

From: [Grant Minor](#)
To: [Lia Meringa](#); [Pierre Bricault](#); [Donald Jackson](#); ["mgallop@triumf.ca"](#); [Yuri Bylinsky](#); [Joe Mildenberger](#); [Jamie Cessford](#); [Gordon Roy](#); ["Bevan Moss"](#); [Maico Dalla Valle](#); [Travis Cave](#);
cc:
Subject: Cyclotron Bridge Orbit Counter and Aluminum Bridge Sector Analysis
Date: March 23, 2011 6:30:00 PM
Attachments: [Cyclotron Bridge Wheels Over Bump March 23 2011.pdf](#)
[Orbit Counter Wheel On Skip Point.JPG](#)
[Aluminum Bridge Sector Bolted To Magnet.JPG](#)
[Aluminum Bridge Sector Bolted To Magnet Counterclockwise Side.JPG](#)
[Aluminum Bridge Sector Clockwise Side.JPG](#)
[Aluminum Bridge Sector Over Extraction 5 Horn Cabling.JPG](#)
[Drive wheel clockwise from bump.JPG](#)
[Free wheel clockwise from bump.JPG](#)
[Orbit Counter Wheel Just Before Skip Point.JPG](#)

Hello all,

I have performed some investigation into the skip in the orbit counter that was experienced during the tank survey this 2011 Shutdown, and made a first-run evaluation of the risks involved.

Some Background:

There is an aluminum bridge spanning the gap between the cyclotron magnet steel at approximately position 140 – 150 degrees. This bridge passes over Extraction 5 Horn. It is one of several bridges that were installed in the 1970's by Dilworth, Secord, Meagher and Associates. According to Gord Roy, they were an afterthought, and were never quite fitted properly, and took quite some effort to install. From our photos collected they appear to be bolted to angle brackets that are welded to the magnet steel. The bridges were installed to allow the remote handling service bridge wheels to travel around the perimeter of the cyclotron over a flat surface.

It appears that the bridge over the Extraction 5 Horn is protruding on the counter-clockwise side by some small fraction of an inch (approx 1/8", see attached photos). It is not known whether it has always been this way or if this has evolved over time. It is general hearsay knowledge that the aluminum bridges were never perfectly fitted or installed to begin with.

The Problem:

- This year, the orbit counter skipped a number of degrees during a tank survey, rendering the survey data invalid.

- The skip has been isolated by Remote Handling to the location where this aluminum bridge is protruding (see attached photos).
- **The skip is not repeatable every time: some tests performed have shown the skip, but some have not.**
- It is unclear yet whether the skip is related to mechanical slippage of the orbit counter wheel at the bump, or another mechanical or electrical issue.
- No prior photos or documentation exist to confirm or deny the existence of this bump over time.
- The aluminum bridges are around the perimeter of the cyclotron which is the hottest (most active) area of the cyclotron.
- The bridges are likely active and any mechanical work on them would be likely high-dose.

The Implications:

- **I am under the impression that the remote automated tank survey cannot be performed reliably with this skip problem.**
- **The remote handling equipment can still be used to take manual position readings and do a manual survey from the RH control room.**
- **It will take additional time and effort to accurately diagnose and solve the orbit counter skip problem.**

Additional Risks:

- There was some concern about the bridge stalling at this bump, and whether the drive motor can generate enough torque to the drive wheel to overcome the bump in this instance.
- This may cause delays in cyclotron maintenance, and force people to accumulate dose running into the vault to try to lift/pry and reposition the bridge should it become stalled.

Actions Taken:

- I have done a preliminary analysis on the bridge drive system and wheel torque (see attached).
- My conclusion, based on some large assumptions, is that there is sufficient torque in the drive system to overcome a 1/8" bump in the worst case.
- We have run the trolley back and forth several times over the bump with full load from the probes trolley, and video recorded the results.
- There is some mechanical vibration passed through the system when the bridge wheels pass over the bump, which transmits through the outrigger cameras.

- Both bridge wheels were successfully able to clear the bump 8 times (4 in each direction) under full load and at the slowest possible speed.

Hypotheses on Cause:

- The aluminum bridge may be dished (bent down at the center and up at the ends) from repetitive stress of the trolley load travelling over it over the past 30+ years.
- The bolts securing the bridge may have loosened over time, due to repetitive stress, allowing the bridge to rock slightly on its fixture points.
- The aluminum bridge may have been bent and protruding in the first place.

Conclusions and Recommendations:

- **The risk of this bump on the bridge's ability to orbit the Cyclotron is very low.**
- **Next shutdown, another manual or compromised survey may have to be performed should the orbit counter skip manifest itself again.**
- **Unless priority is given, we will have to neglect the orbit counter problem this year, as we have no more resources to address it.**

If you have any questions or concerns, please contact me.

Thanks,

Grant

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From: [Grant Minor](#)
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cc: ["Bevan Moss"](#); [Maico Dalla Valle](#); [Travis Cave](#);
Subject: RE: Cyclotron Bridge Orbit Counter and Aluminum Bridge Sector Analysis
Date: March 25, 2011 10:03:00 AM

Apologies all,

Gord Roy has corrected me on the history of the aluminum "bridges" in the tank spanning the magnet gaps.

