**Canadian Nuclear Safety Commission**

**Public hearing**

**July 5th, 2010**

Public Hearing Room
14th floor
280 Slater Street
Ottawa, Ontario

**Commission Members present**

Mr. Michael Binder
Dr. Moyra McDill
Mr. Dan Tolgyesi
Mr. Alan Graham
Dr. Ronald Barriault

**Secretary:**

Mr. Marc Leblanc

**Senior Counsel** :

Ms. Lisa Thiele

**Commission canadienne de sûreté nucléaire**

**Audience publique**

**Le 5 juillet 2010**

Salle d'audiences publiques
14e étage
280, rue Slater
Ottawa (Ontario)

**Commissaires présents**

M. Michael Binder
Mme Moyra McDill
M. Dan Tolgyesi
M. Alan Graham
M. Ronald Barriault

**Secrétaire**

M. Marc Leblanc

**Conseiller principal:**

Mme Lisa Thiele

## TABLE OF CONTENTS

Ottawa, Ontario

--- Upon commencing at 2:32 p.m. /
L'audience débute à 14h32

**Opening Remarks**

**M. LEBLANC:** Bonjour, mesdames et messieurs. Bienvenue aux audiences publiques de la Commission canadienne de sûreté nucléaire.

Mon nom est Marc Leblanc. Je suis le secrétaire de la Commission et j'aimerais aborder certains aspects touchant le déroulement des audiences.

The Canadian Nuclear Safety Commission is about to start a series of two public hearings this afternoon, starting with AECL's request to restart the NRU in Chalk River, to be followed later today with an opportunity to be heard on an order issued by a CNSC Designated Officer to the Saskatchewan Research Council regarding the Gunnar facility in Northern Saskatchewan.

During today's business, we have simultaneous translation. Des appareils de traduction sont disponibles à la réception. La version française est au poste 8 and the English version is on channel 7.

Please keep the pace of speech relatively slow so that the translators have a chance of keeping up.

Les audiences sont enregistrées et transcrites textuellement. The transcripts will be available on the website of the Commission early next week.

To make the transcripts as meaningful as possible, we would ask everyone to identify themselves before speaking.

I would also like to note that this proceeding is being video webcasted live and that the proceeding is also archived on our website for a three-month period after the closure of the hearing.

As a courtesy to others in the room, please silence your cell phones and other electronic devices.

Monsieur Binder, président et premier dirigeant de la CCSN, présidera les audiences publiques d'aujourd'hui.

Mr. Binder.

**THE CHAIRMAN:** Merci, Marc, and good afternoon to everybody and welcome to the hearing of the Canadian Nuclear Safety Commission.

Mon nom est Michael Binder. Je suis le président de la Commission canadienne de sûreté nucléaire et je vous souhaite la bienvenue, and welcome to all of you who are joining us through webcasting.

I'd like to begin by introducing the Members of the Commission that are here with us today. On my right are Dr. Moyra McDill and Mr. Dan Tolgyesi. On my left are Mr. Alan Graham and Dr. Ronald Barriault.

You heard from Marc Leblanc and we also have with us Lisa Thiele, General Counsel to the Commission.

So, Marc?

**MR. LEBLANC:** Yes. Before adopting the agenda, please note that three supplementary Commission Member Documents or CMDs were added to the agenda after publication on June 28, 2010, as listed on the updated agenda.

We have on the agenda a public hearing of the application by Atomic Energy of Canada Limited for the restart of the National Research Universal or NRU reactor located at the Chalk River Laboratories, CRL, site in Chalk River.

This will be followed by a hearing providing an opportunity to be heard to Saskatchewan Research Council on an order issued by a DO regarding the Gunnar site in Northern Saskatchewan.

**10-H13 / 10-H13.A / 10-H13.B**

**Adoption of Agenda**

**THE CHAIRMAN:** Okay. With this information, I would like now to call for the adoption of the agenda by the Commission. Do we have concurrence?

For the record, the agenda is adopted.

So let's now begin the hearing on the restart of the NRU reactor and you can see there's great interest in this story that we're going to hear. I assume it's not only a domestic interest; it's in fact an international interest.

Marc?

**ONE DAY PUBLIC HEARING**
**Atomic Energy of Canada**
**Limited (AECL):**
**Application for the restart of the**
**National Research Universal**
**(NRU) Reactor located at the**
**Chalk River Laboratories (CRL)**
**site in Chalk River, Ontario**

**MR. LEBLANC:** This is a one-day public hearing. The Notice of Public Hearing 2010-H-07 was published on June 11 to inform the public of this upcoming public hearing and the availability of the Commission

Member Documents.

A revised notice was published on June 16th to announce the date of the hearing and the deadline for filing interventions. A second revision was posted on June 25th to change the date of the hearing to today.

The public was invited to participate either by oral presentation or written submission. June 23rd was the deadline set for filing by intervenors. The Commission received four interventions from the public.

I note that supplementary information has been filed by AECL, as listed on the updated agenda.

**THE CHAIRMAN:** Okay. So I'd like to start the hearing by calling on a presentation from AECL as outlined in our CMD 10-H12.1, 12.1A and 12.1B.

I understand that Mr. MacDiarmid, you're going to make the presentation. The floor is yours.

**10-H12.1 / 10-H12.1A / 10-H12.1B**

**Oral presentation by**

**Atomic Energy of Canada Limited**

**MR. MacDIARMID:** Thank you very much, Mr. President. Good afternoon and thank you, ladies and gentlemen.

For the record, my name is Hugh MacDiarmid, President and CEO of Atomic Energy of Canada Limited.

Je voudrais vous présenter monsieur Bill Pilkington, agent principal du nucléaire pour EACL, et monsieur Hank Drumhiller, vice-président et directeur général Opérations, et aussi plusieurs membres de notre équipe de gestion qui sont ici aujourd’hui.

My colleagues and I are here today to report that we have successfully repaired and leak-tested the NRU vessel. We are seeking approval to refuel past the guaranteed sub-critical condition.

I want to thank Commissioners for accommodating our request to reschedule this hearing. I do appreciate that the extensive demands on your time caused a lot of you to move your schedules around.

Completing the repairs to the NRU is a testament to more than a year of dedicated around-the-clock effort by hundreds of AECL employees and contract staff.

I want to take this opportunity to recognize the efforts and achievements of our team at Chalk River, as well as the contributions and support from the Canadian nuclear industry.

We have engaged some of Canada’s leading companies as supplier partners to support us in our efforts. The demonstrated thoroughness and creativity in taking on the challenges that have never been experienced before confirms the world-class status of the Canadian nuclear industry.

We have also engaged some of the world’s leading experts to ensure the effectiveness of the repair techniques that we have deployed.

I want to acknowledge also the timely and capable support of CNSC staff.  They have displayed a high level of professionalism throughout.

As I have said on a number of occasions before Parliament, AECL takes its responsibilities very seriously to provide a reliable supply of medical isotopes to Canada and the world.  It has been our foremost operational priority.

In order to ensure this reliable supply of isotopes, we have taken every reasonable action throughout the outage to improve NRU’s ongoing safety and reliability and this will continue.

We, at AECL, are confident NRU is now ready to resume safe operation.

Let me now turn over the proceedings to AECL’s Chief Nuclear Officer, Bill Pilkington, in order that he can provide a more comprehensive presentation.

Thank you.

**MR. PILKINGTON:**  Good afternoon, Doctor

Binder and Members of the Commission.

For the record, my name is Bill Pilkington, Senior Vice-President and Chief Nuclear Officer.

As Mr. MacDiarmid mentioned, we are here to provide you with an update on our progress on repairing the NRU reactor vessel and on our preparations to return the NRU to service.

My remarks today will follow the outline on the slide you see before you with emphasis on the repairs conducted, future activities and why we are confident that the react can be safely returned to service.

On May 15th, 2009, a heavy water leak was detected from the NRU reactor. The leak was traced to the gas-filled annulus between the heavy water filled reactor vessel and the light water reflector.

The picture in the upper left shows the water that was seen to be seeping through corrosion on the outside surface of the vessel. No corresponding hole could be seen on the inside of the vessel until the surface was prepared for repair as shown in the lower right picture.

The consequences of the heavy water leak were minimal as the water was collected and stored. Some tritium from evaporation was exhausted through the NRU ventilation system but the amount remained well below regulatory limits.

This slide shows a picture of the NRU reactor and a schematic illustrating the location of the leak in relation to the nearest access point on the upper deck, nine metres above the bottom of the vessel. Access to the interior of the vessel is through apertures that are 12 centimetres in diameter, roughly the size of my hand.

In addition, the reactor deck is only 3.7 meters in diameter, limiting the area for staging and executing the in-vessel work. And the pointer right now on the presentation is pointing to roughly the centre of the deck.

One way to appreciate the difficulties of examining and repairing the vessel is to think of repairing the basement wall of a two-storey house by working from the roof through a length of drain pipe.

In the case of the NRU vessel, the work was made more challenging by high radiation fields that pose a risk for staff and can damage electronic equipment. This is a detailed schematic of the base of the NRU vessel showing the annulus, light water reflector, and the location of the leak at the bottom of the annulus shown by the red arrow.

The black arrow below indicates the

circumferential weld at the base of the vessel that is used as a reference elevation. Note that the vessel wall thickens below the circumferential weld.

The actual condition of the inside surface of the vessel was relatively clean with about one millimetre coating of gibbsite. Gibbsite is a corrosion product of aluminum that is formed in water.

Outside the vessel there was corrosion product build-up on the lower vessel wall, the floor of the light water gutter, and the wall of the reflector. Also, the heavy water gutter was filled with corrosion products and the lip was corroded away in some areas.

The first step in assessing the vessel condition was a visual inspection of the full circumference of the NRU vessel. The pictures on this slide show a team of AECL staff using a remote camera to examine the vessel. The visual inspection was followed by a comprehensive non-destructive or NDE campaign undertaken over five months to determine the thickness of the vessel wall.

Progressively more sophisticated probes and delivery systems were used to expand the area of inspection and the quality of data. This represents one of the largest NDE campaigns carried out in the nuclear industry on a single reactor component with over two million data points collected.

This is a composite of the NDE data into one image of a band of the vessel wall from just below the circumferential weld to a height of about 250 millimetres above the weld.  The original wall thickness was 8 millimetres as indicated by dark brown and darkens further as the vessel wall thickens below the circumferential weld.

Lighter shading indicates the degree of wall loss.  The remaining wall over most of the vessel is more than seven millimetres.  Patches of regional wall reduction were found at the base of the vessel extending upward from the level of the floor of the J-rod annulus about 50 millimetres above the circumferential weld.

These show up as light coloured areas in the figure, with some pockets of highly localized corrosion below the areas of regional corrosion.  The areas to note are J-rod 13 to 18 as the largest area of corrosion; the corrosion sites between J-rod 21 and J-rod 30; and the leak site at J-rod 41.

With the challenges posed by the high radiation environment and limited access, proven remote welding technology was chosen as the preferred method of repair.  All activities had to occur within a 12-centimetre hole, 9 metres away.

The picture shows the congestion at the top of the NRU reactor in carrying out in-vessel work. Parallel development was carried out on mechanical repair, welded structural plates, and weld build-up. All have proven valuable.

In November 2009 localized weld build-up was selected as the primary repair strategy. Extensive qualification and practice were undertaken before going to the reactor, using bench tests and integrated tests in full scale mock-ups.

Hundreds of AECL and contractor staff worked around the clock for more than a year. Through the course of the inspection, tooling development and repair, more than 350 contractor staff have provided tooling and services.

A number of mock-ups were built to develop and test tooling and procedures. The photo is a full-height mock-up in the NRX reactor hall. Another full-height partial mock-up was built in the mechanical equipment design building specifically to test tooling developed at Chalk River. And three full-height welding stations were set up at the supplier of the welding technology, Liburdi Automation.

They did this by cutting a hole in their roof and erecting a tent to house the weld control stations and accommodate the full height of the tools. In addition, three full-height mock-ups were built adjacent to the NRU vessel to carry out final weld development and training with in-vessel tools.

A full wall section coupon was required to determine the corrosion mechanism that caused deep penetrations like the one that led to the leak. In the picture on the left, the hole saw for cutting the coupon is seen being tested in a mock-up. The actual cutter is indicated by the blue box.

The tooling was designed to fold up to fit through the 12-centimetre aperture and then unfold to deploy in the vessel. The radiation of the NRU vessel has modified the original material properties through transmutation and alteration of the microstructure. Tooling was developed to remove thin scoop samples about the size of a Canadian quarter from the vessel wall.

In the picture on the right the scoop cutting wheel is highlighted by the green circle and the scoop sites by the blue box. Each scoop is large enough to study material properties without requiring repair of the vessel. Scoops were used to confirm that there was no material sensitization or intergranular corrosion and to determine mechanical properties of the wall material for structural analysis and welding.

In addition, a sample weld was carried out on a scoop which was sectioned to examine the properties of the weld and its heat affected zone.

On the left is a picture of the site where the vessel wall scoops were removed from typical vessel wall material from the weld, and from the heat-affected zone at one of the vertical seam welds. One of the removed scoops is shown in a metal sample holder.

On the upper right is a picture of the coupon hole next to the leak site taken from inside the vessel. You can see the corrosion in the J-rod annulus beyond.

The bottom right picture is the coupon in the cutting tool and you can see the corrosion on the surface of the coupon.

Specialized tooling was required to clean the vessel in preparation for welding and to vacuum the vessel after repairs had been completed. The picture on the left shows staff manipulating tooling through a 12-centimetre hole with the indexing portion of the cleaning tool on the left, it’s the aluminium structure.

The picture on the right is the head of a cleaning tool being tested in a mock-up.

A number of different tools were developed to carry out the repair steps including, from left to right, grinding, plate placement and a vertical weld tool.

The right-hand schematic illustrates how the tools were designed to pass through the 12-centimetre aperture, work around in-vessel obstructions and deploy accurately and reliably to the vessel wall.

The tools also had to meet stringent AECL standards for use in a reactor, undergo foreign material exclusion inspections and retract reliably to be able to exit the vessel after completing a task.

Mock-ups were used extensively to ensure high quality welding operations could be performed reliably. For the final repair site, over 100 test plates were welded in the mock-ups before executing the repair in the vessel.

A preliminary fitness for service assessment was used to determine the sites on the vessel wall that required repair to re-establish leak tightness, structural integrity and corrosion allowance. This slide shows the locations of the 10 repair sites and the location of the test weld. These areas are outlined in red.

Each repair site required a complex sequence of weld development, welder qualification and reliability testing, integration testing, the actual repair work, NDE and certification of the repair.

Before any repairs were undertaken, in-vessel welding was proven with a test weld carried out December 3rd, 2009. Full NDE of the test weld confirmed the in-vessel weld process was acceptable.

In addition, a scoop sample was removed to examine the condition of both the weld material and the heat affected zone adjacent to the weld.

Metalography results were reviewed by AECL and external materials and welding experts to confirm the material condition was acceptable and the repairs could proceed. The basic repair technology used weld overlay to build up the wall thickness and re-establish the mechanical strength. The overlay could be vertical or horizontal depending on the desired feature and in-vessel constraints.

In the month of December, five sites were welded and NDE completed to confirm quality repairs. The expectation was that, as the welders gained experience, their skill and confidence would improve to offset the challenges posed by the increasing size of later repair sites.

However, application of a prudent and rigorous approach to the larger more complex sites required a unique repair design for each site.

J-rod 41 was the original leak site and the location where the through-wall coupon was removed to identify the corrosion mechanism causing deep corrosion pockets.  A 1.5-millimetre thick backing strip was used to cover the hole and the leak location and the adjacent coupon removal site.

The upper left shows tacking the backing strip in place.  The lower left shows additional tacks and fillet welds to secure the backing strip.  The picture on the right shows the weld build-up applied to complete the repair.

In addition to repairing the holes at J-rod 41, backing strips were used to support weld build-up in regions of very thin vessel wall.  At J-rod 23, this repair technology reached its limit of application.  With the thin vessel wall achieving a quality repair was very challenging.

A new concept was developed to provide a repeatable repair.  This concept was based on putting a window frame of weld build-up around the plates as shown in the centre photo, followed by a weld overlay of the plates and window frame to complete the repair as shown on the right.

**(SHORT PAUSE/COURTE PAUSE)**

**MR. PILKINGTON:**  Okay.  Do I need to repeat anything?  Excuse the delay.  I'll pick up on the J-rod 23 repair.

So in addition to repairing the holes at J-rod 41, backing strips were used to repair regions of very thin vessel wall. And so on J-rod 23, with the thin vessel wall, achieving a quality repair was very challenging.

A new concept was developed to provide a repeatable repair and this concept was based on putting a window frame of weld build-ups around the plates and that's shown in the centre picture, followed by weld overlay of the plates and the window frame to give the completed repair as shown on the bottom right.

J-rod 23 was the last site that could use full weld overlay as the stresses for the larger weld areas approached the allowable limits to avoid disturbing the lower vessel seal.

For the larger repairs, structural plates were welded to the vessel to reduce the extent of weld overlay and the resulting stresses. In this approach, the plates were thicker and designed to re-establish mechanical strength of the vessel wall without the covering of weld overlay.

The first application was the J-rod 25/27 repair site using four plates 3 millimetres thick. The tooling used to install the plates had to be modified to tack structural plates in place as shown in the lower right picture taken in the vessel following plate installation.

New weld and NDE techniques also had to be developed to ensure qualified structural welds at the plate edges and between plates.

The completed test plate, number 24, which is the one shown in the picture on the left, was produced in a mock-up and it’s shown in that upper picture.  In all, more than 30 test plates were produced prior to completing the J-rod 25/27 repair in the vessel.

J-rod 13/17 was the last and most complicated repair covering an area of more than twice the size of the next largest repair.

To understand the discussion that follows, you have to know that the plates were numbered in order of installation, in vertical rows starting at the top left.

So the mouse is now over plate number 1, and then 2, 3; then the next row is 4, 5, 6 and then 7, 8, and not yet installed 9.

