Australian National University

14 UD Tank Opening Report

117A/B

5th July to 17th – August 2012 (A)

20th to 24th – August 2012 (B)

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Contents

1 Reason for Tank Opening

This was a scheduled opening to inspect and undertake maintenance of the inner workings of the accelerator. Importantly it included plans to replace old critical components with new.

We had scheduled a visit during this opening for Paul Frecker of IS Technik to demonstrate to us a bearing analyser on some of the mechanicals in the accelerator with a view to purchasing this unit.

This report covers the activities of the planned TO #117 but also a second opening of the accelerator following a short operational period to investigate a problem. There was a poor vacuum reading of ~21mtorr (with turbos off) on the gas stripper vac gauge in the terminal of the accelerator. The terminal ion pumps concurred with this poor pressure. This is a combined tank opening report and the tank openings are referred to as TO#117A and TO#117B.

Plan of action:

- Perform initial 30kV insulation test of the column.
- Perform electrical and mechanical tests and inspect all idlers, chains, pulleys, bearings, shafts and resistors.
- Accommodate the demonstration of a bearing analyser device
- One of the tank slits hadn't worked since being worked on during TO #114. This was to be investigated at TO #115. Time did not allow for this then but it will be addressed during this opening.
- Replenish the terminal stripper mechanism with foils
- Install the Beam Focus 150kV feedthrough in an existing port in the tank top flange.
- Replace the o-rings in both shorting rod clutch mechanisms as routine preventive maintenance.
- Install new and replacement parts including LE Einzel, LE tube isolation valve, LE in tank cup, beam focus system, terminal cup, HE cup and HE object slits.

2 Summary of Work: 5-07-12 to 24-08-12

2.1 Tank Opening #117 A

2.1.1 5-07-12 Thursday

- The SF6 was pumped from the 14UD into the storage vessel.
- The 14UD was vented with air, the porthole doors were opened and the fresh air ventilation system was run overnight.

2.1.2 6-07-12 Friday

- Gas tests showed the atmosphere within the 14UD was OK and compliant with the Confined Space regulations and was safe to enter.
- The in tank platform was deployed and the initial pass down the column completed the 30kV insulation grouped ring tests. The current readings were within specs and recorded. Unit 8, tube 3 was a little high and would be investigated.
- As we were experiencing some instabilities in the HE end of the accelerator, we would make a careful visual inspection before undertaking our usual water and detergent wipe down

- A lot of black dust or flake particulates were noted in the HE end. These looked to be chain wheel sheave plastic transported by the three chains. Black accumulations were mostly on the underside of the castings of the down side of the chains and largely at the castings with chain stabilising idlers and petal arrangements. The up DC idlers and generally all the terminal inductors had some deposits as well.
- The terminal lower spinning was lowered and supported at the casting of unit 18.
- The terminal chain wheel curved contact surfaces were inspected. Position #1 smooth, both sides. Position #2 outer is smooth, but inner surface has spark erosion. Position #3 outer is smooth with a little erosion on the inside.

2.1.3 9-07-12 Monday

- A lot of the day was given to the demonstration of the bearing analyser. During this process we ran the LE shaft and conducted measurements of the drive motor, casting zero, the casting bearings sets in U2, 4, 6, 8 and the mid-section alternator.
- The rotating mechanicals, including the three chains, the LE shaft system were observed and listened to whilst operating.

2.1.4 10-07-12 Tuesday

- The rotating mechanicals were again run and observed. These including the three chains, the HE shaft system. The shaft in U23 looks slightly bent, with a visible eccentricity at its mid height during operation.
- Many HE units were opened in preparation for the cleanup of the black deposits.
- The bottom bearing of the shaft bearing set of U21 (top of U22) has a slight “cage” noise.
- The LE column was wiped down using chamois cloths and water with some RBS detergent.
- Observed chains for slippage on their wheels in the terminal using a strobe lamp.
- We restrained the chains in the terminal to provide slack in them and lift them clear to inspect the wheel sheaves.
- The depth of the groove in the terminal chain wheel sheaves were measured with a depth micrometer. #1 = 0.206”, #2 = 0.207”, #3 = 0.216”

2.1.5 11-07-12 Wednesday

- We removed the casting covers above the terminal
- The upper and middle terminal spinnings were raised and parked.
- Bockwinkel visited the terminal to appraise the requirements for the installation of the second gas species for the gas stripper. The gas stripper box was removed from the outer RF shielded box.
- Units 15 and 16 were cleaned of the black dust.
- A stringer screw fastener was found loose at the tube of U16 Tube 3. A repair was completed.
- The terminal carbon stripper was removed for repopulating with new foils.
- The bellows immediately above the LE accelerator tube was removed.
- (For those with Alzheimer’s there is no “V” electrode in the electrode spacer at the top of the U1, T1)
- The bellows under the tank lid, immediately above the tank BPM was removed.

