

**Poole, Justin**

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**From:** Briegleb Pierre [pierre.briegleb@belv.be]  
**Sent:** Wednesday, July 25, 2012 3:40 AM  
**To:** Sebastien.CROMBEZ@asn.fr; CRESPO BRAVO JULIO; Hardies, Robert; Collins, Jay; Kirk, Mark; petteri.tiippana@stuk.fi; dietmar.Kalkhof@ensi.ch; kees.desbouvrie@minvrom.nl  
**Cc:** De Boeck Benoit; Barras Pierre; Hoebeeck Simon; Fonkwa Christelle; Deledicque Vincent; SCHRAUBEN Manfred; WERTELAERS An; VAN WONTERGHEM Frederik; TOMBUYSES Beatrice; aweyn@vincotte.be  
**Subject:** Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

Dear Sirs,

We are now facing in Belgium a potential problem on the reactor pressure vessel (RPV) of the Doel 3 NPP. Non-destructive examination revealed a lot of "indications" that need to be confirmed by another inspection technique (ongoing).

We would like to have your feedback, experience and advice regarding this potential problem. You will find hereunder a more comprehensive background and some questions we would like to answer.

Best regards,

Pierre Briegleb  
National Project Coordinator  
Bel V – Subsidiary of the Federal Agency for Nuclear Control (Belgium)

#### Potential problem on the reactor pressure vessel

Belgian pressure vessels are inspected according to ASME XI. Volumetric inspections of the beltline zone are normally limited to the circumferential welds and surrounding heat affected zone and base material, within the limits settled by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified method and encompass the whole height of the vessel beltline region. This means that we inspect clad base material in zones where no volumetric in-service inspection was performed up to now.

At Doel 3, according to the Owner, no underclad defects were detected.

Nevertheless, lot of defect indications of an apparently different type were detected by this UT-inspection aiming at detecting underclad defects, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be laminar flaws, more or less parallel to the inner/outer surface of the pressure vessel, located in- and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

The inspection method which revealed the presence of those defects has been qualified for detecting underclad defect.

An inspection of the whole height with the qualified method used to control the beltline welds started on the 16<sup>th</sup> of July; the results should not be available before begin of August. Similar inspections will be performed at Tihange 2 during the month of August.

In the absence of any other explanation at this stage, the Owner supposes to be in presence of fabrication defects.

The Doel 3 and Tihange 2 RPVs were forged by Rotterdam Dockyards (RDM), which according to the Owner provided some 24 vessels in Europe and the US. NUREG 1511 – Suppl. 2, p. 7-3, identifies 8 US units with RDM forged rings. Other European countries possibly concerned are Spain, Switzerland, the Netherlands (Borssele, Dodewaard), and probably others, not identified by Bel V at this stage.

Some questions:

1. Are there in your country RPVs (forged rings) fabricated by Rotterdam Dockyards (RDM)?
2. Is there any known concern with respect to fabrication defects in those rings?
3. Did you perform volumetric inspections in the beltline region which could have detected laminar defects in the beltline base material (a) during fabrication (b) in-service? If the answer is yes, describe which inspection (type, extent, frequency) and the corresponding results.
4. Do you perform inspections aiming at detecting underclad defects? If so, describe which inspection (type, extent, frequency) and the corresponding results.

## **Flaws indications in the reactor pressure vessel**

### **Background**

Belgian reactor pressure vessels (RPV) are inspected according to ASME XI. Volumetric inspections of the beltline area are normally limited to the circumferential welds (there are no axial welds in the Belgian RPVs) and surrounding heat affected zone and base material, within the limits set by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified UT-method for detection of underclad defects, and encompass the height of the vessel beltline region. This means that clad base material was inspected where no volumetric in-service inspection was performed up to now.

### **Results of the inspection performed**

At Doel 3, no underclad defects were detected.

Nevertheless, defect indications of an apparently different type were detected by this UT-inspection, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel, located in and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

### **Current investigations**

In the absence of any other explanation at this stage, the Owner supposes the presence of fabrication defects.

Considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV. Results will not be available before beginning of august.

The Owner is currently investigating the inspection results.

In parallel additional studies are being performed to analyze and, if possible, to validate and confirm the structural integrity of the vessel.

Similar inspections will be performed at another Belgian reactor vessel (unit 2Tihange NPP) during the upcoming outage within a few weeks (see hereunder).

### **Further information**

Upper and lower vessel rings of the Doel 3 and Tihange 2 RPVs were forged by the Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM), at the same time and under the same contract.

**From:** Benson, Michael  
**To:** [Kirk, Mark](#); [Stevens, Gary](#)  
**Subject:** RE: RG 1.161 PVP Paper  
**Date:** Monday, July 30, 2012 9:16:00 AM

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Not to mention all the other conservatism built into the method...

**From:** Kirk, Mark  
**Sent:** Monday, July 30, 2012 9:08 AM  
**To:** Benson, Michael; Stevens, Gary  
**Subject:** RE: RG 1.161 PVP Paper

My understanding of the German view is that not "crediting" either crack stability (for ductile fracture issues) or crack arrest (for brittle fracture issues) is taken as an implicit conservatism (a.k.a. it makes them feel better). Oftentimes the degree of extra protection by dis-allowing crack arrest / ductile tearing is small, making the better feeling purely illusory ... but we humans (Germanic and otherwise) are masters at deceiving ourselves.

I know that this took a cynical term, but it is also correct, I believe



**From:** Benson, Michael  
**Sent:** Monday, July 30, 2012 6:56 AM  
**To:** Stevens, Gary; Kirk, Mark  
**Subject:** RE: RG 1.161 PVP Paper

Just as a practical matter, the initiation criterion dominates the stability criterion. But, that's interesting. I would like to hear why the Germans object to the stability criterion.

**From:** Stevens, Gary  
**Sent:** Wednesday, July 25, 2012 5:27 PM  
**To:** Benson, Michael; Kirk, Mark  
**Subject:** RG 1.161 PVP Paper

I talked to Cipolla today and he gave me a brief report on the presentation of this paper at PVP. There were a few minor questions, but he got some pushback on the tearing instability concept of the RG from the Germans. This is an old argument, as they have never allowed the use of this method in Germany. It ended with "we agree to disagree." Otherwise, an uneventful presentation.

Also, Russ owes Hardin a call-back from a few weeks ago – Hardin contacted him to try and escalate this issue since this is a proposed topic for an NRC/EPRI MOU Addendum.

Gary L. Stevens  
Senior Materials Engineer  
NRC/RES/DE/CIB  
 [Gary.Stevens@nrc.gov](mailto:Gary.Stevens@nrc.gov)  
 301-251-7569

B/48



Poehler, Jeffrey

**From:** Roquecruz, Carla  
**Sent:** Friday, August 03, 2012 11:44 AM  
**To:** Poehler, Jeffrey  
**Cc:** Rosenberg, Stacey  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel  
**Attachments:** FANC\_LOGO.gif; Doel 3 - RPV preliminary IRS report\_final.docx; Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP  
**Importance:** High

Jeff,  
FYI...

**From:** Hopkins, Jon  
**Sent:** Friday, August 03, 2012 9:34 AM  
**To:** Fairbanks, Carolyn; Hardies, Robert  
**Cc:** Roquecruz, Carla; Hiland, Patrick; Chernoff, Harold; Cheok, Michael; McGinty, Tim; Muessele, Mary; Bahadur, Sher; Regan, Christopher; Astwood, Heather; Rodriguez, Veronica; Tehrani, Navid; Sangimino, Donna-Marie; Dehn, Jeff; Fehst, Geraldine; Nieh, Ho; Lubinski, John; Stahl, Eric  
**Subject:** REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel  
**Importance:** High

Carolyn & Bob,

Belgium's regulator, FANC, has invited nuclear regulators from the 7 countries that also have RPVs manufactured by RDM (list below, includes U.S.) to participate in a technical working meeting on Aug. 16 in Brussels to discuss recent UT inspection indications found on the Doel 3 RPV.

France's regulator, ASN, has already responded and said that they would attend ("ASN will participate to this meeting. The representatives will be: Sébastien CROMBEZ Director of the Nuclear pressure Equipment Department and Jean-Luc LACHAUME Deputy Director General.")

Please let me know if we should/can attend this meeting. Note that FANC plans another meeting in Sept. on this issue.

Thank you, Jon

**From:** VAN WONTERGHEM Frederik [mailto:Frederik.VANWONTERGHEM@FANC.FGOV.BE]  
**Sent:** Friday, August 03, 2012 5:05 AM  
**To:** Andre-claude.lacoste@asn.fr; jean-luc.lachaume@asn.fr; francois.balestreri@irsn.fr; Sebastien.CROMBEZ@asn.fr; info@arn.gob.ar; gerald.hennenhoefler@bmu.bund.de; martina.palm@bmu.bund.de; Ulrich.Erven@grs.de; Carla.Schwaeger@grs.de; a.vanlimborgh@mineleni.nl; kees.desbouvrie@minvrom.nl; bert.verweij@minvrom.nl; Roeland.Nieuweboer@minvrom.nl; cmt@csn.es; fjarana@mityc.es; jcb@csn.es; ann-louise.eksborg@ssm.se; Anders.Hallman@ssm.se; Lars.Skanberg@ssm.se; perolof.hagg@ssm.se; petteri.tiippana@stuk.fi; hans.wanner@ensi.ch; georg.schwarz@ensi.ch; markus.straub@ensi.ch; dietmar.Kalkhof@ensi.ch; Hopkins, Jon; Kirk, Mark; Hardies, Robert; Collins, Jay  
**Cc:** WERTELAERS An; SCHRAUBEN Manfred; DE ROOVERE Willy; TOMBUYES Beatrice; pierre.barras@belv.be; pierre.briegleb@belv.be; benoit.deboeck@belv.be; aweyn@vincotte.be; hvandriessche@vincotte.be  
**Subject:** URGENT Message on Nuclear Safety: Flaw indications in Doel 3 Reactor Pressure Vessel

Dear all,

This week, a preliminary IRS Incident Report was published by Belgium related to the detection of a large number of flaw indications in the reactor pressure vessel of Doel 3 (PWR - Framatome Design). (Reference IRS Number 8244: "FLAWS INDICATIONS IN THE REACTOR PRESSURE VESSEL"). In attachment you can find a copy of this IRS report.

As indicated in the IRS report, the Doel 3 NPP outage has been extended to allow further inspections and to perform additional studies by the licensee to analyze and, if possible, to validate and confirm the structural integrity of the vessel. At the moment, the licensee supposes that the flaw indications were already present at the moment of forging of the vessel, which was done by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). Both a deterministic approach (in accordance with ASME XI Appendix A) and a probabilistic approach (in accordance with 10CFR50.61a) are being considered by the licensee to justify the structural integrity of the reactor vessel.

Some additional information on the types of flaw indications and other possible reactor vessels forged by this company can be found below.

Considering the potential consequences of this event, the Belgian regulatory body would like to organise on short notice a technical working meeting in Brussels on this issue for those regulatory bodies which could be interested by these findings, specifically those regulatory bodies of countries where RPVs forged by RDM can be present. During this technical working meeting, additional information on the results found at Doel 3 NPP and the on-going licensee investigations and calculations will be made available by the Belgian regulatory body (FANC, its technical support organisation Bel V and the Authorized Inspection Authority AIB Vinçotte International). In addition, a roundtable discussion between regulatory bodies will be held to discuss relevant experiences with this kind of inspections and flaw indications. Specific topics/questions to be discussed during this roundtable discussion are mentioned in an email by Bel V which was sent last week (see attachment). We are especially interested to know if this type of ISI was already performed in your countries on the reactor vessels forged by this company, and if so, what the results have been. May we kindly invite every country to present additional available input and thoughts to our working meeting .

**This technical working meeting shall take place in Brussels (FANC offices, Ravensteinstraat 36, 1000 Brussels) on Thursday 16 August between 10h00 and 16h00.**

We would be very grateful if one or more technical experts of your organisation could be present during this working meeting.

To confirm your participation, please send me a reply by email to [frederik.vanwonderghem@fanc.fgov.be](mailto:frederik.vanwonderghem@fanc.fgov.be) (tel. ++32 2 289 2082) before Friday 10 August.

If you have further technical questions on this event, you can contact [pierre.briegleb@belv.be](mailto:pierre.briegleb@belv.be) (tel ++32 2 528 0245).

A second technical working meeting could be held in the near future (presumably early September) to discuss the available results of the additional inspections at Tihange 2 and the results of the licensee investigations and calculations aiming to confirm the structural integrity of the reactor vessel. Further actions in your countries can also be discussed during this second meeting. We will inform you as soon as possible of the timing of this second working meeting.

Best regards,

Frederik Van Wonderghem

Department of Nuclear Facilities and Waste  
Federal Agency for Nuclear Control  
Ravensteinstraat 36, 1000 Brussel, Belgium  
[www.fanc.fgov.be](http://www.fanc.fgov.be)  
Tel.: +32 (0)2 289 20 82  
Fax: +32 (0)2 289 21 12

**Additional information on the types of flaw indications and other possible reactor vessels**

Preliminary results from additional inspections



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**Hardies, Robert**

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**From:** Kirk, Mark  
**Sent:** Friday, August 03, 2012 9:35 AM  
**To:** Case, Michael; Tregoning, Robert; Richards, Stuart; Stevens, Gary; Csontos, Aladar; Hardies, Robert; Hiland, Patrick; Cheok, Michael  
**Subject:** FW: URGENT Message on Nuclear Safety: Flaw indications in Doel 3 Reactor Pressure Vessel  
**Attachments:** FANC\_LOGO.gif; Doel 3 - RPV preliminary IRS report\_final.docx; Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

Colleagues -

Here is the e-mail i received today from Belgium.

Best

mark

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From: VAN WONTERGHEM Frederik [Frederik.VANWONTERGHEM@FANC.FGOV.BE]  
Sent: Friday, August 03, 2012 5:04 AM  
To: Andre-claude.lacoste@asn.fr; jean-luc.lachaume@asn.fr; francois.balestreri@irsn.fr; Sebastien.CROMBEZ@asn.fr; info@arn.gob.ar; gerald.hennenhoefler@bmu.bund.de; martina.palm@bmu.bund.de; Ulrich.Erven@grs.de; Carla.Schwaeger@grs.de; a.vanlimborgh@mineleni.nl; kees.desbouvrie@minvrom.nl; bert.verweij@minvrom.nl; Roeland.Nieuweboer@minvrom.nl; cmt@csn.es; fjarana@mityc.es; jcb@csn.es; ann-louise.eksborg@ssm.se; Anders.Hallman@ssm.se; Lars.Skanberg@ssm.se; perolof.hagg@ssm.se; petteri.tiippana@stuk.fi; hans.wanner@ensi.ch; georg.schwarz@ensi.ch; markus.straub@ensi.ch; dietmar.Kalkhof@ensi.ch; Hopkins, Jon; Kirk, Mark; Hardies, Robert; Collins, Jay  
Cc: WERTELAERS An; SCHRAUBEN Manfred; DE ROOVERE Willy; TOMBUYES Beatrice; pierre.barras@belv.be; pierre.briegleb@belv.be; benoit.deboeck@belv.be; aweyn@vincotte.be; hvandriessche@vincotte.be  
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As indicated in the IRS report, the Doel 3 NPP outage has been extended to allow further inspections and to perform additional studies by the licensee to analyze and, if possible, to validate and confirm the structural integrity of the vessel. At the moment, the licensee supposes that the flaw indications were already present at the moment of forging of the vessel, which was done by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). Both a deterministic approach (in accordance with ASME XI Appendix A) and a probabilistic approach (in accordance with 10CFR50.61a) are being considered by the licensee to justify the structural integrity of the reactor vessel.

Some additional information on the types of flaw indications and other possible reactor vessels forged by this company can be found below.

Considering the potential consequences of this event, the Belgian regulatory body would like to organise on short notice a technical working meeting in Brussels on this issue for those regulatory bodies which could be interested by these findings, specifically those regulatory bodies of countries where RPVs forged by RDM can be present.

During this technical working meeting, additional information on the results found at Doel 3 NPP and the on-going licensee investigations and calculations will be made available by the Belgian regulatory body (FANC, its technical support organisation Bel V and the Authorized Inspection Authority AIB Vinçotte International). In addition, a roundtable discussion between regulatory bodies will be held to discuss relevant experiences with this kind of inspections and flaw indications. Specific topics/questions to be discussed during this roundtable discussion are mentioned in an email by Bel V which was sent last week (see attachment). We are especially interested to know if this type of ISI was already performed in your countries on the reactor vessels forged by this company, and if so, what the results have been. May we kindly invite every country to present additional available input and thoughts to our working meeting .

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Fax: +32 (0)2 289 21 12

Additional information on the types of flaw indications and other possible reactor vessels

- Preliminary results from additional inspections

- o As described in the IRS message, considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV of Doel 3.

- o The preliminary results from those additional inspections confirm the presence of several thousand (up to 10000) flaw indications in the reactor vessel base material. These flaw indications seem to be laminar in shape and have average diameters of 25 mm.

- Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.

o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

COUNTRY

PLANT

TYPE

LOOPS

Mwe (net-1)

START (cr-1)

DESIGN

ARGENTINA

Atucha 1

PHWR

335

1980

Siemens

BELGIUM

Doel 3

PWR

3

1000

1982

Framatome

Tihange 2

PWR

3

1000

1982

Framatome

GERMANY

Brünsbittel

BWR

-

770

1977

KWU

Philippsburg 1

BWR

890

1980

KWU

NETHERLANDS

Dodewaard

BWR

-

52

1968

RDM

Borssele

PWR

2

515

1973

KWU

SPAIN

Sta Maria de Garona

BWR

450

1971

General Electric

Cofrentes

BWR

-

1064

1984

General Electric

SWEDEN

Ringhals 2

PWR

3

813

1974

Westinghouse

SWITZERLAND

Leibstadt

BWR

-

1165



1984

General Electric

Mühleberg

BWR

-

373

1971

General Electric

USA

Catawba 1

PWR

4

1129

1985

Westinghouse

McGuire 2

PWR

4

1100

1983

Westinghouse

North Anna 1

PWR

3

903

1978

Westinghouse

North Anna 2

PWR

3

973

1980

Westinghouse

Quad Cities 1

BWR

-

882

1972

General Electric

Sequoyah 1

PWR

4

1162

1980

Westinghouse

Sequoyah 2

PWR

4

1126

1981

Westinghouse

Surry 1

PWR

3

839

1972

Westinghouse

Surry 2

PWR

3

800

1973

Westinghouse

Watts Bar 1

PWR

4

1123

1996

Westinghouse

<<http://fanc.fgov.be/>>[cid:ExclaimerBodyPart0@Exclaimer.net]

Het FANC is ISO 9001:2008 gecertificeerd – L'AFCN est certifiée ISO 9001:2008.

Aub, denk aan het milieu voordat u deze mail uitprint.

Svp, pensez à notre environnement avant d'imprimer ce mail.

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(NI)<<http://www.fanc.fgov.be/nl/page/disclaimer/1165.aspx>>

**From:** Collins, Jay *MLK*  
**Sent:** Friday, August 03, 2012 2:11 PM  
**To:** Lupold, Timothy  
**Subject:** FW: URGENT Message on Nuclear Safety: Flaw indications in Doel 3 Reactor Pressure Vessel  
**Attachments:** FANC\_LOGO.gif; Doel 3 - RPV preliminary IRS report\_final.docx; Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

fyi, if you did not see this already

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**From:** VAN WONTERGHEM Frederik [Frederik.VANWONTERGHEM@FANC.FGOV.BE]  
**Sent:** Friday, August 03, 2012 5:04 AM  
**To:** Andre-claude.lacoste@asn.fr; jean-luc.lachaume@asn.fr; francois.balestreri@irsn.fr; Sebastien.CROMBEZ@asn.fr; info@arn.gob.ar; gerald.hennenhoefer@bmu.bund.de; martina.palm@bmu.bund.de; Ulrich.Erven@grs.de; Carla.Schwaeger@grs.de; a.vanlimborgh@mineleni.nl; kees.desbouvrie@minvrom.nl; bert.verweij@minvrom.nl; Roeland.Nieuweboer@minvrom.nl; cmt@csn.es; fjarana@mityc.es; jcb@csn.es; ann-louise.eksborg@ssm.se; Anders.Hallman@ssm.se; Lars.Skanberg@ssm.se; perolof.hagg@ssm.se; petteri.tiippana@stuk.fi; hans.wanner@ensi.ch; georg.schwarz@ensi.ch; markus.straub@ensi.ch; dietmar.Kalkhof@ensi.ch; Hopkins, Jon; Kirk, Mark; Hardies, Robert; Collins, Jay  
**Cc:** WERTELAERS An; SCHRAUBEN Manfred; DE ROOVERE Willy; TOMBUYES Beatrice; pierre.barras@belv.be; pierre.briegleb@belv.be; benoit.deboeck@belv.be; aweyn@vincotte.be; hvandriessche@vincotte.be  
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Frederik Van Wonderghem

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Tel.: +32 (0)2 289 20 82  
Fax: +32 (0)2 289 21 12

Additional information on the types of flaw indications and other possible reactor vessels

- Preliminary results from additional inspections

o As described in the IRS message, considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV of Doel 3.

o The preliminary results from those additional inspections confirm the presence of several thousand (up to 10000) flaw indications in the reactor vessel base material. These flaw indications seem to be laminar in shape and have average diameters of 25 mm.

- Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.

o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

COUNTRY

PLANT

TYPE

LOOPS

Mwe (net-1)

START (cr-1)

DESIGN

ARGENTINA

Atucha 1

PHWR

335

1980

Siemens

BELGIUM

Doel 3

PWR

3

1000

1982

Framatome

Tihange 2

PWR

3

1000

1982

Framatome

GERMANY

Brünsbittel

BWR

-

770

1977

KWU

Philippsburg 1

BWR

890

1980

KWU

NETHERLANDS

Dodewaard

BWR

-

52

1968

RDM

Borssele

PWR

2

515

1973

KWU

SPAIN

Sta Maria de Garona

BWR

450

1971

General Electric

Cofrentes

BWR

-

1064

1984

General Electric

SWEDEN

Ringhals 2

PWR

3

813

1974

Westinghouse

SWITZERLAND

Leibstadt

BWR

-

1165

1984

General Electric

Mühleberg

BWR



373

1971

General Electric

USA

Catawba 1

PWR

4

1129

1985

Westinghouse

McGuire 2

PWR

4

1100

1983

Westinghouse

North Anna 1

PWR

3

903

1978

Westinghouse

North Anna 2

PWR

3

973

1980

Westinghouse

Quad Cities 1

BWR

-

882

1972

General Electric

Sequoyah 1

PWR

4

1162

1980

Westinghouse

Sequoyah 2

PWR

4

1126

1981

Westinghouse

Surry 1

PWR

3

839

1972

Westinghouse

Surry 2

PWR

3

800

1973

Westinghouse

Watts Bar 1

PWR

4

1123

1996

Westinghouse

<<http://fanc.fgov.be/>>[cid:ExclaimerBodyPart0@Exclaimer.net]

Het FANC is ISO 9001:2008 gecertificeerd - L'AFCN est certifiée ISO 9001:2008.

Aub, denk aan het milieu voordat u deze mail uitprint.

Svp, pensez à notre environnement avant d'imprimer ce mail.

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(Nl)<<http://www.fanc.fgov.be/nl/page/disclaimer/1165.aspx>>

# FANC AFCN

Handbook of Financial Control Software Control  
Handbook of Financial Control Software Control

## **Flaws indications in the reactor pressure vessel**

### **Background**

Belgian reactor pressure vessels (RPV) are inspected according to ASME XI. Volumetric inspections of the beltline area are normally limited to the circumferential welds (there are no axial welds in the Belgian RPVs) and surrounding heat affected zone and base material, within the limits set by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified UT-method for detection of underclad defects, and encompass the height of the vessel beltline region. This means that clad base material was inspected where no volumetric in-service inspection was performed up to now.

### **Results of the inspection performed**

At Doel 3, no underclad defects were detected.

Nevertheless, defect indications of an apparently different type were detected by this UT-inspection, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel, located in and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

### **Current investigations**

In the absence of any other explanation at this stage, the Owner supposes the presence of fabrication defects.

Considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV. Results will not be available before beginning of august.

The Owner is currently investigating the inspection results.

In parallel additional studies are being performed to analyze and, if possible, to validate and confirm the structural integrity of the vessel.

Similar inspections will be performed at another Belgian reactor vessel (unit 2 Tihange NPP) during the upcoming outage within a few weeks (see hereunder).

### **Further information**

Upper and lower vessel rings of the Doel 3 and Tihange 2 RPVs were forged by the Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM), at the same time and under the same contract.

Poehler, Jeffrey

58

**From:** Poehler, Jeffrey *MR*  
**Sent:** Monday, August 06, 2012 3:42 PM  
**To:** Widrevitz, Dan; Fairbanks, Carolyn; Sheng, Simon  
**Cc:** Hardies, Robert  
**Subject:** RE: Answers to questionnaire 3 8 2012.docx

I don't think you are missing anything. UT would pick up the laminations in the inspection volume. However, it might be useful to talk to a UT person to confirm that the UT techniques they use for ISI would reliably detect laminar flaws.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Widrevitz, Dan *MR*  
**Sent:** Monday, August 06, 2012 2:52 PM  
**To:** Fairbanks, Carolyn; Poehler, Jeffrey; Sheng, Simon  
**Subject:** FW: Answers to questionnaire 3 8 2012.docx

Bob is tracking down some info,

My understanding is that our weld examinations should detect any laminar flaws that have a gap, but aside from QA during original fabrication/installation we wouldn't pick up laminar flaws away from the welds.

Regarding underclad defects, I'm not aware we have any active programs.

Am I missing something? Bob will be traveling to Brussels next week concerning the Doel Unit flaw detection, so this is time-sensitive.

--Dan

**From:** Hardies, Robert *MR*  
**Sent:** Monday, August 06, 2012 2:41 PM  
**To:** Cumblidge, Stephen; Widrevitz, Dan; Nove, Carol  
**Subject:** Answers to questionnaire 3 8 2012.docx

Hi there!

Do you know what equivalent exams we do? See attached.

B/102

6

**Lupold, Timothy**

**From:** Collins, Jay  
**Sent:** Tuesday, August 07, 2012 1:14 PM  
**To:** Lupold, Timothy; Hoffman, Keith  
**Subject:** FW: Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP  
**Attachments:** RPV control in France\_2.doc

fyi

**From:** CROMBEZ Sebastien [mailto:Sebastien.CROMBEZ@asn.fr]  
**Sent:** Tuesday, August 07, 2012 12:30 PM  
**To:** Petteri.Tiippaana@stuk.fi; pierre.briegleb@belv.be; jcb@csn.es; Hardies, Robert; Collins, Jay; Kirk, Mark; dietmar.Kalkhof@ensi.ch; kees.desbouvrie@minvrom.nl  
**Cc:** benoit.deboeck@belv.be; pierre.barras@belv.be; simon.hoebeeck@belv.be; christelle.fonkwa@belv.be; vincent.deledicque@belv.be; Manfred.SCHRAUBEN@FANC.FGOV.BE; An.WERTELAERS@FANC.FGOV.BE; Frederik.VANWONTERGHEM@FANC.FGOV.BE; Beatrice.TOMBUYES@FANC.FGOV.BE; aweyn@vincotte.be; Martti.Vilpas@stuk.fi; LACHAUME Jean-Luc; MONNIN-PARIETTI Carole; STREIBIG Laurent; francois.balestreri@irsn.fr  
**Subject:** RE: Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

Dear all,

Please find enclosed ASN answers to your questions. We focused on French manufacturing experience feedback because, in a few cases, large amount of flaws which seem quite similar to those detected in Doel 3 were observed in France. These flaws were detected and the components rejected before end of manufacturing.

Do not hesitate to ask in case you have something to clarify or to ask additional questions.

ASN will attend the meeting planned on 16<sup>th</sup>.

Best regards

**Sébastien CROMBEZ**  
Autorité de Sécurité Nucléaire  
Nuclear Pressure Equipements Department  
**Director**  
21 boulevard voltaire,  
BP 37815, 21078 DIJON CEDEX  
Tél : +33 (0) 3 45 83 22 36 – Fax : +33 (0) 3 45 83 22 94

Sébastien Crombez

**De :** Petteri.Tiippaana@stuk.fi [mailto:Petteri.Tiippaana@stuk.fi]  
**Envoyé :** lundi 6 août 2012 10:07  
**A :** pierre.briegleb@belv.be; CROMBEZ Sebastien; jcb@csn.es; Robert.Hardies@nrc.gov; Jay.Collins@nrc.gov; Mark.Kirk@nrc.gov; dietmar.Kalkhof@ensi.ch; kees.desbouvrie@minvrom.nl  
**Cc :** benoit.deboeck@belv.be; pierre.barras@belv.be; simon.hoebeeck@belv.be; christelle.fonkwa@belv.be; vincent.deledicque@belv.be; Manfred.SCHRAUBEN@FANC.FGOV.BE; An.WERTELAERS@FANC.FGOV.BE; Frederik.VANWONTERGHEM@FANC.FGOV.BE; Beatrice.TOMBUYES@FANC.FGOV.BE; aweyn@vincotte.be; Martti.Vilpas@stuk.fi; Jukka.Harkola@stuk.fi; Olavi.Valkeajarvi@stuk.fi; Petri.Vuorio@stuk.fi  
**Objet :** RE: Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

De : [mailto:Sebastien.CROMBEZ@asn.fr]

please find our answers to your four questions in the attached file. Do not hesitate to ask in case you have something to clarify or to ask additional questions.

Unfortunately, due to regulatory activities related to outage at Loviisa NPP, we are not able to send our expert to the proposed meeting on the 16<sup>th</sup>. Anyhow, we would be interested on any follow-up on this issue.

Best regards

Petteri Tiippana  
Director  
Nuclear Reactor Regulation  
STUK

**From:** Briegleb Pierre [<mailto:pierre.briegleb@belv.be>]

**Sent:** Wednesday, July 25, 2012 10:40 AM

**To:** Sebastien.CROMBEZ@asn.fr; CRESPO BRAVO JULIO; Robert.Hardies@nrc.gov; Jay.Collins@nrc.gov; Mark.Kirk@nrc.gov; Tiippana, Petteri; dietmar.Kalkhof@ensi.ch; kees.desbouvrie@minvrom.nl

**Cc:** De Boeck Benoit; Barras Pierre; Hoebeeck Simon; Fonkwa Christelle; Deledicque Vincent; SCHRAUBEN Manfred; WERTELAERS An; VAN WONTERGHEM Frederik; TOMBUYES Beatrice; [aweyn@vincotte.be](mailto:aweyn@vincotte.be)

**Subject:** Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP

Dear Sirs,

We are now facing in Belgium a potential problem on the reactor pressure vessel (RPV) of the Doel 3 NPP.

Non-destructive examination revealed a lot of "indications" that need to be confirmed by another inspection technique (ongoing).

We would like to have your feedback, experience and advice regarding this potential problem. You will find hereunder a more comprehensive background and some questions we would like to answer.

Best regards,

Pierre Briegleb  
National Project Coordinator  
Bel V – Subsidiary of the Federal Agency for Nuclear Control (Belgium)

#### Potential problem on the reactor pressure vessel

Belgian pressure vessels are inspected according to ASME XI. Volumetric inspections of the beltline zone are normally limited to the circumferential welds and surrounding heat affected zone and base material, within the limits settled by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified method and encompass the whole height of the vessel beltline region. This means that we inspect clad base material in zones where no volumetric in-service inspection was performed up to now.



At Doel 3, according to the Owner, no underclad defects were detected. Nevertheless, lot of defect indications of an apparently different type were detected by this UT-inspection aiming at detecting underclad defects, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be laminar flaws, more or less parallel to the inner/outer surface of the pressure vessel, located in- and outside the inspected zone where underclad defects were looked at. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

The inspection method which revealed the presence of those defects has been qualified for detecting underclad defect.

An inspection of the whole height with the qualified method used to control the beltline welds started on the 16<sup>th</sup> of July; the results should not be available before begin of August. Similar inspections will be performed at Tihange 2 during the month of August.

In the absence of any other explanation at this stage, the Owner supposes to be in presence of fabrication defects.

The Doel 3 and Tihange 2 RPVs were forged by Rotterdam Dockyards (RDM), which according to the Owner provided some 24 vessels in Europe and the US. NUREG 1511 – Suppl. 2, p. 7-3, identifies 8 US units with RDM forged rings. Other European countries possibly concerned are Spain, Switzerland, the Netherlands (Borssele, Dodewaard), and probably others, not identified by Bel V at this stage.

Some questions:

1. Are there in your country RPVs (forged rings) fabricated by Rotterdam Dockyards (RDM)?
2. Is there any known concern with respect to fabrication defects in those rings?
3. Did you perform volumetric inspections in the beltline region which could have detected laminar defects in the beltline base material (a) during fabrication (b) in-service? If the answer is yes, describe which inspection (type, extent, frequency) and the corresponding results.
4. Do you perform inspections aiming at detecting underclad defects? If so, describe which inspection (type, extent, frequency) and the corresponding results.

**1. Are there in your country RPVs (forged rings) fabricated by Rotterdam Dockyards (RDM)?**

No, forged rings for French RPV's were forged by Creusot-Loire Industrie.

**2. Is there any known concern with respect to fabrication defects in those rings?**

Different types of manufacturing flaws were detected in forged components manufactured for French nuclear plants. A precise study was performed by ASN in 1985 concerning main type of defects which led to components rejection between 1980 and 1985. These types of flaws are:

- Inclusions: some pressurizer shells, SG tubesheets, and RPV nozzles were rejected due to this type of defect
- Forging flaws (decohesions, cracks): some RPV nozzles, RPV closure head, SG tubesheets and RPV shells were rejected due to this type of defect
- Hydrogen induced flaws (also called segregation cracks): 14 components were rejected due to this type of defect between 1983 and 1985. SG tubesheets, RPV shells (forged from a hollow ingot), SG bottom heads, RPV flanges, and SG support rings were concerned

In 1968 and 1969 a RPV shell and a RPV flange were rejected due to hydrogen induced cracks (components manufactured for foreign projects).

This year, 2 SG shells for French SG steam generator replacement program were rejected due to a large number of hydrogen induced cracks. These shells were forged from a hollow ingot: one of them contained about 5000 indications and the other one about 700 indications between 2 and 6mm (size estimation based on NDE results). Indications on the second shell were located on two lines on the opposite sides of the shell: it is supposed to be due to combined factors including presence of Hydrogen with critical concentration and stresses caused by a "round shaping" operation performed at a too low temperature.

We used the term "hydrogen induced flaws" for cracks due to hydrogen concentration in segregation areas. These flaws appear between a few days and a month after quality thermal treatment. Their shape can be intergranular or transgranular. Their orientation is parallel to the grain flow (with variations of about 10°).

Regarding French manufacturing experience feedback, only hydrogen could explain such a large number of laminar flaws in a shell. We observed that when hydrogen induced cracks are found in a component, several hundreds or thousands of cracks can appear, with a surface size about 50mm<sup>2</sup>.

**3. Did you perform volumetric inspections in the beltline region which could have detected laminar defects in the beltline base material (a) during fabrication (b) in-service? If the answer is yes, describe which inspection (type, extent, frequency) and the corresponding results.**

In service inspection aims at detecting and sizing undercladd defects and flaws in welds (see next answer)

The manufacturing flaws described previously were detected by non-destructive testing performed during manufacturing.

Concerning Creusot-Loire Industrie, ultrasonic testing has been performed during manufacturing since the 50's. A non-destructive testing with both straight beam and 45° angle beam techniques has

been required from the beginning of manufacturing (1970 <sup>1</sup>), has been described in dedicated procedures since 1976, and has been introduced as a requirement in the RCC M code since 1983.

After rejection of a significant number of components in the early 80's, ASN performed a large review of the results of the non-destructive testings performed between 1980 and 1985. This review aimed at detecting defects that could have been hydrogen induced cracks.

For this purpose, a "surveillance area" corresponding to the area where segregations may occur was defined. Every group of indication in that area was supposed to be hydrogen induced cracks. For example, Framatome rejected components with a group 20 or 30 indications between 3 and 4mm (size estimation based on NDE results).

ASN reviewed the results of control performed on more than 300 components and concluded that they were confident in the inspection performed by Creusot-Loire. But ASN also conclude that it was impossible with this type of control to make a difference between inclusion and hydrogen cracks without taking into account manufacturing parameters (hydrogen concentration, duration of gas stripping heat treatment,...) and considering separately isolated indications and group of indications.

The orientation of hydrogen induced cracks makes ultrasonic control with the straight beam technique at 0° efficient for their detection. Detection criteria was based on the backwall echo loss and corresponded to defects with a diameter of 3mm (expertise of real hydrogen induced cracks detected with UT signal corresponding to 2 to 4 mm diameter defects showed that UT signal underestimated the flaws size: real size was between 3 and 6mm). Detection criterion was set to 2mm. Then, in 1992 this criteria evolved and is now based on reflectivity of a flat bottom hole.

In order to detect manufacturing flaws, non-destructive testings are required at final quality heat treatment stage but they were often performed twice, at different stages, on the same component: at preliminary heat treatment stage and at final quality heat treatment stage.

**4. Do you perform inspections aiming at detecting underclad defects? If so, describe which inspection (type, extent, frequency) and the corresponding results.**

In service inspection to detect undercladding flaws has been performed since 1989 (Fessenheim 1 first decennial outage) but first concerned only welds. From 1991, a control of all the RPV core shells has been required by ASN. Since 1998, this examination is performed on each RPV shell at the second ten years outage. It is renewed at the 3<sup>rd</sup> ten years visit.

Techniques evolved since 1989 and testing method is currently qualified to guarantee the detection of a 5\*25mm defect. The inspection concerned the first 20, 25 or 30mm through wall extent from the interface between cladding and parent metal of the shell depending on the process used). Most shells have been inspected several times.

37 undercladding defects were found, 20 on Tricastin 1 RPV. 12 RPV are concerned. A few other types of defects were found but no crack or laminar flaw. No French RPV can be compared to Doel 3. We asked EDF to give us more precise information about other defects detected to date.

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<sup>1</sup> First version of the CPFC (general requirements for manufacturing, inspection and welding)

## Ring, Mark

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**From:** Shear, Gary  
**Sent:** Friday, August 10, 2012 4:30 PM  
**To:** Ring, Mark  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Could generate some excitement! QC Unit 1 may be affected.

---

**From:** Casto, Chuck  
**Sent:** Friday, August 10, 2012 4:23 PM  
**To:** Shear, Gary; Chandrathil, Prema; Mitlyng, Viktoria  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

FYI...fast breaking

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**From:** Boger, Bruce  
**Sent:** Friday, August 10, 2012 3:48 PM  
**To:** McCree, Victor  
**Cc:** Dean, Bill; Lew, David; Wert, Leonard; Dorman, Dan; Hiland, Patrick; Casto, Chuck; Collins, Elmo  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

If you scroll down to the bottom of this email you'll see the initiating request from the Belgium regulator on the Doel situation. We'll know more next week.

---

**From:** McIntyre, David  
**Sent:** Friday, August 10, 2012 10:03 AM  
**To:** Burnell, Scott; Hiland, Patrick  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; Hopkins, Jon; Hardies, Robert; Brenner, Eliot  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Pat – the Dow Jones reporter is asking for details on our “fact finding”. Have we, or will we, ask our licensees on the list whether their RPV's were from the vendor in question?

Thanks,  
Dave

---

**From:** Burnell, Scott  
**Sent:** Friday, August 10, 2012 7:51 AM  
**To:** Hiland, Patrick  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; McIntyre, David; Hopkins, Jon; Hardies, Robert  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Understood, thanks.

---

**From:** Hiland, Patrick  
**Sent:** Friday, August 10, 2012 7:50 AM  
**To:** Burnell, Scott  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; McIntyre, David; Hopkins, Jon; Hardies, Robert  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

I'm not aware that we've done any "independent" verification of the list of plants whose vessels were reportedly made at RDM. However, the list appears to indicate U.S. RPVs that were manufactured in the 60's and 70's (may not have been operational till the 90's). Bob Hardies is NRR/DE's Senior Level Advisor for Materials and will be on a fact finding mission next Thursday. You should be free to state that one of our experts in the field of Reactor Vessel Materials, has been asked to meet with the Belgian and other regulators next week. As Bruce cautioned, this info is regulator to regulator.