A three-by-three array of 4-millimetre thick structural plates was used to reduce the weld stress on the vessel lower seal.  This was an evolution of previous repairs but still required development of nine specific weld processes plus NDE procedures for the unique groove welds between the plates.

The top left picture shows 8 of 9 plates installed. The tack on the sixth plate, which the mouse is showing, melted through the thinned vessel wall requiring a modification to the placement of the ninth plate.

The bottom left picture shows the complete installation of the plates and the horizontal and vertical window frame of 4-millimetre weld build-up in the vessel.

The bottom right picture shows the addition of a large area of horizontal 3-millimetre build-up on the left side of the completed repair.

J-rod 13/17 is the only repair site that required significant rework after the initial welding was complete. Post-weld eddy current testing indicated a surface breaking flaw between plates 8 and 9 extending across into the groove between plates 5 and 6 and down between plates 6 and 9. These are all located in the lower right corner of the repair.

Follow-up visual inspection showed a crack in the groove wells. The crack is believed to have occurred as the large weld build-up was being carried out on the left-side of J-Rod 13 to 17 repair.

Displacement during the large area of weld build-up, as shown on the finite element model, combined with lack of fusion is believed to have caused the crack.

Note that the deflection shown in the finite element model have been exaggerated to make them visible in this picture or in this figure.

The two horizontal and one vertical crack tip were ground out and welded.  The length of the crack was then excavated to a depth of 2 millimetres and rewelded.  Two attempts were required to achieve an acceptable weld.  Portions of the rework weld were then ground to improve NDE capability.

Visual inspection was repeated for the whole J-Rod 13/17 repair area.  Any current testing was repeated over the repair area and for the groove weld between Plates 7 and 8.

Prior to declaring repairs complete, given the challenges and complexity of the J-Rod 13/17 repair, a workshop was held, including internal and external experts to consider if sufficient repair and inspection had been carried out to assure a quality repair.  Consensus supported declaring the repair complete.

Post-weld inspection results have demonstrated the success of the weld repair program. Engineering has assessed the small areas of lack of fusion and determined they do not affect the effectiveness of the repair.

One reportable indication was identified in the heat-affected zone of the J-Rod 23 repair and shown in red and it will require follow-up monitoring.

Following declaration that the repairs were complete the NRU vessel was refilled with water.

An in-service leak test witnessed by the responsible authority did not find any evidence of water leakage from the vessel.

Trace amounts of tritium were measured in the J-Rod Annulus between the vessel and reflector during the vessel fill but there were no signs of moisture.

Ongoing monitoring over several days with the vessel full indicated tritium levels trending toward background.

Additional visual inspections were undertaken of the inside of the vessel in the region where tritium was detected. No flaws or imperfections were found.

Tritium readings remained close to background levels when the vessel was refilled following the visual inspection.

So, Mr. Chairman, if it would be of help, I have brought samples of weld plates that I could use to help show the actual size of these repairs.

**THE CHAIRMAN:** By all means. I know you can get really excited about the engineering of welding but I really would like to see it and feel it.

**MR. PILKINGTON:** Okay. So these are the test plates that were used for the repair sites and so I’m going in sequence, really, on the last four repairs.

And the first one is of interest because as you can see it was where the coupon was removed and so we have that hole and we also have right next to it the origin of the leak. This is the J-Rod 41 coupon.

So this shows the area of corrosion and this shows the repair that was used to -- to return to structural strength and leak tightness. So we have a structural plate that was welded in place and then that was overlaid with horizontal weld to complete the repair.

Okay, so that is J-Rod 41.

The next one is the J-Rod 23 repair and I don’t know if you can see the difference but -- but the corrosion, although over a small area, was quite extensive. The vessel wall was quite thin at this location.

And by the way, I would just point out that these are actually accurate reproductions of the profile of the vessel wall. They were machined using the NDE data from all of the inspections that were done. So they very accurately represent the condition of the vessel wall, except of course they’re not covered with corrosion products.

**THE CHAIRMAN:** Including the thickness?

**MR. PILKINGTON:** Yes.

So the -- yes, and this represents the original 8 millimetre thickness of the vessel wall.

This repair was the one that resulted in the most welding stress, J-Rod 23, and required us to move to a different strategy for larger sites.

And you can see on this plate that this is -- this is deformation from the welding, this is not the normal shape of the plate.

Now, the vessel would not have seen this much stress because it’s a much better heat sink but this does give you an indication of the kinds of stresses that the welding creates.

And so in this one we had two backing plates and then the window frame around and then an overlay of weld build-up over that.

So then we go to J-Rod 25/27, we see a broader area of corrosion and the repair, this time the first application of structural plates and so we have four 3 millimetre thick structural plates and then we’ve created this window frame of weld build-up between and around the plates to complete the repair.

And finally -- just testing the strength of my assistant here.

Finally, you'll recognize the 3 x 3 of the J-Rod 13/17 repair. Now, this is only representative because in fact this was an early test model for this repair and it does not actually represent the spacing of the plates in their final configuration but it does give you an idea on the plated area. And if you remember, not only is there the plated area but there's a fairly large area above, below, and mainly on this side, a very build-up, this was the build-up that caused the deformation of the vessel and created the problem.

So the point to make here is really the size of the area of corrosion and so that final repair essentially covered from one side of this plate almost to the other.

And it's also clear that -- well, actually, you cannot really see the general scalloping, you can feel it in this area but you can't see it from looking at the plate, but the wall is thinner all the way across.

But what is visible is the deep penetrations or deep pockets that have been formed and it's not too hard to see that they essentially are formed along a waterline; okay?

So that is perhaps the important thing to note from this repair, as well as the fact that on this repair they are very deep over a large area.

In fact, on this repair, when we did the vessel cleaning prior to welding there were actually a couple of areas that went through a wall.

So looking at the corrosion on J-Rod 13 to 17 is then a good segue into talking about the corrosion mechanism.

**THE CHAIRMAN:** Thank you for this representation.

You realize that all of this material now is formal record here. You've got to leave it with us now. At least for a period of time so people can examine it.

**MR. PILKINGTON:** Yes. To be honest, I didn't realize that.

So moving on; based on the evidence from the corrosion coupon and experience with the corrosion in the annulus between the vessel and reflector -- sorry, just a second. I'm on the wrong slide. Okay.

So we're now turning to the source of the degradation of the NRU vessel and so there were two related corrosion mechanisms that have been identified.

First, there's a regional wall loss that results in a scalloped reduction -- which is being shown by the mouse -- in the wall thickness illustrated with NDE results on the left picture at the J-Rod 41 leap site.

Second, as shown in the cross-section of the coupon removed from J-Rod 41, localized corrosion pockets can form below the regional wall loss at a level that would correspond to the water line in the annulus, as I showed you on the J-Rod 13 to 17 plate.

Based on the evidence from the corrosion coupon and experience with corrosion in the annulus between the vessel and reflector, both the regional corrosion and the localized corrosion pockets resulted from nitric acid formed by irradiation of air in the presence of light water from reflector leaks.

Carbon dioxide is distributed into the annulus to displace air, but the delivery has not always been effective. Regional corrosion shown here in NDE results from J-rods 13 to 17 is due to contact of acidic water with the vessel, for example, due to splashing or spraying.

Corrosion pockets, shown in the magnified view of NDE results from J-rod 41, result from an electro-chemical cell where acidic water running down the vessel wall contacts oxygen-rich water from the reflector leaks. Analysis of the coupon from J-rod 41 confirmed that no other contaminants were driving the electro-chemical process.

The series of pictures from top left to bottom right show the condition of the J-rod annulus, first when the vessel was installed, then an area of typical corrosion; next, increased corrosion at the leak site and finally the improvement achieved through vacuuming in the annulus.

The strategy to reduce and arrest corrosion is based on reducing air and water ingress. Immediate action has been taken to address water leaks and clear drains to eliminate pooling and splashing on the vessel wall.

Action has also been taken to reduce air leaks and improve the delivery of $CO_2$. Going forward, $CO_2$ purity and the pH of water drained from the annulus will be closely monitored. Further reductions of water and air ingress will be achieved through physical improvements during regular planned maintenance outages.

Additional mitigation measures are under consideration including the application of a cold spray sacrificial aluminum coating, repair of the reflector leaks, and changes to the reflector water chemistry.

Recognizing that corrosion was not anticipated in the vessel condition assessment performed in 2004 and 2005, AECL undertook actions to ensure that there were no concerns with the assessments of other NRU systems.

First, the condition assessment process was reviewed to ensure there was no generic problem with the process and none was found.

Second, an independent process of review was carried out by an expert panel to validate the results of the condition assessments. And no gaps of safety significance were found.

Going forward, the integrated safety review that is currently underway to support licence renewal will address gaps to modern codes and standards. The isotope supply reliability program is improving plant life management including the maintenance program and system health monitoring.

In assessing the NRU's fitness for service, regional corrosion compromised the vessel's ability to withstand specified loads. The top graphic on the slide shows the results of finite element analysis used to determine site requiring repair. The lower graphic shows acceptable mechanical performance following repair.

Continued fitness for service will be verified through in-service inspections conducted during planned maintenance outages. In future, the reliability of NRU operation will be enhanced through longer planned maintenance outages.

These longer outages will start with the first within nine months of return to service and then will occur annually thereafter subject to review based on NRU performance and outage experience.

The duration of annual maintenance outages will be set by the critical path activities and are expected to be about four weeks in duration.

In-service inspection will monitor wall thickness and thereby assure ongoing structural integrity. The inspection program and ongoing mitigation reduces but does not eliminate the potential for highly localized corrosion pockets.

Such corrosion pockets do not impact the structural integrity but could lead to a heavy water leak. Tooling is being developed to effect a mechanical repair of a small leak without defueling or draining the reactor.

Causes for the NRU leak event have been assessed and found to be consistent with opportunities for improvement identified in a 2008 and 2009 safety culture survey. Corrective actions have been rolled into AECL's improvement program called Voyageur Phase II.

Broad elements of the program are:

1. To improve equipment reliability to ensure a low tolerance for equipment issues, eliminate

work-arounds, improve maintenance programs, spares and system health monitoring;

2. To reinforce desired organizational behaviours such as a questioning attitude and the use of event-free tools;

3. To improve problem identification and corrective action to consistently identify and address problems with a very low significance level;

4. To improve the use of operating experience to learn from internal and external events;

5. To improve standards for operation; for example, through improved procedural adherence, outage planning and the WANO peer review process; and finally

6. To improve leadership and oversight through the strengthening of our leadership academy, change management, and observation and coaching.

Measures of improvement will include site and departmental level event free-day resets, interim safety culture surveys, equipment reliability indicators, and a health index for the corrective action program.

Human resources, equipment upgrades to address obsolescence and equivalency, spare parts, and program improvements are all funded through the isotope supply reliability program.

The NRU outage provided an opportunity to carry out maintenance and inspection activities that cannot be completed within the normal operating cycle. Safety and reliability improvements were made to the heavy water system, to the processed water system, the fuel rod flask, and control rod systems.  All outstanding maintenance activities requiring the reactor drained and defueled were completed.

To address CNSC staff inspection findings, comprehensive system walk-downs were completed on the seven NRU safety upgrades during the outage and all findings have been reviewed and dispositioned.

As we proceed with the NRU Return to Service Program, the safety upgrades will be confirmed fully operational, fully tested, and fully capable of performing their safety functions.

As part of the NRU Return to Service Program, the NRU readiness for service process will assure all systems are fully operational and fully tested.  A detailed integrated plan has been produced for all maintenance, testing, system configuration, and training activities and is being executed as shown by the work-down curve.

A dedicated team was assembled in September 2009 to put together the step-by-step procedures supported by checklists needed to safely and efficiently return systems to service. Operating experience from the restart in 1991 was reviewed and included in the development of procedures and checklists.

More than 2000 activities have been identified and scheduled. The return to service is supported by a dedicated outage control centre and fix-it now teams to address emergent issues on equipment that has been laid up for a year.

Training associated with the NRU return to service includes both update training on new procedures that have been developed and associated with restart activities, and refresher training on activities that have not been routinely performed during the outage.

Training is being delivered close to the time it is required for maximum benefit. This chart shows the over 400 training activities leading up to refilling the reactor vessel. Similar programs are being delivered prerequisite to starting to refuelling activities and prior to restarting the reactor to low power operation.

In the months prior to the May 14th, 2009 shutdown, it was suspected that there was one or more defects in the NRU driver fuel. The current driver fuel design has had excellent performance since it was introduced in NRU in the early 1990s. Until coolant activities rose in late 2008, there has been no record of defects.

Suspect fuel was removed from the reactor in January through March of 2009 and fission product activity in the coolant was decreasing consistent with the defects having been removed from core. Subsequent examination of the suspect fuel removed has confirmed there were defects.

A total of four defects have been found and all are similar to the one shown on the slide. They occur at the ends of the fuel elements as a split in the aluminium fuel sheath in an area where the sheath has bulged.

The defect mechanism appears to occur early in the service interval of the fuel. Defects are limited to batches of fuel manufactured before February 2008. Based on the location and nature of the defects, the most likely cause is organic contamination introduced during the manufacturing process.

No fuel from the batches with known defects will be reloaded in the NRU for start-up. Steps have been taken to ensure the likelihood of fuel failure following restart is acceptably low. The majority of fuel to be reloaded was in the NRU when the shutdown occurred and was demonstrating good performance.

As a further contingency measure, the

procedure for responding to rising coolant activity levels, which may indicate a new defect, has been enhanced to assure appropriate measures are taken in the unlikely event of future fuel defects.

The June 23rd earthquake was a magnitude 5 centred north of Ottawa. A Government of Canada seismic monitoring station is located on the Chalk River site. The peak ground acceleration at Chalk River was 0.006g, where g is the acceleration due to gravity. This would equate to an earthquake with a magnitude between 3 and 4 centred at Chalk River.

NRU’s safety functions have been qualified for an earthquake of magnitude 6 and in addition NRU has a seismic trip set at 0.06g.

Nuclear facilities and buildings were walked down by operations following the earthquake and assessed by engineering to confirm no damage had occurred.

At the time of the earthquake, the in-service leak test was in progress on the reactor vessel. To provide assurance of vessel integrity, those areas that had been completed were re-inspected. Also, the vessel was drained and an additional visual inspection was performed that included the larger repair sites with no anomalies found.

On communications, regular updates have

been provided to the public and stakeholders generally on a weekly basis to ensure they were kept informed of progress. Update number 63 was issued June 30.

AECL has set up the www.NRUCanada.ca website in July of 2009 with frequent updates to provide a wealth of information to all stakeholders. Weekly briefings have been held with senior government officials to report progress on the repair and return to service.

Phone-in meetings have been arranged with healthcare stakeholders and local officials when significant developments have occurred which may impact their constituents; for example, extensions to the repair schedule or major milestones such as the completion of repairs.

AECL is in regular communication with the other major isotope producers on projections for the NRU return to isotope production through the Association of Imaging Producers and Equipment Suppliers, or AIPES, in Brussels.

In summary, the NRU vessel has been successfully repaired and is fit for service. AECL is confident that all requirements for safely restarting the NRU have been met. We respectfully request approval to reload fuel past the guaranteed sub-critical condition thereby allowing full return to service and resumption of

NRU operation and medical isotope production.

Thank you, Mr. Chair.

**THE CHAIRMAN:** Thank you.

I'd like to move now to a presentation from CNSC Staff, as outlined in CMD 10-H12.

Mr. Jammal, the floor is yours.

**10-H12**
**Oral presentation by**
**CNSC Staff**

**MR. JAMMAL**: Bonjour, monsieur le président et membres de la Commission.

For the record, my name is Ramzi Jammal, Executive Vice-President and Chief Regulatory Operations of the Canadian Nuclear Safety Commission.

Avec moi aujourd'hui l'équipe de la Commission canadienne de sûreté nucléaire. I start with Mr. Peter Elder, Director General of the Directorate of Nuclear Safety and Facilities Regulation; Mr. Miguel Santini, Director of the Chalk River Laboratories' Compliance and Licensing Division; Dr. Etienne Langlois, Project Officer responsible of regulatory oversight for the NRU Operations.

With me also, our specialists, licensing compliance team, and through video our Nuclear Site Inspectors office to including Mr. Reuben Marini.

Mr. President, Members of the Commission, the NRU shutdown has impacted multiple directorates at the CNSC. Over the last 13 months, CNSC staff performed various regulatory activities other than those specified in the NRU restart protocol.

CNSC staff executed licence amendments as requested without delays and without compromise to safety. In specific, the Directorate of Nuclear Substance Regulations amended no later than 24 hours requests from hospitals and clinics to increase their possessions, possession limits, to change their inventories in order to have alternate isotopes.

Mr. President, the spent resources for regulatory efforts were above the planned regulatory activity and CNSC staff provided 24/7 services and in specific Doctor Langlois and our site office at Chalk River.

I'd like to give you a brief background.

In May 2009, a small leak was discovered in the vessel of the NRU reactor at Chalk River Laboratory. The reactor was placed in a safe shutdown condition and AECL subsequently decided to de-fuel and drain the reactor to complete inspection and repair activities.

While most aspects of such repair are covered by the existing conditions of the current Chalk River Laboratories licence, this repair and restart required unique considerations that are beyond CNSC staff approval.

Hence, we're before you requesting an approval to re-fuel the reactor and put it into beyond the defined temporary guaranteed sub-critical condition.

As part of CNSC clarity of requirements and transparency, AECL-CNSC established an NRU restart protocol and this protocol was signed by both presidents of the Commission and AECL.

The protocol is an administrative tool that clearly documented the regulatory requirements so the repair and the restart or return to service is done in accordance with applicable codes and standards.

Mr. President, among other things in the protocol was the conflict resolution that was frequently invoked and this was done at my level and Mr. Pilkington's level.

In this slide, I show you the map with respect to the NRU restart protocol and sections in the CNSC CMD in order to indicate how the protocol has been executed during the course of the vessel repair and the NRU return-to-service projects.

The protocol is now closed and CNSC staff confirm that all the necessary information to make a recommendation to the Commission for this approval has been received and that the protocol has met its intent by enhancing communication between the two organizations and very close management oversight.

