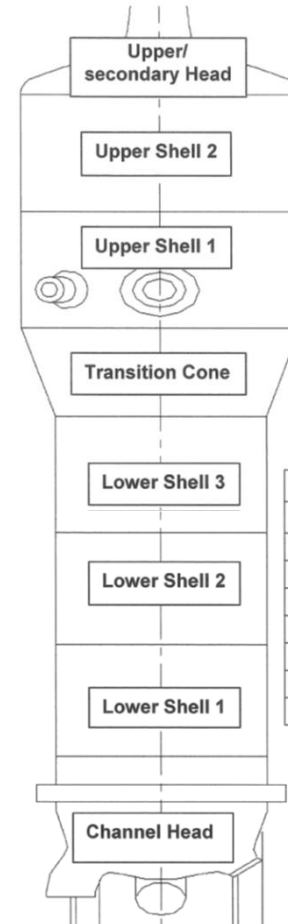
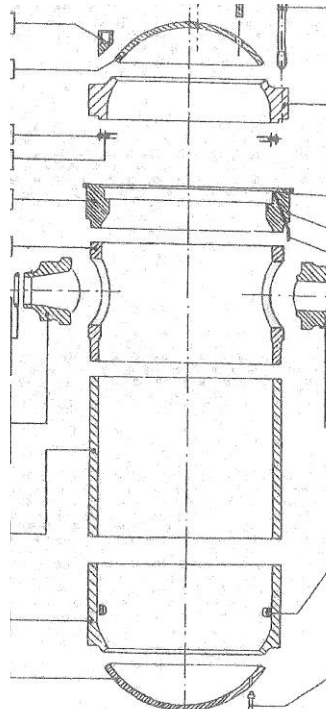
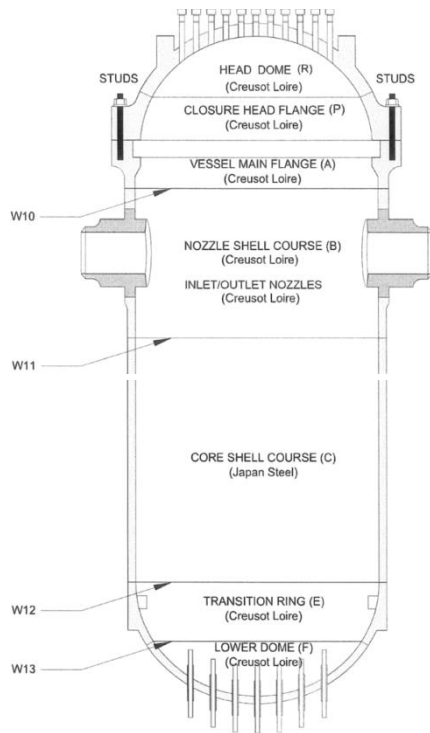
- Flamanville 3 Reactor Pressure Vessel domes (Early 2015)
- Historical production monitoring anomalies (April 2016)

Post 2016 Sizewell B outage developments – see later slides

Forgings supplied by Creusot Forge for the Sizewell B project

- Reactor Pressure Vessel (6 main forgings plus 8 smaller forgings)
 - Lower Dome
 - Transition Ring
 - Nozzle Shell Course (plus 8 inlet/outlet nozzles)
 - Vessel Main Flange
 - Closure Head Flange
 - Head Dome
- Steam Generators (2 forgings per vessel, so 8 forgings in total)
 - Upper Shell 1
 - Upper Shell 2
- 22 Forgings

Reactor Pressure vessel and Steam Generator Forgings



| Component | Forging Manufacturer |
|-----------------|----------------------------------|
| UPPER HEAD | Japan Steel Works, Muroran Plant |
| UPPER SHELL 2 | Creusot-Loire, France |
| UPPER SHELL 1 | Creusot-Loire, France |
| TRANSITION CONE | Japan Steel Works, Muroran Plant |
| LOWER SHELL 3 | KSC, Mizushima, Japan |
| LOWER SHELL 2 | KSC, Mizushima, Japan |
| LOWER SHELL 1 | KSC, Mizushima, Japan |
| CHANNEL HEAD | Japan Steel Works, Muroran Plant |