NRR

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**From:** Burnell, Scott  
**Sent:** Friday, August 10, 2012 7:28 AM  
**To:** Hiland, Patrick; Boger, Bruce; Dorman, Dan; McIntyre, David  
**Cc:** Evans, Michele  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

OPA

Pat;

Thanks very much, that's helpful. Have we had the time to verify Electrabel's list, and how much detail can I share on both that list and Bob's participation in the meeting? Thanks again.

Scott

---

**From:** Hiland, Patrick  
**Sent:** Friday, August 10, 2012 7:21 AM  
**To:** Burnell, Scott  
**Cc:** Hiland, Patrick; Cheok, Michael; Terao, David; Nieh, Ho; Lubinski, John; Rosenberg, Stacey; Chernoff, Harold; Dudes, Laura; Luehman, James; Evans, Michele; Dorman, Dan; Holahan, Gary; Bergman, Thomas; Hopkins, Jon; Boger, Bruce  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel  
**Importance:** High

NRR

Scott, the below info is pretty clear and it includes a list of U.S. plants (at bottom of string) whose RPVs were manufactured by same vendor. The Belgians have asked 7 countries to attend a meeting next Thursday, August 16, and we're sending Bob Hardies from NRR/DE. This would just be a one-day discussion of what type of NDE techniques were used, where the inspections were performed, etc. Looks like a 2<sup>nd</sup> meeting is being lined up for September.

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**From:** Hiland, Patrick  
**Sent:** Monday, August 06, 2012 11:06 AM  
**To:** Boger, Bruce  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel  
**Importance:** High

NRR

Bruce, I've asked Bob Hardies to attend this meeting in response to formal invitation. It's short notice as meeting is next week in Brussels.

---

**From:** Hopkins, Jon  
**Sent:** Friday, August 03, 2012 9:34 AM  
**To:** Fairbanks, Carolyn; Hardies, Robert  
**Cc:** Roquecruz, Carla; Hiland, Patrick; Chernoff, Harold; Cheok, Michael; McGinty, Tim; Muessle, Mary; Bahadur, Sher; Regan, Christopher; Astwood, Heather; Rodriguez, Veronica; Tehrani, Navid; Sangimino, Donna-Marie; Dehn, Jeff; Fehst, Geraldine; Nieh, Ho; Lubinski, John; Stahl, Eric  
**Subject:** REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel  
**Importance:** High

NRR

Carolyn & Bob,

Belgium's regulator, FANC, has invited nuclear regulators from the 7 countries that also have RPVs manufactured by RDM (list below, includes U.S.) to participate in a technical working meeting on Aug. 16 in Brussels to discuss recent UT inspection indications found on the Doel 3 RPV.

France's regulator, ASN, has already responded and said that they would attend ("ASN will participate to this meeting. The representatives will be: Sébastien CROMBEZ Director of the Nuclear pressure Equipment Department and Jean-Luc LACHAUME Deputy Director General.")

Please let me know if we should/can attend this meeting. Note that FANC plans another meeting in Sept. on this issue.

Thank you, Jon

NIRZ

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**From:** VAN WONTERGHEM Frederik [mailto:Frederik.VANWONTERGHEM@FANC.FGOV.BE]

**Sent:** Friday, August 03, 2012 5:05 AM

**To:** Andre-claude.lacoste@asn.fr; jean-luc.lachaume@asn.fr; francois.balestreri@irsn.fr; Sebastien.CROMBEZ@asn.fr; info@arn.gob.ar; gerald.hennenhofer@bmu.bund.de; martina.palm@bmu.bund.de; Ulrich.Erven@grs.de; Carla.Schwaeger@grs.de; a.vanlimborgh@mineleni.nl; kees.desbouvrie@minvrom.nl; bert.verweij@minvrom.nl; Roeland.Nieuweboer@minvrom.nl; cmt@csn.es; fjarana@mityc.es; jcb@csn.es; ann-louise.eksborg@ssm.se; Anders.Hallman@ssm.se; Lars.Skanberg@ssm.se; perolof.hagg@ssm.se; petteri.tippaana@stuk.fi; hans.wanner@ensi.ch; georg.schwarz@ensi.ch; markus.straub@ensi.ch; dietmar.Kalkhof@ensi.ch; Hopkins, Jon; Kirk, Mark; Hardies, Robert; Collins, Jay

**Cc:** WERTELAERS An; SCHRAUBEN Manfred; DE ROOVERE Willy; TOMBUYES Beatrice; pierre.barras@belv.be; pierre.briegleb@belv.be; benoit.deboeck@belv.be; aweyn@vincotte.be; hvandriessche@vincotte.be

**Subject:** URGENT Message on Nuclear Safety: Flaw indications in Doel 3 Reactor Pressure Vessel

NIRZ

Dear all,

This week, a preliminary IRS Incident Report was published by Belgium related to the detection of a large number of flaw indications in the reactor pressure vessel of Doel 3 (PWR - Framatome Design). (Reference IRS Number 8244: "FLAWS INDICATIONS IN THE REACTOR PRESSURE VESSEL"). In attachment you can find a copy of this IRS report.

As indicated in the IRS report, the Doel 3 NPP outage has been extended to allow further inspections and to perform additional studies by the licensee to analyze and, if possible, to validate and confirm the structural integrity of the vessel. At the moment, the licensee supposes that the flaw indications were already present at the moment of forging of the vessel, which was done by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). Both a deterministic approach (in accordance with ASME XI Appendix A) and a probabilistic approach (in accordance with 10CFR50.61a) are being considered by the licensee to justify the structural integrity of the reactor vessel.

Some additional information on the types of flaw indications and other possible reactor vessels forged by this company can be found below.

Considering the potential consequences of this event, the Belgian regulatory body would like to organise on short notice a technical working meeting in Brussels on this issue for those regulatory bodies which could be interested by these findings, specifically those regulatory bodies of countries where RPVs forged by RDM can be present. During this technical working meeting, additional information on the results found at Doel 3 NPP and the on-going licensee investigations and calculations will be made available by the Belgian regulatory body (FANC, its technical support organisation Bel V and the Authorized Inspection Authority AIB Vincotte International). In addition, a roundtable discussion between regulatory bodies will be held to discuss relevant experiences with this kind of inspections and flaw indications. Specific topics/questions to be discussed during this roundtable discussion are mentioned in an email by Bel V which was sent last week (see attachment). We are especially interested to know if this type of ISI was already performed in your countries on the reactor vessels forged by

this company, and if so, what the results have been. May we kindly invite every country to present additional available input and thoughts to our working meeting .

**This technical working meeting shall take place in Brussels (FANC offices, Ravensteinstraat 36, 1000 Brussels) on Thursday 16 August between 10h00 and 16h00.**

We would be very grateful if one or more technical experts of your organisation could be present during this working meeting.

To confirm your participation, please send me a reply by email to [frederik.vanwonderghem@fanc.fgov.be](mailto:frederik.vanwonderghem@fanc.fgov.be) (tel. ++32 2 289 2082) before Friday 10 August.

If you have further technical questions on this event, you can contact [pierre.briegleb@belv.be](mailto:pierre.briegleb@belv.be) (tel ++32 2 528 0245).

A second technical working meeting could be held in the near future (presumably early September) to discuss the available results of the additional inspections at Tihange 2 and the results of the licensee investigations and calculations aiming to confirm the structural integrity of the reactor vessel. Further actions in your countries can also be discussed during this second meeting. We will inform you as soon as possible of the timing of this second working meeting.

Best regards,

Frederik Van Wonderghem

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Fax: +32 (0)2 289 21 12

NRI2

#### **Additional information on the types of flaw indications and other possible reactor vessels**

- Preliminary results from additional inspections
  - o As described in the IRS message, considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV of Doel 3.
  - o The preliminary results from those additional inspections confirm the presence of several thousand (up to 10000) flaw indications in the reactor vessel base material. These flaw indications seem to be laminar in shape and have average diameters of 25 mm.
- Reactor Pressel Vessels forged by Rotterdam Dooqdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)
  - o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
  - o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Atucha 1	PHWR		335	1980	Siemens
Doel 3	PWR	3	1000	1982	Framatom
Tihange 2	PWR	3	1000	1982	Framatom
Brünsbittel	BWR	-	770	1977	KWU
Philippsburg 1	BWR		890	1980	KWU

	Dodewaard	BWR	-	52	1968	RDM
	Borssele	PWR	2	515	1973	KWU
	S <sup>ta</sup> Maria de Garona	BWR		450	1971	General El
	Cofrentes	BWR	-	1064	1984	General El
	Ringhals 2	PWR	3	813	1974	Westinghc
	Leibstadt	BWR	-	1165	1984	General El
	Mühleberg	BWR	-	373	1971	General El
	Catawba 1	PWR	4	1129	1985	Westinghc
	McGuire 2	PWR	4	1100	1983	Westinghc
	North Anna 1	PWR	3	903	1978	Westinghc
	North Anna 2	PWR	3	973	1980	Westinghc
	Quad Cities 1	BWR	-	882	1972	General El
	Sequoyah 1	PWR	4	1162	1980	Westinghc
	Sequoyah 2	PWR	4	1126	1981	Westinghc
	Surry 1	PWR	3	839	1972	Westinghc
	Surry 2	PWR	3	800	1973	Westinghc
	Watts Bar 1	PWR	4	1123	1996	Westinghc



federiaal agentschap voor nucleaire controle

agence fédérale de contrôle nucléaire

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Svp, pensez à notre environnement avant d'imprimer ce mail.

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NR12



EN : FR



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Our mission

'The AFCN promotes the effective protection of the population, employees and the environment against the danger of ionizing radiation'.



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## Info sheet on the reactor and the reactor vessel

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  - Identity card of the reactor Target 3
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### Situation in the nuclear power station of Destination

#### There is currently a danger danger?

-3 silent and currently lies the reactor Target was the fuel from the reactor discharge cycles. So there is no danger to the population, workers and the environment.

Moreover, it can count on a strong team of own experts AFCN and works closely with the experts of as always its subsidiary Bel V. the final decision of the AFCN will additionally based on the safety evaluation of the whole file, and on the advice of its Scientific Council and be subject to an international audit.

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#### What was the reason for the current checks of the reactor vessel of Goal 3?

To the 12 à 18 months the Belgian nuclear plants be shut down for a short period (average 30-40 days). During this "review period" a portion of the core of the reactor replaced by new nuclear fuel and at the same time the necessary maintenance and control operations can be performed on the installation while it is not in operation.

During the overhaul periods are so-called "operational inspections" carried out in order to verify the good condition of the reactor kuip (mainly in the zones where the welds are between the constituent parts of the bowl). Uses non-destructive ultrasonic measurement techniques (sound waves). These checks shall be carried out according to standards which were developed for metal constructions by the American Society of Mechanical Engineers (known as the standard ASME XI).

The latest revision at Goal 3 has started early June 2012. On the occasion of this planned control measurements were performed on the reactor vessel using a new type of ultrasonic measuring probes. On the basis of these initial measurements, it was considered that additional checks were needed.

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### How is an inspection of the vessel performed?

The normal checks happen according to the international standard ASME XI, who prescribes a 10-year inspection cycle: over 10 years are all sensitive areas monitored.

Viewed all cracks sensitive zones, nl. where high (mechanical and thermal) avoid tensions that at the base of a crack growth could lie. These are the zones of the welds (e.g. between the rings) and the mouthpieces for the linkage of the pipes of the reactorkoelkring.

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### What is "ASME"?

*The American Society of Mechanical Engineers (ASME)* is an international organization consisting of thousands of engineers with the intention to cooperate and the technical expertise to share. The activities of this organisation are numerous and cover the field of Mechanical Sciences. ASME is structured in different geographical sections, namely twelve for the United States and abroad, which in itself is further divided into four subsections, one for Europe.

One of the activities of ASME consists in the development of codes and standards regarding mechanical engineering that annually updated.

Part XI of the ASME standards includes the rules for the inspection of the components of operating nuclear power plants.

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### Which bodies carry out the inspection?

The inspection was carried out by the specialized company Intercontrole (belonging to AREVA group), a large number of reactor vessels annually inspects according to the compulsory and additional requirements of the ASME standard and the experience.

In the first place, the inspection was succeeded by an approved inspection body for pressure vessels (Authorized Inspection Agency-AIB Vinçotte International Belgium is the company for this) that agreement must declare with the formulated decisions.

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### What is the role of the AFCN these inspections?

The results of the inspection by the proposed Intercontrole, succeeded by AVI, and then serve to Bel V to the AFCN, which ultimately decides on whether or not to allow the further exploitation.

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### What was there laid down in the additional checks in goal 3?

Error in the end of June were numerous indications of the reactor vessel steel base material, in particular in the bottom ring of the reactor vessel.

The AFCN and Bel V were informed of these auditing results. On 5 July, it was decided to carry out additional checks on the reactor tub of Doel 3 for more information on these results. These additional checks were performed from July 16.

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### What is known about these error indications?

It concerns "laminar" errors. These run parallel with the surface and forms as such, theoretically no risk, because not normally subject to tension.

We remind that the reactor further paralysed as a result of the ongoing revision of Objective 3.

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### How is it that this problem hasn't been said?

A new ultrasonic measuring technique for the first time in June 2012 was applied to the entire surface of the reactor vessel of Objective 3. This audit was conducted by a French company specialised in command of Electrabel. It is the first time that such a service inspection in Belgium in the base material of the reactor vessel is running (outside the zones of the welds). This research is also examined the entire wall of the reactor vessel, while according to the provisions of the applicable ASME XI-standards so far only the sensitive zones were viewed.

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### How is it that this problem has come to light in the stress tests?

The subject of the stress tests was reassessing the robustness of the plants Attn extreme external phenomena such as earthquakes, floods (tsunamis), vliegtuigval, loss of all electrical power supply and the cooling as a result of these phenomena, etc. ... which at the base layers of the events in Fukushima.

The "monitoring the condition of the reactor cockpit", e. d happens according to strict regulatory schemes, provided that be followed to the letter.

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#### **Are the results of the stress tests still valid after what is now established?**

The results of the stress tests are still valid. They had another purpose.

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#### **When this error indications were present for a long time, they would not have to radioactive emissions may lead?**

At this moment the AFCN can confirm that this error indications in the reactor vessel of Objective 3 to no radioactive emissions have led.

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#### **It Is not desirable for all the Belgian nuclear reactors to a same ultrasonic testing immediately to topics?**

A similar ultrasonic control of the reactor vessel of Tihange-2 is equipped during the planned revision of this reactor. This revision starts Middle August. The first results of these checks are expected by the end of september.

Given the recent decision to Tihange-1 ten years to allow additional exploitation, the AFCN has already a similar inspection of the cockpit of this reactor imposed in 2013.

The most recent nuclear power stations, goal 4 and Tihange 3, submit a check according to the AFCN equally to undergo over time.

Similar findings are basically construction-specific. It is also not a aging phenomenon.

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#### **These findings could have an impact on other nuclear power stations worldwide?**

Worldwide there are 21 nuclear reactors of the same type vessels (*number to confirm*). The AFCN consults with the relevant regulators of these countries to give them the necessary information about target to reach out and ask them to 3 also the available experience with them at the disposal of Belgium.

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### **Ongoing and planned actions**

#### **What actions the AFCN currently?**

The AFCN ensures the follow-up of this incident in collaboration with his technical branch, and the company Bel V-AIB-Vinçotte International (AVI) that in Belgium the mandated authorized assessment organisation for such inspections (in service inspections according to the ASME standard).

AFCN and Bel V have several consultation meetings with Electrabel to additional information on this subject had to win.

An independent evaluation of this application is executed by AFCN and Bel V. The AFCN and Bel V also have already contacted foreign nuclear veiligheidsinstantiesoverheden to exchange information and experience.

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#### **What actions expect the AFCN of the operator?**

- Further research of originally construction file of reactor vessel to determine whether it indeed comes to workmanship;
- Metallurgical Research to the cause and to identify any statement (manufacture) errors;
- A full justification dossier must be drawn up in the framework of a restart, which will be submitted to the competent authorities for agreement. This justification dossier will seek to show that the established error indications do not endanger the structural integrity of the reactor vessel.

The revision of Objective 3 is currently in this respect Armistice Day extended until at least 31 August 2012.

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#### **Is a possible repair of vessel possible?**

A possible restoration of the reactor vessel is practically impossible and what the AFCN is also not to be preferred, because it is feared that this probably new internal tensions in the wall of the reactor vessel to avoid is going to occur, what is absolutely.

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### Is a replacement of the reactor vessel possible?

A replacement of the reactor vessel is extremely difficult (high radiation dose, etc ...) and has never occurred in a nuclear power plant worldwide.

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### Technical information

#### Identity card of the reactor Target 3

- Start of the exploitation: 1982
- NET wattage: 1003 MWe
- Type reactor: pressurized water reactor (PWR)
- Manufacturer: Framatome in association with ACEC and Cockerill (FRAMACECO)
- Reactor vessel forged by Rotterdamsche Droogdok Maatschappij (Netherlands) in the ' 70s

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### What are the different levels of protection of a reactor?

In order to ensure the inclusion of the radioactive material, there are three resistant and leakproof physical barriers placed between the radioactive materials and the environment so that they constitute a triple shielding to the radiation and radioactivity in all circumstances to keep within the installation:

#### First barrier: the casing of the fuel element

The ceramic fuel tablets, which already holds the largest portion of the radioactive products, sit in a leakproof metal shell.

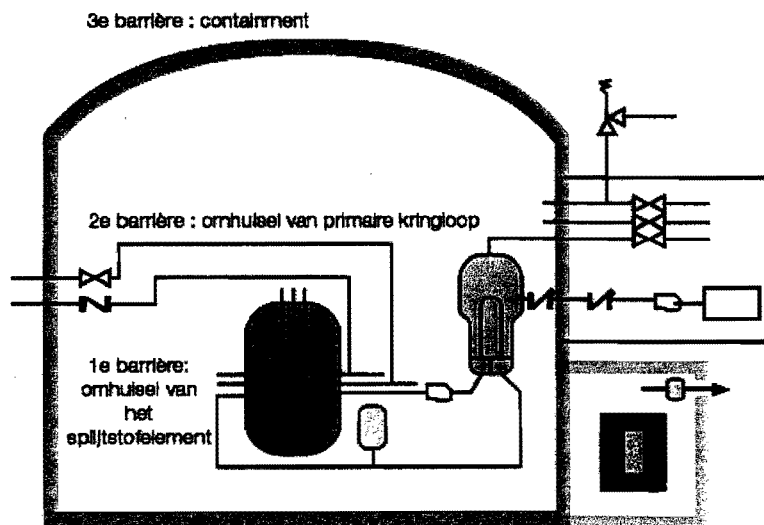
#### Second barrier: the casing of the primary loop

This is formed by the thick steel casing of the primary cooling circuit of the reactor. The reactor vessel is an essential part of this second barrier.

#### Third barrier: the containment

The entire primary cycle (as well as other components of the reactor) is surrounded by a very thick concrete structure that can withstand a lot of pressure and against aggressions from outside file.

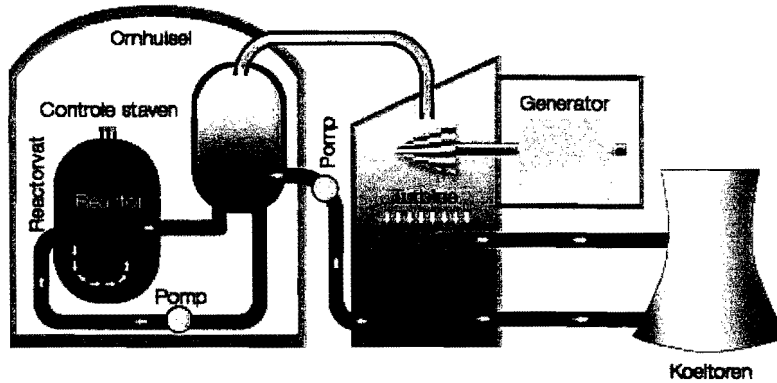
The Belgian nuclear power stations are equipped with a double casing that the primary loop, containing the radioactive fuel, isolates from the outside world.



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### What function has the reactor vessel?

It is in the reactor vessel (reactor vessel) that circulates the water of the primary cooling circuit, through the core, where it is warmed by the hot fuel, after which it issued its heat in the steam generator to the secondary post and return to the reactor. The steam produced is intended for the turbines and for electricity production.



The reactor vessel fulfills a vital role in the three security features of the reactor:

- Inclusion of the radioactive materials;
- Geometric control of critical Assembly;
- Cooling of the core.

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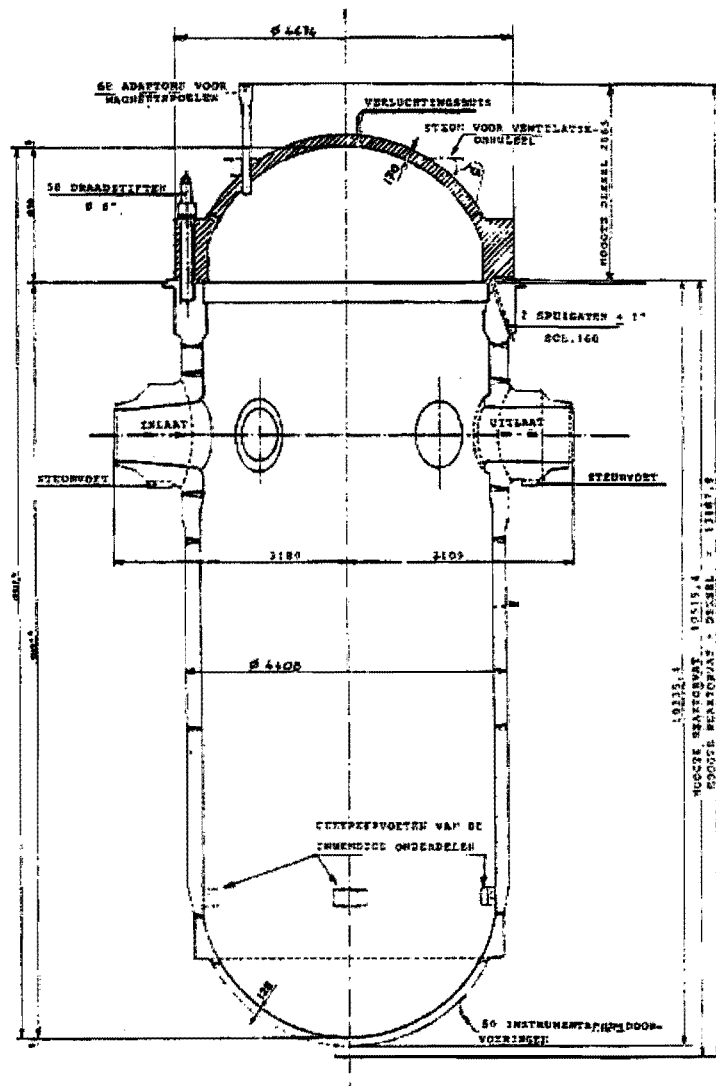
#### What does a reactor vessel look like?

The barrel of a nuclear reactor looks like a cylinder which is closed with a hemispherical bottom and a hemispherical top. Top is located a removable lid in the form of a spherical Cap. This design achieves access to the interior of the barrel by removing the lid, after the reactor was shut down. In this way, the fuel elements be replaced.

The lid is held on the barrel through a series of bolts (58 at Target 3) that are bolted in the reactor flange where the support on the top of the reactor flange nuts.

The in-and outflow of the primary water happens via 6 mouthpieces.

The (three) primary loops of the reactor cooling system are connected to the reactor vessel.

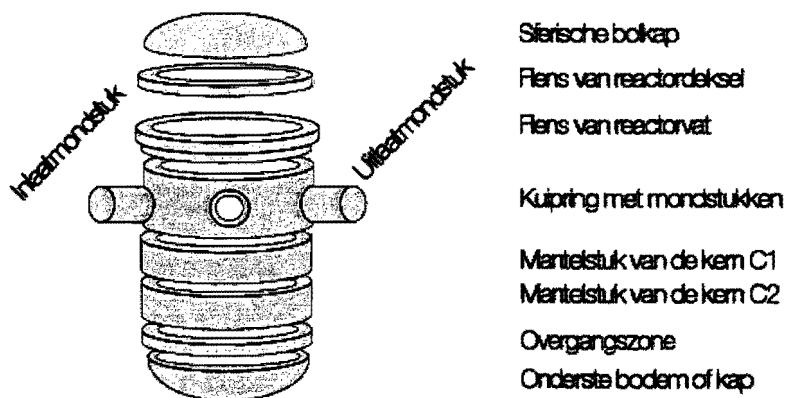


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#### How is a reactor vessel manufactured?

The barrel of a nuclear reactor consists of a barrel and a lid. The barrel is about 13 meters in height (including lid) and has an external diameter of 4.4 metres and a total weight of 330 tons (including lid and connection bolts). The wall thickness of the cylindrical part of the barrel is 20 inches.

The barrel consists of forged and machined components from low alloy steel. The main components of the barrel (casings, flanges and mouthpieces) are manufactured by forgings and metallurgical operations. These pieces welded together and be mutually protected against corrosion by means of a thin coating of stainless steel (approximately 7 millimeters thick), which by means of weld on the interior of the barrel, usually in two layers, is made. The barrel at the end of the manufacturing process is subjected to a pressure test in which it is exposed to a pressure higher than the maximum operating pressure in order to ascertain their resistance. These checks shall be carried out according to the American ASME standards.



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Nove, Carol

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**From:** Malik, Shah  
**Sent:** Sunday, August 12, 2012 7:53 PM  
**To:** RES\_DE\_CIB; RES\_DE\_CMB  
**Cc:** AMY HULL-Tmo-Blackberry  
**Subject:** Regulators to Discuss DOEL-3 Belgian Reactor Pressure Vessel Cracks

FYI --

[http://www.marketwatch.com/story/regulators-to-discuss-belgian-reactor-cracks-2012-08-10?reflink=MW\\_news\\_stmp](http://www.marketwatch.com/story/regulators-to-discuss-belgian-reactor-cracks-2012-08-10?reflink=MW_news_stmp)

Aug. 10, 2012, 2:03 p.m. EDT

Regulators to discuss Belgian reactor cracks

By Anna Perez

(Adds background, U.S. regulator's comment.)

European and U.S. nuclear regulators will meet in Brussels next week to discuss possible cracks found in a key component inside a Belgian reactor, in an effort to coordinate response to a problem that may affect several other countries around the world.

"Our technicians and technical staff from other nuclear regulatory bodies in Europe and also the U.S. will attend a meeting on August 16th," a spokesman for Spain's nuclear safety regulator, Consejo de Seguridad Nuclear, said Friday.

Belgian authorities said this week that they were shutting down, at least until the end of the month, one of their seven nuclear plants on the suspicion that the steel vessel holding the reactor core could be cracked. The same component might be present in other power plants in the region and while regulators say the cracks pose no danger, the fact that they appear to stem from a production defect has prompted checks in other countries.

The problem will likely add new controversy to the debate about the safety of atomic energy. After the meltdown at Japan's Fukushima reactor following last year's earthquake and tsunami, the European Union rushed to undertake tests to ensure the safety of its nuclear power plants. Some countries, including the region's largest economy, Germany, decided to speed up their phase-out of nuclear power.

Checks with a new technology at the Doel power plant near Belgium's biggest port, Antwerp, identified the possible cracks, the Belgian regulator FANC said.

The vessel is a 20-centimeter-thick steel tank, which is roughly three meters tall and four meters in diameter.

At least one reactor in Switzerland, another in Belgium and two in Spain have components produced by the same Dutch firm, Rotterdam Drydock Company, which has gone bankrupt since producing the equipment. The U.S. Nuclear Regulatory Commission said Friday it has been informed that 10 American reactors may have used the component in question, but it hasn't yet verified that information with U.S. nuclear operators.

The U.S. regulator said it will send an engineering expert to next week's meeting. "We want to know more about what tests were done, the methodologies and techniques and equipment used to test it," spokesman David McIntyre said. "It's a little early to be jumping to conclusions

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at this point. There will be more testing to verify that there's a problem and the extent of it."

The Swiss reactor was already shut for routine checks and the second Belgian reactor will be shut next week for tests, the countries' regulators said. Spain didn't find any problem in its vessels, after testing them with the same advanced technology used in Belgium.

Authorities have assured that there are no risks. However, if the cracks are present in sufficient number and size, the reactors might have to be permanently shut down, leaving power generators the challenge of finding alternative sources of electricity.

In Belgium, FANC doubts the Doel 3 reactor, which provides roughly one-sixth of the country's nuclear power, will ever resume operations. "I am pretty skeptical at the moment," Willy De Roovere, the head of FANC, told RTBF radio Friday. "There are many (cracks), and for our taste a bit too many," he added.

Steve Kidd, the deputy director general of the World Nuclear Association, said that it was highly unlikely that there would be radioactive leaks because there is a concrete container around the reactor pressure vessel. However, he add that it wouldn't be possible to continue to operate a reactor with such cracks.

Given the age and origin of the nuclear reactors operating in the U.K. it was highly unlikely that they would have pressure vessels made by the Rotterdam company, Mr. Kidd said.

The Belgian problem is now rated one on the scale of nuclear accidents. Fukushima had reached level seven, the same as the 1986 Chernobyl disaster.

Ryan Tracy in Washington DC and Selina Williams in London contributed to this article.

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<http://www.france24.com/en/20120810-cracked-belgian-nuclear-reactor-impossible-repair-closed-antwerp-radiation>

latest update: 10/08/2012

- Belgium - nuclear power

Cracked Belgian nuclear reactor to remain closed

A crack discovered in a steel tank containing a nuclear reactor at a Belgian power plant will likely keep the station closed, the country's nuclear safety

agency said on Friday. Repairing the crack is "practically impossible," the agency said.

AP - The head of Belgium's federal agency for nuclear safety AFCN said on Friday he was "sceptical" that an ageing reactor closed over fears of cracks could be restarted.

"I'm fairly sceptical for the moment," Willy de Roovere told RTBF public radio, even if "the possibility remains that I am wrong."

According to French-language daily Le Soir, a crack of between 15 and 20 millimetres (0.6 and 0.8 inches) was discovered during a test in June. There has been no denial of this report.

According to the agency, repairs are "practically impossible" and are "not an option" for fear of creating new tensions "which we must avoid at all costs."

Installing a replacement meanwhile has never been attempted anywhere because of the problem of high radiation levels.

The AFCN revealed on Wednesday that the Doel 3 reactor, located 25 kilometres (20 miles) north of Antwerp, would remain closed at least until August 31 after the discovery of possible cracks in the protective vessel surrounding the core during routine June testing.

The agency is also mulling the permanent closure "in the worst case" of a second reactor in the country's south near Liege.

The tests showed "faults in the steel base material" on which the reactor vessel is mounted, the AFCN said.

The Dutch firm, Rotterdam Drydocks, that made the vessels is out of business, which has amplified concerns about others it delivered in Europe and in the Americas.

Spain has indicated it has two reactors in the same bracket, Switzerland and Sweden one each.

The firm supplied one to the Netherlands, but had not manufactured it. The government in The Hague said it has still to decide whether to test its nuclear facilities.

The German government said reactors supplied by the defunct company were no longer in service.

Representatives of nuclear safety bodies from all the countries involved will meet in Brussels on August 16 to "exchange information," the AFCN said.

Lupold, Timothy

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**From:** Hills, David  
**Sent:** Monday, August 13, 2012 4:32 PM  
**To:** Rosenberg, Stacey; Lupold, Timothy  
**Cc:** Bilik, Tom; Bozga, John; Holmberg, Mel; Jones, Donald; Meghani, Vijay; Neurauter, James; Sanchez Santiago, Elba; Shaikh, Atif  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI – See below regarding applicability to Quad Cities. Who in NRR has technical lead on this issue? Any additional details available?

- Dave

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 2:13 PM  
**To:** Hills, David  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Dave,

I asked the Quad RIO to look into what the licensee knew and was doing on the Belgium NDE results indicating cracking in the vessel. Here's the reply I received from Jim McGhee. Please let me know if you need more or if you find out any more from NRC NDE folks. Thanks.

-Mark

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 1:45 PM  
**To:** Ring, Mark  
**Cc:** Draper, Jason; Elliott, Roy; Orlikowski, Robert; Cushman, Brian  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

The UFSAR quote below is from Section 5.3.1.2. It goes on to say

Chicago Bridge and Iron (CB&I), which completed fabrication of the Unit 2 RPV prior to its shipment to the plant site, provided a certification comparable to the ASME Code N-1A form. The following footnote was included in that certification: [5.3-3]

"This unstamped vessel was built as a 'State Special' based on agreements between the State of Illinois and Commonwealth Edison Company. A portion of the vessel was fabricated by Rotterdam Dockyard Company. This vessel was not stamped because Rotterdam Dockyard Company does not hold an ASME certificate of authorization. Procedures equivalent to the requirements of the ASME Code were used."

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 1:38 PM  
**To:** Ring, Mark  
**Cc:** Cushman, Brian; Draper, Jason; Elliott, Roy; 'LUIS GASCO LEONARTE'; Orlikowski, Robert  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

According to the licensee the affected unit is Unit 2. The following discussion comes from the Section 5.3.2 of the USFSAR:

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The Quad Cities Unit 1 RPV was fabricated entirely in the United States by Babcock & Wilcox (B&W). The Unit 2 RPV was fabricated by several different vendors, including one in Holland, as noted in the following paragraphs. [5.3-2]

Fabrication work on the Unit 2 bottom head assembly and lower shell course was performed by the Rotterdam Dockyard Company (RDM) in Rotterdam, Holland. These two pieces were seam-welded together and returned to the United States as a fully completed subassembly including control rod drive (CRD) stub tubes, shroud support skirt, and vessel support skirt.

According to the licensee, the component steel was fabricated in the US by Babcock & Wilcox. These were sent to RDM where they were "bent" to shape and welded together. Final assembly of the vessel was performed in the US. Without looking further, I can't determine if the beltline region was included in the RDM work.

As far as inspection, they only look at the seam welds. According to the ISI guys, the only other inspection they ever did after initial construction was a VT3 on the inner clad surface and that was stopped after it was determined to have no value.

They had the initial communication on the issue and are currently waiting for more specific information from the utility before determining what they need to do. The sites understanding is that the components in question at the Belgian facility were manufactured in total at the RDM facility as opposed to being assembled there as was Unit 2. I will follow up as more information comes available.

Jim

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**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 11:24 AM  
**To:** McGhee, James  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good. Thanks.

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**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 11:06 AM  
**To:** Ring, Mark  
**Cc:** Cushman, Brian; Orlikowski, Robert; Draper, Jason; Elliott, Roy  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Checking to verify manufacture of Unit 1 RPV and any beltline inspections performed that could show this type defect.

Jim

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**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 9:40 AM  
**To:** Cushman, Brian; McGhee, James; Ray, Teresa  
**Cc:** LUIS GASCO LEONARTE; Draper, Jason; Elliott, Roy; Orlikowski, Robert  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI

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**From:** Lara, Julio  
**Sent:** Monday, August 13, 2012 9:30 AM  
**To:** Casto, Chuck; Pederson, Cynthia; Shear, Gary; Reynolds, Steven; OBrien, Kenneth; Skokowski, Richard

**Cc:** Cameron, Jamnes; Daley, Robert; Dickson, Billy; Duncan, Eric; Giessner, John; Hills, David; Kunowski, Michael; Peterson, Hironori; Riemer, Kenneth; Ring, Mark; Skokowski, Richard; Stone, AnnMarie  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

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**From:** Bernardo, Robert *in VR*  
**Sent:** Monday, August 13, 2012 9:26 AM  
**To:** Taylor, Ryan  
**Cc:** Brand, Javier; Lara, Julio; Powers, Dale  
**Subject:** DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good morning,

We wanted to pass this along to the regional OpE POC's, since there are POTENTIALLY US plants that might be affected (mostly region 2). We'll keep you informed as we get more information.

**IRS 8244P - DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL**

Doel 3 is a PWR that commenced operation in 1982. In July, UT examinations to detect possible under-clad defects of the reactor vessel belt region instead found indications of fabrication flaws. This was the first time this type of testing had been performed on this portion of the vessel. The flaws appear to be laminar in nature, running parallel to the inside and outside surfaces being examined. The vessel rings containing the flaws were forged in the early 1980's at the Rotterdam Dockyards, which also forged reactor vessel rings for several plants in the U.S., including Catawba 1, McGuire 2, North Anna 1 & 2, Quad Cities 1, Sequoyah 1 & 2, Surry 1 & 2, and Watts Bar 1. Staff are in communication with the Belgian regulator to exchange information and review pending results from follow-up testing.

*Bob Bernardo*  
Reactor Systems Engineer  
US Nuclear Regulatory Commission  
NRR/DIRS/IOEB  
O-7D17; MS O-7C02A  
301-415-2621  
[Robert.Bernardo@nrc.gov](mailto:Robert.Bernardo@nrc.gov)

**Ring, Mark**

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**From:** Lara, Julio  
**Sent:** Monday, August 13, 2012 9:30 AM  
**To:** Casto, Chuck; Pederson, Cynthia; Shear, Gary; Reynolds, Steven; OBrien, Kenneth; Skokowski, Richard  
**Cc:** Cameron, Jamnes; Daley, Robert; Dickson, Billy; Duncan, Eric; Giessner, John; Hills, David; Kunowski, Michael; Peterson, Hironori; Riemer, Kenneth; Ring, Mark; Skokowski, Richard; Stone, AnnMarie  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL  
**Attachments:** Doel 3 - Status\_02-08-2012.docx

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**Sent:** Monday, August 13, 2012 9:26 AM  
**To:** Taylor, Ryan  
**Cc:** Brand, Javier; Lara, Julio; Powers, Dale  
**Subject:** DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

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*Bob Bernardo*  
Reactor Systems Engineer  
US Nuclear Regulatory Commission  
NRR/DIRS/IOEB  
O-7D17; MS O-7C02A  
301-415-2621  
[Robert.Bernardo@nrc.gov](mailto:Robert.Bernardo@nrc.gov)

## **Subject**

Summary of the available information and preliminary evaluation by Bel V pertaining to the indications of defects found in the Doel 3 RPV in June - July 2012.

## **Background**

Belgian reactor pressure vessels (RPV) are inspected according to ASME XI. Volumetric inservice-inspections of the beltline area are normally limited to the circumferential welds (there are no axial welds in the Belgian RPVs) and surrounding heat affected zone and base material, within the limits set by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified UT-method for detection of underclad defects, cover a zone of about 30mm thickness from the inner RPV wall and encompass the whole height of the vessel beltline region. This means that cladded base material was inspected where no volumetric in-service inspection was performed up to now.

## **Results of the inspection performed to detect and characterize underclad defects (June 2012)**

At Doel 3, no underclad defects were detected.

Nevertheless, lot of defect indications of an apparently different type were detected by this UT-inspection, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel. These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel, located in and outside the inspected zone. Considering the fact that this inspection method is not qualified for detection at such location and for this type of indications, precise information about shape or dimension is not available at this stage. *First evaluation* shows that these sub-surface flaws are almost circular in shape with a mean diameter of about 15 mm (maximum 30 mm), with a flaw density up to 40 indications per dm<sup>3</sup>. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

## **Results of the second inspection performed to detect and characterize base material defects detected in June 2012 (July 2012)**

Considering the limitations of the inspection method which revealed the presence of those defects in the base material, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV. Results will not be available before beginning of august.

However, the *preliminary* results of this second inspection can be so far summarized as follows:

- This inspection confirms the presence of a large amount of indications in the upper and lower shell rings.
- There is a marked disparity in the flaw densities (factor 1 to 5) between the upper and the lower shell rings. Some 10000 indications were detected in the lower shell ring.
- The shape of the flaw distribution is very similar in both cases.

- The bulk of the indications are located in the base material, outside the weld regions, in a thru thickness zone extending from about 30mm from the inner surface to one half of the RPV thickness.
- These flaw indications seem to be laminar in shape and have average diameters of 25 mm.