Today’s presentation will provide details on CNSC staff’s assessment of the information provided by AECL to support the NRU reactor’s return to service. But before I hand the presentation over to Mr. Elder, I wish to make the following statements.

Has the NRU been repaired safely? The answer is yes. Has the repair re-established the structural integrity? The answer is yes.

However, the rest of the presentations will discuss the operational reliability and the need for operational experience and cultural changes at the AECL.

I will now pass the presentation on to Mr. Elder.

**MR. ELDER:** Thank you, Mr. Jammal.

Today’s presentation consists of seven parts. First, I will provide an update on the vessel leak repair and CNSC staff’s overall conclusion on the repair. Then Mr. Santini will go through the other four areas assessed by CNSC staff during this extended outage associated with the decision to allow restart and continued refuelling.

Afterwards, we will provide information on additional activities not directly linked to the restart of NRU but that would be of interest to the Commission.

Finally, we will provide CNSC staff's conclusions and recommendations.

As listed in the restart protocol, CNSC staff required AECL to complete the following activities during the vessel leak repair project: conduct a root cause investigation into the leak.
This was divided into two parts: a technical investigation focussed on the vessel and the cause of the corrosion, and a wider organizational investigation onto why the vessel was allowed to get into such a condition.

The results of the second part will be discussed later in the presentation.

Then AECL was required to perform an extensive assessment of the vessel to determine its complete condition, define a repair strategy and a detailed repair plan based on the condition assessment and the technical root cause, implement a mitigation strategy again based on the cause of the leak, demonstrate that acceptable repair had been done in accordance with applicable codes and standards, and finally to produce a fitness-for-service safety case for the vessel showing structural integrity will be maintained with an acceptable safety margin.

To achieve a high level of confidence in the reactor vessel repair initiative, CNSC staff required a comprehensive conditional assessment to evaluate the state of the vessel, the extent of corrosion damage, the general fitness for service of the vessel and the repair options.

As has been stated by AECL, the original leak occurred at location JR-41 but there was also heavy local corrosion at other locations at the same elevation near the floor of annulus.  And at two locations, JR-41 and JR-13/17, there were through-wall penetrations.  That is to say there was no metal left in these locations in small areas.

It should be noted however that very little general corrosion was identified in the rest of the vessel.  This was also true for other structures associated with the vessels and the walls of the light water reflector tank.

Given the extent of corrosion in the annulus at this floor level, it was evident that repair was required to re-establish the structural integrity of the vessel and to re-establish the design criteria.

The state of the NRU vessel revealed by the non-destructive testing inspection showed the vessel had been subject to a degradation mechanism that was more active than previously believed. AECL submitted a corrosion report which identified the main cause of leak -- vessel leak was nitric acid attack in the J-rod annulus on the outside of the vessel wall attributed to nitric acid production from ingress of both air and water into the J-rod annulus.

The presence of air results in the radiolysis production of oxides of nitrogen that dissolve in water to form nitric acid. The source of the water in the J-rod annulus is a leakage from the light water reflector.

After reviewing the submissions and the data provided by AECL, CNSC staff has accepted AECL’s conclusion that corrosion by nitric acid is the main cause of the observed degradation of the NRU vessel wall.

However, the studies to date have not conclusively dismissed other possible secondary mechanisms and there is limited data on the corrosion rates for nitric acid.

Therefore, ongoing inspections are required to reduce the uncertainty in the corrosion rates and to continue to eliminate other potential sources. These inspections will be detailed on later slides in this presentation.

To address the corrosion -- vessel condition degradation, AECL has developed short-term and long or medium-term mitigation strategy which I'll discuss on the next slide.

As I mentioned earlier, the cause of the corrosion is nitric acid production in the annulus. To mitigate this mechanism, AECL has developed a comprehensive J-rod annulus mitigation strategy.

To date, AECL has implemented six elements of the strategy, including installation of a new $CO_2$ injection system to displace the air in the annulus and improve the sampling of the $CO_2$ that is injected, installation of new upper seals and lower J-rod seals again to reduce air ingress, and the cleaning of annulus drains to provide better drainage of water and prevent standing water formation.

However, these elements do not stop the corrosion but should slow it down. The effectiveness of the elements can only be proven through routine inspections after restart since the reflector has been emptied and air ingress conditions change during operation.

Post the restart, AECL will need to

continue to reduce the air leakage and reflector leaks in the annulus at future extended outages and continue to develop the strategy and implement a contingency plan if there is further corrosion.

One aspect they are discussing is investigating the application of a sacrificial aluminium coating that would act as a barrier to arrest vessel corrosion.  And as a contingency, AECL is developing a mechanical repair tool for small leaks that can repair without de-fuelling the reactor.

I will now shift the focus of the presentation to the repair strategy.

As has been noted by Mr. Jammal, many aspects of the NRU vessel repair are covered by existing conditions in the Chalk River Laboratory site licence and these conditions remain enforced for the current repairs.

The key requirements stem from the CSA Standard N285 series on pressure retaining systems and the associated American Standard of Mechanical Engineering's *Boiler and Pressure Vessel Code*.

Through the NDE's, AECL identified 10 sites requiring repair around the base of the vessel.  These range from small areas of a few millimetres to extended regions as has been presented by AECL.

The selection of the repair sites is

consistent with the requirement that structural integrity in vessel be re-established while minimizing the risk of damaging the bottom seal during welding.

CNSC staff accepted the approach proposed by AECL to use ASME Code Section 11 in defining the repair requirements for the NRU vessel. Use of this section of the Code requires regulatory approval for the repair plan for the vessel and inspection and test plans for each repair site.

These inspections and test plans included a detailed description of the post-repair non-destructive testing and examination, including the techniques that will be used and the limitations of those techniques for each site.

CNSC staff approved the repair plan and the test procedures for each repair site prior to the start of welding that included a description of the repair procedure, the repair areas, the tooling required and the staff training required.

I will now present more details on the post-repair inspections.

After all the repairs and the post-repair inspections are complete, and prior to restart of the reactor vessel, AECL was required to submit a repair report. The repair report, including all the supporting documents for each repair site, must demonstrate that established codes, standards and processes for the vessel repairs have been followed and the detailed results of the post-repair inspections confirm the vessel fitness for service.

Given the tight timeline for the return to service and the complexity of the information to be collected in support of the repair report, AECL submitted the supporting documentation for the first nine of the 10 repair sites and prior to the final repair report.

However, AECL cannot bring the reactor critical until CNSC staff has approved this final report.

AECL has now submitted the final report and I'll discuss the results of the last repair on the next slide.

CNSC staff can confirm that repairs and the post-repair inspections completed to date were all done in accordance with the repair plan and demonstrate the re-establishment of structural integrity of the vessel.

We will provide in writing to the Commission an update when the final repair report has been fully reviewed and accepted.

I will now turn to the final last repair. As stated by AECL this final repair is complete and this was the largest and most complex repair site compared --

in comparison with the previous nine ones.

As AECL has stated, the initial NDE confirmed a crack in the welding and AECL then went back and developed a weld repair strategy to repair the crack and this weld repair was completed on June 14th, 2010 and the NDE on the day afterwards. So this was after the publication of our CMD.

Since then CNSC staff has received the final repair report, including the details of this repair. While we are still doing our comprehensive review the preliminary review has not identified any problems with this repair and include that the vessel is fit to return to service.

In order to monitor future reactor vessel conditions on a continuing basis AECL has developed an in-service inspection program, using non-destructive examinations to identify and monitor any deterioration in integrity of the vessel on a continual basis.

Inspections are mandatory under CSA Standard N285.4 and the first inspection must be no later than nine months after the NRU restart.

To support operation of NRU AECL is required to submit a comprehensive safety case that demonstrates the reactor vessel is repaired and fit for service. AECL has done this in two stages; a preliminary assessment was developed again to determine the areas that needed to repair and this was accepted by CNSC staff.

The final assessment is to be completed within 90 days after the return -- after returning the vessel to service and this report integrates the results of all the post-repair NDU results, as well as the final corrosion reports and will define the ongoing inspection requirements and frequency beyond the first inspection.

The final assessment will also analyse uncertainties in the NDE results and tools and that will be again developed into identifying focused areas for future inspections.

As stated by AECL, there will be a planned extended maintenance outages of NRU in the future of about three to four weeks with the first one reoccurring within nine months.

In these outages they will conduct not only the inspections required but also additional vessel life-management activities like continued corrosion mitigation and other maintenance activities.

Thereafter, the NRU maintenance outage of about four weeks duration is planned, at least annually, to ensure continued and ongoing fitness or service of the vessel.

The actual interval between maintenance

outages will depend on the results of the inspections of the previous outage.

CNSC staff has concluded that the maintenance of the vessel fitness for service case is an ongoing activity that needs to be accounted for, and account for new inspection information and we believe that, again, the fitness for service case needs to be updated to include new supporting information to support licence renewal in 2011.

This slide presents information since CNSC staff CMD was issued on June 11th. After the completion of the final repair AECL did perform the leak test, as required by the repair plan. The leak test was witnessed by the appropriate authority and it verified that the annulus region was dry during the leak test which took about two days to do.

As noted, AECL did measure small concentrations of gaseous tritium above baseline levels prior -- after refilling the vessel and specifically in the area between J-Rod annulus 13 and 23.

There are several potential sources of tritium in the annulus but obvious potential source was the vessel repairs.

However, at no time was water observed in the annulus, meaning that any potential leak from the vessel would be extremely small.

AECL did decide to empty the vessel to further investigate the source of this tritium, detailed visual inspections to the repair sites were made from the inside and outside and no visible cracks were identified nor was any moisture.

This met the Code requirements and CNSC staff has no concerns with the safety case for the vessel.

As the Commission is aware, there was an earthquake on June 23rd, centred near Ottawa. The earthquake was felt at Chalk River and as stated at the June 28th Commission meeting the vessel was full at the time of the earthquake. The leak test verifications were repeated after the earthquake and again, no signs of a leak were identified.

The visual inspections were also -- I just discussed above, about looking for source of tritium were also done after the earthquake and they serve -- so they service part of the post-earthquake verification and that again no damage was identified.

Just to note, in addition to the vessel the NRU building and as well as all buildings and structures and facilities, including the ground -- underground and aboveground waste storage tanks were verified post-earthquake and no damage was identified.

CNSC staff remain satisfied the NRU has the required seismic protection in place.

So CNSC staff concludes that AECL has conducted a thorough examination of the vessel that allowed them to identify they needed repairs, CNSC staff has verified that the vessel was repaired in accordance with applicable nuclear standards and noting of course that we are still doing our detailed confirmatory review of the final report.

The repaired vessel is fit for service, provided the initial period of operation for the NRU is limited to no more than nine months.  This will ensure the first in-service inspection is conducted while there are still margin to the corrosion allowance to cover the worst possible scenario, i.e. the highest potential corrosion rate.

Second, in the long-term ongoing inspections will require NRU to be operated in a different fashion than previously.  Planned extended outages will be needed as part of the operating regime.  AECL has indicated its intention to plan yearly extended outages, exact timing and periodicity of the subsequent inspections will be determined once the final fitness for service report is submitted.

The leak test has been performed and CNSC staff have reviewed the preliminary results of the last area and is satisfied that the vessel's structural integrity is acceptable.

While AECL has had a process in place to monitor and measure tritium presence in the annulus as a possible source of leak congestion, CNSC staff has required AECL to enhance this process to make sure that there is a determined leak detection limit and the prescribed actions, if a leak is detected, are documented and the operators are appropriately trained.

So we're again looking for extra mitigation in case of a potential leak.

I will now pass the presentation over to Mr. Santini who will discuss the other issues around the extended outage.

**MR. SANTINI:** Thank you, Mr. Elder.

The NRU return to service project includes all of the activities other than the vessel repair that must be completed prior to the NRU restart.

The RTS plan is divided into three groups of activities; field work, procedures and supporting activities.

The last time the NRU Reactor underwent an approach to critical after an extended shutdown of more than six months was 1991. Hence, many activities related to these RTS are considered non-routine.

As such, the CNSC required AECL to submit all of the documentation to demonstrate the systematic approach to the return to service and carried out several onsite verifications in relation to this project.

CNSC staff is satisfied that the plans, the procedures and the training developed by AECL adequately support a safe start of the NRU reactor and that the number of certified staff is sufficient to support restart activities.

At this time, the RTS activities are still in progress.  Before approach to critical for restart, AECL needs to declare the reactor ready for service.  CNSC staff will continue to closely monitor the remaining RTS activities through compliance inspections.  CNSC staff's assessment of RTS activity further concludes that the core can be reloaded and the reactor will operate within the safety -- safe envelope established in the current licence and CNSC staff is satisfied that the RTS activities on the training of the NRU personnel are adequate in supporting a savoury start of the NRU reactor.

Next I would provide information on the organization of human factor issues that contributed to the NRU vessel leak event.  Several organizations on human factor issues contributed to the NRU vessel leak event over many years of operation and management and structures.

These casual factors point to organizational weaknesses that are consistent with the results of the safety culture of self-assessment that AECL performed in 2008. AECL and CNSC staff agreed that the corrective action plan should therefore address both the root cause for this event and the 2008 safety culture self-assessment.

CNSC staff concludes that the corrective action plan has identified essential elements required to correct the organizational weaknesses that led to the vessel leak. The plan is ambitious and it covers a broad range of activities from the development of human performance to new policies and implementation of best industry practices.

For some causal factors, the CAP relies heavily on the isotope supply reliability program, to support some assurances of a stability, funding our resources. However, the ability of these programs to effectively provide the required stability and resources in the long term will not be verified since it depends on continued funding from the federal government.

As a result of this, CNSC staff recommends the Commission request AECL to provide updates of the details of the corrective action plan implementation every six months for at least the next two years.

This slide provides information on the gaps in the 2004 and 2005 vessel condition assessment that were uncovered with the event which were initially performed by AECL for the NRU re-licensing in 2005. These gaps raised doubts about the validity of the other condition assessments performed by AECL for this year's licence renewal. For that reason, CNSC staff required AECL to review all of the previous condition assessments, to identify of any potential gaps that may have an impact on safety.

AECL carried out a high level assessment using the Phenomena Identification and Ranking Table, PIRT, process which is based on a systematic top-down approach in assessing importance of the phenomena on the system and then the component -- on the component levels -- and then at the likely phenomenon level. AECL's PIRT looked at the risk to safety and reliable operation of NRU to the year 2021.

CNSC staff concurs with the conclusion of the PIRT process and the overall conclusion that there is little impact to safety as a consequence of the gaps identified in the process. However, the remaining issues with respect to the shortcoming of identifies in the 2004-

5 assessment may have an impact on operating reliability.

Some of the gaps have been addressed through AECL's extended activity project within the current outage but AECL has committed that any remaining items will be addressed in the integrated safety review for licence renewal and the Isotope Supply Reliability Program.

CNSC staff is currently performing a thorough review of AECL's condition assessment under the integrated safety review in preparation for the CRL licence renewal next year as is considered an important component for the continued operation of the NRU reactor.

Prior to the shutdown of the vessel leak, AECL has reported high activity of fission products in the heavy water and it was later found out that this was due to the presence of defective fuel in the reactor.  Given that this is a rare event and it appeared that it was more than one defective fuel element, CNSC staff required AECL to demonstrate that there was not a generic problem with NRU fuel and provided its assurances that the fuel loaded in the reactor, irradiated or fresh, is not likely to fail.

At this time, AECL's investigation is not -- into the defective fuel is not complete and therefore CNSC staff believes that AECL cannot give assurances that the fuel loaded in the reactor is unlikely to fail. Therefore, CNSC staff required AECL to put in place additional mitigating measures.

In response, AECL developed the NRU heavy water system high radiation identification and response procedure to mitigate any impact of any future fuel failures which can lead up to the reactor shutdown if the failed fuel is not promptly localized.

CNSC staff concluded that this is an important extra barrier.  This procedure will reduce the risk of prolonged operation of the reactor with defective failed fuel precluding contamination of the primary system with fission products and provides risk mitigation. Ultimately this procedure will enhance workers’ protection and be consistent with the ALARA principle.

With this extra mitigation, CNSC staff concurs with AECL that the risk to the health and safety of workers, the public and the environment due to fuel failure are acceptable.  However, the risk to fuel failure has not been properly addressed yet so the risk to operational reliability has not been adequately mitigated.

In June 2010, CNSC staff performed an inspection of AECL fuel manufacturing quality assurance and its relation to the fuel effect investigation.  The results of this inspection are still being analyzed but some weaknesses in the QA, quality assurance, were found and AECL will need to address those to improve the fuel manufacturing process.

The following three slides will present information on the additional outage activities performed by AECL that were not required for restart and are presented today for information only.

The extended shutdown of NRU was a unique opportunity to perform maintenance and other activities on the reactor and its systems that are normally limited by time constraints, excessive radiation fields and other obstacles.  The Extended Activity Project, EAP, was developed by AECL to take advantage of this extended outage.

The scope of the EAP work included a large number of jobs selected by an AECL expert panel using a risk-based approach applied to a list of tasks based on such items like the plant life management recommendations, longstanding maintenance and repair work, preventive maintenance backlogs, NRU safety upgrade walk downs and work identified as part of the protocol for the NRU licensing activities.

In the time allowed, AECL completed more than 75 percent of the activities initially identified in the EAP.

On March $19^{th}$, 2010, AECL declared this project closed. The remaining activities initially planned under the EAP were deferred to future extended shutdowns. AECL’s declaration included safety and impact assessment, as justification for these deferrals for future outages.

CNSC staff concurs with AECL’s assessment and will be monitoring to make sure that the outstanding activities are included in the future outage work.

Another additional outage activity performed by AECL is the NRU safety upgrades walkdowns. In 2006 QA audit on the upgrades, CNSC staff found that some of the construction activities were not carried out in accordance with the requirement of CSA 286.3.

One major part of the EAP project was the completion of the comprehensive walkdowns of the seven NRU upgrades to verify that the field installation conforms to the requirements of the standard.