Flamanville 3 Domes - Sizewell Response

- Early 2015 - Flamanville 3 reactor pressure vessel top and bottom domes manufactured at the Creusot Forge works
 - Carbon segregation, high carbon levels – reduced mechanical properties
 - Conventionally cast ingots insufficiently large
- March 2015 - ONR seeks assurance from EdF Energy NGL regarding implications for Sizewell B (SZB)
 - Different manufacturing process for SZB – directional solidification cast ingots (LSD) - carbon segregation well controlled
 - Reports received and accepted
- **Technical problem with the manufacturing process for the ingots which does not apply to Sizewell B**

Historical Production Monitoring Anomalies Sizewell Response - May 2016

- April 2016 – ASN and AREVA issue press releases on historical production monitoring anomalies at the Creusot Forge works
- **Quality Control/Quality Assurance problem**
- Sizewell B response – RO14 outage May 2016
 - 22 forgings supplied by the Creusot Forge works for the Sizewell B (SZB) project
 - ONR seek assurance on whether SZB supplied components are affected
 - ONR sample lifetime records held by EdF Energy on these forgings
 - Unrelated but extensive in-service inspection work undertaken as part of 10 year outage shows no problems
- **ONR has confidence in the quality of the forgings and allows SZB to return to service**

Post Outage response – June/July 2016

- EdF Energy (EdFE) send team to Creusot Forge Works to review manufacturing records held there – none were identified as having an anomaly, but EdFE wanted to review records in any case
- Two one week visits with a team of 4 specialists
- ONR attended on second week to observe the EdFE audit process and samples files itself
- EdFE audit process thorough and comprehensive – files for all SZB forgings reviewed by EdFE
- No systematic failings found in the files and they support ongoing integrity of forgings

Creusot Forge Findings

- Five findings brought back for further review and consideration
- One of the findings of interest – carbon content value test value exceeded manufacturing specification but was recorded in lifetime record as having met the specification – an **‘anomaly’** in a non-marked file
- Carbon value does still meet ASME III (American Society of Mechanical Engineers Boiler and Pressure Vessel Section III) design code specification
- Mechanical properties not affected – strength/toughness/ductility
- Weldability not affected
- Not considered to pose a threat to the integrity of the forging
- Safety case to be updated to reflect these findings

Creusot Forge – ONR Conclusions

- EdFE Audit process thorough and comprehensive – all SZB forging files reviewed by EdFE
- No systematic failings in files and they support ongoing integrity of forgings
- On the carbon content anomaly –
 - ONR cannot exclude the possibility that this was a false recording
 - Carbon value is still within design code specification
 - ONR does not believe that the higher carbon value poses a threat to the integrity of the forging based on good mechanical test results and weld inspection
- ONR considers it prudent to ask for further investigation by EdF Energy also
- EdF Energy asked to review the position on the other main forgings supplied for Sizewell B project in terms of reviewing manufacturing processes and manufacturing records

Further experience in France

Developments post SZB 2016 outage:

- Steam Generator Channel Heads (June 2016)
 - High carbon levels
 - Manufactured at Creusot Forge and at Japan Forging and Casting Corporation
 - Technical problem with the manufacturing process used to cast the ingots

Sizewell B Channel Heads were manufactured at the Japan Steel Works using proven techniques

Further experience continued

- Fessenheim 2 Steam Generator Shell (July 2016)
 - High carbon levels
 - ‘Discard ratio’ too low
 - **Quality Control/Quality assurance problem**

Sizewell B shell forging properties checked at the top and bottom of each forging

- ASN indicate that a review of **all** production monitoring files at Creusot Forge will now be required (October 2016)

All production monitoring files for forgings supplied for Sizewell B have now been reviewed

In conclusion

- ONR has taken steps to identify whether the problems identified in France affect the forgings supplied by Creusot Forge for the Sizewell B project
- Different production methods used in some circumstances
- All Creusot Forge production files now checked for anomalies
 - No systematic failings found
 - One carbon value found to be higher than anticipated, but still within the design code and mechanical properties not affected
- **ONR remain satisfied with the quality of the forgings supplied for Sizewell B**
- ONR judge that the anomalies identified **do not** affect the continued safe operation of Sizewell B
- ONR will continue to monitor developments and cooperate with other international regulators including ASN

In conclusion

- ONR has placed documentation related to this on its website in June 2016 in support of the return to service of Sizewell B
- <http://news.onr.org.uk/2016/06/onr-permission-for-sizewell-b-return-to-service/>
- ONR will place further documentation in relation to the further developments on its website early in 2017