#### **Current investigations by the licensee**

- Upper and lower vessel rings of the Doel 3 and Tihange 2 RPVs were forged by the Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM), at the same time and under the same contract.
- The fabrication of both RPVs took place in the same period, following the same requirements.
- According to the Owner, RDM provided 22 vessels in Europe and the US. The list of concerned units provided by the Owner encompasses following units, not necessarily with forged rings: Atucha 1 (Argentina); Doel 3, Tihange 2 (Belgium); Brünsbittel, Philippsburg 1 (Germany); Borssele, Dodewaard (Netherlands); Santa María de Garoña, Cofrentes (Spain); Ringhals 2 (Sweden); Leibstadt, Mühleberg (Switzerland); Catawba 1, Mc Guire 2, North Anna 1, North Anna 2, Quad Cities 1, Sequoyah 1, Sequoyah 2, Surry 1, Surry 2, Watts Bar 1 (USA). RDM does not exist any more.
- The Owner is currently investigating the inspection results. In parallel additional studies are being performed to analyze and, if possible, to validate and confirm the structural integrity of the vessel.
- In the absence of any other explanation at this stage, the licensee supposes the presence of fabrication defects, but does not exclude other explanations.
- Investigations are conducted to retrieve information pertaining to the fabrication and the associated controls. According to the Owner, the defects detected in 2012 should have been detected with the UT procedures used to control the base material at that time. The results of these inspections are not retrieved yet.
- A justification of the observed defects for further exploitation is required by the Belgian regulations, based on ASME XI, App. A. According to first evaluations made by the Owner, alternate requirements will be necessary. The Owner is investigating a.o. alternative rules for regrouping individual indications. A PTS study based on 10CFR50.61a is planned.
- An inspection similar to the inspection performed in July 2012 at Doel 3 will be performed at another Belgian reactor vessel (unit 2 Tihange NPP), during the upcoming outage within a few weeks.

#### **Actions taken by the Belgian Authorities**

- Communication with foreign countries: preliminary IRS; direct contacts with Safety Authorities of foreign countries having RPVs fabricated by RDM.
- Review of the available information w.r.t. the fabrication of the Doel 3 and Tihange 2 RPVs.
- Preliminary evaluation of the approaches aiming at justifying the observed defects for further exploitation.
- Further contacts with the Owner



### **Preliminary evaluation results by Bel V**

- We retrieved very few information pertaining to the fabrication (process, follow-up...). Nevertheless, there exist some evidences of difficulties during fabrication, due to strikes, delays and technical problems.
- The lack of information related to the origin of the defects, their unusual high density in some portions of the RPV are a.o. elements which could possibly question the applicability of the justification methods proposed by the Owner. It is e.g. unclear whether the basic assumptions behind ASME XI, App. A and 10CFR50.61a are compatible with this case.

Poole, Justin

70

**From:** Guzman, Richard *inrr*  
**Sent:** Monday, August 13, 2012 10:46 AM  
**To:** Quichocho, Jessie  
**Cc:** Wilson, George; Pickett, Douglas; Poole, Justin  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Thanks, Jessie. I see that the list of affected plants doesn't include any RI plants; understand Watts Bar 1 is under George's umbrella. Will be on the lookout for tasking. Note that Doug P. is acting tomorrow and Justin has it the rest of the week.

Rich

**From:** Quichocho, Jessie *inrr*  
**Sent:** Monday, August 13, 2012 10:21 AM  
**To:** Guzman, Richard  
**Cc:** Wilson, George  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Rich – FYI....

There may be a near term tasking and short turnaround request...

**From:** Meighan, Sean *inrr*  
**Sent:** Monday, August 13, 2012 9:53 AM  
**To:** Quichocho, Jessie; Dudek, Michael; Poole, Justin  
**Cc:** Evans, Michele  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Read below, get familiar with, stand by for tasking on this.

V/R  
S

**From:** Evans, Michele *inrr*  
**Sent:** Monday, August 13, 2012 7:47 AM  
**To:** Meighan, Sean  
**Cc:** Coffin, Stephanie; Lund, Louise  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Sean,

For today.

Please sort through this email chain and pull together a clear message for the appropriate PMs/Branch Chiefs to send to the list of affected plants. If you have any questions, let me know. Thanks.

Also, who should contact NEI?

Michele

B/109

**From:** Boger, Bruce *mark*  
**Sent:** Monday, August 13, 2012 6:32 AM  
**To:** Evans, Michele; Lund, Louise; Coffin, Stephanie; Nieh, Ho; Lubinski, John  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

DORL--Please see the email thread below. I'd like the PMs for the sites listed to contact the sites and advise them of the issue and media interest. Thanks.

DIRS—Please have the OpE folks make contact with INPO to see if the INPO/WANO pipeline is working the issue. Thanks.

---

**From:** McCree, Victor *Vic*  
**Sent:** Saturday, August 11, 2012 7:49 AM  
**To:** Boger, Bruce  
**Cc:** Wert, Leonard; Croteau, Rick; Jones, William; Reis, Terrence; Christensen, Harold; Brown, Frederick  
**Subject:** Re: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Thanks Bruce!

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**From:** Boger, Bruce  
**To:** McCree, Victor; Dorman, Dan  
**Cc:** Johnson, Michael; Wert, Leonard; Leeds, Eric; Brenner, Eliot; Casto, Chuck; Collins, Elmo; Dean, Bill  
**Sent:** Sat Aug 11 07:35:09 2012  
**Subject:** Re: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

I like your thoughts. We'll reach out to the sites that have been identified and NEI. I'm interested in how the international OpE network will address this issue. Will the WANO/INPO system get the word out? Of course, if the issue moves into a technical concern, we'll engage differently. Stay tuned.....thanks for sharing your thoughts.  
Sent from my BlackBerry

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**From:** McCree, Victor  
**To:** Boger, Bruce; Dorman, Dan  
**Cc:** Johnson, Michael; Wert, Leonard; Leeds, Eric; Brenner, Eliot; Casto, Chuck; Collins, Elmo; Dean, Bill  
**Sent:** Fri Aug 10 17:06:48 2012  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Dan/Bruce,

Given the media exposure this issue has already received, and the likelihood for heightened interest in the potential impact on U.S. plants; what's our near term strategy for engaging the affected licensees (and/or NEI)? In my opinion, we should at least let them know that we are aware of the issue and that we plan to send an expert to participate in a regulator-to-regulator meeting next week to learn more.

Your thoughts?

Vic

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**From:** Boger, Bruce  
**Sent:** Friday, August 10, 2012 4:48 PM  
**To:** McCree, Victor  
**Cc:** Dean, Bill; Lew, David; Wert, Leonard; Dorman, Dan; Hiland, Patrick; Casto, Chuck; Collins, Elmo  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

If you scroll down to the bottom of this email you'll see the initiating request from the Belgium regulator on the Doel situation. We'll know more next week.

**From:** McIntyre, David *DEA*  
**Sent:** Friday, August 10, 2012 10:03 AM  
**To:** Burnell, Scott; Hiland, Patrick  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; Hopkins, Jon; Hardies, Robert; Brenner, Eliot  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Pat – the Dow Jones reporter is asking for details on our “fact finding”. Have we, or will we, ask our licensees on the list whether their RPV's were from the vendor in question?

Thanks,  
Dave

**From:** Burnell, Scott *DEA*  
**Sent:** Friday, August 10, 2012 7:51 AM  
**To:** Hiland, Patrick  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; McIntyre, David; Hopkins, Jon; Hardies, Robert  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Understood, thanks.

**From:** Hiland, Patrick *DEA*  
**Sent:** Friday, August 10, 2012 7:50 AM  
**To:** Burnell, Scott  
**Cc:** Evans, Michele; Boger, Bruce; Dorman, Dan; McIntyre, David; Hopkins, Jon; Hardies, Robert  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

I'm not aware that we've done any “independent” verification of the list of plants whose vessels were reportedly made at RDM. However, the list appears to indicate U.S. RPVs that were manufactured in the 60's and 70's (may not have been operational till the 90's). Bob Hardies is NRR/DE's Senior Level Advisor for Materials and will be on a fact finding mission next Thursday. You should be free to state that one of our experts in the field of Reactor Vessel Materials, has been asked to meet with the Belgian and other regulators next week. As Bruce cautioned, this info is regulator to regulator.

**From:** Burnell, Scott  
**Sent:** Friday, August 10, 2012 7:28 AM  
**To:** Hiland, Patrick; Boger, Bruce; Dorman, Dan; McIntyre, David  
**Cc:** Evans, Michele  
**Subject:** RE: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

Pat;

Thanks very much, that's helpful. Have we had the time to verify Electrabel's list, and how much detail can I share on both that list and Bob's participation in the meeting? Thanks again.

Scott

**From:** Hiland, Patrick  
**Sent:** Friday, August 10, 2012 7:21 AM  
**To:** Burnell, Scott  
**Cc:** Hiland, Patrick; Cheok, Michael; Terao, David; Nieh, Ho; Lubinski, John; Rosenberg, Stacey; Chernoff, Harold; Dudes, Laura; Luehman, James; Evans, Michele; Dorman, Dan; Holahan, Gary; Bergman, Thomas; Hopkins, Jon; Boger, Bruce  
**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure

Vessel

**Importance:** High

Scott, the below info is pretty clear and it includes a list of U.S. plants (at bottom of string) whose RPVs were manufactured by same vendor. The Belgians have asked 7 countries to attend a meeting next Thursday, August 16, and we're sending Bob Hardies from NRR/DE. This would just be a one-day discussion of what type of NDE techniques were used, where the inspections were performed, etc. Looks like a 2<sup>nd</sup> meeting is being lined up for September.

**From:** Hiland, Patrick

**Sent:** Monday, August 06, 2012 11:06 AM

**To:** Boger, Bruce

**Subject:** FW: REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

**Importance:** High

Bruce, I've asked bob Hardies to attend this meeting in response to formal invitation. It's short notice as meeting is next week in Brussels.

**From:** Hopkins, Jon *mt*

**Sent:** Friday, August 03, 2012 9:34 AM

**To:** Fairbanks, Carolyn; Hardies, Robert

**Cc:** Roquecruz, Carla; Hiland, Patrick; Chernoff, Harold; Cheok, Michael; McGinty, Tim; Muesle, Mary; Bahadur, Sher; Regan, Christopher; Astwood, Heather; Rodriguez, Veronica; Tehrani, Navid; Sangimino, Donna-Marie; Dehn, Jeff; Fehst, Geraldine; Nieh, Ho; Lubinski, John; Stahl, Eric

**Subject:** REQUEST: Belgium - Meeting on 8/16 re Flaw indications in Doel 3 Reactor Pressure Vessel

**Importance:** High

Carolyn & Bob,

Belgium's regulator, FANC, has invited nuclear regulators from the 7 countries that also have RPVs manufactured by RDM (list below, includes U.S.) to participate in a technical working meeting on Aug. 16 in Brussels to discuss recent UT inspection indications found on the Doel 3 RPV.

France's regulator, ASN, has already responded and said that they would attend ("ASN will participate to this meeting. The representatives will be: Sébastien CROMBEZ Director of the Nuclear pressure Equipment Department and Jean-Luc LACHAUME Deputy Director General.")

Please let me know if we should/can attend this meeting. Note that FANC plans another meeting in Sept. on this issue.

Thank you, Jon

**From:** VAN WONTERGHEM Frederik [mailto:Frederik.VANWONTERGHEM@FANC.FGOV.BE]

**Sent:** Friday, August 03, 2012 5:05 AM

**To:** Andre-claude.lacoste@asn.fr; jean-luc.lachaume@asn.fr; francois.balestreri@irsn.fr; Sebastien.CROMBEZ@asn.fr; info@arn.gob.ar; gerald.hennenhoefer@bmu.bund.de; martina.palm@bmu.bund.de; Ulrich.Erven@grs.de; Carla.Schwaeger@grs.de; a.vanlimborgh@mineleni.nl; kees.desbouvrie@minvrom.nl; bert.verweij@minvrom.nl; Roeland.Nieuweboer@minvrom.nl; cmt@csn.es; fjarana@mityc.es; jcb@csn.es; ann-louise.eksborg@ssm.se; Anders.Hallman@ssm.se; Lars.Skanberg@ssm.se; perolof.hagg@ssm.se; petteri.tiippana@stuk.fi; hans.wanner@ensi.ch; georg.schwarz@ensi.ch; markus.straub@ensi.ch; dietmar.Kalkhof@ensi.ch; Hopkins, Jon; Kirk, Mark; Hardies, Robert; Collins, Jay

**Cc:** WERTELAERS An; SCHRAUBEN Manfred; DE ROOVERE Willy; TOMBUYES Beatrice;  
pierre.barras@belv.be; pierre.briegleb@belv.be; benoit.deboeck@belv.be; aweyn@vincotte.be;  
hvandriessche@vincotte.be

**Subject:** URGENT Message on Nuclear Safety: Flaw indications in Doel 3 Reactor Pressure Vessel

Dear all,

This week, a preliminary IRS Incident Report was published by Belgium related to the detection of a large number of flaw indications in the reactor pressure vessel of Doel 3 (PWR - Framatome Design). (Reference IRS Number 8244: "FLAWS INDICATIONS IN THE REACTOR PRESSURE VESSEL"). In attachment you can find a copy of this IRS report.

As indicated in the IRS report, the Doel 3 NPP outage has been extended to allow further inspections and to perform additional studies by the licensee to analyze and, if possible, to validate and confirm the structural integrity of the vessel. At the moment, the licensee supposes that the flaw indications were already present at the moment of forging of the vessel, which was done by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). Both a deterministic approach (in accordance with ASME XI Appendix A) and a probabilistic approach (in accordance with 10CFR50.61a) are being considered by the licensee to justify the structural integrity of the reactor vessel.

Some additional information on the types of flaw indications and other possible reactor vessels forged by this company can be found below.

Considering the potential consequences of this event, the Belgian regulatory body would like to organise on short notice a technical working meeting in Brussels on this issue for those regulatory bodies which could be interested by these findings, specifically those regulatory bodies of countries where RPVs forged by RDM can be present.

During this technical working meeting, additional information on the results found at Doel 3 NPP and the on-going licensee investigations and calculations will be made available by the Belgian regulatory body (FANC, its technical support organisation Bel V and the Authorized Inspection Authority AIB Vincotte International). In addition, a roundtable discussion between regulatory bodies will be held to discuss relevant experiences with this kind of inspections and flaw indications. Specific topics/questions to be discussed during this roundtable discussion are mentioned in an email by Bel V which was sent last week (see attachment). We are especially interested to know if this type of ISI was already performed in your countries on the reactor vessels forged by this company, and if so, what the results have been. May we kindly invite every country to present additional available input and thoughts to our working meeting .

**This technical working meeting shall take place in Brussels (FANC offices, Ravensteinstraat 36, 1000 Brussels) on Thursday 16 August between 10h00 and 16h00.**

We would be very grateful if one or more technical experts of your organisation could be present during this working meeting.

To confirm your participation, please send me a reply by email to [frederik.vanwonderghem@fanc.fgov.be](mailto:frederik.vanwonderghem@fanc.fgov.be) (tel. ++32 2 289 2082) before Friday 10 August.

If you have further technical questions on this event, you can contact [pierre.briegleb@belv.be](mailto:pierre.briegleb@belv.be) (tel ++32 2 528 0245).

A second technical working meeting could be held in the near future (presumably early September) to discuss the available results of the additional inspections at Tihange 2 and the results of the licensee investigations and calculations aiming to confirm the structural integrity of the reactor vessel. Further actions in your countries can also be discussed during this second meeting. We will inform you as soon as possible of the timing of this second working meeting.

Best regards,

Frederik Van Wonderghem

Department of Nuclear Facilities and Waste

Federal Agency for Nuclear Control  
Ravensteinstraat 36, 1000 Brussel, Belgium  
[www.fanc.fgov.be](http://www.fanc.fgov.be)  
Tel.: +32 (0)2 289 20 82  
Fax: +32 (0)2 289 21 12

### Additional information on the types of flaw indications and other possible reactor vessels

- Preliminary results from additional inspections
  - o As described in the IRS message, considering the limitations of the inspection method which revealed the presence of those defects, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV of Doel 3.
  - o The preliminary results from those additional inspections confirm the presence of several thousand (up to 10000) flaw indications in the reactor vessel base material. These flaw indications seem to be laminar in shape and have average diameters of 25 mm.
- Reactor Pressurized Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)
  - o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
  - o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Atucha 1	PHWR		335	1980	Si
Doel 3	PWR	3	1000	1982	Fr
Tihange 2	PWR	3	1000	1982	Fr
Brünsbuttel	BWR	-	770	1977	Kl
Philippsburg 1	BWR		890	1980	Kl
Dodewaard	BWR	-	52	1968	RI
Borssele	PWR	2	515	1973	Kl
S <sup>ta</sup> Maria de Garona	BWR		450	1971	Ge
Cofrentes	BWR	-	1064	1984	Ge
Ringhals 2	PWR	3	813	1974	W
Leibstadt	BWR	-	1165	1984	Ge
Mühleberg	BWR	-	373	1971	Ge
Catawba 1	PWR	4	1129	1985	W
McGuire 2	PWR	4	1100	1983	W
North Anna 1	PWR	3	903	1978	W
North Anna 2	PWR	3	973	1980	W
Quad Cities 1	BWR	-	882	1972	Ge
Sequoyah 1	PWR	4	1162	1980	W
Sequoyah 2	PWR	4	1126	1981	W
Surry 1	PWR	3	839	1972	W
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Watts Bar 1	PWR	4	1123	1996	W



FAIR PLAY FOR AMSTERDAM - FANC - FAIR PLAY FOR AMSTERDAM

FAIR PLAY FOR AMSTERDAM - FAIR PLAY FOR AMSTERDAM

**Het FANC is ISO 9001:2008 gecertificeerd – L'AFCN est certifiée ISO 9001:2008.**

Aub. denk aan het milieu voordat u deze mail uitprint.  
Svp. pensez à notre environnement avant d'imprimer ce mail.

**Disclaimer (Fr) - Disclaimer (Nl)**



**From:** Tsao, John *NTC*  
**Sent:** Monday, August 13, 2012 3:48 PM  
**To:** Lupold, Timothy; Collins, Jay; Wallace, Jay; Alley, David; Hoffman, Keith; Audrain, Margaret; Rezai, Ali; Cumblidge, Stephen; Rodriguez-Luccioni, Hector  
**Subject:** Notes from the Branch chief meeting on 8/13/2012

Notes from the Branch chief meeting On August 13, 2012

1. The Doel nuclear plant in Belgium detected many (thousands?) indications in the undercladding in the reactor vessel beltline area. Belgium originally stated that the indications were fabrication related but some of the indications appeared in the base metal (?). The RPV in Doel was manufactured by Rotterdam which also manufactured RPV in 10 US nuclear plants. Bob Hardies will be going to Belgium this week to find out the situation. Tim knows more about this issue.

DORL—Millstone plants shutdown because the temperature of the ultimate sink (Long Island Sound) exceeded 75 degrees F. Ft Calhoun—NRR/DE/EMCB found discrepancy in strength calculations of structural beams in the containment. EMCB is reviewing whether the beams are able to support the heavy lifting in the upcoming defueling activities.

DLR---will hold a public meeting to discuss the Davis Besse license renewal application and bio-shield issue. Congressman Kushinichi (spelling?) is getting involved.

Tuesday, August 21, NRR executive will meet with NEI's Alex Marion.

Office of Congressional affairs---Congressman Markey is interested in various issues related to Palisades.

JLD (Japan lessons learned division?)—spent fuel pool instrument issue, seismic qualification issue.

Palisades detected leakage in a CRDM housing (CRD-24) up to 0.5 gpm on August 12. The plant is shutdown due to the leakage. The leak occurred at about 1 foot above the CRDM flange which is above the RPV penetration nozzles.

Palo Verde plans to submit a relief request for UT in lieu of RT. We will have a public meeting asking the licensee to make a presentation before it submits the relief request. We will invite RES and NRO to attend the public meeting also.

Thanks.

John

Poehler, Jeffrey

61

**From:** Poehler, Jeffrey *ml*  
**Sent:** Monday, August 13, 2012 4:00 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Watts Bar 2 hasn't operated yet...but may soon. Surry 1 and 2 were welded by Rotterdam but of plate not forgings.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Hardies, Robert *ml*  
**Sent:** Monday, August 13, 2012 3:58 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Mystery solved. The numbers work out now. But which is the plant that has never operated....or s that one not on this list?

**From:** Hopkins, Jon *ml*  
**Sent:** Monday, August 13, 2012 3:52 PM  
**To:** Hiland, Patrick  
**Cc:** Cheok, Michael; Hardies, Robert  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Pat,

Verification from DORL of U.S. NPPs with RDM reactor pressure vessels is below. Yes except for the BWRs, Fermi & Quad, No.

Jon

**From:** Meighan, Sean *ml*  
**Sent:** Monday, August 13, 2012 3:47 PM  
**To:** Roque-Cruz, Carla; Hopkins, Jon  
**Cc:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh; Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon:

Below is the requested info re: RPVs forged by Rotterdam Dockyards (RDM).

With this e-mail I consider the question to be answered. If you need further info, please send e-mail to me and cc: Michele Evans.

V/R

B/HA

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Rehmi 2	no	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	
Quad Cities 1	no	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1 & 2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drogdsk Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1 & 2	Yes	

**From:** Meighan, Sean

**Sent:** Monday, August 13, 2012 10:57 AM

**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh

**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee

would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

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Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westi
Fermi 2					
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North Anna 1	PWR	3	903	1978	Westi
North Anna 2	PWR	3	973	1980	Westi
Quad Cities 1	BWR	-	882	1972	Gener
Sequoyah 1	PWR	4	1162	1980	Westi
Sequoyah 2	PWR	4	1126	1981	Westi
Surry 1	PWR	3	839	1972	Westi
Surry 2	PWR	3	800	1973	Westi
Watts Bar 1	PWR	4	1123	1996	Westi
Watts Bar 2	PWR				Westi

**From:** Hopkins, Jon

**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

- Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)
  - o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.

- o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Doel 3	PWR	3	1000	1982	Fr
Tihange 2	PWR	3	1000	1982	Fr
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**Poehler, Jeffrey**

---

**From:** Hardies, Robert  
**Sent:** Monday, August 13, 2012 3:58 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

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**To:** Hiland, Patrick  
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Pat,

Verification from DORL of U.S. NPPs with RDM reactor pressure vessels is below. Yes except for the BWRs, Fermi & Quad, No.

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**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon:

Below is the requested info re: RPVs forged by Rotterdam Dockyards (RDM).

With this e-mail I consider the question to be answered. If you need further info, please send e-mail to me and cc: Michele Evans.

V/R  
s

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Fermi 2	no	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	

Quad Cities 1	no	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1 & 2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drodgdak Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1 & 2	Yes	

**From:** Meighan, Sean

**Sent:** Monday, August 13, 2012 10:57 AM

**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh

**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

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**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

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- o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
- o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

	Doel 3	PWR	3	1000	1982	Fr
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Catawba 1	PWR	4	1129	1985	W
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Watts Bar 1	PWR	4	1123	1996	W
Watts Bar 2	PWR				W

From: Poehler, Jeffrey  
Sent: Monday, August 13, 2012 4:33 PM  
To: Fairbanks, Carolyn  
Subject: DOEL 3 Issue - List of Plants with Forgings Manufactured by Rotterdam

Carla, in response to the action from last Friday's briefing to confirm the list of plants:

Carolyn – status of what we know so far....

EVIB investigated available information to determine which plants have reactor vessels fabricated by Rotterdam Dockyards, and which of these reactor vessels are fabricated entirely from forgings.

The main source of information is the Reactor Vessel Integrity Database (RVID). The information in this database is from licensee submittals in response to Generic Letter 92-01, "Reactor Vessel Structural Integrity," Rev. 1, and Generic Letter 92-01, Supplement 1. When the database was initially published, the staff requested each licensee to verify the contents of the database were correct for their plants. This was done for each revision of the database – the most recent revision is Revision 2. The staff also referred to NUREG-1511, "Reactor Pressure Vessel Status Report," December 1994, and NUREG-1511, Supplement 2, "Reactor Pressure Vessel Status Report," October 2000.

Summary – Seven US operating reactors have RV's fabricated primarily of forgings and the RV was assembled (welded) by Rotterdam Dockyards.

One US reactor that has never operated has an RVs fabricated primarily of forgings for which the RV was assembled (welded) by Rotterdam Dockyards

Two US reactors have vessels not primarily fabricated of forgings for which some of the vessel welds were made by Rotterdam Dockyards.

One US reactor has a vessel not primarily fabricated of forgings for which some of the vessel welds may have been made by Rotterdam Dockyards (conflicting information).

The following U.S. plants have reactor vessels fabricated primarily from forgings that were also assembled (welded together) by Rotterdam Dockyards:

Catawba 1  
North Anna 1  
North Anna 2  
Sequoyah 1  
Sequoyah 2  
McGuire 2  
Watts Bar 1

The following U.S. plants have reactor vessels with some welds made by Rotterdam Dockyards, but the vessels are primarily fabricated from plate:

Surry 1  
Surry 2

Surry Units 1 and 2, were partially assembled by Rotterdam Dockyards, but the beltline portion of the vessel was manufactured from welded plates, not forgings. Some of the vessel welds were done by Rotterdam. The Surry 1 and Surry 2 reactor vessels do have a "nozzle shell forging" – but the information we have does not indicate the manufacturer for the "nozzle shell forging."

NUREG-1511 indicates that the Quad Cities, Unit 2 RV was partially manufactured by Rotterdam Dockyards. NUREG-1511, Supplement 2 further elaborates that for Quad Cities Unit 2, the axial welds within each shell course were fabricated by Babcock & Wilcox, and the circumferential welds were fabricated by Chicago Bridge & Iron. Therefore, it is not clear if the Quad Cities, Unit 2 RV was fabricated by Rotterdam Dockyards or to what extent.

For Quad Cities 1, the reactor vessel is fabricated from plates. NUREG-1511 lists the vessel manufacturer as Babcock & Wilcox.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Fairbanks, Carolyn  
**Sent:** Monday, August 13, 2012 4:06 PM  
**To:** Poehler, Jeffrey; Hardies, Robert  
**Cc:** Hopkins, Jon  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

I think Quad Cities 1 should be 2, not 1. From NUREG-1511:

Plant Name: Quad Cities 2  
Docket Number: 50-265  
NSSS Vendor: General Electric  
Vessel Manufacturer: CB&I, B&W, and Rotterdam Dockyard Co.  
Edition of ASME Code for Design: Summer 1965 Addenda to the 1965 ASME Code  
Date of Commercial Operation: March 10, 1973  
Date of License Expiration: December 14, 2012  
ART for the Limiting Beltline Material:  
Limiting Beltline Material: Axial welds, heat PQ-1300  
ID Fluence at EOL:  $4.9E17$  n/cm<sup>2</sup>  
Initial RT  $T_t$ : 40°F  
Method of determining the Chemistry Factor: Chemistry data per Paragraph **C.1.1** of RG 1.99, Rev. 2  
Increase in RTNDT at EOL: 46°F  
Margin: 46°F  
ART at EOL: **132 °F**  
USE for the Limiting Beltline Material:  
Limiting Beltline Material: Lower shell plate, heat C-1501-2 and axial welds, heat PQ-1300.  
1/4T Fluence at EOL:  $3.4E17$  n/cm<sup>2</sup>  
Initial USE: Heat-specific values not reported  
Percent Drop at EOL: 12% for plate and 20% for weld  
USE at EOL: Not applicable because heat-specific values not reported  
Date at which Screening Limit will be Exceeded: Not applicable because heat-specific values not reported  
Bases for Accepting the USE at EOL: Equivalent margins analysis was performed in Topical Report NEDO-32205, Rev. 12  
References:  
Initial RT chemical composition, initial USE, and fluence data are from July 1, 1992, letter from M. A. Jackson (CECo) to T. E. Murley (USNRC), Subject: Dresden Station Units 2 and 3; Quad Cities Station Units 1 and 2; LaSalle County Station Units 1 and 2  
iStaff

**From:** Poehler, Jeffrey  
**Sent:** Monday, August 13, 2012 4:00 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

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V/R  
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Nuclear Power Plants						
	Catawba 1	PWR	4	1129	1985	W
	Fermi 2					
	McGuire 2	PWR	4	1100	1983	W
	North Anna 1	PWR	3	903	1978	W
	North Anna 2	PWR	3	973	1980	W
	Quad Cities 1	BWR	-	882	1972	G
	Sequoyah 1	PWR	4	1162	1980	W
	Sequoyah 2	PWR	4	1126	1981	W
Surry 1	PWR	3	839	1972	W	
Surry 2	PWR	3	800	1973	W	
Watts Bar 1	PWR	4	1123	1996	W	
Watts Bar 2	PWR				W	



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**Poehler, Jeffrey**

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**From:** Fairbanks, Carolyn *in yr*  
**Sent:** Monday, August 13, 2012 1:20 PM  
**To:** Poehler, Jeffrey  
**Subject:** Watts Bar 2 did have a (joint) GL 92-01 response

From NUREG-1511"

Plant Name: Watts Bar 2  
Docket Number: 50-391  
NSSS Vendor: Westinghouse  
Vessel Manufacturer: Rotterdam Dockyard  
Edition of ASME Code for Design: Summer 1971 Addenda to the 1971 ASME Code  
Date-of Commercial Operation: License has not been issued  
Date of License Expiration: License has not been issued  
RTpt, for the Limiting Beltline Material:  
Limiting Beltline Material: Circumferential weld, heat 895075  
ID Fluence at EOL: 3.18E19 n/cm2  
Initial RT -50°F  
Method of Determining Chemistry Factor: Chemistry data per Paragraph C.1.1 of RG 1.99, Rev. 2  
Increase in RTNDT at EOL: 89°F  
Margin: 56°F  
RTt at EOL: 950F  
Date at which PTS Screening Limit will be exceeded: After **EOL**  
USE for the Limiting Beltline Material:  
Limiting Beltline Material: Lower shell forging 04, heat 528658  
1/4T Fluence at EOL: 1.90E19 n/cm2  
Initial USE: 105 ft-lb  
Percent Drop at EOL: 22.1%  
USE at EOL: 82 ft-lb  
Date USE Screening Limit will be Exceeded: After EOL  
Bases for Accepting the USE at EOL: Chemistry data per Paragraph C.1.2 of RG 1.99, Rev. 2  
REFERENCES:  
July 7, 1992, letter from R. M. Shell (TVA) to USNRC Document Control Desk, Subject: Browns Ferry Nuclear Plant, Sequoyah Nuclear Plant, and

B/H5

Watts Bar Nuclear Plant--Response to Generic Letter 92-01 (Reactor  
Vessel Structural Integrity)

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Poehler, Jeffrey

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**From:** Fairbanks, Carolyn  
**Sent:** Monday, August 13, 2012 3:48 PM  
**To:** Hardies, Robert; Poehler, Jeffrey  
**Subject:** RE: rotterdam plants

Watts Bar 1 and 2

**From:** Hardies, Robert  
**Sent:** Monday, August 13, 2012 3:43 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** rotterdam plants

According to the Westinghouse folks here, there were 11 plants that have vessels that Westinghouse got from Rotterdam. Some of them were the entire vessel and some were vessels that were started at B&W and finished at Rotterdam. 10 of them are U.S. plants. One of those 10 has not yet started up (which I think means some plant in Tennessee that has never run). That should leave nine plants in the U.S., except that I come up with ten plants without the plant that hasn't started up, so something isn't quite right.

North Anna 1&2  
Surry 1&2  
Quad Cities  
Sequoia 1&2  
Watts Bar  
McGuire 2  
Catawba 1

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66

Poole, Justin

**From:** Meighan, Sean *nmr*  
**Sent:** Monday, August 13, 2012 10:57 AM  
**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh  
**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)  
**Attachments:** Potential problem on the reactor pressure vessel (RPV) of the Belgian Doel 3 NPP; Doel 3 - RPV preliminary IRS report\_final.docx

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

**Due:** COB today.

Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westinghouse
Fermi 2					
McGuire 2	PWR	4	1100	1983	Westinghouse
North Anna 1	PWR	3	903	1978	Westinghouse
North Anna 2	PWR	3	973	1980	Westinghouse
Quad Cities 1	BWR	-	882	1972	General Elect
Sequoyah 1	PWR	4	1162	1980	Westinghouse
Sequoyah 2	PWR	4	1126	1981	Westinghouse
Surry 1	PWR	3	839	1972	Westinghouse
Surry 2	PWR	3	800	1973	Westinghouse
Watts Bar 1	PWR	4	1123	1996	Westinghouse
Watts Bar 2	PWR				Westinghouse

B/117

**From:** Hopkins, Jon *in*  
**Sent:** Monday, August 13, 2012 10:06 AM  
**To:** Meighan, Sean  
**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

- The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
- The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Doel 3	PWR	3	1000	1982	Framatom
Tihange 2	PWR	3	1000	1982	Framatom
Catawba 1	PWR	4	1129	1985	Westinghc
Fermi 2					
McGuire 2	PWR	4	1100	1983	Westinghc
North Anna 1	PWR	3	903	1978	Westinghc
North Anna 2	PWR	3	973	1980	Westinghc
Quad Cities 1	BWR	-	882	1972	General El
Sequoyah 1	PWR	4	1162	1980	Westinghc
Sequoyah 2	PWR	4	1126	1981	Westinghc
Surry 1	PWR	3	839	1972	Westinghc
Surry 2	PWR	3	800	1973	Westinghc
Watts Bar 1	PWR	4	1123	1996	Westinghc
Watts Bar 2	PWR				Westinghc

Poole, Justin

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**From:** Poole, Justin  
**Sent:** Monday, August 13, 2012 11:05 AM  
**To:** Guzman, Richard  
**Cc:** Pickett, Douglas; Hon, Andrew  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Got it. Just talked with TVA and they are getting me the answer.

Justin C. Poole  
Sr. Project Manager  
NRR/DORL/LPWB  
U.S. Nuclear Regulatory Commission  
(301)415-2048  
email: [Justin.Poole@nrc.gov](mailto:Justin.Poole@nrc.gov)

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**From:** Guzman, Richard  
**Sent:** Monday, August 13, 2012 11:01 AM  
**To:** Poole, Justin  
**Cc:** Pickett, Douglas; Hon, Andrew  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Justin – please keep Doug and I informed of your completion of this tasking.

Thanks,  
Rich

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**From:** Meighan, Sean  
**Sent:** Monday, August 13, 2012 10:57 AM  
**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh  
**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

**Due:** COB today.

B/118

Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westinghouse
Fermi 2					
McGuire 2	PWR	4	1100	1983	Westinghouse
North Anna 1	PWR	3	903	1978	Westinghouse
North Anna 2	PWR	3	973	1980	Westinghouse
Quad Cities 1	BWR	-	882	1972	General Elect
Sequoyah 1	PWR	4	1162	1980	Westinghouse
Sequoyah 2	PWR	4	1126	1981	Westinghouse
Surry 1	PWR	3	839	1972	Westinghouse
Surry 2	PWR	3	800	1973	Westinghouse
Watts Bar 1	PWR	4	1123	1996	Westinghouse
Watts Bar 2	PWR				Westinghouse

**From:** Hopkins, Jon *NRK*  
**Sent:** Monday, August 13, 2012 10:06 AM  
**To:** Meighan, Sean  
**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

- o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
- o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

COUNTRY	Plant	Reactor Type	RPV Forged by RDM	Year of Construction	Year of First Criticality	Manufacturer
Belgium	Doel 3	PWR	3	1000	1982	Framatom





Poole, Justin

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**From:** Poole, Justin *MPR*  
**Sent:** Monday, August 13, 2012 1:18 PM  
**To:** Meighan, Sean  
**Cc:** Guzman, Richard; Pickett, Douglas  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

TVA responded back by phone that the Watts Bar 1 and 2 RPV's were forged by Rotterdam.

Justin C. Poole  
Sr. Project Manager  
NRR/DORL/LPWB  
U.S. Nuclear Regulatory Commission  
(301)415-2048  
email: [Justin.Poole@nrc.gov](mailto:Justin.Poole@nrc.gov)

**From:** Meighan, Sean *MPR*  
**Sent:** Monday, August 13, 2012 10:57 AM  
**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh  
**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

**Due:** COB today.

Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westinghouse
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Fermi 2					
McGuire 2	PWR	4	1100	1983	Westinghouse
North Anna 1	PWR	3	903	1978	Westinghouse
North Anna 2	PWR	3	973	1980	Westinghouse
Quad Cities 1	BWR	1	882	1972	General Electric
Sequoyah 1	PWR	4	1162	1980	Westinghouse
Sequoyah 2	PWR	4	1126	1981	Westinghouse
Surry 1	PWR	3	839	1972	Westinghouse
Surry 2	PWR	3	800	1973	Westinghouse
Watts Bar 1	PWR	4	1123	1996	Westinghouse
Watts Bar 2	PWR				Westinghouse

**From:** Hopkins, Jon

**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries).. This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

- o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
- o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Doel 3	PWR	3	1000	1982	Framatom
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	Fermi 2					
	McGuire 2	PWR	4	1100	1983	Westinghc
	North Anna 1	PWR	3	903	1978	Westinghc
	North Anna 2	PWR	3	973	1980	Westinghc
	Quad Cities 1	BWR	-	882	1972	General El
	Sequoyah 1	PWR	4	1162	1980	Westinghc
	Sequoyah 2	PWR	4	1126	1981	Westinghc
	Surry 1	PWR	3	839	1972	Westinghc
	Surry 2	PWR	3	800	1973	Westinghc
	Watts Bar 1	PWR	4	1123	1996	Westinghc
	Watts Bar 2	PWR				Westinghc

Poole, Justin

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**From:** Lingam, Siva *NRV*  
**Sent:** Monday, August 13, 2012 4:24 PM  
**To:** Meighan, Sean  
**Cc:** Quichocho, Jessie; Wilson, George; Poole, Justin; Hon, Andrew  
**Subject:** RE: RPV Material Issue

**From:** Mackaman, Clyde Douglas [<mailto:cdmackaman@tva.gov>] *TVA*  
**Sent:** Monday, August 13, 2012 4:21 PM  
**To:** Lingam, Siva  
**Cc:** Lee, Henry; Proffitt, James W Jr; Guinn, Donna Kay; Robinson, Anne E  
**Subject:** FW: RPV Material Issue

Siva,

We now have evidence that Watts Bar Units 1 and 2 also have reactor vessels manufactured by Rotterdam Dockyard Company.

Clyde Mackaman

TVA Corp. Licensing  
423-751-2834

**From:** Mackaman, Clyde Douglas *TVA*  
**Sent:** Monday, August 13, 2012 1:52 PM  
**To:** 'Lingam, Siva'  
**Cc:** Lee, Henry; Proffitt, James W Jr  
**Subject:** RE: RPV Material Issue

Siva,

I received your emails both at the same time at about 1:25 PM. As indicated in our phone conversation regarding this issue, Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drodgdak Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.

Clyde Mackaman

TVA Corp. Licensing  
423-751-2834

**From:** Lingam, Siva [<mailto:Siva.Lingam@nrc.gov>]  
**Sent:** Monday, August 13, 2012 12:13 PM  
**To:** Mackaman, Clyde Douglas  
**Cc:** Quichocho, Jessie; Meighan, Sean  
**Subject:** RE: RPV Material Issue

B/120

At your request, I am resending the e-mail.

Per our telephone conversation, attached please find the related information.

Please verify if Sequoyah 1 and 2 Reactor Pressure Vessels were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. **NRC is interested in who forged the parts**

Please respond by COB today. Thank you and sorry for the short notice!

---

**From:** Mackaman, Clyde Douglas [<mailto:cdmackaman@tva.gov>]

**Sent:** Monday, August 13, 2012 11:59 AM

**To:** Lingam, Siva

**Subject:** RPV Material Issue

Siva,

I still did not receive your email. Please try to attach the information in a response to this email.

Clyde

**Q&A for Chairman Macfarlane on Cracks Found in Belgian Nuclear Plant Reactor Vessel**  
**For the August 14, 2012, National Press Club Media Roundtable**

**Q: How is the NRC responding to the discovery of cracks in a Belgian nuclear plant's reactor pressure vessel (RPV) and the news that as many as 10 US plants have RPV's manufactured by the same vendor?**

**A:** We are doing two things:

1. We are sending one of our top engineering experts on reactor vessel materials to Brussels to meet Thursday (August 16, 2012) with regulators from Belgium and other countries with plants that used the same vendor. This is a fact-finding mission to learn more about the inspection at the Doel-3 reactor and its findings. I want to stress that the information we have at this stage is preliminary and incomplete – we don't yet know the full nature and extent of the problem, if any. We should know more when our expert reports back on Monday.
2. We are attempting to verify which US plants have pressure vessels from the same vendor. Our databases contain information that can be sorted several different ways, i.e. down to component piece. So, we are asking the 10 most likely owners to verify for us whether their pressure vessels were manufactured by the Dutch company that made the vessel for Doel-3.

**Q: Will you order the US plants to shut down for inspections?**

**A:** It's too early to make any decision on what to do. We do not yet know the full nature and extent of the Belgian reactor's condition. We want to know more about the tests that were performed and any additional inspections that the Belgian regulators may be planning. At this time, there is no information that would warrant further action on our part.