The walkdowns of all NRU upgrades were completed by AECL during this extended outage and resulted in numerous findings following AECL’s accepted corrective action program.

The significance of these findings were classified in accordance to safety impact; again, following AECL’s accepted corrective action program.

About 150 findings were classified by AECL as “must-do’s” before reactors restart since they had a potential impact on safety.

The most significant findings were missing seismic analysis documentation for the new emergency core cooling and the qualified emergency water supply systems.

AECL had to re-design the supports -- seismic reports. CNSC staff will verify that the seismic reports are replaced before restart.

Two inspections based on random sampling were carried out to verify completion of the work related to the walkdown findings when declared completed by AECL. In a few cases, CNSC staff has requested original documentation to AECL to support the completion declaration.

CNSC staff is planning a 100 percent verification of all significant walkdown findings and will update the Commission on future -- on the results in the future.

At this time, CNSC staff is of the opinion that AECL is on track to resolve all safety significant findings prior to restart. To date, all safety upgrades are installed and operational.

Based on the review of AECL’s submissions, inspections of AECL projects and discussions of technical items, CNSC staff concludes that the NRU Reactor vessel has been repaired as to be fit for service noting that AECL has made an acceptable safety case for continued operation and the vessel leak test has been performed and accepted by TSSA.

Therefore, CNSC staff recommends that the Commission approve the return to service of the NRU noting that the acceptance of the final repair report by CNSC staff is pending and the in-service inspections of the vessel are mandatory and the first inspection must be no later than nine months after the NRU restart.

CNSC staff also recommends the Commission to request AECL to provide updates on the progress on effectiveness of the organizational corrective action plan every six months after the restart of the reactor.

This concludes CNSC staff’s presentation. We are now ready to answer any questions the Commission may have.

**THE CHAIRMAN:** Thank you.

First of all, what I would like to do is -- we’re going to do one round of questions then listen to the interventions that were filed with us and then -- and then go for another round of questions.

Before we start, I’d like to recognize that we have some representatives from the Emergency Management of Ontario, should people want to question their views about the seismic event or anything else associated with the emergency planning.

So with that introduction let me start with Mr. Graham.

**MEMBER GRAHAM:** Thank you, Mr. Chair.

I'd just like to start off on a -- first, on a positive note saying that I believe that AECL have assembled perhaps the largest group of engineers and scientists and so on to get this repair fixed and you're to be congratulated for getting that done.

However -- and I'll say "however" -- the rest of my questions are perhaps not going to be quite that complimentary but I'll start off by that we heard today that the vessel has been leak-tested and is ready for restart.

We've heard from CNSC staff that the repairs report by CNSC staff is still pending. My question first of all to AECL is: When do you foresee meeting the CNSC requirements and being able to restart the reactor?

**MR. PILKINGTON:** This is Bill Pilkington, for the record.

AECL has submitted the information for the final repair report. I believe that was done last

Tuesday.

However, there will be time required -- it’s quite an extensive package of documentation and there will be time required for the CNSC to review that.

**MEMBER GRAHAM:** To CNSC staff then: When do you foresee the final approval for the reactor to be restarted?

**MR. ELDER:** So I’d just explain what we mean by in terms of “pending”.

Again, this is -- this is the written documentation that everything has been done. So what we do is we compare it against what was supposed to be done to all their evidence that it has been done.

So it’s a final confirmation step.

All the requirements are already laid out in the original repair plan. The repair report just demonstrates that it was done appropriately.

We are currently reviewing that. As Mr. Pilkington said, it was sent on Tuesday, we didn’t actually receive the whole memory stick that it came on until we actually got it in our offices on Friday. So we’re doing -- reviewing that right now. We figure it’s about a week.

So by the end of this week or maybe at the latest early next week, we would be -- have done that confirmatory review.

Again, it's to make sure that they've dotted the t's and crossed the i's on that final repair.

We've seen the preliminary data.  There is nothing in the preliminary data that indicates a problem but we are going to do a comprehensive walk-through of it to make sure that everything was done that was supposed to be done.

**MEMBER GRAHAM:**  So back to AECL, you're looking at probably by the end of July you would be -- the reactor would be in full operation?

**MR. PILKINGTON:**  So our current schedule would have the reactor operating at high power by the end of July and first delivery of isotopes.

**MEMBER GRAHAM:**  Then, after that, you're down, what?  Generally, on a 30-day basis, down three to four days on general maintenance; that's been the routine of operating of the NRU?

**MR. PILKINGTON:**  Bill Pilkington, for the record.

Currently, the NRU is operating on a 28-day cycle of which 23 days would be operation and five days would be maintenance and testing.

And as said in the presentations, that will now be augmented by an annual extended maintenance shutdown.

**MEMBER GRAHAM:** And that annual extended maintenance shutdown would be at about nine months or at six months?

**MR. PILKINGTON:** So the first planned shutdown will be within nine months.

So we would expect it will occur sometime in the first calendar quarter of 2011.

Following that, planned outages will occur on an annual basis.

**MEMBER GRAHAM:** Thank you.

And the next line of questioning is with regard to -- you were before us about three years ago for licence renewal, had -- did all this corrosion that we're hearing about today and have heard about for the last 14 months, did that occur -- all occur after you came before us, three years ago?

**MR. PILKINGTON:** Bill Pilkington, for the record.

No, that corrosion has been progressing for a number of years.

**MEMBER GRAHAM:** I keep a bit of a library on CNSC -- on AECL appearing before us and it's quite large, for different reasons: for licence renewals, for other significant development reports, for other things.

And when you came before us with regard to -- in reading back -- you came before us in renewing that 50 year-old reactor and so on and the robustness for service.

I'm wondering why you hadn't done the type of inspections that now occurred and caused a 14-month shutdown. Why was that overlooked?

**MR. PILKINGTON:** Bill Pilkington, for the record.

My review of the information and of the findings of the root cause assessment that was done for both the technical root cause and organizational root cause would indicate that the corrosion that was occurring in the vessel was not identified in the condition assessment that was done for licence renewal in 2006.

And a part of that was that, at the time, the technology did not provide for non-destructive examination at the base of the vessel where the build up of gibbsite -- that's the oxide of aluminum in water -- where the build-up of gibbsite was heavier.

And there was an assumption made in the condition assessment that because carbon dioxide is heavier than air, that the carbon dioxide concentrations should be higher, lower in the vessel and, therefore, there should not be a concern since measurements higher up had indicated very very little corrosion of the wall.

So with the limitations of the inspection and assumptions that proved not to be true, we ended up with this corrosion going unnoticed.

**MEMBER GRAHAM:** Well, that's correct. Your assumptions were wrong and by that -- but prior to your application for renewal of the licence three years ago, you did do coupon analysis, I believe, in various parts of the vessel and to my knowledge, some of those coupons were never examined. Is that correct?

**MR. PILKINGTON:** Bill Pilkington, for the record.

So I did not bring with me experts on corrosion coupons to today's hearing. And so I believe that coupons were not examined at that time because they were felt not to represent the conditions in the vessel.

**MEMBER GRAHAM:** Well, yes. But then you were wrong again.

I'd like CNSC to comment on the fact that three years ago, we issued a licence for five years on the information that was provided to this Commission, on the information that the reactor was fit for service for the next five years, and less than two years into that licence, the reactor had to be shut down.

Did you not get sufficient information from

AECL or was there some oversight on behalf of both parties?

**MR. ELDER:** First, we did, in terms of coming up to that licence renewal, ask AECL to do a condition assessment of all the systems and they identified 21 systems that were done. And we looked at overall what they were done and the importance to the safety functions in the reactor.

So we looked at those things in terms of what risk were in gaps in those assessments -- going to cause in terms of looking at the importance of this one. And when you looked -- they did do an assessment of the condition, as Mr. Pilkington said.

They did do a condition assessment of the vessel. It obviously missed something, but you have to look at it in terms of what the safety consequences of that was, given that they detected the leak well before it became a safety issue and then it had a very limited safety impact because they shut down and had to fix it. It had a very large operational impact on them but a very minimal safety impact.

So again, when we're looking at it from a safety point, it didn't -- and the work they've done since then has not identified any major gaps in their safety case.

**MEMBER GRAHAM:** AECL is before us today giving us an update on restart. We’ve heard of over -- missed information and so other things that have led to this which -- and I could ask what this last 14 months has cost AECL at repairing the NRU and I will ask that.

But my other -- my first question is, are there anything else that is being overlooked today that you can assure this Commission that when you start up that you will be able to get the next nine months, then a large shut down, then back for the balance of the licensing period?

Are you confident -- because I’ve read the organizational improvements and read what your improved standards, improved leadership and oversight. And, you know, CNSC [sic] has been before us before with those exact same words. They’ve been before us back in 1998-99. They were back before us in 2003-2004. And they were always going to do better, always going to put together a better organization, always going to put together a better leadership.

And what I want to know today is, as a Commissioner and as a Commission, are we in the position to be assured that these words are not just words? They've got to be meaningfully put together to establish credibility within AECL.

**MR. PILKINGTON:** Bill Pilkington, for the record.

We've put a lot of effort in this presentation this afternoon to talk about the improvements that have been made and the improvements that are underway.

In terms of the equipment, we have taken advantage of this period of outage to do much more than simply repair our reactor vessel.

We have undertaken maintenance that requires the reactor defueled and drained with this opportunity. In fact, we’ve done all outstanding maintenance that requires that condition. We’ve done much more in terms of inspections.

We’ve done walkdowns of systems to verify their installation exactly meets the design. We’ve taken the opportunity to undertake further inspections. We’ve reviewed condition assessments. We’ve returned to condition assessments using the PIRT process from a different approach to get a second view that, in fact, nothing has been overlooked.

And going forward, we will start up with a reactor in a much better condition than it was when we shut down. We will always operate the NRU safely. We will not operate it in an unsafe condition, but we have done more work in this outage to improve the reliability going forward than simply repairing the vessel.

And if I just might add that we continue to invest in improvement in the NRU through the isotope supply reliability program.  We have funding available and we have a program in place whose sole purpose is to improve the reliability of NRU operation, and that program continues.

I am confident that we will operate safely and reliably through the next operating interval.

**MEMBER GRAHAM:**  Mr. Chair, I have a lot of other questions, but I want to pass it on to my colleagues.

But just one question I had -- what have you -- what has this whole episode cost since last May?

**MR. MacDIARMID:**  Hugh MacDiarmid, for the record.

I did make a comment when I appeared before the House of Commons Standing Committee just a couple of months ago that still holds, which is that the total cost will be in the neighbourhood of $115 million.

**THE CHAIRMAN:**  That's including all the repair plus the extra?

**MR. MacDIARMID:**  That's correct.  I'm sorry, I should clarify that.

That does include -- in a sense that's our cash requirement, which includes foregone revenues from isotope production.

**THE CHAIRMAN:** But ---

**MR. MacDIARMID:** So direct costs are about 80 -- about 90 million of that total.

**THE CHAIRMAN:** Any of these costs are also towards getting the licence renewed into 2011? I thought you've done a lot of additional work.

**MR. MacDIARMID:** That would include the extended activities program component of that, which does contribute to the readiness for the licence renewal.

**THE CHAIRMAN:** Okay. Thank you.

Dr. McDill?

**MEMBER McDILL:** Thank you, Mr. Chair.

I'd like to begin by acknowledging the technical complexity and challenge of what's been done over the shutdown period.

My questions, Mr. Chair, are principally technical in nature and for the purposes of providing some transparency to the public reviewing this document.

In your presentation, AECL, on page 5, you show the schematic of the vessel.

Could you point out or tell me where the lower vessel seal is with respect to that schematic so that I understand the residual stress comments later in the document?

**MR. PILKINGTON:** Bill Pilkington, for the record.

I believe the lower vessel seal would not be visible -- or actually, I guess it is.

If you look at the lowest point ---

**MEMBER McDILL:** Maybe we could have the -- could we have it up?

**MR. PILKINGTON:** Could we put it on the screen?

**(SHORT PAUSE)**

**MEMBER McDILL:** It's Slide 5 -- 4 and 5.

**MR. PILKINGTON:** There we go.

Okay, we'll just leave it in that format. But I think if you can put the mouse over the -- or we'll get help.

Thank you for the help.

I think if you just put the mouse over the -- this is the mechanical seal at the base of the vessel. So you're only seeing the top portion of it, it's a double-knife edge aluminium seal and there is a helium interspace.

**MEMBER McDILL:** And where are the bolts that are referred to for that seal, roughly? I know they’re not on the image but can you talk to them?

**MR. PILKINGTON:** So I believe the bolt circle actually passes through the seal but let me -- let me pass that question to Randy Lesco, our Chief Nuclear Engineer.

**MR. LESCO:** So for the record, my name is Randy Lesco. I’m the General Manager of Engineering and the Chief Nuclear Engineer for the site.

The actual bolts actually pass between the two knife edges of the seal.

**MEMBER McDILL:** Thank you. That’s helpful.

My next question, it relates to your Slide 21, but any of the ones with plates would be okay.

What is the material of the plates that have been applied, for example, in JR13 to 17? You haven’t discussed the material.

I know what the material of the vessel is, it’s an irridiation hardened 5052, I believe, but what are the plates?

**MR. PILKINGTON:** Again, I’ll direct that question to Randy Lesco.

**MR. LESCO:** Randy Lesco, for the record.

It’s made out of 5052 aluminium.

**MEMBER McDILL:** So it’s Virgin 5052?

**MR. LESCO:** That is correct.

**MEMBER McDILL:** Okay.

And the filler weld, what alloy was that?

**MR. LESCO:** Randy Lesco, for the record.

It was 4047 aluminium.

**MEMBER McDILL:** Is there any -- is there any long-term issue with chemical corrosion or galvanic corrosion between any of those materials and, if there is, how would you detect it in medium to long-term?

And maybe staff can comment on the answer.

**MR. LESCO:** Randy Lesco, for the record.

So that assessment was done ---

**MEMBER McDILL:** Sorry, I can barely hear you.

**MR. LESCO:** Randy Lesco, for the record.

So that assessment was done to ensure that we did not have galvanic corrosion between the well fill material 4047 and the 5052 aluminium.

**MEMBER McDILL:** And staff concurs?

**MR. ELDER:** Sorry, I'll ask Raoul Awad, our technical lead on this one, to answer.

**MR. AWAD:** Raoul Awad, for the record.

We believe that 4047 and 5052 will behave in the same manner regarding the corrosion.

**MEMBER McDILL:** I'm more concerned about the risk of galvanic corrosion or some inter-material corrosion.

**MR. AWAD:** We don't have any indication that can confirm there could be galvanic corrosion between them.

**MEMBER McDILL:** Thank you.

My next question is with respect to the finite element analysis and you presented a deformation map on Slide 22.

You removed a coupon from the vessel to determine material properties but, in your finite element analysis, were you able to use that coupon to develop a constitutive model or to predict the high temperature behaviour of the material during welding or were you able to use a constitutive model and material properties from other -- some other sources?

**MR. LESCO:** Randy Lesco, for the record.

So we did use some of the data associated with that material properties that we measured from the coupon, as well as the scoop samples.

**MEMBER McDILL:** So you did high temperature tests on the sample to determine its yield strength at welding temperatures?

**MR. LESCO:** So let me just step back one. Randy Lesco, for the record.

What we did in terms of developing this

finite element metals or the techniques for analysing the deformations, we actually did sample coupons in terms of measuring the heat input prior to actually welding demonstration coupons.

**MEMBER McDILL:** Did staff look at the source of the constitutive model for these predictive measurements?

Is an industry code used? Where did the high temperature properties come from?

I can understand the heat input and velocity coming from the test welds but the behaviour is a bit more challenging?

**MR. AWAD:** Actually, we looked at it from two perspectives: the first one is the qualification of the weld itself and the second one is the final fitness for service assessment will model all the stress generated in the -- in the vessel.

But for this particular one, we didn’t look at it.

**MEMBER McDILL:** So this prediction map of deflection from welding, this is one use of the finite element analysis and the other one, the fitness for service on Slide 29, I’ll come to, this image on Slide 22, you’ve exaggerated the deformations by 1000 times, 100 times, 10,000 times? It’s not in the picture.

And what is the red spot on the left that's at the opposite end of the deformation?

This is -- you're using this to talk about the crack so it's very unclear in this map what things are. Perhaps you could explain.

**MR. PILKINGTON:** Okay, Bill Pilkington, for the record.

I'm just going to generally go back over what this picture is describing.

We were aware before we completed the repair at J-Rod 1317 that the welding on the left-hand side, which is a large area of 3 millimetre weld build-up, would result in significant deformation of the vessel.

And so, prior to doing the welding, we did look at the expected deformation and I believe it was in the order of 5 to 6 millimetres, maximum, which I think is your red spot.

And so we made sure that our tooling would be able to complete the repair with that amount of deformation occurring during the repair process.

The significance is that there was also deformation that occurred on the right-hand side of the repair due to the work occurring on the left.

And so that deformation was, we believe, the source of the cracking that occurred as that cracking was not there when the repair was completed on the right-hand side but was there after the complete build-up was done on the left-hand side.

Or excuse me -- excuse me -- and the other point is that I believe that the amount of deformation on the right-hand side was between 2 and 3 millimetres.

**MEMBER McDILL:** Thank you.

Does staff want to follow-up on that?

**MR. AWAD:** Raoul Awad, for the record.

I will ask Mr. Blair Carroll to comment this one.

**MR. CARROLL:** Blair Carroll, for the record. I'm a Technical Specialist with Operational Engineering Assessment Division.

With regards to deflections of the vessel wall, the licensee used laser profilometry after -- after welding to measure the deflections and compare that back to the behaviour predicted in the numerical models.

And with regards to your previous question regarding the post-weld behaviour of the material, one of the tests that was done beforehand was with one of the scoop samples taken from the vessel to actually weld a bead of -- weld a bead over top of that coupon as it was contained within a larger plate of aluminium and the licensee went back in after the coupon was welded and looked at the metallurgy and the mechanical properties of that post-welded coupon to help them predict how the numerical model would behave compared to the actual welds on the vessel.