2.1.6 12-07-12 Thursday

- The bottom flange of the LE quad triplet was removed. A screw from the end of a rod inside the triplet was found loose and sitting on top of this flange. It was fortunate it

had not made its way down into the accelerator. Previously it had been noted that there is a rattle from within the triplet.
- We removed the adaptor/beam tube arrangement that attaches to the underside of the tank lid. The beam tube component of this requires shortening and some holes enlarging. The adaptor will be replaced with a new shorter version that is ready for installation.
- Holes were drilled and tapped in the underside of the tank lid for the beam focus system feedthrough protective can.
- The tank cup, mounted under the tank slit body was removed.
- The initial test fit of the new under tank lid adaptor was made.

2.1.7 13-07-12 Friday

- The under tank lid adaptor needed its fastener holes enlarged and then it bolted up correctly.
- The department hosted a farewell function for Aidan Byrne as he has accepted the position as head of the Australian Research Council. Aidan was a physicist with the department for many years and for the last 5 years his role was the Dean of the College Of Science, ANU.
- The installation of the terminal cup was evaluated and a plan formed on how to proceed.

2.1.8 16-07-12 Monday

- We operated the tank slits to an opening of 0.040” and reset the potentiometer on the down slit as it was out of synch as suspected during the last tank opening.
- The wiring terminations for the tank slits were recorded before the pyrotenax cable was stripped out.
- We removed the tank slit assembly, still attached to its support pedestal onto the service platform.
- The shortened tank lid beam tube piece was welded, leak tested and cleaned.
- We removed a piece of beam tube from the terminal, to be shortened to accommodate the installation of the new terminal cup.

2.1.9 17-07-12 Tuesday

- The Ta aperture at the top of the HE tube in the terminal was inspected for evidence of beam hitting it and photographed.
- The shortened, through the tank lid beam tube piece was fitted and aligned using a target in its top flange. This then allowed the installation of the new ball valve immediately above.
- The alignment of the top flange of the LE tube was checked and it was “spot on”.
- We drilled and tapped the remaining retaining holes of the spark protection can of the beam focus feedthrough. Initially we only drilled every second fastener hole.
- The mechanism of the “Left“ slit axes of the tank slits was removed to investigate a scraping mechanical noise noted during the previous tank opening. The inner magnet coupling half had been rubbing on the flange membrane. Greater clearance was achieved by adding a spacer washer and it operated freely again.

2.1.10 18-07-12 Wednesday

- Without removal of the mechanism from the main body we assessed the operation of the “Down” axes of the tank slits. It was deemed smooth in operation.
- We removed the tank BPM head mechanism and swapped in the proper NEC vac compatible bearings on the internal driven shaft. This was reinstalled into the body.

- The above tank quad triplet had been moved up 20mm to facilitate the changes below it and was realigned.
- An interface adapter piece is used between the quad and the new einzel. The adaptor has an aligning facility on it to facilitate the aligning of the einzel body.
- These pieces were assembled in order and the einzel aligned to the beam axis.

2.1.11 19-07-12 Thursday

- We attached the terminal cup to the bellows below the terminal lens.
- As part of the terminal cup installation we extended the beam tube support structure by adding a pair of 3.5” long spacers. The beam tube and cup bolt together with a bellows at each end and require some restraint and this is done by support attaching to the beam tube of this paired assembly.
- The new wiring of the tank slits, BPM and tank cup in-out signals was started.

2.1.12 20-19-12 Friday

- The tank slits and its support column were re-installed in their new raised (3” higher) position. Much of the day was spent position the support column, aligning and the recalibration of the tank slits

2.1.13 23-07-12 Monday

- The new tank cup assembly bolted to the underside of the tank slits.
- The bellows that fits between the under the tank lid adaptor and the tank BPM requires it to be compressed significantly. To facilitate this we had drilled and tapped radially orientated holes put in its end flanges to attach a pair of turn buckles to compress the bellows during its installation. It was reported to work very well. Now we just have to remember how it was done last time!
- The bellows that fits to the top of the LE tube required its holes in its top flange to be drilled to clearance to mate with the tapped rotatable flange on the bottom of the new NEC cup. This was completed.
- The conduit run from the tank cup switch enclosure was completed and wired up.
- The modifications to the gas stripper gas control box were underway.
- Cooper set up the telescope to look “UP” through the accelerator from the ground level analysing magnet target mount.
- The modified bellows immediately above the LE tube was fitted, completing the closure of vacuum tube from the Einzel above the tank to the terminal.
- The old Switching Magnet (HVE) PS was disconnected (water, mains, controls). The old control functionality was still available for the PS on the off chance it is required. The Danfysik PS (return to OTA 70 degrees magnet) was disconnected and relocated close to the wall.
- The availability of space and control channels in the terminal Lens (lower) RF shielded box was assessed for the planned installation of the terminal cup log amp and suppressor power supply. There are few conduit blank available and ADC/DI/O in the Group3. This installation is planned for the next TO.