**Background information**

- During a scheduled ultrasound exam of Belgium's Doel-3 reactor, the owner identified anomalies or "indications" in the vessel base metal. We understand the scheduled examination used a new technique and identified anomalies in unexpected areas; therefore, the request by Belgium for assistance in characterizing the significance.
- It is premature to call these indications "cracks." They are best characterized as "ultrasonic indications" or "flaw indications." The subtle difference is that they are reflections of sound energy during an ultrasonic examination while a crack is just what it sounds like. The analogy in medical imagery is when an x-ray shows a mass, a follow up technique is applied to see whether the mass is benign, malignant, or something else altogether.
- The Belgian reactor was not shut down because of this problem; the potential indications were discovered during a planned inspection during a refueling and maintenance outage.
- Dominion Nuclear confirmed to Platts that their four Virginia reactors (North Anna 1&2, Surry 1&2) have RPVs from the Dutch vendor.
- The expert going to Brussels is **Robert Hardies**, senior technical advisor for materials science in the Division of Engineering, Office of Nuclear Reactor Regulation (NRR).

## Ring, Mark

**From:** Shear, Gary  
**Sent:** Tuesday, August 14, 2012 6:04 AM  
**To:** Ring, Mark  
**Cc:** Giessner, John; Riemer, Kenneth; Cameron, Jamnes; Casto, Chuck; Kunowski, Michael; Lara, Julio; Duncan, Eric  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

fyi

**From:** Hiland, Patrick  
**Sent:** Monday, August 13, 2012 3:15 PM  
**To:** McIntyre, David; Burnell, Scott  
**Cc:** Wert, Leonard; Howell, Art; Pederson, Cynthia; Lew, David; Brown, Frederick; Ogle, Chuck; Roberts, Darrell; Miller, Chris; Reis, Terrence; Croteau, Rick; Ogle, Chuck; Munday, Joel; Reynolds, Steven; Shear, Gary; OBrien, Kenneth; Kennedy, Kriss; Vogel, Anton; Blount, Tom; Howe, Allen; Dorman, Dan; Boger, Bruce; Cheok, Michael; Hardies, Robert; Poehler, Jeffrey; Evans, Michele  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

David/Scott, we've confirmed through DORL's direct conversations with licensees that 10 U.S. reactor vessels were manufactured at Rotterdam. Note that our list contains one plant not on the Belgium list (Watts Bar -2) and identification that contrary to the Belgium list, Quad Cities 1 was not manufactured by Rotterdam (see note).

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Fermi 2	No	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	
Quad Cities 1	No	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1&2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drodgdak Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1&2	Yes	

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**From:** Rosenberg, Stacey *NR*  
**Sent:** Wednesday, August 15, 2012 8:49 AM  
**To:** Hiland, Patrick  
**Cc:** Fairbanks, Carolyn; Cheok, Michael; Hardies, Robert; Poehler, Jeffrey  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Yes, I agree. I will provide you with a lead POC tomorrow (Thursday).

**From:** Hiland, Patrick *NR*  
**Sent:** Tuesday, August 14, 2012 8:56 AM  
**To:** Rosenberg, Stacey  
**Cc:** Fairbanks, Carolyn; Cheok, Michael; Hardies, Robert; Poehler, Jeffrey  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Stacey, I need someone to follow these types of insights. Hardies can participate, but I believe this task should be lead by your branch?

**From:** Ring, Mark *NR*  
**Sent:** Tuesday, August 14, 2012 8:41 AM  
**To:** Shear, Gary; Hiland, Patrick  
**Cc:** Giessner, John; Riemer, Kenneth; Cameron, Jamnes; Casto, Chuck; Kunowski, Michael; Lara, Julio; Duncan, Eric  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Gary and Pat,

My info from the FSAR by way of the SRI and the licensee is a little different. This indicates that the Quad U2 bottom head assembly of the vessel was "made" by Rotterdam (see below).

According to the licensee the affected unit is Unit 2. The following discussion comes from the Section 5.3.2 of the USFSAR:

The Quad Cities Unit 1 RPV was fabricated entirely in the United States by Babcock & Wilcox (B&W). The Unit 2 RPV was fabricated by several different vendors, including one in Holland, as noted in the following paragraphs. [5.3-2]

Fabrication work on the Unit 2 bottom head assembly and lower shell course was performed by the Rotterdam Dockyard Company (RDM) in Rotterdam, Holland. These two pieces were seam-welded together and returned to the United States as a fully completed subassembly including control rod drive (CRD) stub tubes, shroud support skirt, and vessel support skirt.

The UFSAR quote below is from Section 5.3.1.2. It goes on to say

Chicago Bridge and Iron (CB&I), which completed fabrication of the Unit 2 RPV prior to its shipment to the plant site, provided a certification comparable to the ASME Code N-1A form. The following footnote was included in that certification: [5.3-3]

"This unstamped vessel was built as a 'State Special' based on agreements between the State of Illinois and Commonwealth Edison Company. A portion of the vessel was fabricated by Rotterdam Dockyard Company. This vessel was not stamped because Rotterdam Dockyard Company does not hold an ASME

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certificate of authorization. Procedures equivalent to the requirements of the ASME Code were used."

SRI: "For Unit 2, according to the licensee, the component steel was fabricated in the US by Babcock & Wilcox. These were sent to RDM where they were "bent" to shape and welded together. Final assembly of the vessel was performed in the US. Without looking further, I can't determine if the beltline region was included in the RDM work.

As far as inspection, they only look at the seam welds. According to the ISI guys, the only other inspection they ever did after initial construction was a VT3 on the inner clad surface and that was stopped after it was determined to have no value.

They (licensee) had the initial communication on the issue and are currently waiting for more specific information from the utility before determining what they need to do. The sites understanding is that the components in question at the Belgian facility were manufactured in total at the RDM facility as opposed to being assembled there as was Unit 2. Will follow up as more information comes available."

We communicated this info to Dave Hills and our ISI guys yesterday.

-Mark

**From:** Shear, Gary  
**Sent:** Tuesday, August 14, 2012 6:04 AM  
**To:** Ring, Mark  
**Cc:** Giessner, John; Riemer, Kenneth; Cameron, Jamnes; Casto, Chuck; Kunowski, Michael; Lara, Julio; Duncan, Eric  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

fyi

**From:** Hiland, Patrick  
**Sent:** Monday, August 13, 2012 3:15 PM  
**To:** McIntyre, David; Burnell, Scott  
**Cc:** Wert, Leonard; Howell, Art; Pederson, Cynthia; Lew, David; Brown, Frederick; Ogle, Chuck; Roberts, Darrell; Miller, Chris; Reis, Terrence; Croteau, Rick; Ogle, Chuck; Munday, Joel; Reynolds, Steven; Shear, Gary; OBrien, Kenneth; Kennedy, Kriss; Vogel, Anton; Blount, Tom; Howe, Allen; Dorman, Dan; Boger, Bruce; Cheok, Michael; Hardies, Robert; Poehler, Jeffrey; Evans, Michele  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

David/Scott, we've confirmed through DORL's direct conversations with licensees that 10 U.S. reactor vessels were manufactured at Rotterdam. Note that our list contains one plant not on the Belgium list (Watts Bar -2) and identification that contrary to the Belgium list, Quad Cities 1 was not manufactured by Rotterdam (see note).

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Fermi 2	No	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	
Quad Cities 1	No	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV</b>

		<b>history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1&2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drodgdak Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1&2	Yes	

**Poehler, Jeffrey**

**From:** Hopkins, Jon *inr*  
**Sent:** Wednesday, August 15, 2012 10:10 AM  
**To:** Poehler, Jeffrey  
**Cc:** Cheok, Michael; Hiland, Patrick  
**Subject:** QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jeff,

For Surry 1 and 2, did RDM make the plate for the RPVs or did it just weld together the plates supplied by someone else?

Thank you, Jon

**From:** Poehler, Jeffrey *inr*  
**Sent:** Monday, August 13, 2012 4:00 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Watts Bar 2 hasn't operated yet...but may soon. Surry 1 and 2 were welded by Rotterdam but of plate not forgings.

Jeffrey C. Poehler  
 Sr. Materials Engineer  
 NRR/DE/EVIB  
 (301) 415-8353

**From:** Hardies, Robert *inr*  
**Sent:** Monday, August 13, 2012 3:58 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Mystery solved. The numbers work out now. But which is the plant that has never operated...or s that one not on this list?

**From:** Hopkins, Jon  
**Sent:** Monday, August 13, 2012 3:52 PM  
**To:** Hiland, Patrick  
**Cc:** Cheok, Michael; Hardies, Robert  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Pat,

Verification from DORL of U.S. NPPs with RDM reactor pressure vessels is below. Yes except for the BWRs, Fermi & Quad, No.

Jon

**From:** Meighan, Sean *MSK*

**Sent:** Monday, August 13, 2012 3:47 PM

**To:** Roque-Cruz, Carla; Hopkins, Jon

**Cc:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh; Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon:

Below is the requested info re: RPVs forged by Rotterdam Dockyards (RDM).

With this e-mail I consider the question to be answered. If you need further info, please send e-mail to me and cc: Michele Evans.

V/R

s

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Fermi 2	no	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	
Quad Cities 1	no	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1 & 2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drogdsk Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1 & 2	Yes	

**From:** Meighan, Sean

**Sent:** Monday, August 13, 2012 10:57 AM

**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh

**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

**Due:** COB today.

Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westi
Fermi 2					
McGuire 2	PWR	4	1100	1983	Westi
North Anna 1	PWR	3	903	1978	Westi
North Anna 2	PWR	3	973	1980	Westi
Quad Cities 1	BWR	-	882	1972	Gene
Sequoyah 1	PWR	4	1162	1980	Westi
Sequoyah 2	PWR	4	1126	1981	Westi
Surry 1	PWR	3	839	1972	Westi
Surry 2	PWR	3	800	1973	Westi
Watts Bar 1	PWR	4	1123	1996	Westi
Watts Bar 2	PWR				Westi

**From:** Hopkins, Jon

**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

- Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)
  - o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
  - o The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Doel 3	PWR	3	1000	1982	Fr
Tihange 2	PWR	3	1000	1982	Fr
Catawba 1	PWR	4	1129	1985	W
Fermi 2					
McGuire 2	PWR	4	1100	1983	W
North Anna 1	PWR	3	903	1978	W
North Anna 2	PWR	3	973	1980	W
Quad Cities 1	BWR	-	882	1972	Gr
Sequoyah 1	PWR	4	1162	1980	W
Sequoyah 2	PWR	4	1126	1981	W
Surry 1	PWR	3	839	1972	W
Surry 2	PWR	3	800	1973	W
Watts Bar 1	PWR	4	1123	1996	W
Watts Bar 2	PWR				W

Poehler, Jeffrey

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From: Roque-Cruz, Carla  
Sent: Thursday, August 16, 2012 11:30 AM  
To: Poehler, Jeffrey  
Cc: Fairbanks, Carolyn; Rosenberg, Stacey  
Subject: RE: Pressure Vessel Inspections

Hi Jeff,  
You can use

MC3377 - NRR Technical Assistance to Regions, Other NRC Offices & and Licensees for Rx Licensing Issues

-----Original Message-----  
From: Poehler, Jeffrey  
Sent: Thursday, August 16, 2012 8:39 AM  
To: Roque-Cruz, Carla  
Cc: Fairbanks, Carolyn; Rosenberg, Stacey  
Subject: RE: Pressure Vessel Inspections

Carlo, what TAC should we use for our time spent working on the Doel 3 issue?

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

-----Original Message-----  
From: Roque-Cruz, Carla  
Sent: Tuesday, August 14, 2012 1:49 PM  
To: Rosenberg, Stacey; Poehler, Jeffrey  
Subject: FW: Pressure Vessel Inspections

Stacey, Jeff,  
I believe I should have send this to your branch. Can I have a few sentences to answer this stakeholder's question?

Thank you,

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

-----Original Message-----  
From: Roquecruz, Carla  
Sent: Tuesday, August 14, 2012 11:48 AM  
To: Collins, Jay  
Cc: Lupold, Timothy; McIntyre, David  
Subject: FW: Pressure Vessel Inspections

B/125

Jay,  
I know we do more than just visual but we need a few sentences to send to OPA to answer this question from a stakeholder.

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

-----Original Message-----

From: McIntyre, David <sup>OPA</sup>  
Sent: Tuesday, August 14, 2012 11:40 AM  
To: Roque-Cruz, Carla  
Subject: FW: Pressure Vessel Inspections

Carla - a DE question stemming from the Belgian reactor issue. Can you please advise on the typical US practice?

Thanks,  
Dave Mc, OPA

-----Original Message-----

From: OPA Resource  
Sent: Tuesday, August 14, 2012 11:09 AM  
To: McIntyre, David  
Subject: FW: Pressure Vessel Inspections

I'm having a senior moment and can't remember if this topic is you or Scott, please help!

-----Original Message-----

From: Zachary Singer [mailto:[zsinger@hetco.com](mailto:zsinger@hetco.com)]  
Sent: Tuesday, August 14, 2012 11:03 AM  
To: OPA Resource  
Subject: Pressure Vessel Inspections

Below is the result of your feedback form. It was submitted by

Zachary Singer ([zsinger@hetco.com](mailto:zsinger@hetco.com)) on Tuesday, August 14, 2012 at 11:03:18

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

Thank you,

Zach

organization: HETCO



address1: 1185 Avenue of the Americas

address2:

city: New York

state: NY

zip: 10036

country:

phone: 212-536-88

Poehler, Jeffrey

16

From: Poehler, Jeffrey *NR*  
Sent: Thursday, August 16, 2012 8:32 AM  
To: Roque-Cruz, Carla; Rosenberg, Stacey  
Cc: Lupold, Timothy  
Subject: RE: Pressure Vessel Inspections

Carla, proposed response:

It is standard for US Nuclear Plants to perform ultrasonic testing of reactor pressure vessels. Ultrasonic testing is performed on the welds that join the plates or forgings that make up the reactor vessel, and the material within a few inches of the welds. In general, ultrasonic testing is required to be performed once every ten years on all of the pressure retaining in the reactor pressure vessel. Visual examinations for leakage are also performed on the entire reactor coolant system, including the reactor pressure vessel, during each refueling outage, which occur every 1-1/2 to 2 years.

(Carla, I did not mention the fact that Doel was doing ultrasonic inspections outside the area of what US plants normally do. I also did not go into where our requirements come from - ASME Code through 10 CFR 50.55a etc. I thought that would be too much detail.)

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

-----Original Message-----

From: Roque-Cruz, Carla *NR*  
Sent: Tuesday, August 14, 2012 1:49 PM  
To: Rosenberg, Stacey; Poehler, Jeffrey  
Subject: FW: Pressure Vessel Inspections

Stacey, Jeff,

I believe I should have send this to your branch. Can I have a few sentences to answer this stakeholder's question?

Thank you,

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

-----Original Message-----

From: Roquecruz, Carla  
Sent: Tuesday, August 14, 2012 11:48 AM  
To: Collins, Jay  
Cc: Lupold, Timothy; McIntyre, David

B/126

Subject: FW: Pressure Vessel Inspections

Jay,  
I know we do more than just visual but we need a few sentences to send to OPA to answer this question from a stakeholder.

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

-----Original Message-----

From: McIntyre, David  
Sent: Tuesday, August 14, 2012 11:40 AM  
To: Roque-Cruz, Carla  
Subject: FW: Pressure Vessel Inspections

Carla - a DE question stemming from the Belgian reactor issue. Can you please advise on the typical US practice?

Thanks,  
Dave Mc, OPA

-----Original Message-----

From: OPA Resource  
Sent: Tuesday, August 14, 2012 11:09 AM  
To: McIntyre, David  
Subject: FW: Pressure Vessel Inspections

I'm having a senior moment and can't remember if this topic is you or Scott, please help!

-----Original Message-----

From: Zachary Singer [mailto:zsinger@hetco.com]  
Sent: Tuesday, August 14, 2012 11:03 AM  
To: OPA Resource  
Subject: Pressure Vessel Inspections

Below is the result of your feedback form that was submitted by

Zachary Singer (zsinger@hetco.com) on Tuesday, August 14, 2012 at 11:03:18

---

comments: Hi,

I have read that a nuclear unit in Belgium has detected cracks in its Reactor Pressure Vessel using an ultrasound. Several US plants have Reactor Pressure Vessels manufactured by the same company. Is it standard for US nuclear plants to perform ultrasound on Reactor Pressure Vessels or are they typically only given visual inspection?

Thank you,

Zach

organization: HETCO

address1: 1185 Avenue of the Americas

address2:

city: New York

state: NY

zip: 10036

country:

phone: 212-536-8529

---

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Lupold, Timothy

**From:** Hills, David *RM*  
**Sent:** Thursday, August 16, 2012 9:13 AM  
**To:** Lupold, Timothy  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Thanks Tim ! Maybe then Bob will have more for us during next week's materials engineering counterparts call.

- Dave

**From:** Lupold, Timothy *nmk*  
**Sent:** Thursday, August 16, 2012 8:00 AM  
**To:** Hills, David  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Bob Hardies is in Belgium today for a meeting to discuss the issue. We don't know if the indications are real or not at this point. The issue is more related to who supplied the forgings, assuming these are real indications. Will know more once Bob returns from the meeting. About the only information we have at this point is information from the web. I've attached an email with a link to a French website. You may have to wait a bit for it to translate from French to English.

**From:** Hills, David  
**Sent:** Monday, August 13, 2012 4:32 PM  
**To:** Rosenberg, Stacey; Lupold, Timothy  
**Cc:** Bilik, Tom; Bozga, John; Holmberg, Mel; Jones, Donald; Meghani, Vijay; Neurauter, James; Sanchez Santiago, Elba; Shaikh, Atif  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI – See below regarding applicability to Quad Cities. Who in NRR has technical lead on this issue? Any additional details available?

- Dave

**From:** Ring, Mark *RM*  
**Sent:** Monday, August 13, 2012 2:13 PM  
**To:** Hills, David  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Dave,

I asked the Quad RIO to look into what the licensee knew and was doing on the Belgium NDE results indicating cracking in the vessel. Here's the reply I received from Jim McGhee. Please let me know if you need more or if you find out any more from NRC NDE folks. Thanks.

-Mark

**From:** McGhee, James *nmk*  
**Sent:** Monday, August 13, 2012 1:45 PM  
**To:** Ring, Mark  
**Cc:** Draper, Jason; Elliott, Roy; Orlikowski, Robert; Cushman, Brian  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

The UFSAR quote below is from Section 5.3.1.2. It goes on to say

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Chicago Bridge and Iron (CB&I), which completed fabrication of the Unit 2 RPV prior to its shipment to the plant site, provided a certification comparable to the ASME Code N-1A form. The following footnote was included in that certification: [5.3-3]

"This unstamped vessel was built as a 'State Special' based on agreements between the State of Illinois and Commonwealth Edison Company. A portion of the vessel was fabricated by Rotterdam Dockyard Company. This vessel was not stamped because Rotterdam Dockyard Company does not hold an ASME certificate of authorization. Procedures equivalent to the requirements of the ASME Code were used."

---

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 1:38 PM  
**To:** Ring, Mark  
**Cc:** Cushman, Brian; Draper, Jason; Elliott, Roy; 'LUIS GASCO LEONARTE'; Orlikowski, Robert  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

According to the licensee the affected unit is Unit 2. The following discussion comes from the Section 5.3.2 of the USFSAR:

The Quad Cities Unit 1 RPV was fabricated entirely in the United States by Babcock & Wilcox (B&W). The Unit 2 RPV was fabricated by several different vendors, including one in Holland, as noted in the following paragraphs. [5.3-2]

Fabrication work on the Unit 2 bottom head assembly and lower shell course was performed by the Rotterdam Dockyard Company (RDM) in Rotterdam, Holland. These two pieces were seam-welded together and returned to the United States as a fully completed subassembly including control rod drive (CRD) stub tubes, shroud support skirt, and vessel support skirt.

According to the licensee, the component steel was fabricated in the US by Babcock & Wilcox. These were sent to RDM where they were "bent" to shape and welded together. Final assembly of the vessel was performed in the US. Without looking further, I can't determine if the beltline region was included in the RDM work.

As far as inspection, they only look at the seam welds. According to the ISI guys, the only other inspection they ever did after initial construction was a VT3 on the inner clad surface and that was stopped after it was determined to have no value.

They had the initial communication on the issue and are currently waiting for more specific information from the utility before determining what they need to do. The sites understanding is that the components in question at the Belgian facility were manufactured in total at the RDM facility as opposed to being assembled there as was Unit 2. I will follow up as more information comes available.

Jim

---

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 11:24 AM  
**To:** McGhee, James  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good. Thanks.

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 11:06 AM  
**To:** Ring, Mark  
**Cc:** Cushman, Brian; Orlikowski, Robert; Draper, Jason; Elliott, Roy  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Checking to verify manufacture of Unit 1 RPV and any beltline inspections performed that could show this type defect.

Jim

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 9:40 AM  
**To:** Cushman, Brian; McGhee, James; Ray, Teresa  
**Cc:** LUIS GASCO LEONARTE; Draper, Jason; Elliott, Roy; Orlikowski, Robert  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI

**From:** Lara, Julio *IR III*  
**Sent:** Monday, August 13, 2012 9:30 AM  
**To:** Casto, Chuck; Pederson, Cynthia; Shear, Gary; Reynolds, Steven; OBrien, Kenneth; Skokowski, Richard  
**Cc:** Cameron, Jamnes; Daley, Robert; Dickson, Billy; Duncan, Eric; Giessner, John; Hills, David; Kunowski, Michael; Peterson, Hironori; Riemer, Kenneth; Ring, Mark; Skokowski, Richard; Stone, AnnMarie  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

**From:** Bernardo, Robert *in RR*  
**Sent:** Monday, August 13, 2012 9:26 AM  
**To:** Taylor, Ryan  
**Cc:** Brand, Javier; Lara, Julio; Powers, Dale  
**Subject:** DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good morning,

We wanted to pass this along to the regional OpE POC's, since there are POTENTIALLY US plants that might be affected (mostly region 2). We'll keep you informed as we get more information.

#### **IRS 8244P - DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL**

Doel 3 is a PWR that commenced operation in 1982. In July, UT examinations to detect possible under-clad defects of the reactor vessel belt region instead found indications of fabrication flaws. This was the first time this type of testing had been performed on this portion of the vessel. The flaws appear to be laminar in nature, running parallel to the inside and outside surfaces being examined. The vessel rings containing the flaws were forged in the early 1980's at the Rotterdam Dockyards, which also forged reactor vessel rings for several plants in the U.S., including Catawba 1, McGuire 2, North Anna 1 & 2, Quad Cities 1, Sequoyah 1 & 2, Surry 1 & 2, and Watts Bar 1. Staff are in communication with the Belgian regulator to exchange information and review pending results from follow-up testing.

*Bob Bernardo*

Reactor Systems Engineer  
US Nuclear Regulatory Commission  
NRR/DIRS/IOEB  
O-7D17; MS O-7C02A  
301-415-2621  
[Robert.Bernardo@nrc.gov](mailto:Robert.Bernardo@nrc.gov)



**Alley, David**

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**From:** Hiland, Patrick *mm*  
**Sent:** Thursday, August 16, 2012 4:09 PM  
**To:** Lupold, Timothy; Rosenberg, Stacey  
**Cc:** Cheok, Michael; Alley, David; Cumblidge, Stephen; Fairbanks, Carolyn; Hardies, Robert  
**Subject:** Doel-3 followup  
  
**Importance:** High

As you know, Bob Hardies met with the Belgium regulator today. I'd like EVIB and EPNB to coordinate our division's follow-up with Bob. This has a lot of attention internally and externally, and I expect we will be briefing the TAs soon. The EDO has already asked for a briefing, and I expect that to happen mid-week when Bob Hardies tells me we're ready. EVIB has an important role in clarifying the implicated U.S. plants via record reviews. We can discuss at Monday's BC meeting.

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Poehler, Jeffrey

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**From:** Poehler, Jeffrey *MPK*  
**Sent:** Thursday, August 16, 2012 8:38 AM  
**To:** Hopkins, Jon  
**Cc:** Cheok, Michael; Hiland, Patrick; Rosenberg, Stacey; Fairbanks, Carolyn  
**Subject:** RE: QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon,

I don't have that information. I'm going to have to do some digging to see if it exists. However, it appears that even the forging were made by other companies and supplied to RDM. I doubt that RDM manufactured its own plates.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Hopkins, Jon *MPK*  
**Sent:** Wednesday, August 15, 2012 10:10 AM  
**To:** Poehler, Jeffrey  
**Cc:** Cheok, Michael; Hiland, Patrick  
**Subject:** QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jeff,

For Surry 1 and 2, did RDM make the plate for the RPVs or did it just weld together the plates supplied by someone else?

Thank you, Jon

**From:** Poehler, Jeffrey  
**Sent:** Monday, August 13, 2012 4:00 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Watts Bar 2 hasn't operated yet...but may soon. Surry 1 and 2 were welded by Rotterdam but of plate not forgings.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Hardies, Robert *MPK*  
**Sent:** Monday, August 13, 2012 3:58 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Mystery solved. The numbers work out now. But which is the plant that has never operated...or is that one not on this list?

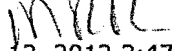
B/129

**From:** Hopkins, Jon  
**Sent:** Monday, August 13, 2012 3:52 PM  
**To:** Hiland, Patrick  
**Cc:** Cheok, Michael; Hardies, Robert  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Pat,

Verification from DORL of U.S. NPPs with RDM reactor pressure vessels is below. Yes except for the BWRs, Fermi & Quad, No.

Jon

**From:** Meighan, Sean   
**Sent:** Monday, August 13, 2012 3:47 PM  
**To:** Roque-Cruz, Carla; Hopkins, Jon  
**Cc:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh; Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon:

Below is the requested info re: RPVs forged by Rotterdam Dockyards (RDM).

With this e-mail I consider the question to be answered. If you need further info, please send e-mail to me and cc: Michele Evans.

V/R  
s

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
Catawba 1	Yes	
Fermi 2	no	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	
Quad Cities 1	no	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>

Sequoyah 1 & 2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drogdsk Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1 & 2	Yes	

**From:** Meighan, Sean

**Sent:** Monday, August 13, 2012 10:57 AM

**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh

**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

**Action:** Ask the licensees of the units below to verify if their units Reactor Pressure Vessel(s) were forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM). The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts

Due to the quick turn around requested and the evolving nature of the issue, we suggest you call your licensing contact, discuss the issue and get a call back with the answer. We understand the licensee would like some context with the question, feel free to send attached to the licensee. We actually suspect this issue is already on their radar screen.

**Due:** COB today.

Any questions, just call me.

BCs – if the primary PM for the site is out today, forward to the backup PM.

FYI, this tasking does not violate the Paperwork Reduction Act due to small number of (<10) requested responders.

Catawba 1	PWR	4	1129	1985	Westi
Fermi 2					

McGuire 2	PWR	4	1100	1983	Westi
North Anna 1	PWR	3	903	1978	Westi
North Anna 2	PWR	3	973	1980	Westi
Quad Cities 1	BWR	-	882	1972	Gene
Sequoyah 1	PWR	4	1162	1980	Westi
Sequoyah 2	PWR	4	1126	1981	Westi
Surry 1	PWR	3	839	1972	Westi
Surry 2	PWR	3	800	1973	Westi
Watts Bar 1	PWR	4	1123	1996	Westi
Watts Bar 2	PWR				Westi

**From:** Hopkins, Jon

**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

The RPV forgings may have been welded together by another company such as B&W. NRC is interested in who forged the parts.

NRC is interested because the of UT indications recently found on the RPV forgings at Doel 3 NPP in Belgium. The Doel 3 licensee, Electrabel, provided the below table of NPPs with RPVs forged by Rotterdam Dockyards (Only Belgium and U.S. included in this email. There are additional plants/countries). This is preliminary information the accuracy of which the NRC wants to confirm for U.S. NPPs.

- Reactor Pressel Vessels forged by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM)

- The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
- The table below gives an overview of these RPVs (this list has been established by the licensee and could contain errors or omissions).

Plant	Reactor Type	Number of RPVs	RPV Weight (kg)	Year of Forging	Country
Doel 3	PWR	3	1000	1982	Fr
Tihange 2	PWR	3	1000	1982	Fr

	Catawba 1	PWR	4	1129	1985	W
	Fermi 2					
	McGuire 2	PWR	4	1100	1983	W
	North Anna 1	PWR	3	903	1978	W
	North Anna 2	PWR	3	973	1980	W
	Quad Cities 1	BWR	-	882	1972	G
	Sequoyah 1	PWR	4	1162	1980	W
	Sequoyah 2	PWR	4	1126	1981	W
	Surry 1	PWR	3	839	1972	W
	Surry 2	PWR	3	800	1973	W
	Watts Bar 1	PWR	4	1123	1996	W
	Watts Bar 2	PWR				W

Poehler, Jeffrey

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**From:** Hopkins, Jon *JP*  
**Sent:** Thursday, August 16, 2012 9:01 AM  
**To:** Poehler, Jeffrey  
**Subject:** RE: QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jeff, Thanks for the info. Please keep me informed as we find out more. Thx, Jon

**From:** Poehler, Jeffrey *JP*  
**Sent:** Thursday, August 16, 2012 9:00 AM  
**To:** Hopkins, Jon  
**Cc:** Fairbanks, Carolyn; Rosenberg, Stacey  
**Subject:** RE: QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

I cannot find the plate manufacturer in any of the references I have. However, according to the Surry FSAR, the major subassemblies that are made from plates (intermediate and lower shells) were already in existence before the vessel was transferred to RDM for completion. Specifically, for Surry 1, the intermediate shell was already welded to the lower shell before being sent to RDM. For Surry 2, the intermediate shell and lower shell were formed and welded but not welded before being transferred to RDM. These intermediate and lower shells were fabricated from two plates each. From this I infer that the plates were of US manufacture.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Hopkins, Jon  
**Sent:** Wednesday, August 15, 2012 10:10 AM  
**To:** Poehler, Jeffrey  
**Cc:** Cheok, Michael; Hiland, Patrick  
**Subject:** QUESTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jeff,

For Surry 1 and 2, did RDM make the plate for the RPVs or did it just weld together the plates supplied by someone else?

Thank you, Jon

**From:** Poehler, Jeffrey  
**Sent:** Monday, August 13, 2012 4:00 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Watts Bar 2 hasn't operated yet...but may soon. Surry 1 and 2 were welded by Rotterdam but of plate not forgings.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

B/130

**From:** Hardies, Robert  
**Sent:** Monday, August 13, 2012 3:58 PM  
**To:** Poehler, Jeffrey; Fairbanks, Carolyn  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Mystery solved. The numbers work out now. But which is the plant that has never operated....or s that one not on this list?

**From:** Hopkins, Jon  
**Sent:** Monday, August 13, 2012 3:52 PM  
**To:** Hiland, Patrick  
**Cc:** Cheek, Michael; Hardies, Robert  
**Subject:** FW: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Pat,

Verification from DORL of U.S. NPPs with RDM reactor pressure vessels is below. Yes except for the BWRs, Fermi & Quad, No.

Jon

**From:** Meighan, Sean  
**Sent:** Monday, August 13, 2012 3:47 PM  
**To:** Roque-Cruz, Carla; Hopkins, Jon  
**Cc:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh; Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele  
**Subject:** RE: ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Jon:

Below is the requested info re: RPVs forged by Rotterdam Dockyards (RDM).

With this e-mail I consider the question to be answered. If you need further info, please send e-mail to me and cc: Michele Evans.

V/R  
s

Site/Unit(s)	Question: Were RPV(s) forged by Rotterdam Droogdok Maatschappij	Comments
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Fermi 2	no	
McGuire 2	Yes	
North Anna 1	Yes	
North Anna 2	Yes	



Quad Cities 1	no	According to the attached Quad Cities UFSAR Section 5.3.1.2 and Manufacturing History, the Quad Cities, Unit 1 RPV was manufactured entirely by Babcock & Wilcox. <b>The Unit 2 RPV history did not include any forging at Rotterdam (RDM), but did include assembly and welding on portions of the RPV at RDM.</b>
Sequoyah 1 & 2	Yes	Section 5.4.2, first sentence (Page 5.4-2), of the SQN UFSAR states that "The reactor vessel manufactured by DeRotterdam Drodgdak Mattschappu N.V. (The Rotterdam Dockyard Company) is cylindrical with a welded hemispherical bottom head and a removable, bolted flanged and gasketed, hemispherical upper head." So, to answer your question, Yes, the Sequoyah Units 1 and 2 reactor vessels are forged by Rotterdam Dockyards.
Surry 1	Yes	
Surry 2	Yes	
Watts Bar 1 & 2	Yes	

**From:** Meighan, Sean

**Sent:** Monday, August 13, 2012 10:57 AM

**To:** Thompson, Jon; Sreenivas, V; Mozafari, Brenda; Lingam, Siva; Cotton, Karen; Poole, Justin; Chawla, Mahesh

**Cc:** Boska, John; Quichocho, Jessie; Dudek, Michael; Guzman, Richard; Martin, Robert; Frankl, Istvan; Coffin, Stephanie; Evans, Michele

**Subject:** ACTION: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

PMs:

(Tasking from Michele Evans)

Please read below and attached.

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**From:** Hopkins, Jon

**Sent:** Monday, August 13, 2012 10:06 AM

**To:** Meighan, Sean

**Subject:** REQUEST: Followup of list of NPPs with RPVs forged by Rotterdam Dockyards (RDM)

Sean,

Question for PMs to ask licensees is; Was your plants' RPV forged by RDM (Rotterdam Dockyards) ?

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- o The Doel 3 and Tihange 2 RPVs were forged by RDM, which according to the Licensee Electrabel provided some 20+ vessels in Europe and the US.
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Surry 1	PWR	3	839	1972	W
Surry 2	PWR	3	800	1973	W
Watts Bar 1	PWR	4	1123	1996	W
Watts Bar 2	PWR				W

**From:** Benson, Michael  
**To:** [Kirk, Mark](#)  
**Subject:** RE: what is the unit "nvt", relative to neutron exposure? <eom>  
**Date:** Friday, August 17, 2012 11:41:00 AM

---

"For reactor vessels of ferritic materials, where the expected neutron fluence over the specified life exceeds  $1 \times 10^{17}$  nvt ( $E_n$  of 1 MeV and above), the design shall make..."

**From:** Kirk, Mark  
**Sent:** Friday, August 17, 2012 11:39 AM  
**To:** Benson, Michael  
**Subject:** RE: what is the unit "nvt", relative to neutron exposure? <eom>

I think it is a typo. Can you send it to me in context?

**From:** Benson, Michael  
**Sent:** Friday, August 17, 2012 11:39 AM  
**To:** Kirk, Mark  
**Subject:** what is the unit "nvt", relative to neutron exposure? <eom>

**Michael Benson, PhD**  
U.S. Nuclear Regulatory Commission  
Materials Engineer - RES/DE/CIB  
*Phone: (301) 251-7492*  
*Email: [Michael.Benson@nrc.gov](mailto:Michael.Benson@nrc.gov)*  
*Office: CSB 5A10*  
*Mail Stop: CSB 5A24m*

B/131

**From:** Benson, Michael  
**To:** Kirk, Mark  
**Subject:** RE: what is the unit "nvt", relative to neutron exposure? <eom>  
**Date:** Friday, August 17, 2012 11:43:00 AM

---

It's a very persistent typo.

**From:** Kirk, Mark  
**Sent:** Friday, August 17, 2012 11:43 AM  
**To:** Benson, Michael  
**Subject:** RE: what is the unit "nvt", relative to neutron exposure? <eom>

Should be neutrons per centimeter<sup>2</sup> ... n/cm<sup>2</sup>

**From:** Benson, Michael  
**Sent:** Friday, August 17, 2012 11:41 AM  
**To:** Kirk, Mark  
**Subject:** RE: what is the unit "nvt", relative to neutron exposure? <eom>

"For reactor vessels of ferritic materials, where the expected neutron fluence over the specified life exceeds  $1 \times 10^{17}$  nvt ( $E_n$  of 1 MeV and above), the design shall make..."

**From:** Kirk, Mark  
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**To:** Benson, Michael  
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**From:** Benson, Michael  
**Sent:** Friday, August 17, 2012 11:39 AM  
**To:** Kirk, Mark  
**Subject:** what is the unit "nvt", relative to neutron exposure? <eom>

**Michael Benson, PhD**  
U.S. Nuclear Regulatory Commission  
Materials Engineer - RES/DE/CIB  
Phone: (301) 251-7492  
Email: [Michael.Benson@nrc.gov](mailto:Michael.Benson@nrc.gov)  
Office: CSB 5A10  
Mail Stop: CSB 5A24m

B/132

## Hills, David

---

**From:** Hills, David  
**Sent:** Tuesday, August 21, 2012 7:57 AM  
**To:** Meghani, Vijay  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL  
**Attachments:** FW: FANC Website

FYI – Some background info in advance of tomorrow's call.

**From:** Lupold, Timothy  
**Sent:** Thursday, August 16, 2012 8:00 AM  
**To:** Hills, David  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Bob Hardies is in Belgium today for a meeting to discuss the issue. We don't know if the indications are real or not at this point. The issue is more related to who supplied the forgings, assuming these are real indications. Will know more once Bob returns from the meeting. About the only information we have at this point is information from the web. I've attached an email with a link to a French website. You may have to wait a bit for it to translate from French to English.

**From:** Hills, David  
**Sent:** Monday, August 13, 2012 4:32 PM  
**To:** Rosenberg, Stacey; Lupold, Timothy  
**Cc:** Bilik, Tom; Bozga, John; Holmberg, Mel; Jones, Donald; Meghani, Vijay; Neurauter, James; Sanchez Santiago, Elba; Shaikh, Atif  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI – See below regarding applicability to Quad Cities. Who in NRR has technical lead on this issue? Any additional details available?

- Dave

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 2:13 PM  
**To:** Hills, David  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Dave,

I asked the Quad RIO to look into what the licensee knew and was doing on the Belgium NDE results indicating cracking in the vessel. Here's the reply I received from Jim McGhee. Please let me know if you need more or if you find out any more from NRC NDE folks. Thanks.

-Mark

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 1:45 PM  
**To:** Ring, Mark  
**Cc:** Draper, Jason; Elliott, Roy; Orlikowski, Robert; Cushman, Brian  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

The UFSAR quote below is from Section 5.3.1.2. It goes on to say

Chicago Bridge and Iron (CB&I), which completed fabrication of the Unit 2 RPV prior to its shipment to the plant site, provided a certification comparable to the ASME Code N-1A form. The following footnote was included in that certification: [5.3-3]

"This unstamped vessel was built as a 'State Special' based on agreements between the State of Illinois and Commonwealth Edison Company. A portion of the vessel was fabricated by Rotterdam Dockyard Company. This vessel was not stamped because Rotterdam Dockyard Company does not hold an ASME certificate of authorization. Procedures equivalent to the requirements of the ASME Code were used."

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 1:38 PM  
**To:** Ring, Mark  
**Cc:** Cushman, Brian; Draper, Jason; Elliott, Roy; 'LUIS GASCO LEONARTE'; Orlikowski, Robert  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

According to the licensee the affected unit is Unit 2. The following discussion comes from the Section 5.3.2 of the USFSAR:

The Quad Cities Unit 1 RPV was fabricated entirely in the United States by Babcock & Wilcox (B&W). The Unit 2 RPV was fabricated by several different vendors, including one in Holland, as noted in the following paragraphs. [5.3-2]

Fabrication work on the Unit 2 bottom head assembly and lower shell course was performed by the Rotterdam Dockyard Company (RDM) in Rotterdam, Holland. These two pieces were seam-welded together and returned to the United States as a fully completed subassembly including control rod drive (CRD) stub tubes, shroud support skirt, and vessel support skirt.

According to the licensee, the component steel was fabricated in the US by Babcock & Wilcox. These were sent to RDM where they were "bent" to shape and welded together. Final assembly of the vessel was performed in the US. Without looking further, I can't determine if the beltline region was included in the RDM work.

As far as inspection, they only look at the seam welds. According to the ISI guys, the only other inspection they ever did after initial construction was a VT3 on the inner clad surface and that was stopped after it was determined to have no value.

They had the initial communication on the issue and are currently waiting for more specific information from the utility before determining what they need to do. The sites understanding is that the components in question at the Belgian facility were manufactured in total at the RDM facility as opposed to being assembled there as was Unit 2. I will follow up as more information comes available.

Jim

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 11:24 AM  
**To:** McGhee, James  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good. Thanks.