**MEMBER McDILL:** Okay. So it would appear there was some back and forth iterative development between the experiments and the FEA model to get a harmonized model then; is that correct?

Okay. Thank you.

My next question is with respect to Slide 23 which I think is the next slide actually. Thank you.

With respect to the red “R” in JR-23 and the -- that was a flaw in the heat affected zone and there’s a follow-up coming.

What is the nature of the reportable flaw? Is it a -- it’s obviously not a lack of fusion, but what is it? What was it?

**MR. LESCO:** Randy Lesco, for the record.

So basically it was a flaw that was detected on the left-hand side, top corner of the weld which was picked up by ultrasonic examination and it was slightly a sub-inner surface defect roughly in the order of 60 millimetres long -- or makeup of 60 millimetres long.

**MEMBER McDILL:** How will that be

dispositioned in over time? What's -- it's been cleared, like you're tracking it?

**MR. LESCO:** Randy Lesco, for the records.

That's correct. So it will be part of our ongoing in-service inspection to monitor that indication.

**MEMBER McDILL:** And staff, can you comment on that please?

**MR. ELDER:** In terms of the disposition it comes up to making sure that this becomes part of their in-service inspection to go back and revisit that indication on a routine basis.

So it may not be annually, but, you know, to see if there's any growth in that crack. It doesn't pose an issue right now, but it certainly is part of the -- it will become part of their in-service inspection to continually monitor that.

**MEMBER McDILL:** And it's oriented in some manner in which it won't experience any kind of crack opening mode to the best of your knowledge?

**MR. LESCO:** Randy Lesco, for the record.

That is correct.

**MEMBER McDILL:** Thank you. And similar comments then, please, with respect to the 4-5 lack of fusion. I realize again that the technical authority has cleared these but how will AECL and staff monitor the lack of fusion?

**MR. LESCO:** Randy Lesco, for the record.

So basically when we were designing the repair we had taken into account some inefficiencies in terms of the weld and so these have been demonstrated in our structural assessment that some minor lack of fusion is acceptable and will not increase in size during operation of the vessel.

**MEMBER McDILL:** Staff?

**MR. ELDER:** Just a comment. When we're looking at this one, we're making sure that none of them had a potential impact on structural integrity so that then they go into the ongoing monitoring program to make sure that they do not get any bigger but we have no evidence to support that they would get bigger than where they are.

**MEMBER McDILL:** AECL showed us some models of test welds and test combinations with considerable deformation. Now I realize those are plates and they're separate from the vessel and so we don't have the heat sink and neither do you have the constraint that the vessel applies.

So my concern is with all of these flaws that there isn't some local bending going on. These are very complex welds with multiple side-by-side passes with one pass sort of heat treating the previous perhaps to some extent but ultimately with large residual stresses.

Does AECL or does staff have a concern about local bending that's happening?

I realize you've got a predictive FEA and I'll come to the predictive FEA in a minute but I'm very concerned about localized bending going on in this loaded vessel.  I realize the pressures are low, it's low temperature, low pressure, but --- maybe AECL first?

**MR. LESCO:**  Randy Lesco, for the record.

So basically to ensure that we don't have an issue with respect to residual stresses or local bending, part of our ultrasonic examination was to look into the heat affected zone to ensure that we do not have any indications associated with that issue.

**MEMBER McDILL:**  My last question, or last series of questions -- you want me to go to round 2?

**THE CHAIRMAN:**  No, I still want somebody to translate to me what this discussion was about.  Somebody better tell me what is the safety concern here that Dr. McDill and AECL and stuff are talking about.

Is there any safety concern?  I mean, you're showing an "R" in red.  It's reportable.  To me it's a red flag.  So please explain to me in terms of safety language.

**MR. PILKINGTON:** This is Bill Pilkington, for the record.

And again, I won't challenge the discussion that just went on but I would say that -- make the point that for the areas of lack of fusion, as was stated, the structural analysis of the repair took into account that there would be some areas of lack of fusion and so allowances were made in the structural analysis.

So our engineering has reviewed the lack of fusion that was identified and determined that it is well within the allowances in the structural analysis.

So our view would be that the lack of fusion does not pose a safety issue. It's well within the structural analysis that was done.

In the case of the reportable indication on J-rod 23, we do not believe that that feature will grow in service. The stresses in operation are essentially the same as the stresses with the vessel at rest.

However, for that indication, we will go back and re-do the NDE on it to confirm that it remains the same as when it was found and so that confirmation over successive inspections over successive years of outage will confirm that it in fact is not growing and does not present any safety hazard.

**THE CHAIRMAN:** Staff want to comment on this?

**MR. AWAD:** For the record, Raoul Awad.

This is related to the code language. There is three levels. One, what we call recordable, reportable and effective flaw.

When you have effective flaws, we have to shut down and repair. Recordable and reportable that just monitor for the next inspection to see how the evolution of this flaw but there is no safety significance of it. It's almost safe.

**THE CHAIRMAN:** Thank you.

Dr. McDill?

**MEMBER McDILL:** Thank you.

My last question relates to a comment made in Section 4.4, the post-weld inspections, and the figure on page 29, or Slide 29, which is the fitness for service slide? Thank you, that's the one.

You have a comment in the report that says:

> "The only area that could not be inspected was the heat affected zone below the wells."

You're developing a tool and then you comment:

> "The stress field in the vessel is oriented in a circumferential

direction which is along the axis of
small cracks and the lower heat
affected zones so there's no driving
force."

I'm concerned again about local bending. That given, looking at your before and after repair stress field maps, there's no indication here of what these are.

Is this effective stress? Is this hoop stress? Are these deformations? It says "stress fields"; so I'm presuming we have stresses here.

And in the one on the lower quadrant of the image, does that finite element model take into account the total new geometry of the vessel with the welded plates or is it an optimized vessel geometry?

So there's a complex set of questions there. Thank you.

**MR. LESCO:** Randy Lesco, for the record.

So what you see in the lower picture is an actual model of the vessel at repair which includes where we have indicated areas of wall loss from the original vessel. So that is a representation of the vessel after repair.

What you see there is basically a stress field of the local membrane stresses after the repair.

**MEMBER McDILL:** Thank you.

So it includes the full geometry, all the welded ---

**MR. LESCO:** Randy Lesco, for the record.

I just wonder if you could repeat your question, Dr. McDill?

**MEMBER McDILL:** That’s fine. I was waiting for the discussion to -- so you've told me that includes the geometry with the new plates, all the new welds completely, every single one? There's no optimization there?

**MR. LESCO:** Randy Lesco, for the record.

So that basically reflects the as-repaired vessel.

**MEMBER McDILL:** Thank you.

And does staff want to comment on the use of membrane stresses in this application? Effective stress I would have thought was ---

**MR. CARROLL:** Blair Carroll, for the record.

This is only one component of the vessel stress analysis. We haven’t received the final fitness for service assessment yet but we do appreciate your comments with regards to local bending stresses and we expect that the laser profilometry measurements that have been taken before and after welding at these locations will help us determine what the bending stress components are so that they can be incorporated in the fitness for service assessment as well.

**MEMBER McDILL:** Thank you, Mr. Chair. I have only one last question and once again it's the fact that we can’t inspect this area and following up Mr. Graham’s comments, there's a certain nervousness up here on the dais with respect to lack of inspection.

So perhaps you could comment on when will the tool be developed so we can -- so there will be an inspection of that area?

**MR. PILKINGTON:** Bill Pilkington, for the record.

The tooling to do this inspection is currently under development and we will have the tooling available and the qualified procedures available to complete this inspection in our first extended shutdown within the first calendar quarter of 2011.

**MEMBER McDILL:** Thank you.

And staff is satisfied that there is sufficient conservatism that this lack of inspection is not an issue at this time?

**MR. ELDER:** Yes, and that's one of the factors when we came with the nine months is going back and looking at all the information we had and looking for, you know, obviously we are going to when we get the final fitness for service reports within the three months. We'll inform you if any of this changes our opinion but right now we're fully satisfied with the nine months as acceptable.

**MEMBER McDILL:** Thank you, Mr. Chair. That's all my questions for round one.

**THE CHAIRMAN:** Okay. Trying to get round one finished before we take a break.

Mr. Tolgyesi?

**MEMBER TOLGYESI:** Merci, monsieur le président.

When you are looking historically, leaks are closely related today in NRU’s history. The first vessel started to leak in 1957 and then was established that the cause is probably nitric acid.

Was this corrosion due to nitric acid the main reason to replace the vessel in 1970-72?

**MR. PILKINGTON:** It's Bill Pilkington, for the record.

And I believe the replacement took place between 1972 and 1974 and the vessel was replaced because of nitric acid corrosion.

There's a couple of things that could be added. One is that the vessel material for the first vessel was susceptible to intergranular corrosion and the 50-52 alloy of the current vessel is not, and in fact has proven not to be.

And the second thing is that the inert gas in the J-rod annulus $CO_2$ I believe was added with the installation of the second vessel. So I believe the first vessel had air in the space between the vessel and the reflector.

**MEMBER TOLGYESI:** And after replacing the vessel in the early seventies, leaks continued through mechanical seal mainly, that's what you were saying?

**MR. PILKINGTON:** That is correct that leaks in the reflector appeared even in the second vessel within, I think, two years of it being put into service. So there was a design issue with both vessels in that they were susceptible to leaks developing in the reflector. That would be light water leaks.

**MEMBER TOLGYESI:** Was the mechanical seal part of this examination and what are the results?

**MR. PILKINGTON:** Bill Pilkington, for the record.

Could you explain what you mean by the mechanical seal?

**MEMBER TOLGYESI:** But you were saying that there are some leaks through mechanical seal. Do you still have some leaks through mechanical seal or not?

**MR. PILKINGTON:** Okay. Bill Pilkington, for the record.

So the true mechanical seal, there's one at the top of the vessel and one at the base of the vessel and both of those have not had a history of leaks since early in the installation.

However, the reflector has had a history of leaks and these leaks have generally occurred at tubes that run through the water box and into the J-rod annulus. And so these tubes in the reflector have chronically developed leaks and a number of actions have been taken over the years to mitigate these leaks but they have not eliminated them.

**MEMBER TOLGYESI:** You were saying that in 2004-2005 assessment, focus was on corrosion at the upper part of the vessel where the first vessel failed. That was the main reason. It was the upper part.

However, the leakage in the 2009 nondestructive examination is concentrated on the bottom 300 millimetres of 9,000 because it's nine metres height I think.

How could you explain that this wide gap in 2004 assessment and what we find in 2009 because it's the kind of what we were saying that's supposed to be? In

2004, we said it's supposed to be on the upper part the corrosion and what we find that it's quite worse, much worse and it's in the bottom part, which we did not expect probably, or did you?

**MR. PILKINGTON:** So Bill Pilkington, for the record.

From the best of what I have learned that the original vessel failed I believe at the bellows. I think there's a couple of expansion bellows partway up but generally in the higher level or higher elevation of the vessel. I believe those were the areas that were most subject to corrosion on the first vessel and so in the inspections done in 2004-2005, that area was the focus of those inspections.

After the leak occurred in May 2009, we did do a very thorough inspection at the base of the vessel which before wasn't possible. So we have a very accurate map of the lower portion of the vessel, the lower 300 millimetres.

We also did samplings of wells higher up in the vessel and other areas higher up in the vessel including these bellows. So we have done, on a sampling basis, a broad examination of the vessel. However the focus here has been on the area that has shown corrosion and that was the cause of the vessel leak.

**MEMBER TOLGYESI:** What you are saying you are mainly examining -- visual examination and non-destructive examination of 300 millimetres, except of six vertical welds which you scan from bottom to the top or from top to the bottom.

**MR. PILKINGTON:** Yes, so I can confirm that we did do further NDE inspections of the vertical welds in the vessel, and we did do vertical strips over the length of the vessel, but I cannot confirm how many we did.

**MEMBER TOLGYESI:** What you are saying on page 35, "Phase 3, six vertical scans were conducted from the top of the vessel to the bottom circumstantial weld using phase RAUT." So there were six at least.

**MR. PILKINGTON:** Okay, the consensus of recollection is six, but I don't have that as a fact.

**MEMBER TOLGYESI:** And do you have any results of these scans?

**THE CHAIRMAN:** Mr. Elder?

**MR. ELDER:** I won't guess -- of the six. My recollection is it was six as well, but one of the things that was very important for us is they repeated some of the scans they had done in 2004 and 2005, so we could see that there was no degradation between those two scans.

So again, that confirmed that there's not something active happening in the rest of the vessel, only at this corrosion at the bottom. Which was not because of limitations to tools and the time they had to look at was not identified in that 2004-2005 scan.

So it was very important that -- for us, they did two things that were very important. They repeated scans, so they have data from 2004-2005 and again in 2009, and they looked at the welds. There are a number of vertical welds in the vessel, and they looked at those vertical welds as well, which were -- again, because they were a weld, they could be potentially susceptible to a different corrosion.

And again, there was no -- there was just a very minimal -- I say very minimal corrosion -- within the technique you'll get, it’s greater than seven millimetres, between seven and eight, eight being the -- within the uncertainty and the technique there’s full wall.

**MEMBER TOLGYESI:** So you were too fast for me because I was asking for results. I couldn’t find it.

You were saying that in Phase 4 that examination -- you did examination on the walls behind the baffle blocks in the Figure 2.2, but I cannot find; where is this baffle blocks, what you call them?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

It shows quite well on one of the early slides, I think about the third or fourth slide in.

**MEMBER TOLGYESI:** Yes.

**MR. PILKINGTON:** So we’re working on the mouse, so that the structure that you see that is angled ---

**MEMBER TOLGYESI:** Yes?

**MR. PILKINGTON:** --- is a baffle block.

**MEMBER TOLGYESI:** Okay.

**MR. PILKINGTON:** I believe it’s a heat shield in order to reduce radiation heating of the material behind it.

Oh yes, so the Phase 4 inspection, we had to design a probe that had a geometry low enough profile to be able to scan behind the baffle block.

**MEMBER TOLGYESI:** And at page 3.7, you are saying that, "these examinations…" -- you were enumerating them -- "…did not reveal any abnormal thinning in the vessel walls."

What's abnormal and what’s normal?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

I have a limited technical capability to answer that question, but I am aware that on the Phase 4 scans, there was a significant amount of indication that was due to the original welds in the vessels. And so in the data that was taken, the analyst had to look, take into account the -- what they were seeing from the original welds in the vessel and look for abnormalities.

We were really looking for wall thickness and for significant changes in wall thickness, and we identified none at those lower elevations.

**MEMBER TOLGYESI:** And just one in this round, you were talking about thickness of the scoops which were from 0.36 to 3.43 millimetres; 3.43 over 8 is about 42 percent. It’s quite thick, scallop sample.

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

Yes, I believe those would be the depth of the depressions that were produced when the scoops were removed. So the scoops themselves, the samples were thinner by the width of the blade that had to cut them.

Now those scoops were taken, there was actually -- they were taken from areas of full wall of the vessel. And so because of the benign shape of the scoop and because of the wall thickness where they were taken, there was adequate structural strength and corrosion allowance remaining after the samples were taken.

**MEMBER TOLGYESI:** And you know when you are looking -- I don’t know what was the figure -- it's 4.1.

It was in a -- you know, you were showing the spots where you were welding. These 10 -- here, Slide 15.

When you are looking at these colour codes, you know, when you were showing these 10 places where you were welding, there are some next to JR-30, which is close to similar colour as the JR-30, if you consider was the thickness. And why you didn't do any work there?

It's similar to the left on -- the JR-13/17 is a spot. Are some reasons why you didn't do welding there or it's eventually a potential of leakage or corrosion?

**MR. PILKINGTON:** So the strategy was to do repairs in areas that, through the structural analysis, would not meet structural requirements plus corrosion allowance or that had a leak existing.

So in JR-41 where we had both, a leak and a coupon removed, the repair was obvious.

But when you look at some of the other areas, unfortunately, the strips are not blown up that large, but you may see very small areas of very deep penetrations.

As I showed in the samples that I had, the general scalloping that occurred from the general corrosion mechanism really was an issue in few sites. The other issue of deep pockets or deep penetrations was, I guess, the main reason for needing to do repairs.

So when you look at those sites, every area that we did not repair has sufficient material for structural -- to meet structural requirements and to have an adequate corrosion allowance.

And so the mitigating strategies that we're taking to arrest corrosion will prevent those from ever reaching the point of requiring repair.

**MEMBER TOLGYESI:** My last is just -- tell me in the future -- now, you have all these technologies to measure the thickness -- what is the minimum thickness, what you will reach, you will act to make sure that the vessel is safe; six, four, three millimetres?

**MR. PILKINGTON:** Bill Pilkington, for the record.

I believe that the minimum thickness is not an absolute but is a function of the stress at every location on the vessel.

So we will take measurements of the wall thickness going forward, and we would put those into our stress analysis to determine that we still have full structural integrity and sufficient corrosion allowance for whatever the next operating interval would be.

**MEMBER TOLGYESI:** Okay, thank you.

**THE CHAIRMAN:** Dr. Barriault?

**MEMBER BARRIAULT:** Thank you, Mr. Chairman.

First of all, I would like to comment also really on the fact that it's been a very interesting, fascinating engineering process for me to follow during the repair of this vessel.

However, I often wonder really whatever happened to the person that you had responsible for corrosion management. Does that function still exist?

I understood from previous presentation that you had a person responsible for monitoring the corrosion in this vessel during its operation; is that correct?

**MR. PILKINGTON:** Bill Pilkington, for the record.

That would not be entirely correct, and one of the challenges we faced as an organization is accepting conditions, equipment conditions, that really should be brought to the attention of the organization.

And so we have world-class corrosion experts and we've in fact brought them into play in dealing with this issue. However, the people that had the corrosion knowledge and understood the consequences didn't have the information to tell them that there was a corrosion issue in the vessel.

**MEMBER BARRIAULT**: So -- I'm sorry.

**MR. PILKINGTON:** I would just say that the staff who were working with the vessel didn't recognize the risk that this corrosion presented.