See below,

Grant

.....

Hi Grant;

I do not remember saying that the "bridges" were an "afterthought".

The Service Bridge was required to install the resonators and other items and as such it was engineered to do so. Since the magnet surface was not contiguous, in order for the Service Bridge to rotate fully, "bridges" were required between the magnet sectors. The problem encountered was that each gap was slightly different and as such each of the six "bridges" had to be custom fitted, which is what we were talking about.

A necessity, yes; an installation problem; yes, but an "afterthought" no.

Gord

From: Grant Minor [mailto:gminor@triumf.ca]
Sent: March 23, 2011 6:30 PM
To: Lia Meringa; Pierre Bricault; Donald Jackson; 'mgallop@triumf.ca'; Yuri Bylinsky; Joe Mildenerger; Jamie Cessford; Gordon Roy
Cc: 'Bevan Moss'; Maico Dalla Valle; Travis Cave
Subject: Cyclotron Bridge Orbit Counter and Aluminum Bridge Sector Analysis
Importance: High

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to be performed should the orbit counter skip manifest itself again.

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If you have any questions or concerns, please contact me.

Thanks,

Grant

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Nuclear Engineer
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gminor@triumf.ca
(604) 222-7359

From: [Don Jackson](#)
To: [Grant Minor](#);
cc: [Bevan Moss](#);
Subject: Bridge Orbit Anomaly
Date: March 17, 2011 4:45:51 PM
Attachments: [Bridge Orbit Anomaly.docx](#)

Grant:
Attached report on bridge orbit issues.
Don

From: [Grant Minor](#)
To: ["Anne Trudel"; Noel Giffin;](#)
cc: ["Donald Jackson"; "Pierre G. Bricault"; Lia Meringa;](#)
Subject: RE: pick-up wheel for Tank Survey
Date: September 21, 2011 6:55:00 PM
Attachments: [Cyclotron Bridge Orbit Counter and Aluminum Bridge Sector Analysis.pdf](#)

Hi Anne, Noel,

I analyzed this problem in March and circulated a written report for it via e-mail, see attached docs.

From what I can tell, the problem is not repeatable, difficult to diagnose the exact cause, and if it is in-fact related to misalignment of an aluminum bridge sector, it will be a high-dose job trying to repair it and will require resources and planning.

It is on the list of things to repair, but due to other priorities we may not get to this in 2011. If the potential exists that an automated orbit position readout skip will render the data un-usable, then a manual survey would have to be performed using the cameras and the hard-scribed position markings on the cyclotron perimeter.

My recommendation is to try the automated orbit program during the winter shutdown 2012, and if the skip re-occurs, we will have to resort to a manual scan.

Hope this answers your question, if you need any more info let me know.

Thanks,

Grant

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

From: Don Jackson [<mailto:djacks@triumf.ca>]

Sent: September 21, 2011 7:47 AM

To: Grant Minor

Subject: FW: pick-up wheel for Tank Survey

Grant:

I will let you handle this one.

Don

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

From: Anne Trudel [<mailto:atrudel@triumf.ca>]

Sent: September-20-11 2:55 PM

To: Donald Jackson

Cc: Noel Giffin

Subject: pick-up wheel for Tank Survey

Don,

I may be out of the loop on this but I was reminded recently that we weren't able to get a tank survey completed with the shields in last shutdown because of a problem with the pick up wheel on the bridge. Do you know when we might expect to have that fixed so that the surveys can resume?

Thanks,

Anne

From: [Grant Minor](#)
To: ["Anne Trudel"; Noel Giffin;](#)
cc: [Donald Jackson; "Lia Merminga"; "Pierre G. Bricault"; "tlyth@triumf.ca"; "kur@triumf.ca";](#)
Subject: Pick-up wheel on cyclotron orbit
Date: September 26, 2011 5:18:00 PM

Hi Anne, Noel,

Noel phoned me today and expressed concern on the criticality of the cyclotron bridge orbit system counter being fully operational to complete the surveys needed this coming shutdown.

I had a few suggestions that might make addressing the problem easier:

- In preparation for this upcoming shutdown, it would be useful if Noel could organize a meeting with Remote Handling and present to us his understanding of the problem and outline any data, photos, video, etc. he has collected on the problem, perhaps indicating regions in the orbit where the problem occurs more frequently, etc. As I explained in my previous e-mail, we put the bridge and trolleys through their paces at the end of the shutdown several times at the slowest possible speeds, and we were unable to reproduce the problem as we understood it, but maybe there was some miscommunication down the line about what exactly the problem is.
- I still suggest that we try again to perform the tank survey with the orbit counter wheel as-is, with both Noel and Remote Handling staff present, and that way if the problem arises we can use the outrigger cameras, etc. to zoom in on the problem areas and see exactly what is happening. This will give us more information on whether it is a mechanical issue (i.e. the wheel is skidding or skipping) or an electrical / controls issue.
- Noel commented to me that it his understanding that the orbit position counter was historically not designed properly, and perhaps it was designed to be too sensitive or too accurate, and that the accuracy required by the user (Safety?) is not as tight as what was designed. In this case, I asked Noel if he could put a specification together in writing summarizing what the actual requirements of the system are, and describe quantitatively the negative experiences he has had using the current system. With a proper specification of what is needed from the user, it will

be much easier to correct the system with a proper design the next time we go in to address whatever problem may exist.