**From:** McGhee, James  
**Sent:** Monday, August 13, 2012 11:06 AM

**To:** Ring, Mark  
**Cc:** Cushman, Brian; Orlikowski, Robert; Draper, Jason; Elliott, Roy  
**Subject:** RE: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Checking to verify manufacture of Unit 1 RPV and any beltline inspections performed that could show this type defect.

Jim

**From:** Ring, Mark  
**Sent:** Monday, August 13, 2012 9:40 AM  
**To:** Cushman, Brian; McGhee, James; Ray, Teresa  
**Cc:** LUIS GASCO LEONARTE; Draper, Jason; Elliott, Roy; Orlikowski, Robert  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

FYI

**From:** Lara, Julio  
**Sent:** Monday, August 13, 2012 9:30 AM  
**To:** Casto, Chuck; Pederson, Cynthia; Shear, Gary; Reynolds, Steven; OBrien, Kenneth; Skokowski, Richard  
**Cc:** Cameron, Jamnes; Daley, Robert; Dickson, Billy; Duncan, Eric; Giessner, John; Hills, David; Kunowski, Michael; Peterson, Hironori; Riemer, Kenneth; Ring, Mark; Skokowski, Richard; Stone, AnnMarie  
**Subject:** FW: DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

**From:** Bernardo, Robert  
**Sent:** Monday, August 13, 2012 9:26 AM  
**To:** Taylor, Ryan  
**Cc:** Brand, Javier; Lara, Julio; Powers, Dale  
**Subject:** DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL

Good morning,

We wanted to pass this along to the regional OpE POC's, since there are POTENTIALLY US plants that might be affected (mostly region 2). We'll keep you informed as we get more information.

#### **IRS 8244P - DOEL 3 (BELGIUM) - FLAW INDICATIONS IN THE REACTOR PRESSURE VESSEL**

Doel 3 is a PWR that commenced operation in 1982. In July, UT examinations to detect possible under-clad defects of the reactor vessel belt region instead found indications of fabrication flaws. This was the first time this type of testing had been performed on this portion of the vessel. The flaws appear to be laminar in nature, running parallel to the inside and outside surfaces being examined. The vessel rings containing the flaws were forged in the early 1980's at the Rotterdam Dockyards, which also forged reactor vessel rings for several plants in the U.S., including Catawba 1, McGuire 2, North Anna 1 & 2, Quad Cities 1, Sequoyah 1 & 2, Surry 1 & 2, and Watts Bar 1. Staff are in communication with the Belgian regulator to exchange information and review pending results from follow-up testing.

*Bob Bernardo*  
Reactor Systems Engineer  
US Nuclear Regulatory Commission



NRR/DIRS/IOEB  
O-7D17; MS O-7C02A  
301-415-2621  
Robert.Bernardo@nrc.gov

**From:** Benson, Michael  
**To:** Kirk, Mark  
**Subject:** Throwing a Dart at FAVOR  
**Date:** Thursday, August 23, 2012 8:35:00 AM

---

Mark,

I have a question. BCC materials can exhibit brittle cleavage fracture, so we analyze vessels with LEFM in FAVOR. However, at high temperatures EPFM may be more appropriate (a la RG 1.161). So, why does FAVOR not use EPFM?

Thanks,

**Michael Benson, PhD**  
U.S. Nuclear Regulatory Commission  
Materials Engineer - RES/DE/CIB  
*Phone: (301) 251-7492*  
*Email: Michael.Benson@nrc.gov*  
*Office: CSB 5A10*  
*Mail Stop: CSB 5A24m*

B1/134

**From:** Benson, Michael  
**To:** Kirk, Mark  
**Subject:** RE: Throwing a Dart at FAVOR  
**Date:** Monday, August 27, 2012 11:22:00 AM

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At one point, I heard Terry say something about "ductile tearing". By that, was he referring to potentially incorporating EPFM to FAVOR?

**From:** Kirk, Mark  
**Sent:** Monday, August 27, 2012 10:37 AM  
**To:** Benson, Michael  
**Subject:** RE: Throwing a Dart at FAVOR

This is better for a lunch time conversation ... but I'll throw a few things out.

- Don't confuse metallurgy and mechanics.
- All cleavage is not brittle, and (so) cannot all be analyzed by LEFM. In particular in the upper transition region (as you point out) EPFM is probably more appropriate ... even though a structural engineer would probably regard the ultimate failure as brittle.
- In NUREG-1806, Section 3.3.3.1 you will see our cut at justifying the use of FAVOR. You will further see that it is admittedly imperfect. There are certainly situations where EPFM would be the better choice
  - <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1806/v1/sr1806.pdf>

I did not go to pains to point out where we are not doing the best job in the report and, frankly, have not much been called on it. Sean's recent analysis of itty bitty flaws speaks to the accuracy of FAVOR in those cases. The worst case for EPFM appropriateness would be an embedded flaw with some small distance between the inner crack tip and the clad/base interface. In that case the plastic zone would, I expect, be large with respect to that dimension ... causing LEFM problems.

**From:** Benson, Michael  
**Sent:** Thursday, August 23, 2012 8:35 AM  
**To:** Kirk, Mark  
**Subject:** Throwing a Dart at FAVOR

Mark,

I have a question. BCC materials can exhibit brittle cleavage fracture, so we analyze vessels with LEFM in FAVOR. However, at high temperatures EPFM may be more appropriate (a la RG 1.161). So, why does FAVOR not use EPFM?

Thanks,

**Michael Benson, PhD**  
U.S. Nuclear Regulatory Commission  
Materials Engineer - RES/DE/CIB  
Phone: (301) 251-7492

B/185

Oberson, Greg

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**From:** Cinson, Anthony D [anthony.cinson@pnnl.gov]  
**Sent:** Monday, August 27, 2012 3:19 PM  
**To:** Oberson, Greg  
**Subject:** RE: publication of nozzle 63 NUREG/CR

Excellent! Thank you Greg for the kind words :-)

Ps how is your journal article coming?

---

**From:** Oberson, Greg [Greg.Oberson@nrc.gov]  
**Sent:** Monday, August 27, 2012 11:20 AM  
**To:** Hanson, Brady D; Crawford, Susan L; Cinson, Anthony D; MacFarlan, Paul J; Hass, Kay E; Unwin, Stephen  
**Subject:** publication of nozzle 63 NUREG/CR

All,

This afternoon the final version of the nozzle 63 NUREG/CR was sent to our printing department, thanks to Kay for last minute formatting. My commendations again for a job well done to get a quality product completed. I will provide you some courtesy hard copies when I get them.

Thanks,  
Greg

B/136

Fairbanks, Carolyn

79

**From:** Fairbanks, Carolyn *mc*  
**Sent:** Monday, August 27, 2012 4:02 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Hardies, Robert; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Widrevitz, Dan; Rosenberg, Stacey  
**Subject:** COMMENTS - RE: RESEND: draft slides for 8/28 public meeting  
**Attachments:** 2012-08-28 - pub mtg slides - NRR comments.pptx

Attached are comments on 2 slides for the 8-28-2012 meeting. There were no comments on the other slides.

**From:** Hardies, Robert *NR*  
**Sent:** Monday, August 27, 2012 3:37 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Awesome, thanks.

Robert Hardies  
Senior Level Advisor for Materials Engineering  
Division of Engineering  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

**From:** Kirk, Mark *RES*  
**Sent:** Monday, August 27, 2012 3:36 PM  
**To:** Hardies, Robert  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Ah yes! We can introduce this as a topic for further enlightened investigation when I get to slide 6 ... and I can bring a few backup slides from our end of May briefing of NRR and NRO that I can use to provide additional details, should these be needed.

**From:** Hardies, Robert  
**Sent:** Monday, August 27, 2012 3:34 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

I don't mean that we would go into solution space on item c), I meant that we would introduce it as an item to be worked.

Robert Hardies

Senior Level Advisor for Materials Engineering  
Division of Engineering  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

**From:** Kirk, Mark  
**Sent:** Monday, August 27, 2012 2:26 PM  
**To:** Hardies, Robert  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

The stated purpose of the meeting (from the public meeting announcement, attached, was purposely vague and evasive. It said:

The purpose of this meeting is to discuss current findings from the NRC staff evaluation of P-T limits established according to MRP-250 guidelines, as well as of P-T limits established according to current ASME Code practice.

Bob's objective is more precise ... but I would not agree totally. My point of disagreement is on Item (c), which we went over in detail last week at ASME Code. There is not time on the agenda tomorrow to review this in any level of detail ... the code discussion took 5 hours on this topic alone (staff presentation is limited to half an hour giving us time to only highlight what has been said, *ad nauseum*, before), so it is not in our (RES's) plan. My view is that if the industry wants to have continued discussions on / critique the cladding & shallow flaw model, and offer alternatives then that is a fine action item that we can, and should, assign to a smaller working group to take up after tomorrow's meeting.

I agree with Bob's objectives (a) & (b).

Mark

**From:** Hardies, Robert  
**Sent:** Monday, August 27, 2012 2:18 PM  
**To:** Kirk, Mark  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael; Hiser, Allen; Ray, Neil; Sheng, Simon; Poehler, Jeffrey; Fairbanks, Carolyn; Widrevitz, Dan  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

The objectives for tomorrow's meeting is?

I think it is to: a) solicit industry help in defining heat up and cooldown actual transient shape and frequency, b) solicit industry help in understanding procedural and physical constraints on heat up and cooldown that might prevent plants from being able to challenge the limiting transient, and c) outline for industry the structure of the FAVOR cladding model to enable industry to offer insight into potentially missing or misapplied metallurgical factors associated with cladding flaw density and cladding and near surface material properties, or anything else they might know that we might find to be enlightening and essential.


Is my understanding correct?

Robert Hardies

Senior Level Advisor for Materials Engineering  
Division of Engineering  
Office of Nuclear Reactor Regulation  
U.S. Nuclear Regulatory Commission

Office Phone 301 415-5802

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**From:** Widrevitz, Dan   
**Sent:** Monday, August 27, 2012 1:45 PM  
**To:** Fairbanks, Carolyn; Poehler, Jeffrey; Sheng, Simon; Hardies, Robert  
**Subject:** FW: RESEND: draft slides for 8/28 public meeting

Eh? See paragraph below, which is Mark's response to my suggestion of having a slide concerning clad-cracking. I'm not sure how to respond...

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**From:** Kirk, Mark  
**Sent:** Monday, August 27, 2012 1:39 PM  
**To:** Widrevitz, Dan  
**Cc:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Focht, Eric; Benson, Michael  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

Dan –

It is a bit late to include this level of detail in a slide for tomorrow, in my opinion. Some of these points I do not agree with ... or perhaps the more accurate point is that I'm not sure I understand enough to say I agree or not depending only on what is in an e-mail. In my view the work done by ORNL to date speaks to the adequacy and accuracy of the FAVOR model. There may, however, be something we have missed ... and I think that a completely appropriate action coming out of tomorrow's meeting would be for a more comprehensive – broader based – review of the clad model. Maybe NRR would like to collaborate with the industry on such a review as you both seem to have similar questions ☺.

Regarding your PS, several things to consider:

- Within the context of a LEFM model (which we have shown to be appropriate for the crack depth and toughness values we are looking at) the postulated crack is loaded with the stresses acting on the uncracked body.
- For the type of stress relief you postulate to be complete the cracking would have to be quite extensive. That is not, to me, a credible case.
- The cladding is FCC and, as such, very ductile. I can't see crazing occurring.

Mark

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**From:** Widrevitz, Dan  
**Sent:** Monday, August 27, 2012 1:28 PM  
**To:** Kirk, Mark  
**Subject:** RE: RESEND: draft slides for 8/28 public meeting

In discussion with my colleagues this morning, we noted that it may be profitable to add a slide covering the gaps in FAVOR modeling of the clad to base-metal interface.

Something along these lines:

FAVOR Clad Model

[does/assumes this]

Flaws exist, material properties in clad, material properties in base metal, propagation when criteria met

[does not account for: this]

HAZ toughness, crazing -> stress relaxation, something or other

The benefit of this is striking the other end of the CDF numbers (the first end being our uncertainty with transients).

If this isn't clear, I should be available until ~4PM at 301-415-2620.

--Dan

Ps – Tell me where I'm going wrong, but if the stress was really bad in the clad, wouldn't it delaminate or craze BEFORE driving cracks much deeper into the base metal? Just my old composites classes whispering in my mind's ear.

---

**From:** Kirk, Mark

**Sent:** Monday, August 27, 2012 8:43 AM

**To:** Kirk, Mark; Hardies, Robert; Csontos, Aladar; Rosenberg, Stacey; Widrevitz, Dan; Poehler, Jeffrey; Purtscher, Patrick; Fairbanks, Carolyn; Sheng, Simon; Ray, Neil

**Cc:** Tregoning, Robert; Benson, Michael; Stevens, Gary; Focht, Eric; Rowley, Jonathan

**Subject:** RESEND: draft slides for 8/28 public meeting

I'm sure this e-mail has by now scrolled off everyone's screen, and since I have to date received no comments from anyone I thought I would resend. If you wish to comment on the attached slides for tomorrow's meeting you should do so today. I would like to call NRR's attention to 2 questions regarding schedule (highlighted in yellow below) that are likely to arise at tomorrow's meeting.

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**From:** Kirk, Mark

**Sent:** Wednesday, August 22, 2012 2:16 PM

**To:** Hardies, Robert; Csontos, Aladar; Rosenberg, Stacey; Widrevitz, Dan; Poehler, Jeffrey; Purtscher, Patrick; Fairbanks, Carolyn; Sheng, Simon; Ray, Neil

**Cc:** Tregoning, Robert; Benson, Michael; Stevens, Gary; Focht, Eric; Rowley, Jonathan

**Subject:** draft slides for 8/28 public meeting

All –

Attached, for your review and comment, is a short set of slides that we (RES Staff) are planning to use to guide discussion at the 8/28 public meeting (the afternoon meeting) on 10 CFR 50 Appendix G, the risk informed revision, and so on. Since we recently (on 8/14) had a detailed technical discussion on this topic at the WGOPC meeting at the ASME Code the purpose of the meeting on the 28<sup>th</sup> is NOT to go into technical details, but rather to plan next steps. In fact you have seen virtually all of the slides in the attachment except for the 8<sup>th</sup> (& final!) slide. I have pasted a copy of that slide below for your convenience.

Calling your attention to the 1<sup>st</sup> major bullet on the slide below I have two questions/comments on which I would value your feedback before the meeting:

- In RES we believe we can pull together documentation of the work we have done to date and have it over to NRR/NRO for review by early to mid October. We feel that it is important to allow the industry to see this information since we are seeking to involve them and want them to do work, but don't want to do so without enabling you all time to comment on the document. To facilitate the easier release of this information we were thinking to (a) just focus on the analysis done and the results (i.e., on the facts) and say nothing of conclusions, and (b) not format this as a NUREG report but more as a topical report, or a note to file. The industry and the public will of course be interested in when such




information can be made available to them. Would it be possible for NRR/NRO to say at the meeting when their reviews could be complete so that the information can be released?

- In the documentation section I have also called attention to the risk analysis that is being documented in the LIC-504 document. Will this document be available for public release? Can it be? The industry was asking for details on this analysis, so if we could provide it to them it would be helpful.

Thanks in advance for your help

mark

## Next Steps



- **NRC documentation**
  - Description of current analysis and current results
  - FAVOR 12.0
    - To be released by 10/31/2012
  - NRR LIC-504 document – risk analysis based on currently available information
- **Further Analysis**
  - System constraint transients
    - Need information on how these are specified, generic or plant specific, etc.
  - Analysis of actual normal operating transients
    - Need data on these transients
  - Refined risk assessment
    - Need data on event frequency
  - Other ????
- **Questions**
  - Do other actions need to be added above?
  - Who will be doing what, and by when?

Mark Kirk  
Senior Materials Engineer  
NRC/RES/DE/CIB  
mark.kirk@nrc.gov

# List of Major Findings

## 1. Concerning risk informed vs. ~~current~~ limiting P-T limit procedures

- a. R-I lowers CPF for cooldown (relative to current procedures)
- b. R-I often increases CPF for heatup (relative to current procedures)
- c. R-I increases CPF for leak tests (relative to current procedures)

## 2. Concerning ~~current P-T limit procedures~~ a postulated transient following the P-T limits

- a. Can produce  $CPF > 10^{-6}$
- b. The  $\frac{1}{4}T$  flaw does not produce the highest risk for cooldown, shallow flaws do
- c. Leak tests are permitted at temperatures close to  $RT_{NDT}$  in BWRs
- d. Actual transients (usually) have  $< CPF$  than idealized transients
  - Other P-T limits would produce different results

Today's focus

**(2a) ~~Current~~ Using a postulated transient following the P-T limits, P-T limit procedures can produce  $CPF > 10^{-6}$**

Loading Condition	Flaws for which where Current Pressure Limits Produce $CPF > 10^{-6}$	CPF Range
Cooldown	Embedded	Slightly above $10^{-6}$ if $RT_{MAX(AW)} > 247^{\circ}F$
	Shallow surface breaking	$10^{-4}$ to $10^{-2}$ across a wide range of $RT_{NDT}$
Heatup	Deep surface breaking	Up to $5 \times 10^{-5}$ if $RT_{MAX(AW)} > 247^{\circ}F$
	Deep surface breaking	$10^{-4}$ to $10^{-2}$ above $a/t = 0.2$
Leak Test*	Any surface breaking	$10^{-4}$ to $10^{-2}$ across a wide range of $RT_{NDT}$

\* Leak test temperature can be close to, or below,  $RT_{NDT}$  depending on margin & vessel geometry

Oberson, Greg

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**From:** Crawford, Susan L [Susan.Crawford@pnnl.gov]  
**Sent:** Wednesday, September 05, 2012 11:09 AM  
**To:** Oberson, Greg  
**Subject:** RE: publication of nozzle 63 NUREG/CR

Thanks Greg, it was a good project. Any progress on a journal article?

Regards,  
Susan

**From:** Oberson, Greg [<mailto:Greg.Oberson@nrc.gov>]  
**Sent:** Monday, August 27, 2012 11:21 AM  
**To:** Hanson, Brady D; Crawford, Susan L; Cinson, Anthony D; MacFarlan, Paul J; Hass, Kay E; Unwin, Stephen  
**Subject:** publication of nozzle 63 NUREG/CR

All,

This afternoon the final version of the nozzle 63 NUREG/CR was sent to our printing department, thanks to Kay for last minute formatting. My commendations again for a job well done to get a quality product completed. I will provide you some courtesy hard copies when I get them.

Thanks,  
Greg

B/138

Oberson, Greg

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**From:** Collins, Jay  
**Sent:** Wednesday, September 05, 2012 4:14 PM  
**To:** Thadani, Mohan; Poole, Justin  
**Cc:** Oberson, Greg  
**Subject:** NUREG CR-7142 on Volumetric Leak Path Assessment

Greetings,

The link below to a recently completed NRC NUREG contains information on the effectiveness of the volumetric leak path assessment technique. It is publicly available.

[View ADAMS P8 Properties ML12241A160](#)

[Open ADAMS P8 Document \(NUREG/CR-7142 " Ultrasonic Phased Array Assessment of the Interference Fit and Leak Path of the North Anna Unit 2 Control Rod Drive Mechanism Nozzle 63 with Destructive Validation."\)](#)

Jay Collins  
Sr. Materials Engineer  
Piping and NDE Branch  
US NRC  
(301)415-4038

B/139

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**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Wednesday, September 05, 2012 3:29 PM  
**To:** Dion, Jeanne  
**Subject:** Re: Research Assistance Request

Ok. We can move down to .2

---

**From:** Dion, Jeanne  
**To:** Csontos, Aladar  
**Sent:** Wed Sep 05 15:14:17 2012  
**Subject:** RE: Research Assistance Request

Al- I spoke to Stu about this. Any way you can change it to be less than 0.2 FTE (300 staff hours)?  
There are also some typos that need to be corrected. The package is on your desk.

Jeanne

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, September 05, 2012 2:23 PM  
**To:** Richards, Stuart  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Subject:** Re: Research Assistance Request

To be honest, that number was a shot in the dark. We really don't know how much it will really be and we won't until we have our first mtgs with FANC and industry for Gary's effort. I see two mtgs for Carol and Mark.

Can we reduce the amount of time to get this approved by management and then we revisit the UNR for later when we get our pencil sharpened.

---

**From:** Richards, Stuart  
**To:** Csontos, Aladar  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Sent:** Wed Sep 05 14:10:39 2012  
**Subject:** RE: Research Assistance Request

Al

I'm reviewing our response back to Pat Hiland on their Research Assistance Request for Doel. In general, it looks good.

The problem is that we estimate at least 0.6 FTE to do the work.

The threshold for doing the work under a Research Assistance Request is a maximum of 0.2 FTE (300 hours).

If I'm reading the Office Instruction right, it looks like we have to kick it up to a User Need.

Your thoughts?

B/140

Stu

---

**From:** Hiland, Patrick

**Sent:** Monday, August 27, 2012 3:42 PM

**To:** Case, Michael

**Cc:** Richards, Stuart; Fairbanks, Carolyn; Rosenberg, Stacey; Cheok, Michael; Hardies, Robert; Dorman, Dan; Boger, Bruce; Evans, Michele

**Subject:** Research Assistance Request

The Office of Nuclear Reactor Regulation (NRR), Division of Engineering is requesting that the Office of Nuclear Regulatory Research (RES), Division of Engineering provide research assistance to assess the implications of the indications discovered in the Doel 3 reactor pressure vessel forgings to domestic reactor pressure vessel forgings. Specifically, NRR is requesting technical assistance in the areas of nondestructive examination (NDE) and deterministic and probabilistic fracture mechanics

In the area of NDE, NRR request technical expertise to assess the procedures, techniques, equipment, standards, qualifications, inspections, acceptance criteria and other relevant NDE variables used to examine the Doel 3 reactor pressure vessel forgings. This assistance may include contact with the licensee (Doel 3), the Belgian nuclear regulatory authority and possibly contractors. Travel to Belgium may also be necessary.

In the area of fracture mechanics, NRR requests assistance to support the Belgian regulator, FANC. FANC has requested the participation of Dr. Mark Kirk in an expert peer review panel. The peer review panel would assist the regulator in assessing the deterministic and probabilistic fracture mechanics analyses being prepared by the licensee for Doel 3. Telephone, video conference, and in-person meetings in Belgium would likely be necessary for this effort.

Also in the area of fracture mechanics, NRR requests assistance to perform analyses related to the implications of similar indications (to Doel 3) in domestic reactor pressure vessel forgings. This effort is currently less well defined. The industry has proposed performing both deterministic and probabilistic fracture mechanics analyses of generic reactor pressure vessel forgings with indications similar to those discovered in Doel 3. If the industry performs these analyses, RES would perform confirmatory analyses. In the event that industry did not perform analyses of hypothetically flawed vessels, this request would be for RES to perform research to verify the adequacy of current ASME Section III acceptance criteria for laminar flaws in reactor pressure vessel forgings by performing appropriate deterministic or probabilistic fracture mechanics analyses.

A-48

## Kusnick, Joshua

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**From:** Csontos, Aladar  
**Sent:** Wednesday, September 05, 2012 5:44 PM  
**To:** Richards, Stuart  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Subject:** Re: Research Assistance Request

Thanks!!!

---

**From:** Richards, Stuart  
**To:** Csontos, Aladar  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Sent:** Wed Sep 05 17:14:27 2012  
**Subject:** RE: Research Assistance Request

OK.

Jeanne's working on it.

Stu

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, September 05, 2012 2:23 PM  
**To:** Richards, Stuart  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Subject:** Re: Research Assistance Request

To be honest, that number was a shot in the dark. We really don't know how much it will really be and we won't until we have our first mtgs with FANC and industry for Gary's effort. I see two mtgs for Carol and Mark.

Can we reduce the amount of time to get this approved by management and then we revisit the UNR for later when we get our pencil sharpened.

---

**From:** Richards, Stuart  
**To:** Csontos, Aladar  
**Cc:** Case, Michael; Tregoning, Robert; Dion, Jeanne  
**Sent:** Wed Sep 05 14:10:39 2012  
**Subject:** RE: Research Assistance Request

Al

I'm reviewing our response back to Pat Hiland on their Research Assistance Request for Doel. In general, it looks good.

The problem is that we estimate at least 0.6 FTE to do the work.

The threshold for doing the work under a Research Assistance Request is a maximum of 0.2 FTE (300 hours).

If I'm reading the Office Instruction right, it looks like we have to kick it up to a User Need.

B/141



Your thoughts?

Stu

---

**From:** Hiland, Patrick

**Sent:** Monday, August 27, 2012 3:42 PM

**To:** Case, Michael

**Cc:** Richards, Stuart; Fairbanks, Carolyn; Rosenberg, Stacey; Cheek, Michael; Hardies, Robert; Dorman, Dan; Boger, Bruce; Evans, Michele

**Subject:** Research Assistance Request

The Office of Nuclear Reactor Regulation (NRR), Division of Engineering is requesting that the Office of Nuclear Regulatory Research (RES), Division of Engineering provide research assistance to assess the implications of the indications discovered in the Doel 3 reactor pressure vessel forgings to domestic reactor pressure vessel forgings. Specifically, NRR is requesting technical assistance in the areas of nondestructive examination (NDE) and deterministic and probabilistic fracture mechanics

In the area of NDE, NRR request technical expertise to assess the procedures, techniques, equipment, standards, qualifications, inspections, acceptance criteria and other relevant NDE variables used to examine the Doel 3 reactor pressure vessel forgings. This assistance may include contact with the licensee (Doel 3), the Belgian nuclear regulatory authority and possibly contractors. Travel to Belgium may also be necessary.

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Poehler, Jeffrey

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**From:** Garmon, David *MR*  
**Sent:** Friday, September 07, 2012 8:18 AM  
**To:** Poehler, Jeffrey  
**Subject:** RE: Research on Hydrogen Cracking in Reactor Vessels Related to Doel 3

Jeff,

Thanks for your call. I have not found anything yet. Most of the older documents I have reviewed deal with embrittlement and cracking along nozzles with dissimilar welds. I also found a few cases that we addressed dealing with flaws along girth welds (e.g. 1984 IP 2).

I will keep looking.

Have a great weekend,  
Dave

**From:** Poehler, Jeffrey *MR*  
**Sent:** Thursday, September 06, 2012 4:18 PM  
**To:** Garmon, David  
**Subject:** Research on Hydrogen Cracking in Reactor Vessels Related to Doel 3

Dave,

I just wanted to touch base and see if you had found anything related to hydrogen cracking (flaking) in reactor vessels that the NRC may have investigated during the 1980's.

I'll be working at home on Friday, September 5 but will be back in the office on Monday.

Thanks,

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

B1142

  
**Kusnick, Joshua**

---

**From:** Csontos, Aladar  
**Sent:** Tuesday, September 11, 2012 11:05 AM  
**To:** Brown, Christopher; Hackett, Edwin; Case, Michael  
**Cc:** Santos, Cayetano; Dias, Antonio; Kirk, Mark; Tregoning, Robert  
**Subject:** Re: Large NSSS Component Fabrication and Inspection

Ok thanks Christopher. Will keep you in the loop once I discuss with RES, NRR, and NRO folks.

---

**From:** Brown, Christopher  
**To:** Hackett, Edwin; Case, Michael; Csontos, Aladar  
**Cc:** Santos, Cayetano; Dias, Antonio; Kirk, Mark; Tregoning, Robert  
**Sent:** Tue Sep 11 11:01:56 2012  
**Subject:** RE: Large NSSS Component Fabrication and Inspection

Hi Al,

I will be the lead ACRS engineer for this briefing.

Thanks,

Christopher

---

**From:** Hackett, Edwin  
**Sent:** Tuesday, September 11, 2012 10:58 AM  
**To:** Case, Michael; Csontos, Aladar  
**Cc:** Santos, Cayetano; Dias, Antonio; Kirk, Mark; Brown, Christopher; Tregoning, Robert  
**Subject:** FW: Large NSSS Component Fabrication and Inspection

Meant to reply to all!

---

**From:** Hackett, Edwin  
**Sent:** Tuesday, September 11, 2012 10:55 AM  
**To:** Csontos, Aladar  
**Subject:** RE: Large NSSS Component Fabrication and Inspection

Hi Al,

Just an info/overview briefing for the Full Committee.

Ed

---

**From:** Csontos, Aladar  
**Sent:** Tuesday, September 11, 2012 10:54 AM  
**To:** Hackett, Edwin; Case, Michael  
**Cc:** Kirk, Mark; Tregoning, Robert; Santos, Cayetano; Dias, Antonio; Brown, Christopher  
**Subject:** Re: Large NSSS Component Fabrication and Inspection

Ed,

Would this be for the full committee or materials sub-committee?

Thanks,  
Al

---

**From:** Hackett, Edwin  
**To:** Case, Michael; Csontos, Aladar  
**Cc:** Kirk, Mark; Tregoning, Robert; Santos, Cayetano; Dias, Antonio; Brown, Christopher  
**Sent:** Tue Sep 11 10:46:14 2012  
**Subject:** Large NSSS Component Fabrication and Inspection

Mike, Al,

The Members had a discussion at the Sept. Meeting on the recent vessel flaw findings at Doel. This led to an appreciation of the fact that they not had a briefing in this area (Large NSSS Component Fabrication and Inspection) for quite some time (probably not since the last PTS discussion).

Would you guys be able to pull together an information briefing for the October ACRS Meeting (Oct. 4-5) on the latest that is going on in large section steel fabrication and inspection? The Members were particularly interested in the International perspective, since all or most of this fabrication will be taking place outside the U.S.

We will also want to include NRR and NRO on this, but I would like to get your perspectives first.

I realize that this is very short notice – if it helps, this could be viewed as an initial briefing (1 hour) with more to follow in the future.

Thanks,

Ed

A-46

**Kusnick, Joshua**

---

**From:** Csontos, Aladar  
**Sent:** Tuesday, September 11, 2012 3:20 PM  
**To:** West, Stephanie  
**Subject:** RE: RES Response to NRR Research Assistance Request on Doel 3 Reactor

Never mind. I found it.

---

**From:** West, Stephanie  
**Sent:** Thursday, September 06, 2012 4:34 PM  
**To:** Hiland, Patrick  
**Cc:** Stevens, Gary; Benson, Michael; Focht, Eric; Nove, Carol; Cheok, Michael; Poehler, Jeffrey; Rosenberg, Stacey; Fairbanks, Carolyn; Kirk, Mark; Csontos, Aladar; RidsResDE Resource; Dion, Jeanne  
**Subject:** RES Response to NRR Research Assistance Request on Doel 3 Reactor

If you have any questions, please contact Mark Kirk.

[View ADAMS P8 Properties ML12242A333](#)

[Open ADAMS P8 Package \(RES Response to NRR Research Assistance Request on Doel 3 Reactor\)](#)

B/1424

A. 37

**Kusnick, Joshua**

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, September 12, 2012 7:52 AM  
**To:** Case, Michael  
**Cc:** Richards, Stuart  
**Subject:** Re: Large NSSS Component Fabrication and Inspection

I agree that NRO should be involved, but I think the committee wants to know what's going on at Doel and this is the way to get that info. Then they compare that fabrication to new fabrication.

Let me call Chris Brown to get more info and then I'll call some of my NRO BCs.

---

**From:** Case, Michael  
**To:** Csontos, Aladar  
**Cc:** Richards, Stuart  
**Sent:** Wed Sep 12 07:08:46 2012  
**Subject:** RE: Large NSSS Component Fabrication and Inspection

Yes, let's proceed. I would try and see if we can get NRO to take the lead.

---

**From:** Csontos, Aladar  
**Sent:** Tuesday, September 11, 2012 11:08 AM  
**To:** Case, Michael  
**Subject:** Re: Large NSSS Component Fabrication and Inspection

Mike,

I see a joint talk by NRR, NRO, and RES. NRO would best answer the new plant issues - both construction/inspection division and DE. The recent OpE on the Vogtle plant would be useful although ACRS may want to only discuss RPV forgings rather than dropout welding to the RPV. And then, we could discuss the publically available info on DOEL and have NRR talk to that and our response, e.g. FANC requests and our support. RES can then talk about the RPV database that houses the existing RPV fabrication information, buying the Westinghouse RPV dropouts and obtaining the Zorita RPV samples.

This is off the top of my head, so with your blessing, I'll interface with NRR and NRO for their inputs.

Al

---

**From:** Hackett, Edwin  
**To:** Case, Michael; Csontos, Aladar  
**Cc:** Kirk, Mark; Tregoning, Robert; Santos, Cayetano; Dias, Antonio; Brown, Christopher  
**Sent:** Tue Sep 11 10:46:14 2012  
**Subject:** Large NSSS Component Fabrication and Inspection

Mike, Al,

The Members had a discussion at the Sept. Meeting on the recent vessel flaw findings at Doel. This led to an appreciation of the fact that they not had a briefing in this area (Large NSSS Component Fabrication and Inspection) for quite some time (probably not since the last PTS discussion).

B/145

Would you guys be able to pull together an information briefing for the October ACRS Meeting (Oct. 4-5) on the latest that is going on in large section steel fabrication and inspection? The Members were particularly interested in the International perspective, since all or most of this fabrication will be taking place outside the U.S.

We will also want to include NRR and NRO on this, but I would like to get your perspectives first.

I realize that this is very short notice – if it helps, this could be viewed as an initial briefing (1 hour) with more to follow in the future.

Thanks,

Ed

**Cheruvenki, Ganesh**

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82

**From:** Cheruvenki, Ganesh *NOTE*  
**Sent:** Wednesday, September 12, 2012 9:56 AM  
**To:** Guzman, Richard  
**Cc:** Sheng, Simon; Scarbrough, Thomas; Basavaraju, Chakrapani  
**Subject:** VY steam dryer

Rich—

So far, the vendor's reports are consistent with the GE's (proprietary) documents. We will review the upcoming documents and come to a decision.

B/146



34  
**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Thursday, September 13, 2012 8:16 AM  
**To:** Case, Michael; Richards, Stuart  
**Subject:** Fw: Briefing

Fyi. As I suspected, this is an attempt to get to Doel info too.

----- Original Message -----

**From:** Hackett, Edwin  
**To:** Csontos, Aladar  
**Cc:** Mitchell-Funderburk, Natalie  
**Sent:** Wed Sep 12 22:13:01 2012  
**Subject:** Briefing

Hi Al,

Natalie relayed your message but I did not have phone access earlier. Ideally we would like to hear about both Doel and fabrication and inspection. However, if that is problematic, we can discuss further.

Let me know.

Thanks,

Ed

A-45

**Iyengar, Raj**

---

**From:** Csontos, Aladar  
**Sent:** Thursday, September 13, 2012 2:37 PM  
**To:** Hardies, Robert  
**Subject:** FW: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Looking better.

---

**From:** Sangimino, Donna-Marie  
**Sent:** Thursday, September 13, 2012 2:36 PM  
**To:** Sheron, Brian; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian,

I spoke with OIP and they do believe our participation on these WGs is in the best interest of the US Government.

NRR is paying for their travel and it would be expected that RES would fund RES staff travel (but OIP is paying for Mark Kirk to go to Belgium and S. Korea).

Donna-Marie

---

**From:** Sheron, Brian  
**Sent:** Wednesday, September 12, 2012 3:52 PM  
**To:** Sangimino, Donna-Marie; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Thanks. I will await the OIP response.

---

**From:** Sangimino, Donna-Marie  
**Sent:** Wednesday, September 12, 2012 3:41 PM  
**To:** Sheron, Brian; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian,

I called OIP after Al and I spoke Monday about all the particulars of this potential visit and asked the questions you noted below. They are currently considering the request and said they'd get back to us this week.

Donna-Marie

---

**From:** Sheron, Brian  
**Sent:** Wednesday, September 12, 2012 3:28 PM  
**To:** Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Sangimino, Donna-Marie; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

B/148

- a.) Have we coordinated with OIP and do they believe our participation on these WGs is in the best interest of the US Government?
- b.) Is FANC, OIP, or NRR paying for the travel? If not, why not?

---

**From:** Richards, Stuart

**Sent:** Wednesday, September 12, 2012 8:15 AM

**To:** Sheron, Brian; Uhle, Jennifer

**Cc:** Case, Michael; Sangimino, Donna-Marie; Eisenberg, Wendy; Csontos, Aladar

**Subject:** Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian/Jennifer

As you know, the Belgian regulator, FANC, requested technical assistance from the NRC with regards to the Doel Unit 3 RPV NDE indications. NRR/DE subsequently sent us a research assistance request to provide assistance to assess the implications of the Doel Unit 3 indications to domestic RPV's. There are about 10 US plants with RPV's which were fabricated by the same European shop that fabricated the Doel RPV.

NRR requested technical assistance in the areas of both NDE and fracture mechanics.

As part of their effort FANC wants to set up the following three working groups:

- 1) Working group #1: NDE techniques
- 2) Working group #2: Metallurgical origin/root causes of the flaw indications
- 3) Working group #3: Structural mechanics & fracture mechanics

FANC proposes to have the working groups meet in mid-October. The purpose of the Working Group meetings is to provide technical assistance to the Belgian nuclear safety authorities (FANC, Bel V, AIB Vinçotte) on specific topics / questions related to the Doel 3 RPV issue and to share information and experience between nuclear safety authorities on similar issues. The participants in the three expert working groups will be composed of members proposed by several foreign nuclear safety authorities or related organizations.

NRR is planning to send Bob Hardies and Jeff Poehler for Working Group #2. NRR is asking RES to support Working Groups 1 and 3.

With your approval, we would send Carol Nove for the NDE Working Group and Gary Stevens for the structural mechanics Working Group.

Note that Mark Kirk is also committed to serve on a separate International Review Board, which is independent of the FANC Working Groups.

The safety value to the NRC is to gain access to detailed technical information about the flaws at Doel, and the related fabrication information. In that the same or similar problems could potentially exist at some US plants, the knowledge gained by our participation will likely be very valuable in assessing the applicability of this safety issue to US plants, and in determining the appropriate regulatory actions needed to address the issue, should it be necessary.

Thanks  
Stu

A-44

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Thursday, September 13, 2012 4:06 PM  
**To:** Uhle, Jennifer; Sheron, Brian  
**Cc:** Sangimino, Donna-Marie; Case, Michael; Richards, Stuart  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

I've got it and bringing it up now.

---

**From:** Uhle, Jennifer  
**Sent:** Thursday, September 13, 2012 4:06 PM  
**To:** Sheron, Brian  
**Cc:** Sangimino, Donna-Marie; Csontos, Aladar; Case, Michael; Richards, Stuart  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Tracking it down. Not with Shirley. J

---

**From:** Sheron, Brian  
**Sent:** Thursday, September 13, 2012 3:22 PM  
**To:** Uhle, Jennifer  
**Cc:** Sangimino, Donna-Marie; Csontos, Aladar; Case, Michael; Richards, Stuart  
**Subject:** Fw: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

I'm OK with sending Kirk + one other. Please sign multiple traveler form for me that Hardies left with Shirley. Thx.

---

**From:** Sangimino, Donna-Marie  
**To:** Sheron, Brian; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Sent:** Thu Sep 13 14:35:58 2012  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian,

I spoke with OIP and they do believe our participation on these WGs is in the best interest of the US Government.

NRR is paying for their travel and it would be expected that RES would fund RES staff travel (but OIP is paying for Mark Kirk to go to Belgium and S. Korea).

Donna-Marie

---

**From:** Sheron, Brian  
**Sent:** Wednesday, September 12, 2012 3:52 PM  
**To:** Sangimino, Donna-Marie; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Thanks. I will await the OIP response.

---

**From:** Sangimino, Donna-Marie  
**Sent:** Wednesday, September 12, 2012 3:41 PM

B/149

**To:** Sheron, Brian; Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian,

I called OIP after Al and I spoke Monday about all the particulars of this potential visit and asked the questions you noted below. They are currently considering the request and said they'd get back to us this week.

Donna-Marie

---

**From:** Sheron, Brian  
**Sent:** Wednesday, September 12, 2012 3:28 PM  
**To:** Richards, Stuart; Uhle, Jennifer  
**Cc:** Case, Michael; Sangimino, Donna-Marie; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** RE: Request for Approval of Foreign Travel to attend Doel Technical Work Groups

- a.) Have we coordinated with OIP and do they believe our participation on these WGs is in the best interest of the US Government?
- b.) Is FANC, OIP, or NRR paying for the travel? If not, why not?