**MEMBER BARRIAULT**: So were these people involved before this problem, or after the problem appeared?

**MR. PILKINGTON:** So our corrosion people would have been involved in the condition assessment that was done in 2004-2005. I believe they have not been involved in general ongoing corrosion monitoring in the vessel that contributed to the condition assessment that was done.

**MEMBER BARRIAULT**: With the change in management culture, do you see an involvement of these people at the onset?

**MR. PILKINGTON:** So the organization that we are moving to is one where our operating and maintenance staff will not accept low standards of equipment condition and where anything that appears to be of a low standard will be raised to the attention of the organization for disposition.

And that's the way that the people who understand the science of the corrosion will be brought into the loop as a part of the overall health monitoring of the NRU systems.

**MEMBER BARRIAULT:** If I can -- I’m sorry.

If I can ask the same question of the CNSC staff -- are you comfortable that all of the reactor vessels out there do not have corrosion problems?

**MR. ELDER:** In terms of this type of corrosion, you’ve got to understand this is a research reactor. It’s actually a unique research reactor in terms of having aluminum vessel.

**MEMBER BARRIAULT:** I understand that.

**MR. ELDER:** Yeah.

**MEMBER BARRIAULT:** But there are other vessels out there.

**MR. ELDER:** There are other vessels out there and they -- I’m going back into the power reactor. They’re much more -- they’ve always had more defined inspection programs based on the higher risk systems, the high-pressure systems and high-pressure, high-temperature systems.

And as I said there has been a structured program. If there has been a -- from our perspective on this one is how you translate those down into a low-pressure system. We’re looking at -- you know, certainly we’ve figured out how NRU going forward has to have in-service inspection.

What we’re looking at what does this mean for other systems. We have no other reactors. We have no indication of a problem but in general how would you approach it differently so you would not develop this problem in another one. So we are looking at that.

**MEMBER BARRIAULT:** Okay. So what I'm hearing then is that you're not completely comfortable at this point but you're going to look into it.

**MR. ELDER:** We are comfortable where we are but we want to make sure that we don't end up down this road 10 to 15 years in the future with something else.

**MEMBER BARRIAULT:** Thank you.

My next issue to the CNSC staff is with Slide 19. It's mentioned -- and you don't have to look it up -- what it mentions in there is that there was no safety issue to the public with this reactor and I would like to beg to disagree with that.

And the reason why I disagree is because I think that the shut down of isotope production created a safety issue with the public in Canada and internationally for that matter. But we won't belabour that one.

A few medical questions really -- during the repair of the vessel, did you have any work-related injuries or lost time injuries?

**MR. PILKINGTON:** It's Bill Pilkington, for the record.

And we did have -- we have had lost time accidents on site. I believe over the space of the outage we have had a total of four. I'm not pleased with that as our record of performance. However, I would point out that as a site, our lost time accident rate actually decreased in the past year over the prior year. But again, we're continuing to focus on safety and improving that record.

**MEMBER BARRIAULT:** So we did have some safety issues to the public, I guess, or to the workers, for that matter.

And the next point really is that you mention that you're going to have isotope production in early July. Do you have a date on that, or am I wrong in assuming this?

**MR. PILKINGTON:** I'm sorry. We were saying that we expect to ship isotopes by the end of July.

**MEMBER BARRIAULT:** By the end of July. Okay.

On that same point, the cost to repair is 150 million, if I understand correctly a while ago. Will that cost be passed on to the health, I guess, management of this country with the increase in costs for isotopes or will you just absorb that cost?

Or is that confidential information?

I don’t want to get into ---

**MR. MACDIARMID:** Hugh MacDiarmid, for the record.

Basically we’re -- we have a combination here of a commercial revenue stream from the sale of isotopes ---

**MEMBER BARRIAULT:** Exactly.

**MR. MACDIARMID:** --- and we forego that -- we have foregone that for the past year and it will be resumed.

But we simply bring those revenues in as part of our normal commercial arrangements, commercial contract, and then when it comes to unanticipated expenditures such as this, we do need to seek additional funding from the government which is done through the annual cycle or supplements as necessary.

So it will -- the additional costs that were not built into our original plans are indeed being borne by the government.

**MEMBER BARRIAULT:** So I guess what I’m hearing is that we’re not operating on a cost-recovery system. We’re operating on a subsidized system to the health industry, no? Am I correct?

**MR. MACDIARMID:** I think I’d -- rather than judging it I’ll simply say that we operate within our contract and the contract does provide for the recovery of some of our costs.  But again we've been rather clear that if you were to look at the full costs of producing isotopes, they're substantially greater than the revenues we generate.

**MEMBER BARRIAULT:**  Okay.  And I guess I'm not going to ask if in the future you want to change that. I'll leave that alone.

Next question really -- the repair to the vessel.  What do you think is the life expectancy of this or do we know at this point?  Or perhaps it's all unknown at this point.

**MR. PILKINGTON:**  It's Bill Pilkington, for the record.

And so we have provided a repair that meets the structural requirements and provides for some corrosion allowance.  And so our success at fully arresting corrosion essentially will determine the life of the vessel.

So we believe that through the mitigating strategies that we have in place and the additional strategies which we will be implementing, we will be able to show the vessel fit for service through its expected life.

**MEMBER BARRIAULT:**  And what is the expected life?

**MR. PILKINGTON:** So the target in the repair program was to assure a vessel life beyond 2016, likely out to beyond 2021.

**MEMBER BARRIAULT:** Okay, so we're looking at about another 10 or 11 years, I guess. Yeah.

We mentioned earlier that you were going to look at sacrificial aluminum coating to prevent, I guess, galvanic action in the future or to prevent problems with corrosion. Do you care to expand a little more on that? How do you propose to do that? Is it a lining that's going to be placed inside the vessel or is it just paint, or what is it?

**MR. PILKINGTON:** Okay. It's Bill Pilkington, for the record.

And so cold spray is a technique by which essentially pure aluminum is sprayed in very fine particles at very high velocities, I think using helium as a carrier gas. And it actually mechanically welds to the surface that it's sprayed on.

And so we actually just completed within the last week a factory acceptance test of a process that proved very very positive. It's able to apply coatings up in the range of three to four millimetres onto a wall with good adhesion and provide excellent coverage. So we see this as a very likely -- a good candidate for part of our mitigation program going forward.

**MEMBER BARRIAULT:** Thank you.

That's all for now, Mr. Chairman. Thank you.

**THE CHAIRMAN:** Thank you.

Just a couple of observations. First of all, the one thing that really surprised me that -- to learn that there was not an extending shutdown since 19 -- a planned extended shutdown since 1991, if I got it right, which the two organizations -- I cannot understand how that was allowed to go on because I thought you do need some relief from operational pressures to take like a very good look, in a more fundamental way at the vessel.

And I'm happy to see that, from now on, it'll become a general practice which I assume was a good management practice to all nuclear kind of facilities internationally.

Am I -- am I correct about that?

So you care to comment on this, AECL?

**MR. PILKINGTON:** It's Bill Pilkington, for the record.

And so it is normal nuclear utility practice to take shutdowns on some period and, in fact, nuclear utilities are finding that they can extend their operating intervals between shutdowns.

However, there does normally need to be a maintenance shutdown and one that allows for the implementation of improvements to the plant on some frequency.

And so, operating the NRU on the cycle I believe that was actually a shorter cycle than 28 days some years ago but this allowed for only very short intervals to carry out maintenance and inspection.

So certainly, as the NRU has aged, the benefit from taking extended shutdowns on some frequency has also increased and so we see that as the optimum path for safety and reliability going forward.

**THE CHAIRMAN:** I understand you -- it’s just probably a situation where the isotope production, pressures, may have driven -- I think, I’m guessing, may have driven you guys to try to do everything within five days but I’m surprised that the regulator, us, didn’t insist on a little bit more extended shutdown so you can take a look at a more profound way at the systems and what’s wrong with them.

So I don’t know if you care to comment on that: do you?

**MR. JAMMAL:** If you want me, sir, I will comment.

It's Ramzi Jammal, for the record.

The safety is our responsibility, the operation is the responsibility of the operators. So as long as there were no indications with respect to the safety and the corrective action plan that was done with respect to the self-assessment conducted by AECL and the inspection that we've carried out ourselves with respect to corrective action plan that highlighted exactly to what you were saying, that the isotope production trumpeted any of the operation's perspective.

But we lived through the safety components, the verification of safety and were able to manage with respect to the balance, the fact of the isotope production and the safety.

**THE CHAIRMAN:** Thank you.

We've moving to a little bit more positive thing. I'm still amazed at the technology that AECL developed and, in fact, my question is now you have now developed the capacity to fix this vessel forever and ever.

What is the meaning of "end of life" here if you can actually keep welding?

I'm sure Dr. McDill will have a point of view on this. There must be a limit somewhere but, I mean, what is the limit if you can actually keep on fixing it?

And if you are able to actually do the fixing from outside, you don't even have to drain this machine, so what is the meaning of how long you can keep the machine running?

**MR. PILKINGTON:** It's Bill Pilkington, for the record.

And I might just go back because I didn't mention when I spoke of cold spray that that would be applied to the outside surface of the vessel from the J-Rod Annulus.

I guess the challenge here is that it would not be cost-effective to remove the fuel and the heavy water from the vessel on a periodic basis to do more extensive repairs. And, with the stresses induced in the vessel, there certainly are limits to the amount of repair that can be done.

So first of all, I don't believe the vessel has an infinite life. I believe that we can show it fit for service for many years into the future.

But the other thing is that -- that NRU is now, I think a 53 year-old reactor and so there's more maintenance required, there's more obsolescence issues to be faced, there's more gaps between current standards that need to be addressed.

And so, in licence renewal, we're investing in assessing the improvements that will -- need to be made in the next licence interval and there will be significant cost involved in making those improvements.

So at some point in time, you know, the investment required to continue to operate would exceed that, that would be -- make good business sense, I guess.

**THE CHAIRMAN:** My last question then, it's -- I think I asked you that question previously: So you stand by your decision about not replacing the vessel but rather keep on repairing it?

**MR. PILKINGTON:** So I have heard from some quarters the question raised on whether it would have been a better strategy to replace the NRU vessel with a new one and the main driver for the strategy that was taken was to minimize the duration that the NRU was unavailable for isotope production.

So we will have been out of service for 13 to 14 months by the time we return to isotope production and the time to acquire and install a new vessel would have been in the order of 48 months or more.

So the real driver for that decision was to minimize the time that NRU was unavailable as opposed to looking for a solution that would allow for the longest life extension.

**THE CHAIRMAN:** Thank you.

I think this is a good time to take a break for about 10 minutes -- until 5:30.

Thank you.

--- Upon recessing at 5:17 p.m.

--- Upon resuming at 5:32 p.m.

**THE CHAIRMAN:** Okay, we are now moving to the interventions.

We have one oral presentation and three written submissions, so I would like to start with the oral presentation by the Canadian Nuclear Workers' Council as outlined in CMD 10-H12.2.

And I understand, Mr. Shier, you're going to make the presentation. Please carry on.

**10-H12.2**

**Oral presentation by the**

**Canadian Nuclear Workers' Council**

**MR. SHIER:** Thank you.

For the record, my name is David Shier; I'm the President of the Canadian Nuclear Worker Council and with me today is Mr. Gabe Peplinski and Mr. Gordon Tapp.

Mr. Peplinski is a representative from the Power Workers Union at AECL's Chalk River site and represents the operators and Mr. Tapp is the President of the Chalk River Technician and Technologists Union; and both Mr. Tapp and Mr. Peplinski both actually worked on the repairs at the NRU.

The Canadian Nuclear Workers’ Council is a council union to represent members working in the Canadian nuclear industry and the majority of the union at AECL are members of the council.

I should point out that the other unions at Chalk River Laboratories have had input into our submission and are in full support.

Our presentation will be non-technical but we believe that is important that the Commission and the public hear the views of the workers that were involved in this endeavour over the past 14 months.

And we are here today to request support for AECL’s request to restart the NRU Reactor and our presentation will be brief.

Workers at AECL/Chalk River have naturally been fully engaged in the rehabilitation of the NRU. During the past 14 months of work at this site, I've had many challenges, changing work environments, et cetera during this project.

Many workers were brought in from other facilities on-site to assist the NRU work and this created a need for training and safety orientation for many of these workers. Many workers required many additional hours to complete this work.

Fortunately, during this period, there were -- or unfortunately, there were four lost time injuries but only two of them would be related directly to the actual NRU rehabilitation.

During maintenance and repair at nuclear facilities, there is a tendency that worker radiation dose increase. During the NRU work, no worker received a dose above the regulatory limit.

It needs to be pointed out that workers at Chalk River have been under an extreme pressure during this period. There was the issue of concerns for their livelihood as well as the fact that NRU and medical isotopes have and are still big news. The public is now aware of the location of the Chalk River Laboratories and these workers have been required to answer many questions from family, friends and the public.

Union leaders from Chalk River are constantly being asked questions at labour events that they attend, and their answers to these queries were always optimistic that the NRU would be repaired and would return to service.

The workers at Chalk River live with their families in the vicinity of the facility, and you can be assured that if there were any safety issues in regard to the NRU, that the on-site unions would bring them to the forefront.

The workers at the Chalk River site are very proud of their work in the repairs of the NRU over the last 14 months. The Canadian Nuclear Worker Council is of the opinion that the repairs to the NRU are complete and AECL meets all requirements for the reactor to be operated safely.

We therefore urge the Commission to approve the start-up of the NRU as requested. We will naturally be happy to answer any questions you may have. Thank you.

**THE CHAIRMAN:** Thank you. The floor is open. Questions? Mr. Graham?

**MEMBER GRAHAM:** We heard from AECL's presentation that there have been improved standards of operation in the last year. Would you mind giving us an overview of what those improved standards have been in operation at AECL?

**MR. SHIER:** I'll ask Mr. Tapp or Mr. Peplinski to -- and they are right from the site to comment on that.

**MR. PEPLINSKI:** For the record, Gabriel Peplinski.

Training is ongoing. There's training to re-introduce us to courses and jobs we haven't done since we've been shut down. Ongoing new programs are trained up. It seems like, not in a bad way, but we're always shuffling our staff around in the training courses, so we can get the training done as well as do the work; so it is an ongoing process and it's very intense.

**MEMBER GRAHAM:** Can you give us a little overview of those new programs that you refer to of what new programs have been initiated and also what improvements have also been done with regard to leadership and oversight?

**MR. PEPLINSKI:** The event-free tools have been introduced in the past couple of years and a refresher periodically is a standard. Radiation protection courses too for all the non-radiation workers, so we can monitor situations ourselves a little more closely. Just normal training and safety is part of the regimen as well now.

**MEMBER GRAHAM:** Were radiation production courses not in place before?

**MR. PEPLINSKI:** We were -- had Group 3 training but now there are certain parameters that we can do on our own in a Group 2 course. So up to a certain level, we can monitor ourselves, monitor the work station and if it's above that, then we have to get radiation protection support to help us.

But it streamlines the process a bit because if there’s certain jobs that past practice shows that they're not rated really high contamination areas, we can go ahead and do them without slowing the worker, drawing people from other work areas.

**MEMBER GRAHAM:** Have you seen a change in the resources with regard to program improvements?

**MR. PEPLINSKI:** The dose rate is down per year. We have tritium masks for work in our rod bays, our tritium dose intake is down. We’re working on rod bay improvement. We have meetings ongoing about that in order to clean it up to make it -- that was one of the major dose areas before.

There was very little dose actually taken by anybody on top of the reactor because all of the reactor was de-fuelled and if we were over on an open position, there was a beam. But other than that, it was a very, very clean area and periodically it was wiped up and mopped by RP support.

**MEMBER GRAHAM:** In AECL’s presentation they talked about reinforcing strong organizational behaviours that, e.g., questioning attitudes, et cetera. Had there been a problem with regard to attitudes in the past?

**MR. PEPLINSKI:** Not so much a problem but maybe more complacency by the workers somewhat. I don't want to pick on us, but we just got a reinforcement that we, you know, we have to -- continually upgrade ourselves as well and be aware of what goes on around us a little more.

**THE CHAIRMAN:** Just on that point, there is no -- let me use maybe indelicate language -- there's no fear about reporting something that workers feel should be reported and fixed or taken up the line?

**MR. TAPP:** For the record, I'm Gordon Tapp.

Right now, we have a process in place called the impact system where if somebody sees something that's out of the ordinary, whether it's safety related or not, they can immediately put this into the system and it's brought to attention of the appropriate management, and management reviews it and then it's brought up the line.

If it's of safety concern, of course, the Site Safety and Health Committee, which is run jointly by management and union, is always there where these issues can be brought up and there's been no retribution. I don't think there's any fear of retribution to bring any important item of significance up.

**THE CHAIRMAN:** Thank you. Dr. Barriault?

**MEMBER BARRIAULT:** Over the last year or two, have you had any work stoppage for what's considered an unsafe worksite?

**MR. TAPP:** For the record, Gordon Tapp.

No, I don't believe we have any records of work stoppage or work refusals that have been brought forward to the Site Safety and Health Committee.

**MEMBER BARRIAULT:** Would these four work related injuries that you've had on shutdown, and I don't want to get into personal medical history, but is there anything that could have been done to prevent these injuries?

**MR. TAPP:** For the record, Gordon Tapp.

For two of these injuries, I was actually the Site Safety and Health Committee person that investigated it for the Hazardous Occurrence and Injury Report. For a lot of them it's attention to detail; you know, you saw the pictures of how congested the top of the reactor was. One of the injuries happened up there where a person twisted her ankle. It's as simple as that. And it's just because it's a little bit of a hazard. I know when I went up to investigate it, you had to step-stone around things.

And the other injury that I was aware of, down the rod bays again, it was a moment of inattention and people made assumptions. A minor injury occurred but overall usually the level of awareness once these things happen is raised and factors put in to mitigate future incidents.

**MEMBER BARRIAULT:** Thank you, Mr. Chairman. Thank you.

**THE CHAIRMAN:** Thank you very much.

The next intervention is a written submission from Ms. Darlene Buckingham as outlined in CMD 10-H12.3.