- Regarding the urgency of this repair, I can only say that we are strapped for resources right now fighting fires (ex. M20 Q1Q2, M9T2 Joint), and if this is urgently needed, some other project will have to fall to the wayside until we get it fixed. If we have to re-design the counting mechanism, this may take months to design, build, and test a prototype, and I have to make it clear to my supervisors that another project will have to suffer.

Let me know how you would like to proceed, and I will help any way I can.

Thanks,

Grant

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(604) 222-7359

From: DJACKS@triumf.ca
To: [Grant Minor](#);
Subject: Re: Pick-up wheel on cyclotron orbit
Date: September 26, 2011 6:56:23 PM

Grant:

I don't agree with the statement that it wasn't repeatable. Every time I tried it up to and including the last day of the shutdown I could repeat the error at the exact same location: Where the orbit wheel transitions over the gap of the bridge sector on the west side of the tank. This was observable with both the outrigger and by local direct observation.

Travis also noticed that this happened on a similar location on the east side of the tank. These only occur at slow speed without a load on the outboard extremity of the bridge. At higher orbit speeds the counter is useless anyways so any repeatability wouldn't be observable. In other words the failure is due to a mechanical fault.

Travis noted that during the 2C operation which passes over the same location at slow speed the orbit readings were perfect. This uses the upper resonator trolley which is considerably heavier than the radiation survey. I consider this only as a qualitative observation not conclusive as there were no recorded observations. I suspect we are seeing a deterioration of the bridge sectors but not a major one as "bumps" have been observed when orbiting over the sectors have been observed since 1976.

Electrical and mechanical operation of the encoder were repeatable tested outside of the tank and never failed. The electronics is a quadrature decoder which requires a precise signal to work. If there is any problems with the signal, electronics or wiring the end result is no count at all. In other words it is virtually impossible to have an intermittent count.

I agree with you that an attempt should be made to do an "automated" survey. The accuracy should be immediately obvious as a calibration is done on each orbit. The program only has the ability to calibrate at the D-Gaps. Additional calibration points may be useful but not be ready until the 2013 shutdown when hopefully a better solution has presented itself.

Even if manpower and priorities are adjusted it won't be of much help to Noel for 2012. The only place any solution can be tested (or repaired if it is the tank) is in the tank after shields are in place. Then again if no attempt is made in 2012 then it shifts to 2013 to 2014 etc.

If Noel wants repeatable results for 2012 then he better be prepared for remote operation and manual data entry. It will take a significant amount of time and be a very tedious operation: But it will get the results he

needs.

As to accuracy the encoder (for radiation survey purposes) is only measured to within 1/2 degree. If he is willing to live with nearest 10 degrees or even more than I would never have bothered with any encoder and just left it at manual entry anyways.

Don

> Hi Anne, Noel,

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> Grant
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From: [Noel Giffin](#)
To: [Grant Minor](#);
cc: ["Anne Trudel"](#); [Donald Jackson](#); ["Lia Meringa"](#); ["Pierre G. Bricault"](#);
[tlyth@triumf.ca](#); [kur@triumf.ca](#);
Subject: Re: Pick-up wheel on cyclotron orbit
Date: September 30, 2011 12:13:27 PM
Attachments: [orbit-wheel-memo.pdf](#)

Hello everyone,

Here is an attached memo that I have produced in response to Grant's request for more information about the failure of the orbital position sensor of the Cyclotron R.H. bridge.

regards,

Noel Giffin

On 09/26/2011 08:07 PM, Grant Minor wrote:

> Hi All,
>
>
> I should correct my first point below:
>
> -Don Jackson WAS able to reproduce a particular error near a misaligned aluminum bridge sector near
> Extraction Horn 5, but I am still unclear of the relationship between that error and Noel's observed
> failure. There is some conflicting information in my notes that I will have to clarify with Don
> tomorrow.
>
> In the meantime, I still think it would be very valuable for Noel to attempt to document and
> quantify the failure he observed last shutdown, specifying the operating conditions (orbit speed,
> direction etc.) and the location of the failure, so our group has something to work with to try to
> address the problem.
>
> Thanks,
>
> Grant

>
> *From:* Grant Minor [<mailto:gminor@triumf.ca>]
> *Sent:* September 26, 2011 5:18 PM
> *To:* 'Anne Trudel'; Noel Giffin
> *Cc:* Donald Jackson; 'Lia Merminga'; 'Pierre G. Bricault'; 'tlyth@triumf.ca';
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> *Subject:* Pick-up wheel on cyclotron orbit
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