---

**From:** Richards, Stuart  
**Sent:** Wednesday, September 12, 2012 8:15 AM  
**To:** Sheron, Brian; Uhle, Jennifer  
**Cc:** Case, Michael; Sangimino, Donna-Marie; Eisenberg, Wendy; Csontos, Aladar  
**Subject:** Request for Approval of Foreign Travel to attend Doel Technical Work Groups

Brian/Jennifer

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The safety value to the NRC is to gain access to detailed technical information about the flaws at Doel, and the related fabrication information. In that the same or similar problems could potentially exist at some US plants, the knowledge gained by our participation will likely be very valuable in assessing the applicability of this safety issue to US plants, and in determining the appropriate regulatory actions needed to address the issue, should it be necessary.

Thanks  
Stu

**From:** Guzman, Richard *mark*  
**Sent:** Thursday, September 13, 2012 10:50 AM  
**To:** Sheng, Simon; Cheruvengi, Ganesh  
**Cc:** Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY Steam Dryer Cracks

All,

I recommend we have this internal discussion, if needed, *after* the licensee submits their revised RAI response. They plan to have this updated response (to include the more detailed growth history for the detected flaws and a stronger qualitative justification) ready for staff's review by next week. I will keep you informed.

Thanks,  
Rich

---

**From:** Sheng, Simon *mark*  
**Sent:** Thursday, September 13, 2012 8:00 AM  
**To:** Cheruvengi, Ganesh  
**Cc:** Basavaraju, Chakrapani; Scarbrough, Thomas; Guzman, Richard  
**Subject:** RE: VY Steam Dryer Cracks

Ganesh,

What is the purpose of this call? I thought the license is going to provide a history of growth for detected flaws for the past 6 operation cycles.

Simon

-----Original Appointment-----

**From:** Cheruvengi, Ganesh *mark*  
**Sent:** Wednesday, September 12, 2012 2:03 PM  
**To:** Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas; Guzman, Richard  
**Subject:** VY Steam Dryer Cracks  
**When:** Monday, September 17, 2012 10:30 AM-11:00 AM (GMT-05:00) Eastern Time (US & Canada).  
**Where:** HQ-OWFN-08B02-12p

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**Poehler, Jeffrey**

**From:** Kirk, Mark *RE*  
**Sent:** Thursday, September 13, 2012 10:37 AM  
**To:** Labeau Pierre-Etienne  
**Cc:** Burnell, Scott; Stevens, Gary; Nove, Carol; Poehler, Jeffrey; Sangimino, Donna-Marie; Eisenberg, Wendy; Richards, Stuart; Case, Michael; Fehst, Geraldine; Hardies, Robert; Csontos, Aladar  
**Subject:** RE: Doel 3 international committee

Dear Professor Labeau -

Thank you for this information. It is good to have at least some idea of when our meeting will occur (for planning purposes). Some of my other colleagues here at the NRC, who are participating in the three international working groups, have been informed that they will be having a meeting in Brussels on 16th October. It seems from the information that I have that the meeting of our group will occur on a different date; is this also your understanding?

Be assured that, per your request, both I and the NRC will studiously avoid making any solicitations to comment from the media. I quite agree with your policy in this regard so that we may, as you say, fulfill our mission in an independent and peaceful way.

One question for you. At some point I recall I was asked to send a copy of my CV to FANC. Are you aware of this request and, if so, are you aware of any standardized format we should use.

I look forward to meeting you. If I can provide any assistance to you before our meeting please do not hesitate to ask.

Best regards,

mark

Mark Kirk  
 Senior Materials Engineer  
 NRC/RES/DE/CIB  
[mark.kirk@nrc.gov](mailto:mark.kirk@nrc.gov)

-----Original Message-----

**From:** Labeau Pierre-Etienne [<mailto:pelabeau@ulb.ac.be>]  
**Sent:** Thursday, September 13, 2012 9:23 AM  
**To:** [helmut.Schulz.krtn@t-online.de](mailto:helmut.Schulz.krtn@t-online.de); [andre.pineau@mines-paristech.fr](mailto:andre.pineau@mines-paristech.fr); [timwilliams@39bhr.fsnet.co.uk](mailto:timwilliams@39bhr.fsnet.co.uk); [kim.wallin@vtt.fi](mailto:kim.wallin@vtt.fi); [stvims@ims.bas.bg](mailto:stvims@ims.bas.bg); Kirk, Mark; [benedikt.martens@sckcen.be](mailto:benedikt.martens@sckcen.be)  
**Cc:** [willy.deroovere@fanc.fgov.be](mailto:willy.deroovere@fanc.fgov.be)  
**Subject:** Doel 3 international committee

Dear Colleagues,

The Belgian Federal Agency for Nuclear Control has just officially published today on its website the names of the members of the international committee in charge of providing a recommendation on the future safe operation on the Doel 3 reactor.

I will have the honour to chair this committee and I am grateful to each of you, given your high expertise in the field, who accepted to fulfil this important mission to guarantee a safe operation of nuclear power plants in Belgium - and probably abroad as well.

B/151



The first information I can give you today is the following: first feedback from investigations carried on on the reactor vessel of Tihange 2 has revealed similar anomalies as in Doel 3. Both vessels were delivered by the same manufacturer.

A recommendation I want to ask you to strictly follow is to politely refuse all solicitations from the media to comment on the committee's mission and work until the release of our final report. One or two hours after FANC posted the official composition of the committee on its website, I had already got two phone calls from journalists. Of course, the situation is probably currently more touchy in Belgium than in other countries (and Benedikt Martens and I will probably be more solicited), but this policy will help us keep an independent and peaceful way of fulfilling our mission.

I expect that our mission will really start at the time Electrabel delivers its report to FANC, at the end of September. Yet this calendar is not confirmed yet, and the observations made in Tihange could have an impact on this deadline.

I will anyway send you soon a few proposals of dates for a two-day meeting in Brussels, that we will try to schedule during the second half of October.

Looking forward to fruitfully collaborating together.

Yours sincerely,

Pierre-Etienne LABEAU

Professor

Service de Metrologie Nucleaire - Ecole Polytechnique de Bruxelles Universite Libre de Bruxelles (CP165/84)

Av.F.D.Roosevelt, 50 - 1050 Bruxelles - Belgium

Tel: +32 2 6502060 (secr: 2061) -

Visit the Imuhira Village: <http://www.villageimuhira.be>

**Cheruvengi, Ganesh**

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**From:** Cheruvengi, Ganesh  
**Sent:** Friday, September 14, 2012 3:42 PM  
**To:** Guzman, Richard  
**Subject:** ENVIRONMENTAL EVALUATION FOR VY STEAM DRYER AMENDMENT---TAC# ME7733

Rich—There are certain paragraphs that address effect of the proposed license amendment for the steam dryer on the environment issue (per CFR 50.92). EVIB does not handle this and I hope you already contacted the environmental reviewers.

Ganesh x2501

B/152

9/17/2012

## **An Ultrasonic Leak Path Assessment of a Pressurized Water Reactor Control Rod Drive Mechanism Nozzle**

P.G. Oberson,<sup>a</sup> D.S. Dunn,<sup>a</sup> A.D. Cinson,<sup>b</sup> S.L. Crawford,<sup>b</sup> P.J. MacFarlan,<sup>b</sup> B.D. Hanson<sup>b</sup>

<sup>a</sup> U.S. Nuclear Regulatory Commission, Washington, DC, 20555, USA

<sup>b</sup> Pacific Northwest National Laboratory, Richland, WA, 99352, USA

### **ABSTRACT**

Leakage of reactor coolant at the reactor pressure vessel (RPV) head in pressurized water reactors (PWRs) may occur because of primary water stress corrosion cracking of nickel-based alloy penetrations and welds. U.S. Nuclear Regulatory Commission regulations require surface or volumetric leak path assessments of RPV head penetrations in PWRs. The objective of this investigation was to evaluate the efficacy of ultrasonic testing (UT) for the leak path assessments with a control rod drive mechanism nozzle removed from an operating reactor. Using a phased-array probe, the nozzle was examined and the UT response indicated leakage paths and surface deposits left by reactor coolant between the nozzle penetration and the RPV head. Following acquisition of the UT data, destructive examination visually confirmed the features identified by UT. Measurements were made of the surface deposit thicknesses and they were found to correlate with the amplitude of the UT response. Further, surface replication of the leak path indicated minimal loss of material on the RPV head surface

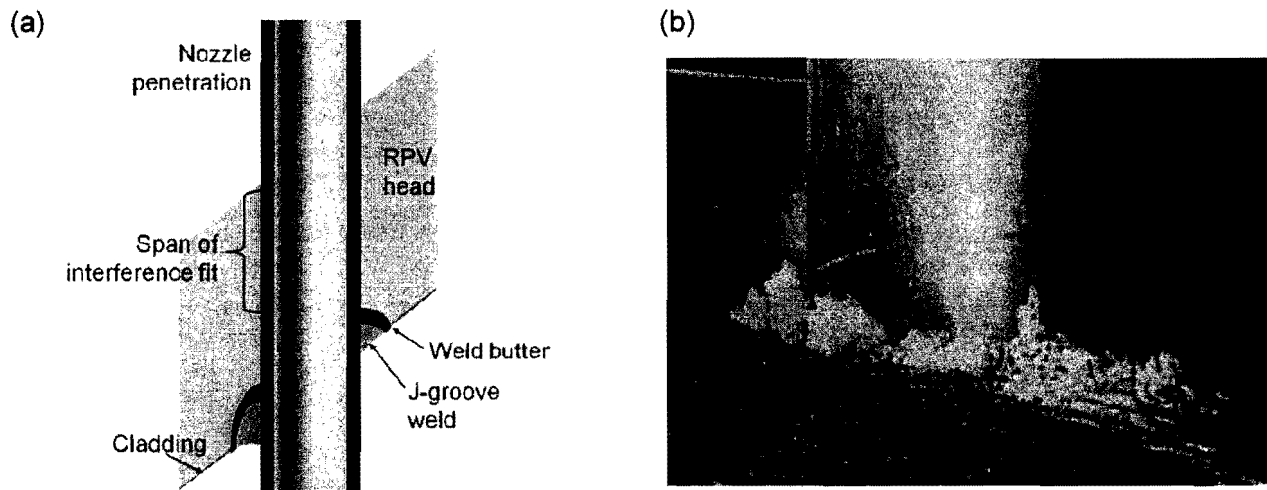
\* The views expressed in this article are those of the authors and are not necessarily those of the U.S. Nuclear Regulatory Commission.

**B11513**

## 1. Introduction

Nickel-based alloys exposed to reactor coolant in pressurized water reactors (PWRs) may experience a form of degradation known as primary water stress corrosion cracking (PWSCC) [1-3]. One component that is susceptible of PWSCC is the control rod drive mechanism (CRDM) nozzle and associated J-groove weld. As shown in Figure 1(a), the CRDM nozzles are cylindrical penetrations through machined bores in the upper reactor pressure vessel (RPV) head that allow for the insertion and removal of control rods. Above the weld there is no mechanical bond between the penetration and the RPV head. At ambient temperature, the penetration diameter is slightly larger than that of the bore. The penetration may be cooled to shrink it, allowing it to be inserted through the bore. Then upon returning to ambient temperature, the penetration and RPV head are in close contact. The part of the annulus where the RPV head surrounds the penetration for the full 360° circumference is referred to as the interference fit.

Most CRDM nozzles originally placed into service in PWRs were fabricated from Alloy 600, using Alloy 82 and 182 weld metals. Cracking in CRDM nozzles and welds may compromise the reactor pressure boundary by allowing primary water leakage through a path in the annulus of the interference fit between the CRDM nozzle and the RPV head. The primary water may eventually reach the top of the RPV head where boric acid may leave visible white deposits, as shown in Figure 1(b). PWSCC of a CRDM nozzle in a PWR was first identified in the Bugey Unit 3 plant in France in 1991 [4], and has since been detected in U.S. plants. At the Davis Besse plant in 2003, significant wastage of a portion of the RPV head occurred in the vicinity of a leaking CRDM nozzle, leaving only stainless steel cladding at the pressure boundary [5].



**Figure 1. (a) Schematic illustration of CRDM penetration in a PWR, (b) Boric acid deposits on top of a RPV head near a leaking CRDM penetration [6].**

After the incident at the Davis Besse plant, U.S. Nuclear Regulatory Commission (NRC) regulations were modified to require a more robust inspection program for PWR upper head penetrations. Title 10 of the Code of Federal Regulations, Part 50.55(a), requires PWR licensees to perform a demonstrated surface or volumetric leak path assessment of all J-groove welds in upper head penetrations. This involves the use of a non-destructive examination technique to determine whether a flow path exists between the nozzle and the RPV that would allow reactor coolant to access the outside of the RPV head. Ultrasonic testing (UT) is one non-destructive technique that may be used for the leak path assessment. The UT methodology relies on the principle that at an interface between two materials with different elastic properties, part of the ultrasonic energy is transmitted through the interface and a part is reflected back. The amount of energy that is transmitted through the interface depends on the relative acoustic impedance of the respective materials. More energy is transmitted when the acoustic impedance of the materials are similar, as would be the case if the nozzle and RPV head were in contact at the interference fit. Less energy is transmitted when the acoustic impedance of the materials is dissimilar, as would be the case if there were an air gap or leakage path between the nozzle and RPV head.

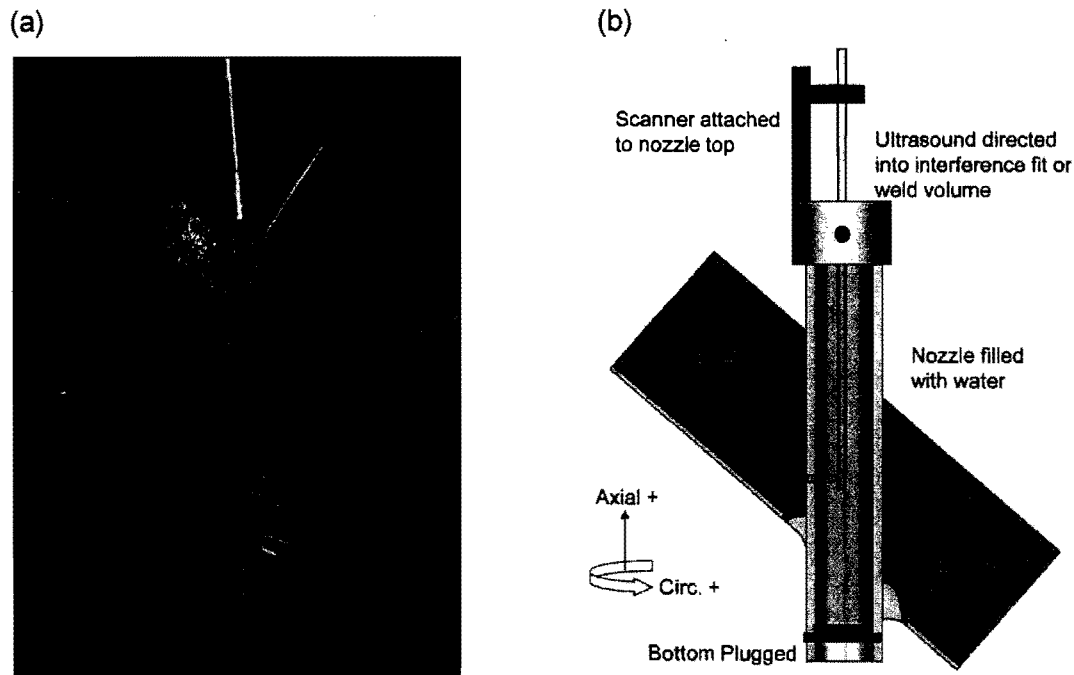
For this investigation, the NRC sponsored an evaluation of the UT leak path assessment methodology at the Pacific Northwest National Laboratory (PNNL). PNNL used a phased array (PA) UT system to acquire leak path data for a CRDM nozzle, referred to as Nozzle 63, removed from the North Anna Unit 2 RPV head that was replaced in 2002. Following acquisition of the UT data, the nozzle was destructively examined to confirm the features identified by UT. This paper will present the findings of this investigation.

## **2. Experimental Methods**

### *2.1 Testing Setup*

Nozzle 63, shown in Figure 2(a), was a peripheral CRDM nozzle in the upper head of North Anna Unit 2, a Westinghouse PWR that entered service in 1980. The materials of construction for Nozzle 63 were Alloy 600 base metal and Alloy 182 J-groove weld metal. Following indications of leakage of reactor coolant onto the upper head during an outage in 2001, the J-groove weld was overlaid with Alloys 52 and 152 in 2001 [7]. Subsequent visual examination during the fall 2002 outage revealed six CRDM nozzles that were suspected of leaking and 21 that were masked to the extent that their status could not be determined, including Nozzle 63. Given the level of degradation of the RPV head, the decision was made to replace the head. The Electric Power Research Institute took possession of a number of the nozzles, including number 63, which were transferred to PNNL and made available for NRC research.

The UT leak path data acquisition for nozzle 63 was performed at PNNL using a ZETEC Tomoscan III system with a pulse-echo longitudinal-wave immersion PA probe. The PA probe was designed in a 1-D annular configuration with 8 elements and a total aperture of 296.81 mm<sup>2</sup>. Further details on the UT system are found in Cinson *et al* [8]. The scanning apparatus attached to the nozzle, with the probe face oriented to direct the ultrasonic beam radially towards the interface between the nozzle and RPV head, as illustrated in Figure 2(b). The

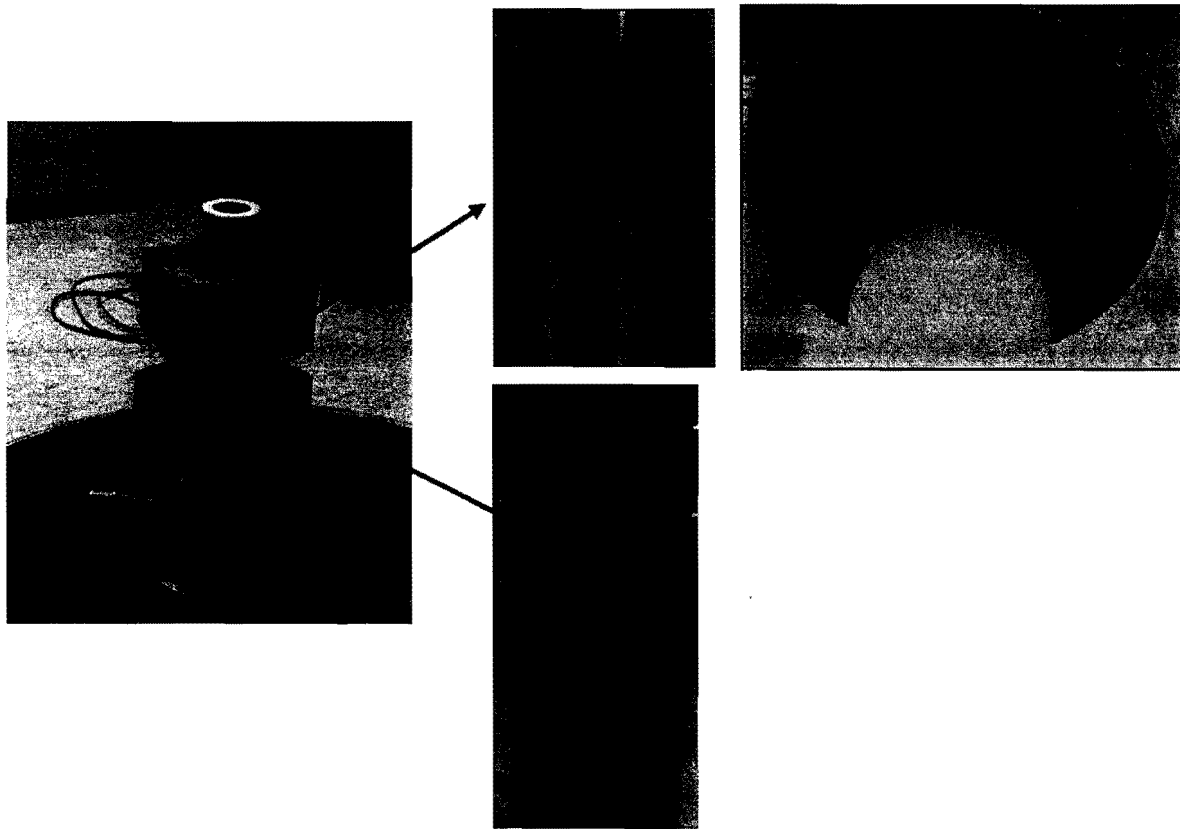


**Figure 2. (a) CRDM nozzle 63 used for this investigation, (b) Schematic illustration of ultrasonic scanning setup for Nozzle 63.**

scanner could move vertically along the length of the nozzle and rotate around the nozzle circumference. For acquiring data from Nozzle 63, the nozzle was put in a vertical orientation, plugged with a water tight seal in the bottom end, and then filled with distilled water. In immersion scanning, water serves as both the wedge material and the ultrasonic couplant material. The probe was manually lowered to the bottom of the interference fit region and the data collected while indexing the probe upwards.

## *2.2 Interference Fit Mockup*

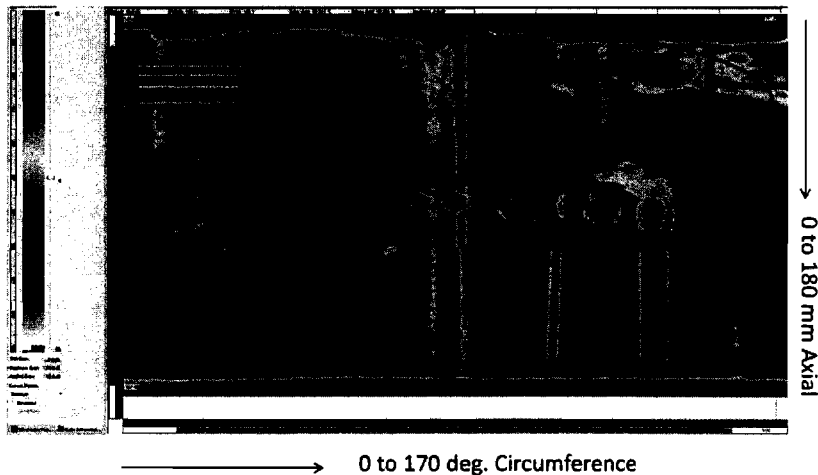
Before acquiring the UT data for Nozzle 63, an interference fit mockup was constructed to assess the capability of the test system to detect features could indicate leakage. The mockup consisted of an Alloy 600 tube with similar dimensions as the CRDM nozzle and two carbon steel blocks with machined bores of slightly smaller diameter than the tube. The tube was shrunk with liquid nitrogen and the carbon steel blocks were fit onto it to create two interference fits once the tube returned to room temperature, as shown in Figure 3. For the top interference fit, machined notches with various orientations and dimensions were placed on the outer diameter (OD) surface of the tube and the inner diameter (ID) surface of the hole in the block to determine the capability of the UT probe to detect cracks or air gaps between the nozzle and RPV head that could indicate a leakage path. For the bottom interference fit, simulated boric acid deposits were made between the tube and the other carbon steel block. A thin boric acid-methanol paste was applied to the tube before the block was placed on, which left dried boric acid after the methanol evaporated.



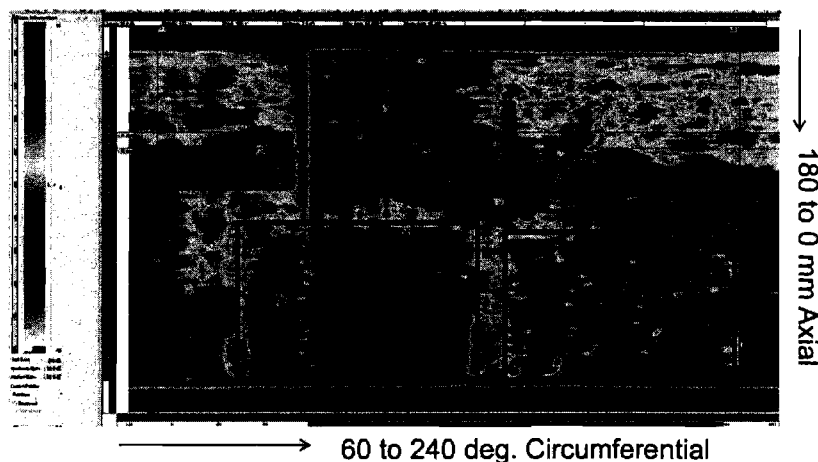
**Figure 3. Interference fit mockup on left showing two carbon steel blocks fit onto Alloy 600 tube. Top interference fit has notched machined into the OD of the tube and ID of the bore in the block. Simulated boric acid deposits were placed on the OD of the tube for the lower interference fit.**

The UT image for the upper interference fit with notches in the tube is shown in Figure 4(a). The colors of blue to green represent a relatively low amplitude ultrasonic signal response, meaning that much of the acoustic energy is transmitted from the tube to the block and does not return to the detector. This indicates a tight fit between the tube and block. The notches appear as yellow to orange in the images, which represents a relatively high amplitude ultrasonic signal response. The air gap between the tube and the block created by the notches reflects much of the acoustic energy from the interface back to the detector. This suggests that a leak path between a nozzle penetration and the RPV head may be identified by a high amplitude ultrasonic response. The UT image for the lower interference fit with boric acid deposits in the annulus between the tube and carbon steel block is shown in Figure 4(b). The regions with the boric acid deposits appear blue, indicating a lower amplitude signal response or greater acoustic energy transmission compared to regions with no deposits. The boric acid deposits may serve to couple the tube and block, facilitating a more efficient transfer of acoustic energy. This indicates that deposits left by primary water leakage between the nozzle and RPV head may be identified by a low amplitude ultrasonic response. Additional details on the mockup examination and system calibration are found in Cinson *et al* [8].

(a)



(b)



**Figure 4. Ultrasonic images for the interference fit mockup. (a) shows the response for the interference fit where there are notches in the OD of the Alloy 600 tube. Notches are circled and the word “PNNL” which was inscribed into the tube is also visible. (b) shows the response for the interference fit where there are boric acid deposits between the tube and blocks. The regions with boric acid deposits are boxed.**

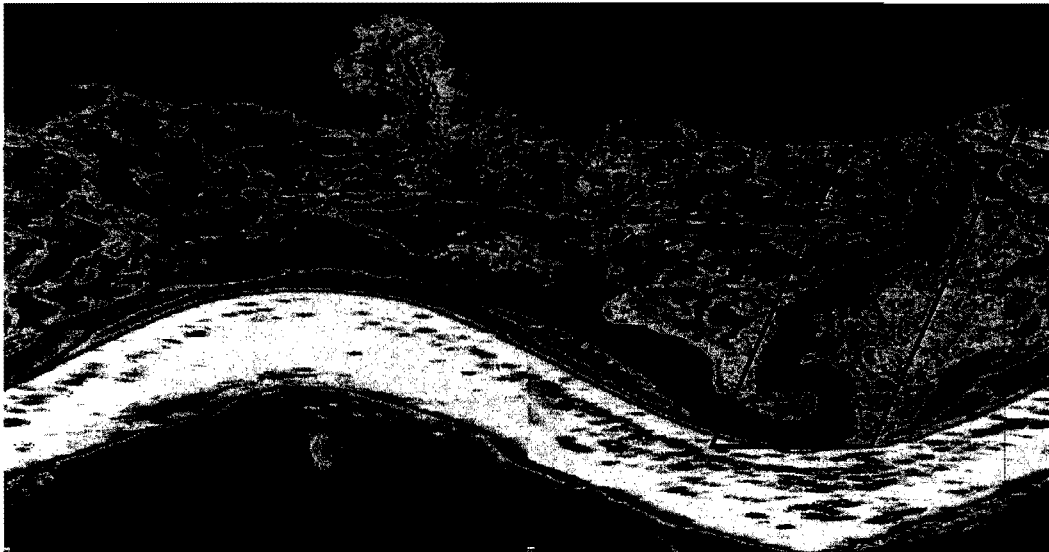
### 3. Results

#### 3.1 UT Leak Path Assessment

The ultrasonic image from the scan of Nozzle 63 is shown in Figure 5. This image shows the full 360° circumference of the nozzle. The light blue region toward the bottom of the figure is the J-groove weld. The portion of the figure above the weld represents the annulus between the nozzle and the RPV head. Based on the known response from the mockup, it was assumed



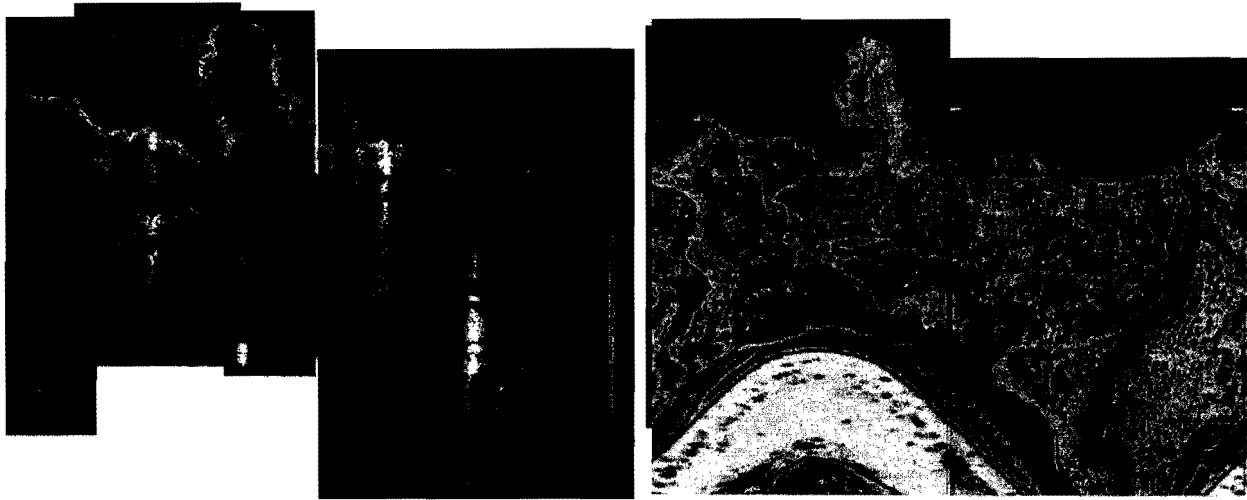
that the green-to-yellow colors indicated regions of the annulus with metal-to-metal contact between the nozzle and RPV head and that the orange color indicates a metal-to-air interface. Following this interpretation, the box in Figure 5 indicates a region of the annulus where there is an air gap or potential leakage path between the nozzle and the RPV head. This would be on the downhill side of the penetration. Other partial leakage paths are visible in orange towards the uphill side of the nozzle. The mockup response also indicated that boric acid deposits left by primary water leakage would appear blue in the ultrasonic image. Thus, the UT response indicates potential deposits throughout the annulus.



**Figure 5. Ultrasonic image of the interference fit for Nozzle 63. The boxed region indicates a potential leakage path between the nozzle and the RPV head.**

### *3.2 Destructive Examination of Nozzle 63*

Following acquisition of the UT data at PNNL, Nozzle 63 was sent to Babcock and Wilcox Technical Services Group for destructive visual examination. The nozzle was separated from the RPV head to expose the annulus, thereby allowing confirmation of the features identified by UT. The nozzle and attached RPV were first bisected along the tube length direction, and then the J-groove weld was removed from each half. After the weld was removed, the nozzle pieces freely separated from the RPV head. Figure 6(a) shows the exposed annulus surface of the RPV head along with the UT image to the same scale in Figure 6(b) for comparison. The arrows indicate the vertical span of the interference fit. The appearance of the surface correlates well with the UT data. The leak path is visible in the same location indicated by UT and the pattern of deposits on the annulus surface is also similar to that shown by UT.

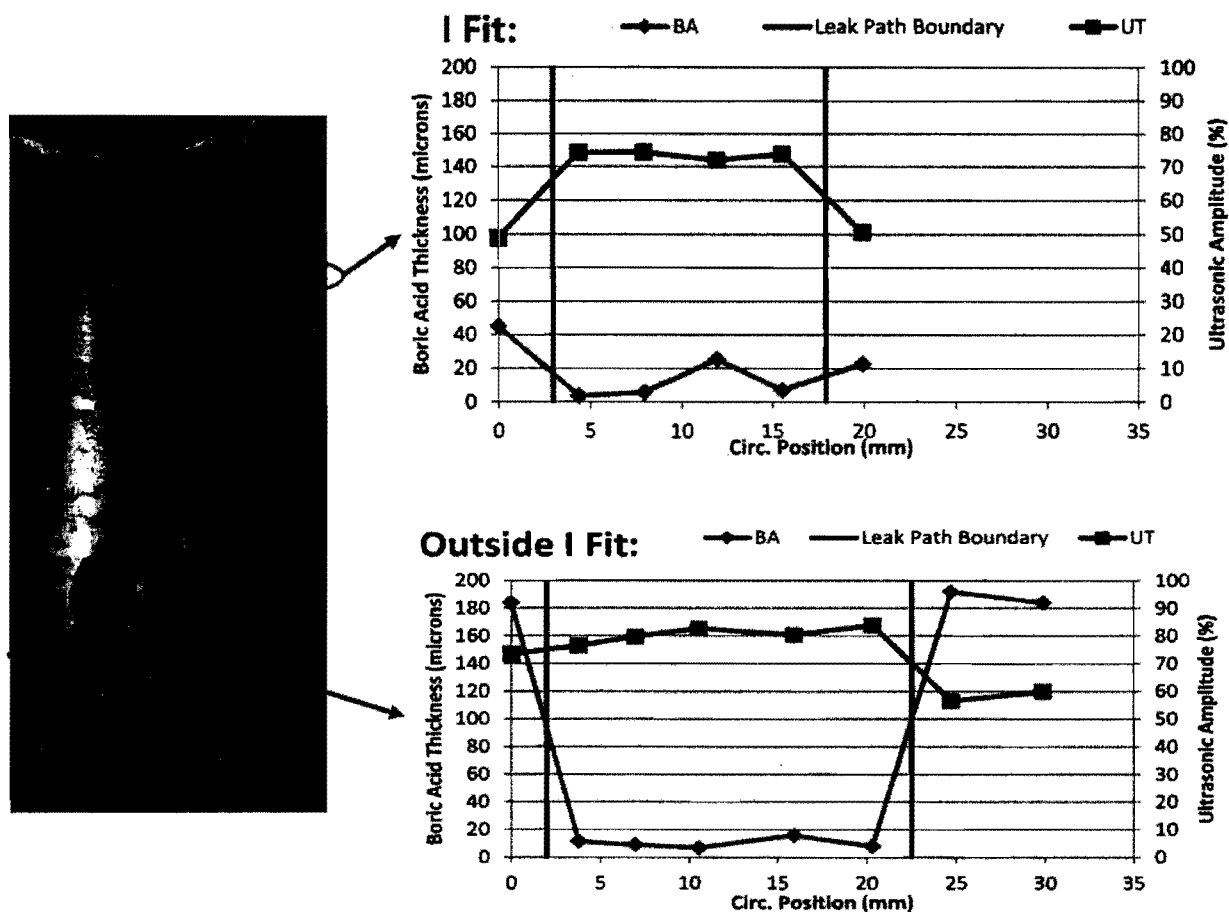


**Figure 6. (a) Exposed annulus surface for the RPV head. (b) UT image of the annulus to same scale as (a). Red arrows show the vertical span of the interference fit.**

### *3.3 Surface Deposit Thickness Measurements*

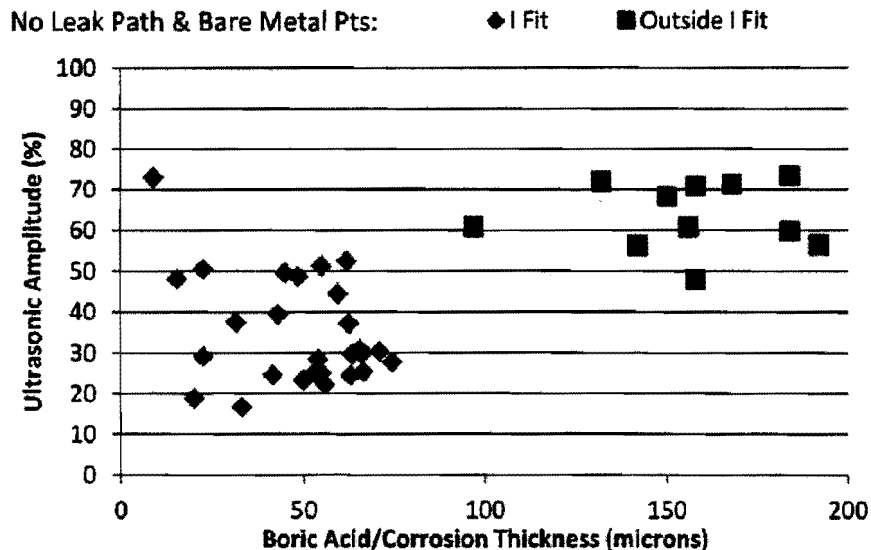
The thickness of deposits on the annulus surface of the RPV head were measured to determine if these had any correlation with the amplitude of the UT response. The deposit thicknesses were measured using a DeFelsko PosiTector 6000 Series eddy current coating thickness gage. It was assumed that the deposits could be crystalline boric acid left by primary water or corrosion products from degradation of the RPV head, such as iron oxides. In the eddy current probe, a coiled wire sets up an alternating current on the probe tip. When brought into proximity of a surface with a coating or surface deposit, the probe creates eddy currents in the base material. The deposit thickness affects the magnitude of the eddy currents, which create an electromagnetic field that is measured by a second coil. The probe had a point contact area of 1 mm in diameter and is calibrated for coating thicknesses in the range of 0 to 1.14 mm. Thickness measurements were made across the leakage path and at a number of other locations in the annulus, both inside and outside the vertical span of the interference fit.

Figure 7 shows the surface deposit thickness measurement and amplitude of the UT response at a number of points across the leak path. The series of measurements across the leak path in the vertical span of the interference fit, (designated "I Fit") in Figure 7, shows that there is minimal deposit thickness within the leak path and the amplitude of the UT response, given as a percentage of full screen height, is relatively high. Outside the leak path, on both sides, the deposits are thicker and the amplitude of the UT response decreases. A similar pattern holds for the measurements across the leak path below the span of the interference fit (designated "Outside I Fit"), though the deposits are somewhat thicker. This response can be explained if it is assumed that the active flow of primary water prevents the formation of deposits directly in the leak path and that the deposits would tend to accumulate to the sides. Because there are no deposits in the leak path, an air gap is maintained between the nozzle OD and the RPV head which gives a high amplitude UT response. Outside the leak path, the deposits serve to couple the nozzle and RPV head, allowing greater transmission of ultrasonic energy, and thus a lower amplitude UT response.



**Figure 7. Measurements of the surface deposit thickness (BA) and amplitude of the UT response (UT) across the leak path for locations in the vertical span of the interference fit (I Fit) and below the interference fit (Outside I Fit). The vertical black lines on the graphs represent the side boundaries of the leak path.**

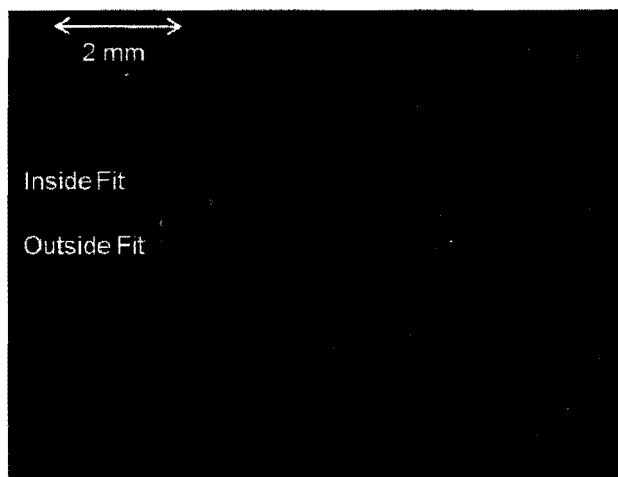
The deposit thicknesses were also measured for various other locations in the annulus, both within and outside the vertical span of the interference fit. The correlation between the deposit thickness and the amplitude of the UT response is shown in Figure 8. The data pattern indicates that within the span of the interference fit, the deposits tend to be thinner, with the locations giving a relatively low amplitude UT response. Outside the span of the interference, the deposits are generally thicker, with locations giving higher amplitude UT response. From these responses, it is postulated that at reactor operating temperature, a gap may open in the annulus between the nozzle and RPV head because of differing thermal expansion coefficients. If leakage occurs, primary water may flow throughout the annulus by the path of least resistance. As the reactor cools down, the gap between the nozzle and RPV head will close, trapping primary water that will leave deposits as it evaporates. It is likely that in the span of the interference fit, the gap between the nozzle OD and the RPV head is narrower than outside, which would significantly compact any deposits left behind. Thus deposits in the span of the interference will tend to be thin and dense relative to deposits outside. The thin and dense deposits should more efficiently couple the nozzle and RPV head allowing greater transmission of ultrasonic energy and a lower amplitude UT response.