**10-H12.3**

**Written submission from**

**Darlene Buckingham**

**THE CHAIRMAN:** Any questions? No question? Okay, I'll have a little kind of observation.

On the second page, this is really something that I'm sure maybe, Dr. Barriault, you'll have a view on.

The second paragraph it starts,

> "Now what about radioactive isotope used for medical purposes? This has been blown up and distorted by the medical profession as saving lives."

You want to say something?

**MEMBER BARRIAULT**: I think you're asking me a question; are you? Yes.

**THE CHAIRMAN:** What I’d like to hear is AECL. Would you like to react to this?

**MR. PILKINGTON:** Bill Pilkington for the record.

And no, Dr. Binder, we do not have a comment on that.

**THE CHAIRMAN:** Anybody else has any other observation or question?

Okay, thank you.

The next submission is a written submission for Ms. Jennifer Tsun as outlined in CMD 10-H12.4.

**10-H12.4**

**Written submission by**

**Ms. Jennifer Tsun**

**THE CHAIRMAN:** Mr. Graham.

**MEMBER GRAHAM:** A couple of questions and I know one of them was answered already today with regard to after the earthquake inspection. And I guess the intervenor on the top of page three brought up the subject of spent fuel dry storage silos and dry casts. And you do have a lot of tile holes with storage -- tile storage, I believe -- on site.

Have those been inspected also after the earthquake to see that there was no damage?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

And our waste management areas were inspected following the earthquake and no damage or abnormality was identified.

**MEMBER GRAHAM:** So not only -- we’re not only talking about the reactor; we’re talking about all of the facilities on site whether it be storage tanks, underground storage of waste, and so on. Those have all been inspected?

**MR. PILKINGTON:** Bill Pilkington, for the record.

And that is correct. There was a broad inspection of all of the facilities at the Chalk River site carried out.

**MEMBER GRAHAM:** The only other question I had with regard to -- and it was with regard to earthquakes and so on and you gave the observation somewhere that -- and I had it somewhere here with regard to the size of an earthquake and what the readings were on site and so on.

And the largest it's been or the plant has been designed for, I believe, .24 if I have that correct? And the largest that’s ever been in that vicinity was a .25? Am I correct on that or I find my notes here somewhere.

Would you like to comment on that with regard to the size of a seismic event?

Yes, the plant was built to a seismic event of .24 Gs. At chalk River, the last one that we just had the other day was a .006 G measurement at Chalk River, but there has been no historic record in that area of more than .07.

But they are -- the design is -- pardon me, the earthquake at the epicentre was a .14, I believe, in Quebec where the epicentre was, which is significantly higher than Chalk River. But you go on to say that no historic observations of an earthquake in the vicinity of Chalk River of that magnitude -- but there have been up to .25. And in it’s 1 in 1000 years it would be a .25 -- I believe that’s what you’re saying.

My question would be -- is 1 in 1000 is significant. It’s a long time away but as my colleague always uses the comparison, the Ocean Ranger was 1 in 1000 also. And it happened. So I’m just wondering about -- if the epicentre was right at Chalk River and it was a .25, I know you have automatic shut downs, but what damage would that cause to the reactor?

**MR. PILKINGTON:** It’s Bill Pilkington for the record.

And I do not have very strong knowledge on either the seismic history in the Chalk River area or the details around the seismic design. So I do know that there has never been an earthquake in that area recorded near the design basis of .25 G and that is the earthquake that the plant was designed to.

And so under that condition I believe that the plant would be safely shut down and that the fuel would be cooled essentially indefinitely. I do not believe that one could conclude that the structures would remain operable as a reactor going forward. But the plant would be in a safe state following a seismic event of that magnitude.

By the way, I appreciate that you corrected the fact that the seismic activity on the recent earthquake was .006 G. When I was making my presentation I left out a zero.

**MEMBER GRAHAM:** Correct -- 006 is what it was but it was 014 -- 0.14 at the epicentre which was 100-and-some kilometres away. But if the epicentre had been closer, it would have been higher.

I understand we have Emergency Measures Ontario, Mr. Chair. I just wonder if they have any comments or anything to add with regard to their concerns with regard to earthquake or seismic activities in the vicinity of Chalk River in view of the fact that the last one that was several weeks ago was a 0.14 which is significantly high. It’s up almost to what your design is for the whole plant.

Emergency Measures Ontario here?

**MR. MORTON:** Thank you for the opportunity. For the record, my name is Mike Morton. I’m a deputy chief with Emergency Management of Ontario. I am joined by Dave Nodwell who is our manager for planning and exercises, and Kathy Blyer who is one of our senior nuclear planners.

In terms of the impact of a seismic event, we really plan overall for the effects of any event that might cause offsite consequences so regardless of what the cause is, we look really at what would be the worst accident that could occur. And in terms of the Chalk River facility, we’re looking at the loss of coolant and also a subsequent failure of the emergency cooling system which would result potentially in some sort of offsite release of radiological material.

And that would then, in accordance with the provincial Nuclear Emergency Response Plan trigger a protective measure depending on the offsite dose ranging from sheltering, which is by far more likely than the others which would be evacuation or KI administration.

**MEMBER GRAHAM:** Are you satisfied that AECL have a sufficient plan in place for seismic activities or, I should put, for all possible accidents? Are you -- is the Emergency Response Plan filed with you and are you satisfied that it's sufficient to meet all the needs at Chalk River?

**MR. MORTON:** Our primary concern is with plans that would be in place for the offsite response, so primarily looking at the plans that would be filed by Deep River, Laurentian Hills which should be the municipalities potentially impacted.

Those plans were last exercised in 2007 and are currently undergoing some upgrading and review. We are confident that we can respond effectively to an incident at the provincial level and over the next months we'll be working very closely with the facility and the municipalities to put forward an updated version based on lessons of that exercise to ensure that we are indeed at the best possible programmic level in terms of international practice for emergency management.

**MEMBER GRAHAM:** Would CNSC or CNSC first or

AECL care to respond to first of all the revisions to the 2007 plan and how that -- the new plan that's under review -- how that new plan will correspond with other emergency response plans for other bordering communities at other nuclear facilities?

So I guess what -- it should maybe be the AECL first.

**MR. WHITE:** Andrew White, Chief Regulatory Officer and General Manager.

We have our own emergency preparedness program onsite and that program takes into account a broad range of possible threats to the site, including things like earthquakes or major failures of systems, and these plans are exercised on a regular basis and I believe that they interface with the communities and the EMO. So I think that our plans are robust and would deal with any of these types of circumstances.

**MEMBER GRAHAM:** The question was how are you responding to the 2007 update that was referred to by Emergency Preparedness? Are you preparing one and when will it be available and when -- how much different will it be and so on?

**MR. WHITE:** Andrew White for the record.

These updates are primarily with the communities, so we would interface with the communities and aid them in their updates. So our plan is really in terms of how we interface with the communities in their updates and so we are working with them as they work on their updates right now.

**THE CHAIRMAN:** I can't resist. I got you -- we've got you in front of us and I want to ask a little bit a general question and that is the role of alerting the citizens that there's an emergency. I'm talking about sirens. Now, we used to have sirens -- you guys are too young to remember World War II sirens.

We discontinued them but now I'm told that -- I thought that was an agreement that in certain communities in a certain situation, you should have sirens. Now, is that true in all facilities; would it apply to Chalk River, Deep River? What is your view about sirens and do you enforce them or not?

**MR. MORTON:** Under the provincial nuclear emergency response plan, which was recently upgraded and then subsequently approved by the Ontario Cabinet in 2009, we set standards for public alerting. So rather than outlining the specific methodology for meeting those standards, we stated in the current nuclear emergency response plan that the communities must be able to alert those both indoors and outdoors of an incident within 15 minutes.

For the area around Chalk River, and it's a nine kilometre zone from the site, the indoor requirement, we are indeed satisfied with; there's a phone dialing system.

The outdoor system currently relies on going through communities with vehicles that have PA systems. One of the things that we are looking at following the exercise of 2007 and the current revision to the plan is whether the community can go further to guarantee that that outdoor requirement can absolutely be done within the 15-minute standard.

There's currently some question following the exercise of whether it can be carried out in the exact 15-minute timeframe and, as a part of this planned review, we want to make sure with complete satisfaction that the people who may be outside at the time of incident would not -- who would not potentially receive a phone call, can be made aware.

Certainly, looking at sirens would be one of the methodologies that I'd imagine they would want to look at in reflecting on that standard.

**THE CHAIRMAN:** Just by way of information, our little exercise, does the Can-seismic thing prove that the so-called priority phone line did not work; they were jammed? So the 15 minutes as standard to reach citizen is a very high standard, and I'm not sure we figured out how to do it properly yet.

**MR. MORTON:** From a -- from the perspective of Ontario, we certainly want to make sure that without a doubt, that standard can be met within 15 minutes and, again, I think that's a very important line of discussion for the reissuing of this plan over the next months.

**THE CHAIRMAN:** Thank you. Mr. Graham? Anybody else? Dr. Barriault.

**MEMBER BARRIAULT:** My question is to AECL. In this presentation, the comment was made that a rad-waste incinerator is in operation at Bruce and one is proposed for Chalk River. Now I don't know if that's going to deal with the NRU Reactor at all, and that's what we are dealing with.

But could you comment on what a Rad-waste incinerator is? I would assume it's something that burns contaminated clothing, radioactive material.

**MR. PILKINGTON:** Excuse me, but could you clarify where that appears in our presentation?

**MEMBER BARRIAULT:** It's not in your presentation; it's the presentation that was made by this intervenor a few minutes ago ---

**MR. PILKINGTON:** Okay ---

**MEMBER BARRIAULT:** --- that we are talking about now.

**MR. PILKINGTON:** Okay, so we are not aware of any plans that AECL has to go forward with construction of an incinerator.

**MEMBER BARRIAULT:** Okay. Thank you.

Does CNSC want to comment on this because it comments on the fact that it releases radioactive material into the environment.

**MR. SANTINI:** This is Miguel Santini for the record.

No, we don't have any -- AECL does not have any incinerator and we haven't seen any plans from them either.

**MEMBER BARRIAULT:** Does Bruce have one?

**MR. SANTINI:** I'm not aware of the Bruce site waste facility -- not to our knowledge, I'm told.

**MEMBER BARRIAULT:** Thank you, Mr. Chairman.

**THE CHAIRMAN:** Well I'd like to follow up on this.

This intervenor makes some interesting statement maybe -- that you know, somebody got to count here.

First of all, plutonium from Russia -- this is -- I'm talking at -- I don't know, there's no page number but if you look at the -- I think the second page, it says that the growing piles of nuclear waste includes weaponable plutonium shipped from Russia in the U.S. and stored underground.

Anybody can comment? I wasn't aware that you guys received plutonium from Russia.

**MR. PILKINGTON:** So again it's a topic that we didn't come with a lot of knowledge, but I do understand that there have been experiments done in the past with finding ways to downblend reactor grade -- sorry, not reactor grade, weapons grade materials in order to turn it into reactor fuel. And so there may have been experimental amounts of these materials used at Chalk River but certainly no significant quantities.

**THE CHAIRMAN:** Mr. Graham?

**MEMBER GRAHAM:** I believe we have been briefed before that you had 25-kilos or something had been shipped on two different occasions back a number of years ago for some tests. That was reported, made public but I'm not sure whether that has been used or disposed of, but it was a very small quantity and I think if I check my records, it's about 25 kilos.

**MR. PILKINGTON:** Bill Pilkington for the record.

And I'm afraid I cannot comment on specific quantities simply because I do not know.

**MR. SANTINI:** Miguel Santini for the record.

There have been very small quantities of plutonium shipped from weapons from Russia that were used for experimental MOX fuel, but those were in the order of grams -- grams, yes.

**MR. JAMMAL:** If I may, to put it in perspective here, this is the amount of MOX that was shipped is the equivalent of a plutonium to be used in a pacemaker in the old design.

**10-H12.5**

**Witness Submission from**

**Bill MacCallum**

**THE CHAIRMAN:** Okay. Thank you. Anything else on this one? Thank you very much.

The next witness submission is from Mr. Bill MacCallum as outlined in CMD 10-H12.5. Questions?

He makes a statement in the first paragraph here that "while NRU can produce 30 percent of the world requirement, it has the capacity to provide 100 percent of isotope requirement."

Is that true?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

And certainly in the past the NRU has had the capability to meet the full global demand or I would say that demand has grown to the point that, at this time, on a steady ongoing basis, NRU would not be sufficient to meet full world demand.

**THE CHAIRMAN:** Anything else?

Okay, thank you.

So this concludes the questions regarding interventions. So we're now going into the second round and Mr. Graham, you've got the floor again.

**MEMBER GRAHAM:** Just a couple of questions.

First of all to CNSC, this is not -- there's no licence attached because this is not a licence renewal but are there licence amendments or are there -- because there is going to be some -- I read in different places about licence conditions that would be put in place.

I'd like you to comment on licence conditions but I'd also like you to comment on: Is AECL operating under your new handbook procedure and are these conditions put into the handbook in that way?

**MR. ELDER:** Peter Elder, for the record.

We're not, at this time, have identified any changes that have to be done to the licence.

So part of the reason for the approval today is they wanted to do something that was outside their licence; this is to bring them back in.

There are some ongoing -- we mention in a couple places about new procedures.  There's a general requirement that'd licence them to follow those procedures, so they are captured.

For licence renewal next year, we are working on the handbook and, if we identify going forward, in terms of -- on the corrective action program or when we get the final fitness for service report that there are licence conditions that we need to add before licence renewal, we'll bring that to you at the updates that we're planning.

But we don't have anything that has to be changed today; it's really to make sure that, before they restart it, they were back within the licensing basis.

**MEMBER GRAHAM:**  Thank you.

My other question -- my only other question that I had at this time -- well, I guess I had two.

The first one is with regard to the rods and the defective fuel and the defective fuel comments:

"… and AECL disassembled and inspected 10 of 28 suspected rods as part of initial investigation.

AECL found splits in the aluminium cladding …”

which we saw today in the overviewsi

“… of two of those suspended fuel rods.”

Two of ten is about 20 percent. Why were not all 28 inspected?

Or have I not got the right context of 10 versus 28 and so on?

And that would be to AECL.

**MR. PILKINGTON:** Okay, it’s Bill Pilkington, for the record.

We did, in fact, initially inspect the 10 which we believed had the highest probability of having defect elements and, following that, we did disassemble and inspect four more.

So in essence, we have inspected 14 of the rods.

I would point out that we would see diminishing return because we’ve gone from the most probable rods towards the less and that, in keeping with ALARA, there is significant dose expended in disassembling these rods to be examined.

**MEMBER GRAHAM:** Okay, so you’ve done 50 percent of them, 10 to 14, 14 of the 28, and you say it’s a diminishing -- we just hope that there won't be a significant development report in the months to come that there were found to be another defective rod.

In reading that, it more or less indicates that you still have those rods in stock. Why would they not have been sent back to the -- as defective, sent back to the manufacturer as non-useable?

Why would you -- why would you keep any of them and not demand a whole new batch?

**MR. PILKINGTON:** So it's Bill Pilkington, for the record.

And they, effectively, have been sent back to the manufacturer because the manufacturer is AECL.

However, from the point of view of disposing of them, they are quarantined, they will not be used and we'll have to look at the most effective way of recovering the materials.

**MEMBER GRAHAM:** Thank you. I didn't realize that.

The other -- the only other question I have is with regard ---

**THE CHAIRMAN:** Before you leave this, I still want to hear somebody tell me what are the safety issues, if any, with operating with this defective fuel bundles.

**MR. PILKINGTON:** Bill Pilkington, for the record.

And I will give a position from AECL in that small defects of this type do not represent a significant safety issue.

However, we have just put a full charge of new moderator water into the reactor to reduce the tritium and we've reduced the tritium by a factor of 10 which is -- has a very positive impact on both staff exposures and also on releases to the environment.

The existence -- the continued existence of defects in the reactor does release radionuclides into the coolant and, once released, these nuclides take a significant amount of time to remove.

And so they increase the radiation fields in the facility and, as I said, once released it takes a significant amount of time to bring the coolant back to the very low activity levels.

So, really, the issue here is around ALARA, it's around minimizing worker dose and it's around maintaining a clean reactor for operation and maintenance.

**THE CHAIRMAN:** So to staff, you're going to -- what's your proposal to -- if this problem kind of fix according to some timeline that AECL puts forward?

**MR. ELDER:** Peter Elder, for the record.

There are two things we're looking at: obviously, they have to complete their investigation on the cause and make any changes that -- in their fuel manufacturing side.

The other one we've required them to do is put in a defined procedure for how they will deal with potential defects that they identify.

So a more strict monitoring of their coolant chemistry and then defined actions about what will they do when they find something to make sure they are dealt with before they become any sort of risks to any of the workers.

So it's an extra barrier to make sure that they identify and remove the defect fairly quickly, in a timely -- but there's no immediate concern here.

This is again something that we want to make sure there wasn't a widespread problem that would cause a problem immediately after restart and that they have then procedures in place to make sure they don't get into a problem where there are increased doses to workers for doing routine maintenance or other things.

**THE CHAIRMAN:** Okay, thank you.

Mr. Graham?

**MEMBER GRAHAM:** The question I had was with regard to the vessel. Your indication of the present, just before we took a short break, was four years for a new vessel.

Four years from the time of ordering it ‘till it was installed; but if there was one on order and it was planned, my understanding is about two years; is that correct?

**MR. PILKINGTON:** That’s Bill Pilkington, for the record.

So that’s a very rough approximation but I would agree that that’s -- that would be correct.

**MEMBER GRAHAM:** Two years for manufacturing, two years for installation.

My concern is is that, in planning for the future, the vessel now is about 36 years old. At the time of the licensing -- re-licensing, it’ll be about 39 years old and at the end of that licence period, if you had another licence period, it’d be 44 years old.

Is there any planning or any policy at AECL to look towards the purchase or the ordering of a new vessel down the road or is it strictly the policy that you -- at the end of life of this reactor, you’ll be out of the isotope production business?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

And I think the answer to that probably

goes beyond AECL because those are long-term strategic decisions for Canada.