**Figure 8. Measurements of the surface deposit thickness and amplitude of the UT response for points inside and outside the span of the interference fit (I Fit).**

### 3.4 Surface Replication

Following measurement of the surface deposit thickness with the eddy current probe, the leakage path on the RPV head side of the annulus was analyzed by surface replication with Microset to determine if any loss of material or wastage could be detected. On viewing with a stereomicroscope, machining marks were visible on the replicated surfaces, as shown in Figure 9. This indicates minimal loss of material, and likely a relatively low leakage flow rate during plant operation.



**Figure 9. Image of surface replication for leakage path on RPV had surface showing transition from outside to inside span of interference fit. Machining marks are visible.**

#### **4. Conclusions**

The efficacy of UT for leak path assessment of upper RPV head penetrations in PWRs was evaluated using Nozzle 63 that was removed from service at North Anna Unit. Ultrasonic examination of Nozzle 63 using a PA probe indicated the presence of a leakage path and scattered boric acid deposits in the annulus between the nozzle penetration and the RPV head. These features were identified by comparing with data acquired from an interference fit mockup. A gap or leak path between the nozzle and RPV head was characterized by a high amplitude UT response whereas deposits in the annulus of the interference fit gave a low amplitude UT response.

Following acquisition of UT data, Nozzle 63 was destructively examined by separating the nozzle from the RPV head to allow visual examination of the annulus region. Visual examination confirmed the presence of the leak path and the pattern of surface deposits in the regions indicated by UT. Measurements were taken of the surface deposit thicknesses using an eddy current probe and correlated to the UT response. There is minimal deposit thickness within the leak path and the amplitude of the UT response is relatively high. Outside the leak path the deposits are thicker and the amplitude of the UT response drops off. This suggests that the flow of primary water prevents the formation of deposits directly in the leak path and that the deposits would tend to accumulate to the sides. The lack of deposits in the leak path allows an air gap between the nozzle OD and the RPV head which gives a high amplitude UT response. Outside the leak path, the deposits serve to couple the nozzle and RPV head, allowing greater transmission of ultrasonic energy, and thus a lower amplitude UT response.

Measurements of the deposit thicknesses elsewhere in the annulus of the interference fit showed that within the span of the interference fit, the deposits tend to be thinner, with the locations giving a relative low amplitude UT response. Outside the span of the interference, the deposits are generally thicker, with locations giving higher amplitude UT response. It is postulated that the narrower gap between the nozzle penetration and the RPV head in the span of the interference fit leads to the compact deposits that more efficiently transmit acoustic energy.

Finally, surface replication of the leak path on the RPV head surface revealed that machining marks were still visible. This indicates that minimal corrosion or wastage of the RPV head surface was needed for the leak path to develop.

#### **Acknowledgements**

This work was funded by the U.S. Nuclear Regulatory Commission. The authors wish to acknowledge the valuable contributions of Mr. Jay Collins of the NRC for this project.

## References

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2. B. Alexandreanu, O. K. Chopra, W. J. Shack, NUREG/CR-6907, "Crack Growth Rates of Nickel Alloy Welds in a PWR Environment," U.S. Nuclear Regulatory Commission, Washington, DC, 2006.
3. B. Alexandreanu, O. K. Chopra, W. J. Shack, NUREG/CR-6964, "Crack Growth Rates and Metallographic Examinations of Alloy 600 and Alloy 82/182 from Field Components and Laboratory Materials Tested in PWR Environments," U.S. Nuclear Regulatory Commission, Washington, DC, 2008.
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8. A.D. Cinson, S.L. Crawford, P.J. MacFarlan, R.A. Matthews, B.D. Hanson, A.A. Diaz, ASME Conference Proceedings PVP2011 (2011) 225-234.

**From:** Poehler, Jeffrey  
**Sent:** Monday, September 17, 2012 3:42 PM  
**To:** Reichelt, Eric; McIntyre, Richard  
**Subject:** New Reactors Audits of Forging Producers

Rich and Eric,

In connection with NRR research related to the Doel 3 (Belgium) reactor vessel indications, I called Dave Terao to find out if NRO had done any audits on Japan Steel Works or other forging producers making new reactor vessel components. Dave didn't know of any audits of JSW but mentioned that you had been to Doosan, in Korea. Do they use forgings from JSW, some other shop, or make their own? I would be interested in finding out any details related the manufacturing processes for the forgings, or useful contacts over there.

Give me a call at your convenience and I can give you more specifics.

Thanks,

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

Poehler, Jeffrey

88

**From:** Poehler, Jeffrey *JEFF*  
**Sent:** Tuesday, September 18, 2012 8:34 AM  
**To:** Reichelt, Eric  
**Subject:** RE: New Reactors Audits of Forging Producers

Thanks.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Reichelt, Eric *ERIC*  
**Sent:** Tuesday, September 18, 2012 8:33 AM  
**To:** Poehler, Jeffrey; McIntyre, Richard  
**Subject:** RE: New Reactors Audits of Forging Producers

Jeff,

Doosan makes their own forgings. I think Rich and Kerri went to JSW for some audits. I will give you a call tomorrow when I am in the office.

Eric

**From:** Poehler, Jeffrey  
**Sent:** Monday, September 17, 2012 3:42 PM  
**To:** Reichelt, Eric; McIntyre, Richard  
**Subject:** New Reactors Audits of Forging Producers

Rich and Eric,

In connection with NRR research related to the Doel 3 (Belgium) reactor vessel indications, I called Dave Terao to find out if NRO had done any audits on Japan Steel Works or other forging producers making new reactor vessel components. Dave didn't know of any audits of JSW but mentioned that you had been to Doosan, in Korea. Do they use forgings from JSW, some other shop, or make their own? I would be interested in finding out any details related the manufacturing processes for the forgings, or useful contacts over there.

Give me a call at your convenience and I can give you more specifics.

Thanks,

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

B/155



A-40

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Wednesday, September 19, 2012 5:13 PM  
**To:** Hardies, Robert  
**Subject:** Accepted: FW: Recap of Doel 3

B/156

**From:** Kirk, Mark *mark*  
**Sent:** Thursday, September 20, 2012 4:30 PM  
**To:** Hardies, Robert; Poehler, Jeffrey  
**Cc:** Csontos, Aladar; Stevens, Gary; Case, Michael; Richards, Stuart; Nove, Carol; Tregoning, Robert  
**Subject:** hydrogen flake papers  
**Attachments:** Tremaine Forgings Vol 17 Issue 3 (2006) p18.pdf; Dayal & Parvathavarthini Sadhana 28 (2003) 431-451.pdf; Ren et al Met Mat Trans A 38 (2007) 1004-1011.pdf; Steiner & Murphy ASTM STP 1259 (1997) 241-248.pdf; Fruehan Hydrogen Flaking.pdf

Bob -

As I mentioned, here are some papers I have found on H2 flakes, which is the type of cracking postulated to be in Doel. I have only skimmed these, but they look informative. I thought that you and Jeff might find them helpful on your Belgian mission

Best

mark



# THE KEENE SENTINEL

FRIDAY, SEPTEMBER 21, 2012

## Reactor needs checking

About a month ago, I began seeing reports from various European news sources that the Doel 3 nuclear reactor in Belgium had been shut down because of possible cracks in the reactor vessel.

A few days later, reports were that though they were each tiny, there were thousands of them. The head of the regulating agency in Belgium said it was hard to envision the reactor ever being repaired.

The investigation that followed indicated the cracks were the result of manufacturing flaws. All reactors built by the Rotterdam Drydock Company, which went bankrupt some years back, are considered suspect.

There were 21 such reactors, and the regulators of the countries where these reactors were sited met to consider what to do about the situation. One thing clear is that cursory inspection is not enough. It must be done by ultrasound.

Some countries, including Belgium and Germany, shut down reactors built by Rotterdam Drydock for inspection. The government of the UK took the matter a step further, and shut down a reactor for inspection even though it was made by a different manu-

facturer, because it was of the same design.

Vermont Yankee has one of the reactors in question. I am finding two different stories about this, and unfortunately NRC records do not seem to clarify them for me.

The reactors involved were made so long ago that in some cases it is difficult to know precisely who made them. Some reports say Rotterdam Drydocks subcontracted the entire reactor for a U.S. company, while others say it only manufactured a huge part of the reactor, with other parts from this country.

In either case, there could be trouble.

I would think the NRC would be on this and talking about what they intend will do. I should think Entergy would issue a statement, unless it is afraid there may be something to hide. I find the silence on this issue distressing, and I think everyone should be made aware of it.

Vermont Yankee's reactor must be considered suspect until all reactor parts that may have been made by Rotterdam Drydock have been cleared by ultrasound inspection.

**GEORGE HARVEY**  
181 Elliot St.  
Brattleboro

B/158

## Basavaraju, Chakrapani

87

**Subject:** Vermont Yankee LAR - Steam Dryer Review (Internal Discussion will precede call w/licensee)  
**Location:** HQ-OWFN-08B06-12p

**Start:** Mon 9/24/2012 2:30 PM  
**End:** Mon 9/24/2012 3:30 PM  
**Show Time As:** Tentative

**Recurrence:** (none)

**Meeting Status:** Not yet responded

**Organizer:** Guzman, Richard  
**Required Attendees:** Cheruvenki, Ganesh; Scarbrough, Thomas; Sheng, Simon; Basavaraju, Chakrapani



Figure 1.pdf



DRAFT- Steam  
Dryer Draft RAI R...

---

**From:** Guzman, Richard *RR*  
**Sent:** Tuesday, September 18, 2012 9:11 AM  
**To:** Cheruvenki, Ganesh  
**Cc:** Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking

Sure. I'm also ok with you coordinating w/the group directly, as necessary, to make an EMCB technical determination on the acceptability of the licensee's proposed RAI response as lead reviewer. You can just let me know once you reach that internal alignment. We will wait to have the call w/the licensee until you are comfortable with a proposed recommendation from your branch.

Can we shoot for a call w/the licensee on Monday afternoon or Wednesday a.m? Is everyone available to support?

Thanks,  
Rich

**From:** Cheruvenki, Ganesh *RR*  
**Sent:** Tuesday, September 18, 2012 8:56 AM  
**To:** Guzman, Richard; Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking

Rich—Since Pani and Tom will not be here on 9/20, can we meet next week?

**From:** Guzman, Richard  
**Sent:** Monday, September 17, 2012 2:59 PM  
**To:** Cheruvenki, Ganesh; Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking

All – please see revised draft response from VY and provide your thoughts/comments and whether it adequately addresses the RAI question(s). I'd like to target Wedn a.m. to discuss internally and then have our call w/the licensee. Please update your calendar for wedn as I plan to use the outlook scheduler to check your availabilities.

B/159

Thanks,  
Rich

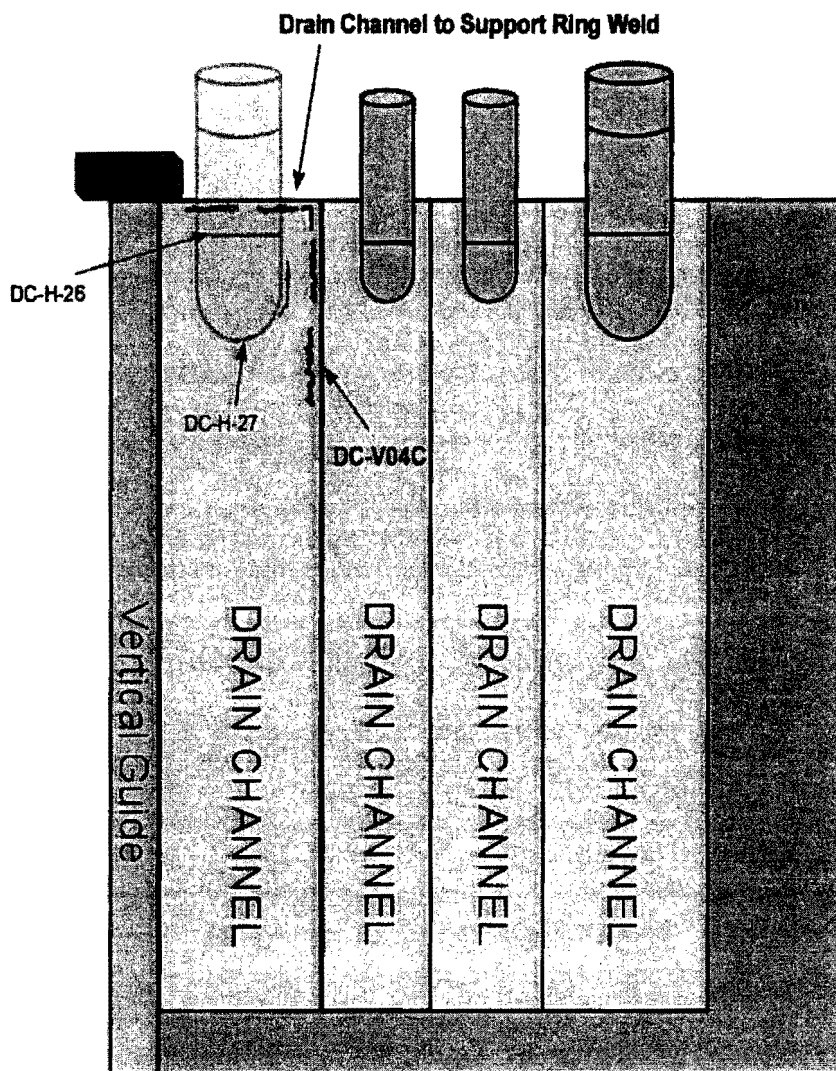
**From:** Cheruvenki, Ganesh

**Sent:** Thursday, September 13, 2012 3:11 PM

**To:** Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas; Guzman, Richard

**Subject:** VY steam dryer cracking

All—I agree with Rich—We will wait for the final submittal and discuss the course of action.



**Poehler, Jeffrey**

**From:** Poehler, Jeffrey *NR*  
**Sent:** Wednesday, September 26, 2012 7:28 AM  
**To:** McIntyre, Richard  
**Subject:** RE: Japan Steel Works Info Related to Forging Practices

What time works for you? I'm free all day today, and free anytime tomorrow except 10-12.

Jeffrey C. Poehler  
 Sr. Materials Engineer  
 NRR/DE/EVIB  
 (301) 415-8353

**From:** McIntyre, Richard *NR*  
**Sent:** Tuesday, September 25, 2012 6:14 PM  
**To:** Poehler, Jeffrey  
**Cc:** Reichelt, Eric; McIntyre, Richard; Kavanagh, Kerri  
**Subject:** RE: Japan Steel Works Info Related to Forging Practices

Jeff

Come down and I will show you the info that JSW went over when we were in Japan

Richard P. McIntyre  
 Senior Reactor Engineer  
 Construction Mechanical Vendor Branch (CMVB)  
 Division of Construction Inspection & Operational Programs  
 Office of New Reactors  
 U.S. Nuclear Regulatory Commission

[richard.mcintyre@nrc.gov](mailto:richard.mcintyre@nrc.gov)  
 301-415-3215

**From:** Poehler, Jeffrey  
**Sent:** Monday, September 24, 2012 10:08 AM  
**To:** McIntyre, Richard  
**Cc:** Reichelt, Eric  
**Subject:** Japan Steel Works Info Related to Forging Practices

Rich, in connection with recent operating experience at Doel 3 on Belgium with extensive reactor vessel indications, I would like to get any information you may have from your visits to JSW related to the steelmaking process, forging process, and post-forging heat treatment, for large pressure vessel forgings. The preliminary root cause by the owner and Belgian regulator identified hydrogen flaking as the most likely cause of the indications. NRR is following the investigation and is trying to determine the relative susceptibility of US plants to the same mechanism. Since most of the forging producers for operating reactors are defunct, we would like to see what the practices are for the currently operating producers, with respect to prevention of hydrogen flaking. Types of information that would be particularly useful include:

Information on the vacuum degassing processes used during melting and casting the ingot  
 Measurements of hydrogen in the melt, ingot, or forging

Post-forging cooling practices and heat treatment – Do they perform a special de-hydrogenation heat treatment before heat treatment for properties?

Ultrasonic testing of the forgings

Metallurgical tests of the ingot or forging

Eric, per our conversation this morning the same information regarding Doosan would be helpful.

Thanks for your help!

Jeffrey C. Poehler

Sr. Materials Engineer

NRR/DE/EVIB

(301) 415-8353



*A 23*  
**Kusnick, Joshua**

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, September 26, 2012 1:26 PM  
**To:** Brown, Christopher  
**Subject:** RE: reducing the susceptibility of cracking in alloy 690

Ok, here's the link to the 10/4 public meeting:

<http://adamswebsearch2.nrc.gov/webSearch2/doccontent.jsp?doc=%7B2790028A-EF5A-403F-A015-8084DD88E42E%7D>

So, 10-4 on meeting with Sam at lunch on 10/4.

---

**From:** Brown, Christopher  
**Sent:** Friday, September 21, 2012 9:47 AM  
**To:** Csontos, Aladar  
**Subject:** RE: reducing the susceptibility of cracking in alloy 690

10-4

BTW, Tanny will be going on rotation to the EDO. Not sure who will be acting BC.

---

**From:** Csontos, Aladar  
**Sent:** Friday, September 21, 2012 9:42 AM  
**To:** Brown, Christopher  
**Cc:** Santos, Cayetano  
**Subject:** RE: reducing the susceptibility of cracking in alloy 690

Christopher,

I was supposed to present our NDE programs to an interagency group including DOD, DOE, DOC, NSA, DOT, etc. on the 3<sup>rd</sup> and 4<sup>th</sup> near the Pentagon. I'm trying to get my talk changed to the morning of the 4<sup>th</sup> so that I can attend both the public meeting and the Doel presentation.

Can I get back to you about the timing once I get my talk rescheduled?

Thanks,  
Al

---

**From:** Brown, Christopher  
**Sent:** Friday, September 21, 2012 9:36 AM  
**To:** Brown, Christopher; Csontos, Aladar  
**Cc:** Santos, Cayetano  
**Subject:** RE: reducing the susceptibility of cracking in alloy 690

Sorry, I misspelled a word.

Hi Al,

Per our phone conversation yesterday, I discussed our conversation with Sam. He wants to know if he can have an informal chat with you on October 4<sup>th</sup> or 5<sup>th</sup>. Perhaps after the Doel presentation on Oct 4th. It the last presentation on the 4<sup>th</sup> and you will be attending.

Also, I was unable to find the public meeting you mentioned on Oct 3<sup>rd</sup>.

thanks

Poehler, Jeffrey

92

**From:** Poehler, Jeffrey *NR*  
**Sent:** Thursday, September 27, 2012 8:37 AM  
**To:** Stevens, Gary  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

Thanks,

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Stevens, Gary *NR*  
**Sent:** Thursday, September 27, 2012 7:48 AM  
**To:** Poehler, Jeffrey  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

Yes, that one I've seen.

Also, I am reviewing your hydrogen flaking document. I should have some minor comments to you later this a.m.

Gary L. Stevens  
Senior Materials Engineer  
NRC/RES/DE/CIB  
E-mail: [Gary.Stevens@nrc.gov](mailto:Gary.Stevens@nrc.gov)  
Office: 301-251-7569

**From:** Poehler, Jeffrey  
**Sent:** Thursday, September 27, 2012 7:41 AM  
**To:** Stevens, Gary  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

Maybe next Wednesday's meeting will provide us all some more direction....you have seen the attached document? Bob forwarded it last week but it is not obvious by the title or email subject what it is.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**From:** Stevens, Gary  
**Sent:** Wednesday, September 26, 2012 3:52 PM  
**To:** Poehler, Jeffrey  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

I am on the FM working group, but have not been given any direction, information, or data by anyone. All I know is I'm supposed to go to Belgium for a 10/16 meeting, and have a beer party in your hotel room.

Gary L. Stevens

*B/102*

Senior Materials Engineer  
NRC/RES/DE/CIB  
E-mail: [Gary.Stevens@nrc.gov](mailto:Gary.Stevens@nrc.gov)  
Office: 301-251-7569

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**From:** Poehler, Jeffrey  
**Sent:** Wednesday, September 26, 2012 3:50 PM  
**To:** Stevens, Gary  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

As far as the objective, I was assigned by my management to work on the metallurgical piece of the flaking issues. Bob Hardies wanted to find out if we could identify factors that could be used to identify susceptible forgings. I'm attending the metallurgical /root cause expert group next month and so is Bob for continuity. The other pieces were the NDE aspects (Carol Nove) and fracture mechanics/structural integrity being worked on by you or Mark Kirk? Carolyn Fairbanks is working on a communications plan on the Doel 3 issue for NRR.

So, I kind of made up the objectives for the document because my direction was rather vague to begin with.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

---

**From:** Stevens, Gary  
**Sent:** Wednesday, September 26, 2012 3:00 PM  
**To:** Poehler, Jeffrey  
**Subject:** RE: Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

Jeff:

Nice work.

Are you working towards a stated objective? If so, where did you obtain that objective?

I'm not trying to be smart or anything, I'm just wondering because I have not been given any information regarding our pending visit to Belgium. No data, nothing. So, I'm not doing anything. It makes me feel like I'll be showing up uninformed and stupid.

Gary L. Stevens  
Senior Materials Engineer  
NRC/RES/DE/CIB  
E-mail: [Gary.Stevens@nrc.gov](mailto:Gary.Stevens@nrc.gov)  
Office: 301-251-7569

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**From:** Poehler, Jeffrey  
**Sent:** Wednesday, September 26, 2012 2:36 PM  
**To:** Hardies, Robert; Fairbanks, Carolyn; Stevens, Gary; Nove, Carol; Kirk, Mark  
**Cc:** Rosenberg, Stacey  
**Subject:** Metallurgy of Hydrogen Flaking Document - for Doel 3 Meeting

The attached summarizes what I have learned regarding the metallurgy of hydrogen flaking so far. It's obviously still a work in progress but I wanted to get something out in time for people to have time to skim it prior to next Wednesday's meeting.

Jeffrey C. Poehler  
Sr. Materials Engineer  
NRR/DE/EVIB  
(301) 415-8353

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Thursday, September 27, 2012 10:31 AM  
**To:** Richards, Stuart  
**Subject:** Re: Counterintelligence (CI) Travel Briefings and Debriefings

Thanks!!

---

**From:** Richards, Stuart  
**To:** Csontos, Aladar; Case, Michael; Hogan, Rosemary; Gavrilas, Mirela; Boyce, Tom (RES); Sydnor, Russell  
**Cc:** Dion, Jeanne  
**Sent:** Thu Sep 27 10:01:29 2012  
**Subject:** RE: Counterintelligence (CI) Travel Briefings and Debriefings

Brian has some concerns with the amount of time which will be required to carry out this program. He wants to ensure that a level of common sense is involved. For instance, someone traveling to Paris 2 or 3 times in a year should only be briefed once, unless there is some specific threat that requires more frequent interactions.

I think Brian has Brett talking to NSIR about this.

Fyi  
Stu

---

**From:** Csontos, Aladar  
**Sent:** Thursday, September 27, 2012 8:17 AM  
**To:** Case, Michael; Hogan, Rosemary; Gavrilas, Mirela; Boyce, Tom (RES); Sydnor, Russell  
**Cc:** Dion, Jeanne; Richards, Stuart  
**Subject:** Re: Counterintelligence (CI) Travel Briefings and Debriefings

Yup, Gary and Carol have to take this course next week in order to travel to Belgium for their Doel trip. Didn't know that was a hotbed of humint!!!

---

**From:** Case, Michael  
**To:** Csontos, Aladar; Hogan, Rosemary; Gavrilas, Mirela; Boyce, Tom (RES); Sydnor, Russell  
**Cc:** Dion, Jeanne; Richards, Stuart  
**Sent:** Thu Sep 27 06:20:14 2012  
**Subject:** FW: Counterintelligence (CI) Travel Briefings and Debriefings

FYI folks.

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**From:** Uhle, Jennifer  
**Sent:** Wednesday, September 26, 2012 6:09 PM  
**To:** Gibson, Kathy; Scott, Michael; Richards, Stuart; Case, Michael; Coe, Doug; Correia, Richard; Grancorvitz, Teresa; Sangimino, Donna-Marie; Rini, Brett  
**Subject:** FW: Counterintelligence (CI) Travel Briefings and Debriefings

See below. J

**From:** Dapas, Marc

**To:** Leeds, Eric; Dorman, Dan; Boger, Bruce; Satorius, Mark; Holian, Brian; Tracy, Glenn; Holahan, Gary; Sheron, Brian; Uhle, Jennifer; Haney, Catherine; Moore, Scott; Doane, Margaret; Shaffer, Mark; Dean, Bill; Lew, David; McCree, Victor; Wert, Leonard; Brown, Frederick; Casto, Chuck; Pederson, Cynthia; Collins, Elmo; Howell, Art; Zimmerman, Roy; Campbell, Andy

**Cc:** Johnson, Michael; Weber, Michael; Wiggins, Jim; Masse, Todd; Wray, Barry; Holahan, Patricia; Westreich, Barry

**Sent:** Tue Sep 25 20:09:21 2012

**Subject:** Counterintelligence (CI) Travel Briefings and Debriefings

The purpose of this e-mail to ensure your awareness of an initiative being led by NSIR to conduct counterintelligence (CI) briefings and debriefings for agency employees who are involved in foreign travel.

By way of background, back in February 2011, the Commission approved a defensive CI program. This program includes CI and information security training as part of international travel briefings. The Intelligence Liaison and Threat Assessment Branch (ILTAB) within NSIR (specifically, Barry Wray, the Counterintelligence Program Manager (CIPM)) is conducting the subject briefings. When fully implemented, the travel briefings will have two components and two levels. The two components are the pre-travel briefing and the post travel debriefing. The two levels are related to the location of the travel and venues of concern.

A country of concern list – comprised of those nation-states which pose the greatest level of human intelligence (HUMINT) threat towards NRC staff – will be developed. Staff and contractors traveling to those countries of concern will receive a country specific briefing from the ILTAB/CIPM. Also included in this category will be travel to venues of concern. A venue of concern relates more to the topic of the meetings and the attendees than it does the location. As an example: Austria will be on the countries of concern list, not due to the Austrian intelligence services, but because of the numerous foreign intelligence services (FIS) operating in Vienna, and the sensitivity of some of the issues discussed at the International Atomic Energy Agency based there.

Staff and contractors that are not traveling to a location on the country/venue of concern list will be able to use the "International Travel" training on iLearn as the pre-travel briefing.

All travelers will be required to complete a post travel de-briefing questionnaire and return it to the ILTAB/CIPM. The questionnaires will be reviewed by the CIPM and follow-up one-on-one briefings will be conducted as needed.

The purpose of these foreign travel-related briefings and debriefings is to protect NRC personnel, programs, and information. This is achieved through the following means:

- *Defensive Briefings and Debriefings.* Briefings provide the traveler with information to counter elicitation and to respond appropriately. Debriefings are opportunities for staff to voluntarily share with the CI program anything that may have happened in their travels or interactions that didn't seem right or caused them concern.
- *Threat Awareness.* There is a HUMINT threat directed at the NRC. The travel briefings are designed to make travelers aware of this threat, provide information on FIS recruiting and elicitation tactics, and provide advice on what to do and not to do if the traveler is, or believes that they have been, targeted in a collection effort.

- *Debriefing Feedback.* As the DCI program accumulates suspicious activity and known targeting activities from debriefings, this information will be fed back into the pre-briefings so NRC travelers are made aware of the elicitation or other threats, and can take steps to avoid or mitigate such threats.
- *Threat Data Analysis.* Debriefings also provide an opportunity for the NRC to analyze the data provided to look for patterns of suspicious activity, such as an individual showing up at different venues trying to elicit specific sensitive or proprietary information from different NRC staff.

Hopefully, this e-mail provides you with a better understanding of the CI program elements relating to foreign travel. Should any of your staff, supervisors, or managers have questions, please have them contact either Barry Wray, the CIPM, or Todd Massey, the ILTAB Branch Chief.

We will be providing you with a separate communication once we have the iLearn training module referenced above, up and running.



Oberson, Greg

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**From:** Oberson, Greg  
**Sent:** Friday, September 28, 2012 10:04 AM  
**To:** Collins, Jay  
**Subject:** journal article on Nozzle 63 work

Jay,

I believe I mentioned this but I'd like to submit a paper on the nozzle 63 work to journal of nuclear materials. I have a draft that has been approved by my management for submission. I have placed a copy on sharepoint here:

<http://portal.nrc.gov/edo/res/de/cmb/PWSCC/Shared%20Documents/Other%20PWSCC%20Technical%20Reports/Nozzle%2063%20journal%20article.docx>

There is no analysis or commentary beyond what is in the NUREG/CR, but I think this should put a nice bow on the project. Please confirm that you are ok with submitting this before I proceed.

Thanks,  
Greg

B1764  
H911B

+33

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Tuesday, October 02, 2012 4:15 PM  
**To:** Hardies, Robert  
**Subject:** Accepted: ACRS presentation on the Doel 3 indications

B1165

**Basavaraju, Chakrapani**

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94

**From:** Guzman, Richard *NRK*  
**Sent:** Wednesday, October 03, 2012 1:39 PM  
**To:** Cheruvenki, Ganesh  
**Cc:** Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking  
**Attachments:** BVY 12-061 Steam Dryer RAI Response.pdf

Ganesh,

Please see attached – advanced copy of docketed RAI response from Vermont Yankee. I expect it to be in ADAMS within the next couple of days. Let me know if you have everything at this point, to complete your review. As we discussed during our last internal meeting, please coordinate w/Pani, Tom, and Simon to draft up license conditions, as appropriate. I'd like to target 11/5 as the updated EMCBS SE due date. Let me know if that works for you.

Thanks,  
Rich

Rich Guzman  
Sr. Project Manager  
NRR/DORL/LPL1-1  
US NRC  
301-415-1030

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**From:** Cheruvenki, Ganesh *NRK*  
**Sent:** Tuesday, September 18, 2012 8:56 AM  
**To:** Guzman, Richard; Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking

Rich—Since Pani and Tom will not be here on 9/20, can we meet next week?

---

**From:** Guzman, Richard  
**Sent:** Monday, September 17, 2012 2:59 PM  
**To:** Cheruvenki, Ganesh; Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas  
**Subject:** RE: VY steam dryer cracking

All – please see revised draft response from VY and provide your thoughts/comments and whether it adequately addresses the RAI question(s). I'd like to target Wedn a.m. to discuss internally and then have our call w/the licensee. Please update your calendar for wedn as I plan to use the outlook scheduler to check your availabilities.

Thanks,  
Rich

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**From:** Cheruvenki, Ganesh  
**Sent:** Thursday, September 13, 2012 3:11 PM  
**To:** Sheng, Simon; Basavaraju, Chakrapani; Scarbrough, Thomas; Guzman, Richard  
**Subject:** VY steam dryer cracking

All—I agree with Rich—We will wait for the final submittal and discuss the course of action.

B/166

A-31

**Kusnick, Joshua**

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**Subject:** ACRS Meeting on Doel-3 Indications  
**Location:** T2B1

**Start:** Thu 10/4/2012 1:00 PM  
**End:** Thu 10/4/2012 2:30 PM  
**Show Time As:** Tentative

**Recurrence:** (none)

**Meeting Status:** Not yet responded

**Organizer:** Csontos, Aladar

When: Thursday, October 04, 2012 1:00 PM-2:30 PM (GMT-05:00) Eastern Time (US & Canada).

Where: T2B1

Note: The GMT offset above does not reflect daylight saving time adjustments.

\*~\*~\*~\*~\*~\*~\*~\*~\*~\*

1:15 PM - 2:15 PM Reactor Pressure Vessel Fabrication and Flaw Assessment (Closed) (JSA/CLB)

4.1) Remarks by the Subcommittee Chairman

4.2) Briefing by and discussions with representatives of the NRC staff regarding issues related to reactor pressure vessel fabrication and flaw assessment.

[NOTE: This session will be closed in order to discuss and protect information provided in confidence by a foreign source, pursuant to 5 U.S.C 552b(c)(4)]

B/167

## Trapp, James

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**From:** Sheehan, Neil  
**Sent:** Thursday, October 04, 2012 8:25 AM  
**To:** Gray, Harold; Hardies, Robert  
**Cc:** Screnci, Diane; Trapp, James; Burns, Thomas; Wilson, Peter; Miller, Chris; Dean, Bill; Lew, David  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

I sent a letter to the editor to the Keene Sentinel last week responding to this.

-----Original Message-----

**From:** Gray, Harold  
**Sent:** Thursday, October 04, 2012 7:49 AM  
**To:** Hardies, Robert  
**Cc:** Screnci, Diane; Sheehan, Neil; Trapp, James; Burns, Thomas; Wilson, Peter; Miller, Chris  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

Bob,

In case you do not already have it, the attached.

Is NRC going to issue a summary on the significance to US plants of these UT indications, which have been characterized as hydrogen flaking, small indications in the plane of the shell surface, similar to laminations?

As I read the related info, it looks like the vacuum degassing or post forming heat treatment of the shell ring forging by the steel producer were factors in the indication development.

Harold Gray

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:25 AM  
**To:** Gray, Harold; Burns, Thomas  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

Either of you know anything? Or, are the current ISI and NDE inspections such that we already know it isn't possible?

Thanks,  
Scott

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:20 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** Newspaper opinion article RE reactor vessel cracks

I read this article in a local newspaper last night. I'm evaluating it for potential to be an allegation. I would think this would be an issue for which the validity is known, making it NOT an allegation. However, I don't recall any such discussion or information. Anyone know anything?

Thanks,  
Scott

## Trapp, James

---

**From:** Burns, Thomas  
**Sent:** Thursday, October 04, 2012 8:06 AM  
**To:** Rutenkroger, Scott  
**Cc:** Gray, Harold; Lupold, Timothy; Trapp, James  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

Scott: I did see the initial report of this condition but, info was very sparse. No specific data was provided and speculation seemed to be the rule of the day. I had a brief discussion with Harold regarding what our thoughts were on the issue but, no action items were developed here in the Region as it's somewhat beyond the Scope of ISI inspections at this point in time. Perhaps HQ's has some action for just where this is or will lead us.

I'll make sure your in the loop if anything should materialize that shows the direction NRC is contemplating as we are made aware and better understand just how this issue will be dispositioned. Right now, I know of nothing active planned (at the Region level).

Tom Burns

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:25 AM  
**To:** Gray, Harold; Burns, Thomas  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

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**Subject:** Newspaper opinion article RE reactor vessel cracks

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Thanks,  
Scott

## Trapp, James

---

**From:** Gray, Harold  
**Sent:** Thursday, October 04, 2012 7:49 AM  
**To:** Hardies, Robert  
**Cc:** Screnci, Diane; Sheehan, Neil; Trapp, James; Burns, Thomas; Wilson, Peter; Miller, Chris  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks  
**Attachments:** Scan File.pdf

Bob,

In case you do not already have it, the attached.

Is NRC going to issue a summary on the significance to US plants of these UT indications, which have been characterized as hydrogen flaking, small indications in the plane of the shell surface, similar to laminations?

As I read the related info, it looks like the vacuum degassing or post forming heat treatment of the shell ring forging by the steel producer were factors in the indication development.

Harold Gray

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:25 AM  
**To:** Gray, Harold; Burns, Thomas  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

Either of you know anything? Or, are the current ISI and NDE inspections such that we already know it isn't possible?

Thanks,  
Scott

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:20 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** Newspaper opinion article RE reactor vessel cracks

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Thanks,  
Scott

B1170



## Setzer, Thomas

---

**From:** Setzer, Thomas  
**Sent:** Thursday, October 04, 2012 7:22 AM  
**To:** Rutenkroger, Scott; Bellamy, Ronald; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

I think the ISI inspections and NDEs done on the reactor vessel over its life make the validity of this issue known.

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:20 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** Newspaper opinion article RE reactor vessel cracks

I read this article in a local newspaper last night. I'm evaluating it for potential to be an allegation. I would think this would be an issue for which the validity is known, making it NOT an allegation. However, I don't recall any such discussion or information. Anyone know anything?

Thanks,  
Scott

8/17/11

## Setzer, Thomas

---

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 8:08 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

-----Original Message-----

**From:** Burns, Thomas  
**Sent:** Thursday, October 04, 2012 8:06 AM  
**To:** Rutenkroger, Scott  
**Cc:** Gray, Harold; Lupold, Timothy; Trapp, James  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

Scott: I did see the initial report of this condition but, info was very sparse. No specific data was provided and speculation seemed to be the rule of the day. I had a brief discussion with Harold regarding what our thoughts were on the issue but, no action items were developed here in the Region as it's somewhat beyond the Scope of ISI inspections at this point in time. Perhaps HQ's has some action for just where this is or will lead us.

I'll make sure your in the loop if anything should materialize that shows the direction NRC is contemplating as we are made aware and better understand just how this issue will be dispositioned. Right now, I know of nothing active planned (at the Region level).

Tom Burns

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 7:25 AM  
**To:** Gray, Harold; Burns, Thomas  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

Either of you know anything? Or, are the current ISI and NDE inspections such that we already know it isn't possible?

Thanks,  
Scott

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**Sent:** Thursday, October 04, 2012 7:20 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** Newspaper opinion article RE reactor vessel cracks

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Thanks,  
Scott

B1172

## Setzer, Thomas

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**From:** Guzman, Richard  
**Sent:** Thursday, October 04, 2012 8:44 AM  
**To:** Setzer, Thomas; Rutenkroger, Scott; Bellamy, Ronald; Keighley, Elizabeth; DeBoer, Joseph  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

I'll follow-up w/the HQ allegations folks and get their take.

Rich

-----Original Message-----

**From:** Setzer, Thomas  
**Sent:** Thursday, October 04, 2012 8:28 AM  
**To:** Rutenkroger, Scott; Bellamy, Ronald; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

Harold Gray spoke about this in this morning's meeting. He has forwarded it on to HQs.

-----Original Message-----

**From:** Rutenkroger, Scott  
**Sent:** Thursday, October 04, 2012 8:08 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

-----Original Message-----

**From:** Burns, Thomas  
**Sent:** Thursday, October 04, 2012 8:06 AM  
**To:** Rutenkroger, Scott  
**Cc:** Gray, Harold; Lupold, Timothy; Trapp, James  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

Scott: I did seer the initial report of this condition but, info was very sparse. No specific data was provided and speculation seemed to be the rule of the day. I had a brief discussion with Harold regarding what our thoughts were on the issue but, no action items were developed here in the Region as it's somewhat beyond the Scope of ISI inspections at this point in time. Perhaps HQ's has some action for just where this is or will lead us.

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Tom Burns

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Scott

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To: Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph; Guzman, Richard

Subject: Newspaper opinion article RE reactor vessel cracks

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Thanks,  
Scott

**Setzer, Thomas**

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**From:** Rutenkroger, Scott  
**Sent:** Friday, October 05, 2012 7:33 AM  
**To:** Bellamy, Ronald; Setzer, Thomas; Keighley, Elizabeth; DeBoer, Joseph  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

FYI, below is what Neil Sheehan had sent in for an Op-Ed to the newspaper. I hadn't seen it before.

-Scott

-----Original Message-----

**From:** Gray, Harold  
**Sent:** Friday, October 05, 2012 7:29 AM  
**To:** Rutenkroger, Scott  
**Subject:** FW: Newspaper opinion article RE reactor vessel cracks

Scott,

FYI,

Neil's letter to the Editor.

If question or more info needed, please call

Harold Gray,  
610-337-5325

-----Original Message-----

**From:** Sheehan, Neil  
**Sent:** Thursday, October 04, 2012 11:19 AM  
**To:** Gray, Harold  
**Subject:** RE: Newspaper opinion article RE reactor vessel cracks

Here you go

To the Editor:

In a recent letter to the editor, a reader raised a question regarding the reactor vessel at the Vermont Yankee nuclear power plant. The reactor vessel houses the nuclear fuel and is where the splitting of atoms and production of heat that are central to the plant's energy production process occurs.

Specifically, the reader said clarity is needed on whether the vessel was manufactured by the same company that built the reactor vessel for the Doel-3 nuclear power plant in Belgium. The reason: Flaw indications identified in August in the Doel-3 vessel.

Preliminary information indicates that Vermont Yankee's vessel was not among 10 in use in the United States produced by the Rotterdam Drydock Co. Indeed, none of the vessels ordered for nuclear power plants in the Northeastern U.S. was apparently built there.