I would simply offer from AECL’s perspective, we have studied vessel replacements and NRU refurbishments in the past, we currently have no plans to extend the life of NRU beyond the life of its components of which the vessel is one.

So we believe that through inspection and maintenance that we can continue to operate with the current vessel through the next licence interval and likely through the one beyond that and to be able to show fitness for service.

But the horizon beyond 2021, there would need to be a long-term strategy in place.

**MEMBER GRAHAM:** Just for rule of thumb, what would a new vessel cost today?

**MR. PILKINGTON:** So as a part of the current outage, we did dust off some studies that had been done and we came up with a very rough number for the complete outage which would include a vessel replacement and very minimal upgrading of other parts of the facility in parallel with that, not a full refurbishment of the NRU, and the price tag was in the range of 400 million.

**MR. MacDIARMID:** If I might just volunteer one additional comment, it’s Hugh MacDiarmid, for the record.

The Minister of Natural Resources did commission the expert panel on isotope production options and clearly that process was one that was designed to explore any and all avenues that would be productive and worth pursuing in the future.

So our marching orders are to be producing as quickly as we can, produce reliably through to the end of our licence period, secure the renewal through 2011 to 2016 and during that period of time a full range of options are going to be pursued.

**THE CHAIRMAN:** Thank you.

Dr. McDill?

**MEMBER McDILL:** Two final questions. On the first fill you found some -- or noticed some tritium which on refill you didn’t detect. Is there any sense going forward of where that tritium came from?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

And so we have not been able to identify the source of the tritium. We have looked at the systems that, I guess, physically interact with the J-rod annulus trying to identify what might have been the likely source and to this point we’re still investigating. But to this point we have not identified a source.

And then we looked at the possibility that the tritium was as a result of filling the vessel and that it may have come from the vessel. And so to that end we drained the vessel and did a very thorough visual inspection of the quadrant of the vessel where we had seen elevated tritium in the J-rod annulus.

And even before we drained the vessel for that inspection, the tritium levels had essentially returned to background level. We have filled the vessel actually twice since and on neither occasion have we seen any significant increase in the tritium levels as we did the first time that we filled the vessel.

So at this point we'll continue to monitor but we will not be taking further action.

**MEMBER McDILL:** Thank you.

Does staff have any comment to add?

**MR. ELDER:** Two things on this as said is we have no concerns about the structural integrity; so we're confident on the structural integrity on this one. Because obviously they haven't been able to find a definitive cause, we've asked to make sure that they have proper procedures in place in case a leak, actually a measurable leak does develop.

So they will have procedures in place to take appropriate action in a timely fashion if they actually get a measurable release of -- a measurable leak.

But at this point what they're measuring is very, very small quantities and it would be extremely difficult to actually pinpoint a definitive source.

**MEMBER McDILL:** And what constitutes a "measurable leak"?

Maybe we should ask AECL.

**MR. PILKINGTON:** One for which we could have a reasonable expectation of being able to locate it. I would look to the example of very small steam generator leaks in utility reactors and the fact that until you get to a certain level you're really expending dose and staying in a shutdown state with essentially no opportunity to identify the source.

**MEMBER McDILL:** Thank you.

And my final question is for the scientific and engineering community. When will they have access to the neutron beam lines for further scientific work? Or is that something that you cannot speak to?

**MR. PILKINGTON:** Today I have come ready to be able to speak to that question.

And so we have talked to officials of the National Research Council and they have not really found an alternative facility for the work that they would do on the NRU. They have taken the opportunity of the shutdown to do maintenance and improvements to their equipment and they're very much looking forward to the return to service of NRU.

The facility will essentially be available to them from the time that we raise the power on the reactor. However, they have indicated that there will be time required on their end to re-energize programs that have been put on hold. They would be expected -- they expect to be back to full utilization by next spring.

**MEMBER McDILL:** Thank you, Mr. Chair.

**THE CHAIRMAN:** Thank you.

Mr. Tolgyesi?

**MEMBER TOLGYESI:** Merci.

I hope that you will include these scientific requirements when you evaluate the long-term options for the NRU because as what you said, it's a unique place where you could do that. So it should be incorporated.

I have just maybe one comment. On Figure 3.2 it's a little bit hard to read what's there and where it is -- this latest configuration of NRU reactor. It's not too clear, the numbers and letters and you know. What's where?

I could read just only that the red "x" is adjacent to the J-rod position 41 but when you're looking at all those -- all the numbers and figures, it’s not so easy to read. I don’t know if it’s only on my copy but I am quite sure it’s on all of the copies.

I have one question. What you were saying that to do all this repair work you were putting some plates and welding on the top which could go to 3 or 4 millimetres or even thicker; it depends on conditions.

So how these plates and welding and eventual, if any, heat deformation, you were talking about it could be that the vessel could be -- that the wall could be deformed.

How it will affect -- there will be some restrictions. How it will affect the performance of the vessel specifically of the annulus?

**MR. PILKINGTON:** It’s Bill Pilkington, for the record.

And so the deflections on the vessel wall resulting from the repairs would come from the build-up, the additional material that’s put on and then also from the deflections from welding stress.

And so even adding those together you would be looking at deflections significantly less than 10 millimetres. And so in terms of the operation of the reactor, those would be insignificant and in terms of the function of the J-rod annulus which I believe is about 15 centimetres across, there would also be no effect.

So the way the NRU reactor is designed, there is very low flow in the vessel at the locations of the wall. And so there would not be really any significant change in the operating performance of the NRU because of the physical changes.

**MEMBER TOLGYESI:** But when you're looking where the leak is located, it's in a heavy water gutter which is much thinner than the annulus which is 15 centimetres. The gutter is quite -- I don't know. It seems to be maybe a centimetre or so and then when you do 10 or 15-millimetre restriction, which is more important?

**MR. PILKINGTON:** Bill Pilkington for the record.

And so the maximum deformations are well above the reference circumferential weld and the vessel wall thickens significantly below the circumferential weld. We would not expect to see any significant deflections in the area that's adjacent to the gutter.

**MEMBER TOLGYESI:** And my last is you were saying that gutters were filled with corrosion products and even the lip was corroded so it disappeared. It's some effect of this lip if it disappearing or there is no operational problem?

**MR. PILKINGTON:** So originally on the design, I believe the lip was to provide separation for light water leaks and heavy water leaks and the gutter was intended to collect heavy water leakage and it has drains associated with it.

So in looking at the work to put the NRU back into operation, our inspections indicated that we did not have significant corrosion occurring as a result of having corrosion products in the gutter. So as we go forward, we'll be looking at a strategy on what to do about that configuration but for the present it was felt the best thing was to not change the condition that we know is not aggressive.

**MEMBER TOLGYESI:** And my last. When you are looking at the maintenance schedule, you were talking about 28 day periods of which 23 are production, five are maintenance. If you are looking over the year, it's about 12 periods which means 12 times 5 is 60 days -- I will say lost; not lost but not producing isotopes. When you're adding to this one month shutdown, because that's what you will do about annually, this is about a 50 percent increase. How it will affect?

**MR. PILKINGTON:** So this is Bill Pilkington for the record.

The choosing of five day outages was done specifically because we can continue to harvest isotopes in the period that the reactor's shut down. So in fact, with that 28 day cycle there is no interruption in the production of isotopes.

I think the other thing that's important is that we have much better communications with the worlds isotope producers and so we can, in fact, schedule outages and the other producers in the world can adjust their outages and production schedules to ensure that there is no reduction in supply when we're shut down.

**MEMBER TOLGYESI:** Is there -- the one of intervenors by Mrs. -- I don't know who was that -- Mrs. Darlene Buckingham -- she was saying that many medical doctors are now saying that this using radioactive isotopes are being overused. Are you witnessing this increase of isotopes, a need for isotopes for medical purposes?

**MR. PILKINGTON:** So it's Bill Pilkington for the record. I'm afraid we have nobody in our group today who could give an answer to that kind of a question.

I could point out that the medical community has done really a great job over the period that NRU and another significant supplier have been out of service to make the most of the isotope supply that is available; to schedule diagnostics procedures, to not lose isotope to decay, to look for alternatives that can be used for some procedures.  So I would say the medical community's done an excellent job of mitigating the shortage but I can't comment on the value of the supply to the medical community.

**MEMBER TOLGYESI:**  I will ask that Dr. Barriault after.  Thank you.

**THE CHAIRMAN:**  Thank you, Dr. Barriault?

**MEMBER BARRIAULT:**  Thanks.  Merci.

On Slide 22 of CNSC, there's a comment that upset me a little bit and it says on a walk-down resulted in numerous finding; field installation not matching documentation.  I guess the question I have is that poor record keeping or is it cooking the books?

Slide 22.  Additional outage activities, NRU upgrade walk-downs.  It's third bullet down.  CNSC to comment on it.

**MR. ELDER:**  Okay, first I'll go back and give you a history -- Peter Elder for the record -- in terms of the walk-downs.  It's going back and people around will remember that we did evaluation 2006 of the quality assurance around those upgrades.

We, at that time, had trouble finding all the documentation that showed they were done in a quality manner.  Part of the solution to that, to establish that there was a quality installation, was to have AECL do these walk-downs and what they were looking for in the walk-downs was exactly that -- does the field insulation match their documentation?

We asked them to do this because we expected, based on their 2006 audit, to find instances where there was not a match. The walk-downs did find these, a number of them, and then from there AECL used their corrective action program to classify all those, to address them and they're addressing all the ones that had any potential safety impact prior to restart. So in terms of it looks like, you said, that's what the walk-down was looking for. It was looking for mismatch between the field insulation and what was documented. We ---

**MEMBER BARRIAULT:** Go ahead. I'm sorry.

**MR. ELDER:** --- and we expected them to find things based on what came out of our previous audit.

**MEMBER BARRIAULT:** So what I'm hearing then is it was poor record keeping rather than ---

**MR. ELDER:** Well, whether it was poor record keeping, it was not following through a number of stages that the proper quality assurance procedures when the upgrades were put in and recognizing they were put in over a number of years.

**MEMBER BARRIAULT:** So there's no way of knowing if it was poor record keeping or else somebody making inadvertent entries.

**MR. ELDER:** It's very hard to know. All we can end up finding is that we couldn't find the documentation whether it was record keeping or not following procedures, we can only come back with the finding that there was a mismatch and this is where.

This is the solution to make sure that what was there matches the documentation.

**MEMBER BARRIAULT:** Thank you. I don't know if it's fair -- does AECL care to comment on this?

**MR. PILKINGTON:** It's Bill Pilkington for the record.

And so I would comment that the installation of these upgrades over short outages over a very long period of time did present -- I think an unusual challenge to both our organization in carrying out the work and also to our organization and the regulator to provide proper oversight.

And so the solution, I agree, was for us to go back and walk-down each of these systems and confirm that our design documentation was exactly the same as the field installation and so we did find a number of discrepancies and we have assessed those to determine what we felt needed to be corrected in the field, what could be documentation updates, what would require future planned maintenance activities and so these have all been assessed and acted on accordingly.

**MEMBER BARRIAULT:** Thank you. Just two more short questions.

My next question, really, is that -- and it's of a, I guess, just a yes or no answer. During your shutdown, did you get the chance to test the backup electrical system on the famous pumps that we had discussed some years ago?

**MR. PILKIINGTON:** No.

However -- Bill Pilkington for the record -- however, having said that, only because with the fuel and water out of the core there wasn't a requirement for that system to be available. As a part of our return to service, all of these systems are being thoroughly tested to confirm that they are fully available to perform their safety functions and in fact we have already operated the DC motors on the pumps in question.

**MEMBER BARRIAULT:** Thank you. Mr. Chairman, just one brief question and you can rule me out of order if you want to.

If I ask you to do some crystal ball gazing, do you see anything in there that looks like a Maple reactor in the future?

**MR. MacDIARMID:** No.

Hugh MacDiarmid, for the record.

**THE CHAIRMAN:** Anything else?

I’ve got a couple of questions here. Let me start with a kind of a multi parts one.

I am -- I don’t want to deal with some historical issues. So I'm looking forward to what is it that we can expect to be achieved in the planned -- in the next big planned shutdown within the nine months?

And the reason is because on Slide 33, I was struck that you still identify something like 833 activities not complete. According from your slide, if you look at Slide 33, I am anal keeping up to commitments on both sides now of the organization.

So can we -- can you assure us that within the next -- after the next planned shutdown, the extensive shutdown, that those 833 will not be -- shall we say all be complete?

And while you're thinking about that, you know my favourite question I always ask you is when the reflector is going to be fixed, if ever? Because as you know, this NRU, if you're coming back after 14 months, it will still be the old leaky machine and that's something that you'll have to explain to the public why it's still leaking.

**MR. PILKINGTON:** Okay. Bill Pilkington, for the record and I'll start with your first question and those 800 and some odd activities are all activities that will be completed before the NRU is back into service. So these are all activities to be completed in this -- within this shutdown.

And I would point out this is an accumulation of all planned activities. So every piece of maintenance, every preventative maintenance, every test that needs to be carried out, every significant operation that needs to be carried out, everything is captured; in fact, even training activities.

Everything is captured on that work-down curve because we have to make sure that all of them get done at the appropriate time between now and return to high power operation.

**THE CHAIRMAN:** Does that include the gaps that were identified in the walkabout?

**MR. PILKINGTON:** So that includes all of the gaps that have been assessed to require or suggest that we should do physical work in this shutdown, but it does not include all of the findings.

If I can speak to the next planned outage -- so the major activities that would be carried out in the next planned outage would be the inspections that we be called up as a result of the repairs that have been done and the continued effort on mitigation of corrosion.

So we'll be taking measurements of $CO_2$ gas purity and of pH of the water that we drain from the J-rod annulus and we'll be using that to look at whether we have fully mitigated corrosion now and using that to plan what measures we will take in the next outage to improve that.

We are also working towards methods of reducing and eventually eliminating the leakage from the reflector. And so in the first five-day outage following return to service, we currently plan to introduce a carbon fibre compound which has shown effective in other utilities at reducing similar kinds of leaks and we are pursuing tooling and repair strategies to be able to better repair leakage from the reflector.

And I believe you had a second question that I may not have addressed.

**THE CHAIRMAN:** Staff, you want to comment on all of this is going to be done before the return to service, the 800 -- it's a big number.

**MR. ELDER:** Peter Elder, for the record.

What's on that Slide 33 is the remaining activities on the return to service plan. So this is what we're monitoring and this is what our site inspectors will be monitoring for the next month or three weeks to make sure all those ones are done.

Again, we have looked at the plans. We have looked at their procedures for doing this and this is carrying out those procedures. So that's going back in doing all their -- there's a lot of maintenance you can't do until the system is actually operational. So they have to do all that. There are a number of tests they have to do and that's all in those 800 items and that's what we are monitoring in terms of the return to service plan.

And below, if you look on the chart, you probably -- it's small. My version is small but I can just read it saying the end of that is July 25th is getting down to zero and having experience, I'm looking at these ones on other big projects. This is the trend you like to see. They've stopped growing about a few weeks ago. It's a very good sign.

Usually as you go in and put things back in service, you find items. So the better planning you do, the better you start to work down that curve and you stop adding maintenance items in that. So we're -- they look like they're on track.

**THE CHAIRMAN:** So all the other outstanding issues, including documentations, gaps, all of these, by when that will be sort of done, particularly the legacy from ’95, ’96, or ’94-’95, something like that?

**MR. ELDER:** What we've done in terms of --

Peter Elder, for the record -- in terms of -- we're tracking all of these things in terms of anything that's not going to be done by July 25th and in our view and we've communicated to AECL that we expected all to be done certainly before they show up for a licence renewal hearing in about a year from now.

So they've got -- what they have to do at the outage they have to do in the first outage. Anything that they get done during the shorter periods or operational they have time to do but we're looking at that one all being resolved by the time they come back for licence renewal.

**THE CHAIRMAN:** Okay. My last question exactly relates to this.

What did this stoppage do to the critical part towards October 2011, if anything? Did it slow you down, speed you up?

**MR. PILKINGTON:** Bill Pilkington, for the record.

It actually did both. That fact that we were shut down gave us an opportunity to access equipment for things like these walk-downs that would have been very, very difficult to schedule around short outages.

So in terms of the work that is more difficult or most difficult to get done, it presented us with an opportunity.

The other side of that coin is that we have committed our resources very heavily to the repair and return to service and so the things relating more to documentation and analysis we will have to accelerate our efforts in order to be ready for licence renewal.

However, I point out that the most difficult challenges around getting access to field equipment is something that was available to us in this shutdown.

**THE CHAIRMAN:** Thank you.

Doctor McDill?

**MEMBER McDILL:** One last question. You have all of these marvellous wonderful tools. What's going to happen to them?

**MR. PILKINGTON:** We do have an arm of AECL whose job is services and so we have great expertise between ourselves and our contractors, all of which could be available to anyone who needs them.

In terms of the actual tools, we will be storing the tools until there is a requirement for them and we of course have learned for the design of all these tools and so we have that learning to apply both to our unit and to others.

**MEMBER McDILL:** Thank you.

**THE CHAIRMAN:** Thank you. Last chance?

Well, thank you very much. Thank you for your patience and perseverance with us here.

We shall take -- anything I need to do now, Marc?

**MR. LEBLANC:** Well, the Commission will confer with regards to the information that it has considered today and then determine if further information is needed or whether the Commission is ready to proceed with a summary decision in a very short time period. So we will advise accordingly.

**THE CHAIRMAN:** Okay. Thank you.

We will reconvene in 10 minutes.

--- Upon recessing at 6:44 p.m. /

L'audience est suspendue à 18h44

--- Upon resuming at 7:03 p.m.

L'audience est reprise à 19h03

**THE CHAIRMAN:** Okay, good afternoon.

My name is Michael Binder. Je suis le président de la Commission canadienne de sûreté nucléaire.

And the next item on the agenda is the opportunity to be heard to Saskatchewan Research Council on the Order issued on June 18 by the Designated Officer.

So I wish to welcome Mr. Joe Muldoon, Vice President, Environment and Forestry for SRC.