As for what the NRC is doing in response to the issue, several top engineering experts on reactor vessel materials are taking part in international discussions on what inspections of the Doel-3 reactor have found, as well as any plans to respond to the issue.

The NRC will continue to gather information about the Doel-3 issue and any implications for U.S. reactors.

Neil Sheehan  
NRC Public Affairs Officer

-----Original Message-----

From: Gray, Harold  
Sent: Thursday, October 04, 2012 8:29 AM  
To: Sheehan, Neil  
Subject: RE: Newspaper opinion article RE reactor vessel cracks

Neil,

Please send me a copy.

Thanks

H Gray,

X5325

-----Original Message-----

From: Sheehan, Neil  
Sent: Thursday, October 04, 2012 8:25 AM  
To: Gray, Harold; Hardies, Robert  
Cc: Screnci, Diane; Trapp, James; Burns, Thomas; Wilson, Peter; Miller, Chris; Dean, Bill; Lew, David  
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Cc: Screnci, Diane; Sheehan, Neil; Trapp, James; Burns, Thomas; Wilson, Peter; Miller, Chris  
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Harold Gray

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Thanks,  
Scott

Hardies, Robert

23

**From:** VAN WONTERGHEM Frederik [Frederik.VANWONTERGHEM@FANC.FGOV.BE]  
**Sent:** Tuesday, October 09, 2012 10:22 AM  
**To:** adrien.thibault@asn.fr; bernhard.elsing; Nove, Carol; drozanski@vincotte.be; erik.zeelenberg@lr.org; gerard.cattiaux@irsn.fr; hvandriessche@vincotte.be; janssens@nrg.eu; kck@kins.re.kr; martin.ryf@ensi.ch; matsumoto-mitsuyoshi@jnes.go.jp; MENDOZA GOMEZ CARLOS; Michel.bieth@ec.europa.eu; Olavi.Valkeajarvi@stuk.fi; Richard.Sundberg@ssm.se; Tony.Wooldridge; vincent.deledicque@belv.be; Hardies, Robert  
**Cc:** awayn@vincotte.be; WERTELAERS An; TOMBUYES Beatrice; OULIDDREN Kamreddine; pierre.briegleb@belv.be  
**Subject:** RE: Doel 3 RPV Issue - Details on October 16th meeting - WG1: Non-Destructive Examination Techniques  
**Attachments:** CNT-KCD\_4NT\_17868\_000\_01\_TOTALDOC.pdf

PART 3/3 of the documents

**Van:** VAN WONTERGHEM Frederik

**Verzonden:** 09 October 2012 16:22

**Aan:** adrien.thibault@asn.fr; bernhard.elsing; Carol.Nove@nrc.gov; drozanski@vincotte.be; erik.zeelenberg@lr.org ; gerard.cattiaux@irsn.fr; hvandriessche@vincotte.be; janssens@nrg.eu; kck@kins.re.kr; martin.ryf@ensi.ch; matsumoto-mitsuyoshi@jnes.go.jp; MENDOZA GOMEZ CARLOS; Michel.bieth@ec.europa.eu; Olavi.Valkeajarvi@stuk.fi; Richard.Sundberg@ssm.se; Tony.Wooldridge; vincent.deledicque@belv.be; Robert.Hardies@nrc.gov  
**CC:** awayn@vincotte.be; WERTELAERS An; TOMBUYES Beatrice; OULIDDREN Kamreddine; pierre.briegleb@belv.be  
**Onderwerp:** RE: Doel 3 RPV Issue - Details on October 16th meeting - WG1: Non-Destructive Examination Techniques

PART 2/3 of the documents

**Van:** VAN WONTERGHEM Frederik

**Verzonden:** 09 October 2012 16:20

**Aan:** [adrien.thibault@asn.fr](mailto:adrien.thibault@asn.fr); [bernhard.elsing](mailto:bernhard.elsing); [Carol.Nove@nrc.gov](mailto:Carol.Nove@nrc.gov); [drozanski@vincotte.be](mailto:drozanski@vincotte.be); [erik.zeelenberg@lr.org](mailto:erik.zeelenberg@lr.org) ; [gerard.cattiaux@irsn.fr](mailto:gerard.cattiaux@irsn.fr); [hvandriessche@vincotte.be](mailto:hvandriessche@vincotte.be); [janssens@nrg.eu](mailto:janssens@nrg.eu); [kck@kins.re.kr](mailto:kck@kins.re.kr); [martin.ryf@ensi.ch](mailto:martin.ryf@ensi.ch); [matsumoto-mitsuyoshi@jnes.go.jp](mailto:matsumoto-mitsuyoshi@jnes.go.jp); MENDOZA GOMEZ CARLOS; [Michel.bieth@ec.europa.eu](mailto:Michel.bieth@ec.europa.eu); [Olavi.Valkeajarvi@stuk.fi](mailto:Olavi.Valkeajarvi@stuk.fi); [Richard.Sundberg@ssm.se](mailto:Richard.Sundberg@ssm.se); Tony.Wooldridge; [vincent.deledicque@belv.be](mailto:vincent.deledicque@belv.be); [Robert.Hardies@nrc.gov](mailto:Robert.Hardies@nrc.gov)  
**CC:** [awayn@vincotte.be](mailto:awayn@vincotte.be); WERTELAERS An; TOMBUYES Beatrice; OULIDDREN Kamreddine; [pierre.briegleb@belv.be](mailto:pierre.briegleb@belv.be)  
**Onderwerp:** Doel 3 RPV Issue - Details on October 16th meeting - WG1: Non-Destructive Examination Techniques

Dear Member of WG 1,

We are pleased to welcome you as member of WG 1 and hope that the collaboration may be useful for all participants. We sent you last week (02/10/2012) already some details about the October 16th meeting in Brussels. Here below you find more specificities and the (preliminary) agenda for the WG 1 meeting on Non-Destructive Examination Techniques

**Preliminary Agenda for the WG1 meeting sessions**

1. Welcome and presentation of all attendees.
2. Objectives.
3. Overview of the findings in the reactor shells Doel 3 & Tihange 2.
4. Experiences of the WG members with respect to the observed phenomena : Round table discussion of results of inspections performed (or planned inspections) on other reactor vessels to search for these kinds of phenomena.
5. Discussion on the following documents, made available by the Licensee, and which are related to the Reactor Vessel Inspection of the Nuclear Power Plants Doel 3 (KCD3) and Tihange 2 (CNT2):



Technical Note CNT-KCD/4NT/0017885/000/01 : 1.0.1 - Strategy on Ultrasonic Examinations (LBE0267719)  
Technical Note CNT-KCD/4NT/0017748/001/00 : 1.1.2 - Ultrasonic examination of core shells for underclad cracking synthesis report Doel 3  
Technical Note CNT-KCD/4NT/0017787/001/01 : 1.1.5 - Ultrasonic examination for laminar flaws - Synthesis report Doel 3  
Technical Note CNT-KCD/4NT/0017887/000/01 : 1.4.1 - Assessment of UT Inspection Sensitivity (LBE02612128)  
Technical Note CNT-KCD/4NT/0017886/000/01 : 1.6.1 - Doel 3 - RPV Transition ring C0064 - Consistency of UT results (LBE02676489)

6. Discussion on extracts (related to UT Examination) of other documents made available by the Licensee:  
Technical Note CNT-KCD/4NT/0017817/001/01 : 3.0.1 - Strategy of materials investigations  
Technical Note CNT-KCD/4NT/0017868/000/01 : 3.1.1 - Note AREVA on the metallurgical origin of the indication(PEEM-F 12.1190)  
Technical Note CNT-KCD/4NT/0017740/000/04 : 3.2.4 - Specification for the operations and tests to be performed on a small block from the steam generator shell containing flaws

7. Specific Topics/Questions for discussion:  
> Assessment of the inspection technique and acceptance criteria used in the fabrication.  
> Assessment of the results of the 2012 in-service inspection.  
> Is it plausible that the flaw indications found during the in-service inspection in 2012, have been declared acceptable at the manufacturing stage ?  
> May the observed flaw indications come from other degradation mechanisms than the supposed hydrogen flaking ?  
> Qualification of the inspection procedure used in 2012 for detecting and characterizing the flaws of the assumed degradation type.  
> Does the applied UT allow to detect interconnections between flaw indications in the thickness direction ?  
> Are additional UT or other NDE examinations required to increase the confidence in the measurement results ?

8. Other topics: to be proposed by the WG members.

#### **Available documentation**

We received a number of documents from the Licensee (Electrabel) of which the ones listed in points 5 and 6 of the agenda are of importance to our working group.

The WG members are invited to review the referenced Technical Notes (see points 5 and 6 above) before the meeting and to send their preliminary comments, if any, to the Technical Secretary.

All these documents are included in attachment. Taking into account the total size of these documents, these documents are being sent to you in several emails.

In addition you will, by a separate email, receive shortly information on how to access all these (and future) documents on a specific FANC-server (using a specific login and password).

Two remarks on these documents:

- Some of these documents contain preliminary information (indicated as "PRL" on the bottom of the cover page instead of "FIN" or final). This means that not all the information on this topic is currently available and the licensee expects to write a new (final) version of this document as soon as additional information becomes available.
- Most of the documents are categorized as "Limited Distribution" (in Dutch: "Beperkte verspreiding", in French: "Diffusion Restreinte"). This means that these documents are considered confidential and that further distribution or disclosure of these documents is not allowed to third parties without the prior, written consent of the party which provided the information. At the beginning of the working meeting of October 16<sup>th</sup> the confidentiality modalities related to documents will be explained further in detail.

We are looking forward to meet you in Brussels next week.

Kind Regards,

Frederik Van Wonterghem (Technical Secretary WG1)  
*On behalf of André Weyn (chairman WG1)*

FEDERAL AGENCY FOR NUCLEAR CONTROL

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A-55

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Wednesday, October 10, 2012 10:49 AM  
**To:** Kirk, Mark  
**Subject:** Re: Task Request: TASK: Doel 3

BTW, did you catch the initial Oakridge consulting company reference in the documents that Gary put on the sharepoint site or did someone else? In other words, should I expect someone to contact me about this?

---

**From:** Kirk, Mark  
**To:** Csontos, Aladar  
**Sent:** Wed Oct 10 10:38:45 2012  
**Subject:** RE: Task Request: TASK: Doel 3

I'll provide you with a draft later today.

I assume Richard is taking care of his own business ... but I shall enquire

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, October 10, 2012 10:37 AM  
**To:** Kirk, Mark  
**Subject:** Re: Task Request: TASK: Doel 3

Yes. And your comments on the record to a closed door ACRS meeting emphatically saying ORNL is not working with Electrabell, etc. was not the complete.

Please provide a draft to me first. Then we need to CC the DOEL folks here to include NRR and IP.

Does ORNL know, i.e. did Richard tell anyone at ORNL? I imagine that they would want to know that he would be working for a foreign entity.

---

**From:** Kirk, Mark  
**To:** Csontos, Aladar  
**Sent:** Wed Oct 10 10:29:35 2012  
**Subject:** RE: Task Request: TASK: Doel 3

OK, I will e-mail FANC as you suggest. Who should I CC here?

As to why I did not tell you, I had literally found out just that morning and was frankly still processing it. This all seems way to complicated.

---

**From:** Csontos, Aladar  
**Sent:** Wednesday, October 10, 2012 10:24 AM  
**To:** Kirk, Mark  
**Subject:** Re: Task Request: TASK: Doel 3

Also, its not completely proper to say that Bass' company is in no way affiliated with ORNL since much of his intellectual property expertise on these matters have been developed over his ORNL career. You can say that Bass' company is not

affiliated with ORNL in name only, but intellectual property is another matter for ORNL and Richard to deal with. Does ORNL know this arrangement? if not, why not?

---

**From:** Csontos, Aladar  
**To:** Kirk, Mark  
**Sent:** Wed Oct 10 10:15:48 2012  
**Subject:** Re: Task Request: TASK: Doel 3

You need to let FANC know about this. Its their call and we need to be CC'd.

If you knew about this last week, why didn't you tell me?

---

**From:** Kirk, Mark  
**To:** Csontos, Aladar  
**Sent:** Wed Oct 10 09:35:37 2012  
**Subject:** Task Request: TASK: Doel 3

**Subject:** TASK: Doel 3

**Status:** Not Started  
**Percent Complete:** 0%

**Total Work:** 0 hours  
**Actual Work:** 0 hours

**Owner:** Csontos, Aladar

Ah – my 1<sup>st</sup> chance to send you a “task”!!!

On page 5 of the attached document (this is one of the several documents recently received by Gary from FANC) you will see the following table:

You should be aware of the following points:

- “Oakridge Consulting International Inc”, or OCII, is Richard Bass’ private consulting firm. OCII is in no way associated with ORNL.
- I was aware last week at the ACRS meeting that this arrangement between Electrabel and OCII had been made. The reason I did not bring it up at that point because it just seemed too distracting in that venue.
- Also the above list shows that EMc<sup>2</sup> is a consultant to Electrabel. This is news ... at least to me.

Believing that the best defense is a strong offense I feel we should address any legal concerns these affiliations generate at this time. My view is that there are in fact no problems for the following reasons:

- There is no conflict of interest associated with me being on the Doel International Review team and me being the ORNL program manager because there is no contract between the Oak Ridge National Laboratory and the Belgian Licensee (Electrabel).
- There is no conflict of interest associated with EMc<sup>2</sup> (one of our contractors) having a contract with the Belgian Licensee (Electrabel) based on the precedent of this having been acceptable in the past ... as you reviewed in your various e-mails of October 4<sup>th</sup> on this topic.

It would be my preference to deal with this as directly and expeditiously as follows, to which end I ask you the following questions:

1. Do we need to do anything more than this e-mail?
2. If "Yes" to #1, what? Exactly?
3. If the response to #2 includes "talk to OGC" then I would ask/recommend that Mike Case be involved in the discussion. In past discussions with Mike I have found his perspective on such matters to be quite pragmatic ... I think his voice would help being whatever issues there may be to a speedy conclusion.

f-6

**From:** Hardies, Robert  
**To:** Fairbanks, Carolyn; Kirk, Mark; Nove, Carol; Poehler, Jeffrey; Stevens, Gary  
**Cc:** Csontos, Aladar; Rosenberg, Stacey  
**Subject:** FW: EPRI Questions to Electrabel  
**Date:** Wednesday, October 10, 2012 6:58:13 PM  
**Attachments:** EPRI Questions for visit to Doel-3 Sept 19 2012.docx

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**From:** Hardin, Timothy [mailto:thardin@epri.com]  
**Sent:** Wednesday, October 10, 2012 1:56 PM  
**To:** Hardies, Robert  
**Cc:** Demma, Anne; Dyle, Robin; Selby, Greg  
**Subject:** EPRI Questions to Electrabel

Bob,

As requested in our call this morning, please find attached several pages of questions that EPRI sent to Electrabel in advance of our visit on September 19. Most were addressed, to some degree, in the Electrabel presentations on 9/19.

Regarding significant unanswered questions, Greg Selby mentioned the detailed procedure used by Intercontrol; also, the spreadsheet that details flaw location and geometry would be useful.

I hope your team has a good trip.

Regards,  
Tim

**Tim Hardin**

Sr. Project Manager  
**Electric Power Research Institute**  
3420 Hillview Avenue | Palo Alto, CA 94304  
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B1177

A-51

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Thursday, October 11, 2012 9:16 AM  
**To:** Rosenberg, Stacey  
**Subject:** Re: RIC

Sounds good, but what session would you want to present at? Tim wanted to discuss some on UT in lieu of RT. We could have a session on NDE and Operational Events or something similar. We could discuss: 1) Doel NDE indications/ope 2) Implications of North Anna NDE/ope, 3) UT in lieu of RT, 4) etc etc

I'm sure we could fill a session with recent work across NRR, RES, and NRO.

---

**From:** Rosenberg, Stacey  
**To:** Csontos, Aladar  
**Sent:** Thu Oct 11 09:12:13 2012  
**Subject:** RIC

Hi Al,

We were considering having a presentation regarding the Doel situation at the RIC. What are your thoughts?

Stacey

B/178

A-57

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Tuesday, October 16, 2012 10:27 AM  
**To:** Clark, Theresa  
**Subject:** Re: WESTEMS discussion

Great thanks

---

**From:** Clark, Theresa  
**To:** Csontos, Aladar  
**Sent:** Tue Oct 16 09:50:41 2012  
**Subject:** RE: WESTEMS discussion

I don't think you need to. I think Rob is attending and can brief you afterward—it's just for awareness of what we're working on. Thanks!

--  
**Theresa Valentine Clark**  
Acting Chief, Engineering Mechanics Branch  
Division of Engineering  
U.S. NRC Office of New Reactors  
T-10F10 | 301-415-4048  
Theresa.Clark@nrc.gov

---

**From:** Csontos, Aladar  
**Sent:** Tuesday, October 16, 2012 9:15 AM  
**To:** Clark, Theresa; Stevens, Gary; Basavaraju, Chakrapani; Hardies, Robert; Hiser, Allen; Hsu, Kaihwa; Li, Yueh-Li; Manoly, Kamal; Ng, Ching; Tregoning, Robert; Yee, On; Wu, Cheng-Ih; Murphy, Martin; Pham, Bo  
**Cc:** Tsirigotis, Alexander  
**Subject:** RE: WESTEMS discussion

FYI, Gary is in Belgium working on the Doel 3 RPV issues and I'm working on appraisals today. I can call in if you want.

---

Aladar A. Csontos, Ph.D

Chief, Component Integrity Branch

Division of Engineering

Office of Nuclear Regulatory Research

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21 Church Street M/S 0507M

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B/179



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Email: [aladar.csontos@nrc.gov](mailto:aladar.csontos@nrc.gov)

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**From:** Clark, Theresa

**Sent:** Thursday, September 20, 2012 11:33 AM

**Required:** Clark, Theresa; Stevens, Gary; Basavaraju, Chakrapani; Csontos, Aladar; Hardies, Robert; Hiser, Allen; Hsu, Kaihwa; Li, Yueh-Li; Manoly, Kamal; Ng, Ching; Tregoning, Robert; Yee, On; Wu, Cheng-Ih; Murphy, Martin; Pham, Bo

**Optional:** Tsirigotis, Alexander

**Subject:** WESTEMS discussion

**When:** Tuesday, October 16, 2012 10:00 AM-11:00 AM.

**Where:** HQ-TWFN-10C04-15p

When: Tuesday, October 16, 2012 10:00 AM-11:00 AM (GMT-05:00) Eastern Time (US & Canada).

Where: HQ-TWFN-10C04-15p

Note: The GMT offset above does not reflect daylight saving time adjustments.

\*~\*~\*~\*~\*~\*~\*~\*~\*~\*

**\*\*Appointment moved to accommodate NRR/DLR staff. Hope this is OK with all!\*\***

Hi, everyone—I'm just following up on today's quarterly EAF strategy meeting with a placeholder appointment to discuss the WESTEMS topical report (acceptance) review that NRO will be embarking on shortly. We expect the report to be submitted on October 1.

For now, it looks like this is a decent time for most and I wanted to block the time. Before the meeting, Robert or I will share more details with you, including background information from license renewal reviews, previous new reactor interactions, the report itself once it's in ADAMS (proprietary), and an agenda.

Thanks,  
Theresa

--

**Theresa Valentine Clark**

Acting Chief, Engineering Mechanics Branch

Division of Engineering

U.S. NRC Office of New Reactors

T-10F10 | 301-415-4048

[Theresa.Clark@nrc.gov](mailto:Theresa.Clark@nrc.gov)

## **Freeman, Scott**

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**From:** Freeman, Scott  
**Sent:** Wednesday, October 17, 2012 7:11 AM  
**To:** Shaeffer, Scott  
**Subject:** RE: laminations detected in Belgian reactor vessel (not good)

Yes. The Sequoyah & Watts Bar reactors were made at the same facility as the Belgian reactor with the laminations.

---

**From:** Shaeffer, Scott  
**Sent:** Tuesday, October 16, 2012 5:25 PM  
**To:** Freeman, Scott  
**Subject:** RE: laminations detected in Belgian reactor vessel (not good)

Where is this generically?

---

**From:** Freeman, Scott  
**Sent:** Friday, August 03, 2012 7:53 AM  
**To:** Bartley, Jonathan; Shaeffer, Scott; McCoy, Gerald  
**Subject:** FW: laminations detected in Belgian reactor vessel (not good)

See below. At the Belgian reactor below the owner has found evidence of laminar flaws in one of the forged rings on the reactor vessel. This vessel was made at the same Rotterdam yard that is linked to Rx head problems. Several US reactor vessels were also made there. You can see below but it looks to be: Catawba 1, Mc Guire 2, North Anna 1, North Anna 2, Quad Cities 1, Sequoyah 1, Sequoyah 2, Surry 1, Surry 2, Watts Bar 1.

The conE folks will look at this but I just wanted to make you aware.

---

**From:** Harmon, David  
**Sent:** Thursday, August 02, 2012 3:31 PM  
**To:** R2DCI\_B3  
**Cc:** Collins, Brendan; Sengupta, Abhijit; Issa, Alfred  
**Subject:** laminations detected in Belgian reactor vessel (not good)

### **Dave's Summary:**

During ISI inspections at Doel 3 (in Belgium) laminations were detected in the reactor vessel forged rings. The vessel was made by Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM) The same folks that gave us reactor vessel heads with defects in the j-groove welds. Numerous reactor vessels from RDM are in service around the world and in the US. ASME III requires 100% UT of class 1 materials and these defects should have been found during original fabrication of the vessel.

I recall hearing Jerry Blake talk about RDM and the NRC buying off on the licensees accepting vessels/heads with only a COC instead of the full set of records. Wish he was still here ☹

## **Subject**

Summary of the available information and preliminary evaluation by Bel V pertaining to the indications of defects found in the Doel 3 RPV in June - July 2012.

## **Background**

Belgian reactor pressure vessels (RPV) are inspected according to ASME XI. Volumetric inservice-inspections of the beltline area are normally limited to the circumferential welds (there are no axial welds in the Belgian RPVs) and surrounding heat affected zone and base material, within the limits set by the code.

Additionally, as a result of the experience at Tricastin, inspections aiming at detecting possible underclad defects in the pressure vessel beltline region are planned for all Belgian plants. The first inspection of this kind took place at Doel 3 this summer.

These inspections are performed with a qualified UT-method for detection of underclad defects, cover a zone of about 30mm thickness from the inner RPV wall and encompass the whole height of the vessel beltline region. This means that clad base material was inspected where no volumetric in-service inspection was performed up to now.

## **Results of the inspection performed to detect and characterize underclad defects (June 2012)**

At Doel 3, no underclad defects were detected.

Nevertheless, lot of defect indications of an apparently different type were detected by this UT-inspection, especially in one of the three forged rings (SA-508-cl.3). These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel. These indications appear to be of a laminar type of flaw, more or less parallel to the inner/outer surface of the pressure vessel, located in and outside the inspected zone. Considering the fact that this inspection method is not qualified for detection at such location and for this type of indications, precise information about shape or dimension is not available at this stage. *First evaluation* shows that these sub-surface flaws are almost circular in shape with a mean diameter of about 15 mm (maximum 30 mm), with a flaw density up to 40 indications per dm<sup>3</sup>. Obviously, it is not possible to justify those indications on a one-by-one basis by means of an analytical evaluation according to the App. A of ASME XI code requirements.

## **Results of the second inspection performed to detect and characterize base material defects detected in June 2012 (July 2012)**

Considering the limitations of the inspection method which revealed the presence of those defects in the base material, an inspection of the whole height of the RPV with the UT-qualified method used to control the beltline welds has subsequently been performed. This inspection covers the whole thickness and the whole height of the RPV. Results will not be available before beginning of august.

However, the *preliminary* results of this second inspection can be so far summarized as follows:

- This inspection confirms the presence of a large amount of indications in the upper and lower shell rings.
- There is a marked disparity in the flaw densities (factor 1 to 5) between the upper and the lower shell rings. Some 10000 indications were detected in the lower shell ring.
- The shape of the flaw distribution is very similar in both cases.
- The bulk of the indications are located in the base material, outside the weld regions, in a thru thickness zone extending from about 30mm from the inner surface to one half of the RPV thickness.
- These flaw indications seem to be laminar in shape and have average diameters of 25 mm.

## **Current investigations by the licensee**

- Upper and lower vessel rings of the Doel 3 and Tihange 2 RPVs were forged by the Rotterdam Droogdok Maatschappij (also referred to as Rotterdam Dockyards or RDM), at the same time and under the same contract.
- The fabrication of both RPVs took place in the same period, following the same requirements.
- According to the Owner, RDM provided 22 vessels in Europe and the US. The list of concerned units provided by the Owner encompasses following units, not necessarily with forged rings: Atucha 1 (Argentina); Doel 3, Tihange 2 (Belgium); Brunsbüttel, Philippsburg 1 (Germany); Borssele,

- Dodewaard (Netherlands); Santa María de Garoña, Cofrentes (Spain) ; Ringhals 2 (Sweden); Leibstadt, Mühleberg (Switzerland); Catawba 1, Mc Guire 2, North Anna 1, North Anna 2, Quad Cities 1, Sequoyah 1, Sequoyah 2, Surry 1, Surry 2, Watts Bar 1 (USA). RDM does not exist any more.
- The Owner is currently investigating the inspection results. In parallel additional studies are being performed to analyze and, if possible, to validate and confirm the structural integrity of the vessel.
- In the absence of any other explanation at this stage, the licensee supposes the presence of fabrication defects, but does not exclude other explanations.
- Investigations are conducted to retrieve information pertaining to the fabrication and the associated controls. According to the Owner, the defects detected in 2012 should have been detected with the UT procedures used to control the base material at that time. The results of these inspections are not retrieved yet.
- A justification of the observed defects for further exploitation is required by the Belgian regulations, based on ASME XI, App. A. According to first evaluations made by the Owner, alternate requirements will be necessary. The Owner is investigating a. o. alternative rules for regrouping individual indications. A PTS study based on 10CFR50.61a is planned.
- An inspection similar to the inspection performed in July 2012 at Doel 3 will be performed at another Belgian reactor vessel (unit 2 Tihange NPP), during the upcoming outage within a few weeks.

#### **Actions taken by the Belgian Authorities**

- Communication with foreign countries: preliminary IRS; direct contacts with Safety Authorities of foreign countries having RPVs fabricated by RDM.
- Review of the available information w.r.t. the fabrication of the Doel 3 and Tihange 2 RPVs.
- Preliminary evaluation of the approaches aiming at justifying the observed defects for further exploitation.
- Further contacts with the Owner

#### **Preliminary evaluation results by Bel V**

- We retrieved very few information pertaining to the fabrication (process, follow-up...). Nevertheless, there exist some evidences of difficulties during fabrication, due to strikes, delays and technical problems.
- The lack of information related to the origin of the defects, their unusual high density in some portions of the RPV are a.o. elements which could possibly question the applicability of the justification methods proposed by the Owner. It is e.g. unclear whether the basic assumptions behind ASME XI, App. A and 10CFR50.61a are compatible with this case.

Thanks,  
Dave Harmon



US NRC Construction Inspector  
RII/CCI/DCI/CIB3 - Welding  
404-997-4447

A-36

**Kusnick, Joshua**

---

**From:** Csontos, Aladar  
**Sent:** Thursday, October 25, 2012 2:50 PM  
**To:** Stevens, Gary  
**Subject:** RE: Doel 3 one pager update in september.docx

Nevermind. I thought you sent it to us, but it was mark sending it to you.

---

**From:** Stevens, Gary  
**Sent:** Thursday, October 25, 2012 2:50 PM  
**To:** Csontos, Aladar  
**Subject:** RE: Doel 3 one pager update in september.docx

HUH????? See below – Hardies sent it to me.

---

**From:** Csontos, Aladar  
**Sent:** Thursday, October 25, 2012 2:49 PM  
**To:** Stevens, Gary  
**Subject:** RE: Doel 3 one pager update in september.docx

You only sent this to me and others, not hardies.

---

**From:** Kirk, Mark  
**Sent:** Thursday, October 25, 2012 2:44 PM  
**To:** Stevens, Gary; Tregoning, Robert; Csontos, Aladar  
**Subject:** RE: Doel 3 one pager update in september.docx

No comments ... other than that I think it is well written

---

**From:** Stevens, Gary  
**Sent:** Thursday, October 25, 2012 2:33 PM  
**To:** Tregoning, Robert; Csontos, Aladar; Kirk, Mark  
**Subject:** FW: Doel 3 one pager update in september.docx

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**From:** Hardies, Robert  
**Sent:** Thursday, October 25, 2012 1:39 PM  
**To:** Stevens, Gary; Nove, Carol; Fairbanks, Carolyn; Poehler, Jeffrey  
**Subject:** Doel 3 one pager update in september.docx

I am going to send this to the commission as a one pager. Please let me know if you find anything that needs to be changed.

This is not subject to the current FOIA because that FOIA only applies to documents and communications that occurred before October 11, 2012 (if I remember the applicability date correctly).

I am going to send this up today, so if you don't have time to look at it until tomorrow then don't bother looking at it at all.

B/181

K-8  
**Kirk, Mark**

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**From:** Kirk, Mark  
**Sent:** Thursday, October 25, 2012 3:40 PM  
**To:** Csontos, Aladar; Stevens, Gary; Tregoning, Robert; Nove, Carol  
**Subject:** RE: roles and responsibilities

Excellent ... your highlighted point was my own.

**From:** Csontos, Aladar  
**Sent:** Thursday, October 25, 2012 3:38 PM  
**To:** Kirk, Mark; Stevens, Gary; Tregoning, Robert; Nove, Carol  
**Subject:** RE: roles and responsibilities

Guys,

Let's not clutter up Mike's, Stu's, and Jennifer's emails. If I get 300+ per day, they get 500+ per day.

We know of the issue, we have some guidelines for Mark. Now we need to discuss these with NRR. I think Mark's plan is a good starting point for further discussions.

OK?

Thanks,  
Al

**From:** Kirk, Mark  
**Sent:** Thursday, October 25, 2012 3:36 PM  
**To:** Stevens, Gary; Csontos, Aladar; Tregoning, Robert; Nove, Carol; Richards, Stuart; Case, Michael; Uhle, Jennifer  
**Subject:** RE: roles and responsibilities

Perhaps I restricted my paste from your "terms of reference" too much, and you lost the context. Try this:

**Mission**

- Share information and experience between nuclear safety authorities on regulatory approaches and actions in relation with this issue
- Taking into account the lessons learned from this issue, discuss actions to be considered in other countries
- Provide technical advice to Belgian nuclear safety authorities (FANC, Bel V, AIB Vinçotte) on specific topics / questions related to the Doel 3 & Tihange 2 RPV issue. However, the actual evaluation of potential continued operation of the Doel 3 and Tihange 2 reactors remains the responsibility of the Belgian nuclear safety authorities.

In any event, all I'm suggesting is that (with management approval, of course) it might be good to send to Mr. Rousseel a clear statement of what we can, and cannot, provide. I offer the long paragraph from Item 1 in the original e-mail as a fine starting point ... because this language has already received management approval. I think this paragraph is quite clear ... it worked very well once, so I think we should use it again.

**From:** Stevens, Gary  
**Sent:** Thursday, October 25, 2012 3:31 PM  
**To:** Kirk, Mark; Csontos, Aladar; Tregoning, Robert; Nove, Carol; Richards, Stuart; Case, Michael; Uhle, Jennifer  
**Subject:** RE: roles and responsibilities

B/182

The limitations seem much clearer for your participation on the Intl Expert Review Team. I do not see or feel such clarity with respect to my working group participation. Item 3 below is all that applies for the working groups, and it doesn't say anything about "NRC positions," which I have been requested to give.

Gary

---

**From:** Kirk, Mark

**Sent:** Thursday, October 25, 2012 3:24 PM

**To:** Stevens, Gary; Csontos, Aladar; Tregoning, Robert; Nove, Carol; Richards, Stuart; Case, Michael; Uhle, Jennifer

**Subject:** roles and responsibilities

Dear All –

Following on the discussion of "roles and responsibilities" we had at the meeting this morning, I wanted to provide information supporting the comment I made at the meeting that we have worked this out already, and our position is well documented and is quite clear. I believe all we need to do is remind our Belgian colleagues of what we have agreed to do, and what we cannot do. I offer for your information three pieces of information:

1. **E-mail sent to FANC authorizing my participation.** It is copied below in full, and it includes the following language:

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Based on this language, the FANC included sentences into their "Terms of Reference", documents as described in items 2 & 3

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Best

mark

Mark Kirk

Senior Materials Engineer

NRC/RES/DE/CIB

mark.kirk@nrc.gov

**From:** Sangimino, Donna-Marie  
**To:** Willy.deroovere@fanc.fgov.be <Willy.deroovere@fanc.fgov.be>  
**Cc:** Kirk, Mark; Fehst, Geraldine; Eisenberg, Wendy  
**Sent:** Fri Sep 07 16:53:06 2012  
**Subject:** Doel 3 Reactor Vessel International Review Board

Dear Dr. De Roovere,

Please allow me to introduce myself. My name is Donna-Marie Sangimino; I am the head of the International Programs Team in the NRC's Office of Nuclear Regulatory Research.

I am responding to the e-mail request dated August 28<sup>th</sup> 2012 sent to our staff member, Mark Kirk, requesting that he participate in an international taskforce that FANC is convening to help with your assessment of the indications recently found in the Doel 3 reactor. The NRC is pleased to support your request by enabling Mark to participate in the meetings you have outlined. We thank you for your offer to reimburse Mark's travel cost, but NRC will cover all costs (including travel) associated with Mark's participation in this activity.

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I understand that you are still establishing dates for your meetings in Brussels. Please interact with Mark directly ([mark.kirk@nrc.gov](mailto:mark.kirk@nrc.gov)) to establish suitable dates, provide read ahead material, or any other matters associated with the conduct of your meetings. Also please be advised that Mark has an upcoming trip to Korea from September 22<sup>nd</sup> to 29<sup>th</sup>, so those dates should be avoided.

Finally, I would appreciate it if you would include me on "cc" in any e-mail correspondence with Mark so that I can keep the appropriate offices within the NRC informed of these activities.

Please let me know if any additional support is needed to help facilitate this important exchange.

Best regards,

*Donna-Marie Sangimino*

International Programs Team Leader  
US Nuclear Regulatory Commission  
Office of Nuclear Regulatory Research (RES)  
[Donna-Marie.Sangimino@nrc.gov](mailto:Donna-Marie.Sangimino@nrc.gov)  
(+1) 301-251-7673



A.52

**Kusnick, Joshua**

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**From:** Csontos, Aladar  
**Sent:** Friday, October 26, 2012 10:59 AM  
**To:** Kirk, Mark; Stevens, Gary; Tregoning, Robert; Nove, Carol  
**Cc:** Hardies, Robert; Poehler, Jeffrey  
**Subject:** RE: roles and responsibilities  
**Attachments:** FW: Request for a favor

I want to have a meeting with Mark, Carol, and Gary at a minimum to discuss the appropriate correspondence between Mark and the other WG members since he's on the International Review Team. He can interact with you if he wants, but, I don't want this to dominate our resources since we have focus on how the Doel issue affects domestic plants. Remember, that's our priority and that's what Jennifer reiterated yesterday. Remember, we don't work for FANC or the Belgians. We work for NRC on domestic safety.

I want to be kept in the loop on the level of effort each of you are doing and what you're doing for both NRR and FANC. Please route all correspondence with CC to me on this matter from this point forward.

---

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B/183

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NRC/RES/DE/CIB  
mark.kirk@nrc.gov

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(+1) 301-251-7673

5-13

### **Doel 3 Brief/Next Steps Meeting**

*November 1, 2012, 0830*

**Purpose:** RES Management requested that we meet and decide on what we recommend to do regarding Doel 3 support and agree up through Stacey/AI level.

Gary's Questions to Get the Conversation Rolling:

1. What (if anything) has anybody done regarding the FOIA? If nobody, who will print-out the Sharepoint site?
2. What (if anything) are we doing to support the Belgians going forward?
3. What (if anything) are we doing for the U.S. fleet?
4. Are we authorized to go back to Belgium, if requested, before the end of the year? Is everyone available to go back to Belgium before the end of the year?
5. Can NRC host a meeting of the Belgians in 2 weeks? (see attached)
6. Anything else?

B/184

# ASME Code Section XI Nonmandatory Appendix K Update

Michael Benson  
RES/DE/CIB

ASME Code Week  
November 4-8, 2012  
Phoenix, AZ



*The views expressed herein are those of the authors and do not reflect the views of the U.S. Nuclear Regulatory Commission.*

## Historical Background

### RPV Integrity Regulations



- NRC has been evaluating regulatory positions on RPV integrity
- NRC revisited RG 1.161 in order to ensure a solid technical foundation for rulemaking
- NRC sees value in withdrawing the RG, in favor of referring to ASME Code Section XI Nonmandatory Appendix K

B/185

## Technical Background

RG 1.161/ASME Section XI, Nonmandatory Appendix K



- Procedures acceptable to NRC staff for determining required upper shelf energy (USE)
- Regulatory limit: 75 ft-lb initially, 50 ft-lb throughout the life of the plant
- Methodology is based upon elastic-plastic fracture mechanics
  - Estimate  $J$
  - Estimate  $J_R$
  - Apply acceptance criteria to calculate alternative USE

3

## Technical Background

Eason Correlations



- RG 1.161 references lower bound empirical correlations for estimating  $J_R$ , see NUREG/CR-5729

$$J = C1 (\Delta a)^{C2} \exp[C3(\Delta a)^{C4}]$$

$$\text{Charpy Model: } \ln C1 = a_1 + a_2 \ln CVN + a_3 T + a_4 \ln B_s$$

$$C2 = d_1 + d_2 \ln C1 + d_3 \ln B_s$$

$$\text{Cu-}\phi\text{ Model: } \ln C1 = a_1 + a_2 Cu(\phi)^{a_3} + a_4 T + a_5 \ln B_s$$

$$C3 = d_4 + d_5 \ln C1 + d_6 \ln B_s$$

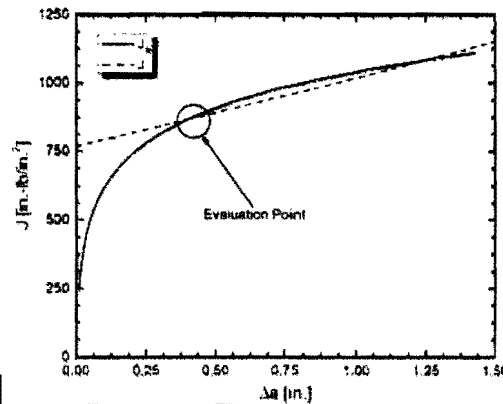
$$\text{CVN}_p \text{ Model: } \ln C1 = a_1 + a_2 Cu(\phi)^{a_3} + a_4 T + a_5 \ln B_s + a_6 \ln CVN_p$$

4

## Technical Background

### Acceptance Criteria

- Initiation:  $J < J_R$  at  $\Delta a = 0.1$  in,  $SF = 1.15$
- Stability:  $\frac{\partial J}{\partial a} < \frac{\partial J_R}{\partial a}$  at  $J = J_R$ ,  $SF = 1.25$



5

## Technical Review

RG 1.161

- Refer to PVP2012-78227
- Improved discussion of the  $J_R$  correlation limitations
- Possible update of the  $J_R$  correlations, of particular interest:  $\phi t < 10^{18}$  n/cm²
- Justification of crack tip temperature input
- Improved discussion of Crack Driving Force Diagram approach
- Added discussion of J-Tearing Modulus and Failure Assessment Diagram approaches

6



## RG 1.161 vs. Appendix K

### Differences



- Material resistance properties
  - RG 1.161 endorses  $J_R$  correlations developed by Eason in NUREG/CR-5729, 1991
  - Appendix K states that the  $J_R$  curve "shall be a conservative representation of the toughness of the controlling beltline material at upper shelf temperatures in the operating range"
- Evaluation of the crack stability criterion
  - RG 1.161 endorses one method: "direct application"
  - Appendix K endorses three methods: crack driving force diagram, failure assessment diagram, J/Tearing Modulus procedure

7

## Conclusions

### RG 1.161/ASME App K



- NRC RES has performed a technical assessment of RG 1.161
- If ASME App K is updated to satisfy NRC comments, NRC would consider withdrawing the RG
- $J_R$  correlations may need to be included in App K
- Updating the  $J_R$  correlations offer significant technical challenges
- From Gary Stevens: What does the WGFE plan to do with App K, if anything? What is the schedule?

8