2.1.14 24-07-12 Tuesday

- The new conduits for the under-lid hardware (BPM, tank slits, cup in/out) were tidied up. This included bundling them and use of hose clamps to restrain them together.
- A survey of the set positions of the object slits was recorded before their removal for replacement with the new NEC unit.

- The gas stripper box plumbing and wiring was finalised. This was followed with a comprehensive leak testing including many variations of opened solenoid and fine valves.
- The mounting and plumbing of the SF6 gas bottle in the terminal was completed. This including the hard pipework from the bottle to the shielded box, the through box fitting and the flexible bellows that connects to the inner gas box.
- The pressure of the SF6 bottle when installed was 0.250 barG.

2.1.15 25-07-12 Wednesday

- The gas stripper gas box was installed back into the terminal lower shield box.
- We checked the O2 bottle contents and it read 0.226 barG
- The shortened tube nipple connecting the terminal cup to the top of the bellows above the HE tube was fitted and clamped up in the modified support.

2.1.16 26-07-12 Thursday

- The outside protection can for the power supply coax cable of the beam focus system feedthrough on the top of the tank lid was fitted.
- The wiring changes for the gas stripper control box to communicate with the Group3 control system in the terminal were completed.
- The geometry of the internal wiring and its end connection to the protection resistor for the beam focus system was finalised and could proceed to being made.
- We created “shorted” BNC connectors and fitted them to the collector and suppressor fittings on the terminal cup. (log/amp and power supply not available)
- Tidied up HE alternator conduit that was disturbed after the terminal cup installation.

2.1.17 27-07-12 Friday

- The installation of the beam focus system feedthrough was completed. This included the installation of the 3.2mm dia stainless steel conductor. Following the installation of the 3.2mm conductor we were concerned that its natural frequency of vibration was too high and we would make another using 6.4mm tube.
- The casting idler petal assemblies were all removed, disassembled and cleaned by shot blasted them.
- The hold down screws of some of the individual casting idler petals have been replaced over the last few tank openings with screws that have a larger hex socket as the smaller hex sockets were deteriorating and becoming difficult to remove. The new screws require a modified countersunk detail. All remaining petals received the same modification for the new fasteners.
- After careful evaluation it was decided to invest the time and effort to construct a new “without compromise” support structure for the new HE object slit assembly.

2.1.18 30-07-12 Monday

- The construction of the HE object slit support system was well underway.
- The cleaned and modified casting idler petals were refitted.
- The resistor spark gap/protection can of the beam focus system feedthrough extended below the height of the resistor end, spark gap electrode arrangement. The can was shortened to be flush with the resistor end electrode. It projected into the tank less and we were less likely to bang our heads on it as well.
- The concentricity of the resistor end spark gap electrode to the mating can end electrode required improvement. The retaining hole was enlarged on the resistor end spark electrode, allowing the gap to be set concentric with its mate.

- A survey of “stringer” end fixings was undertaken. We found post end lugs loose on the column post electrode at U15 T1, U21 T1, and the first connection of the shorting loops of post B of U19 (He mid-section)

2.1.19 31-07-12 Tuesday

- We tested the beam focus feedthrough by applying a HV to the in tank resistor end spark electrode. The resistor “mounting” end, spark gap would break down at ~29kV in air. In SF6 it would be ~6 times higher, this was deemed an appropriate higher voltage for protecting the system designed to operate at 150kV.
- The chain oiler reservoirs were reinstalled as previously mounted on the chain drive motors.
- The depth of the groove in the lower chain wheel sheaves were measured with a depth micrometer so as to have a reference for sheave wear.
- Position #1 = 0.187”, #2 = 0.208”, #3 = 0.210”
- Fitted the remaining casting idler petals now that we had stock of the new fasteners.
- The U1 T1 stringer was moved to the opposite column post, as it was too close to the beam focus system electrical connection.
- The HE BPM pre-amplifier has arrived from EU after safety assessment and tagging. We have got all cables and spare channels in the BPM control module in the rack in OTA. Foote and Gratton are to configure computer control system to incorporate HE BPM.
- We strobed the lower chain wheels looking for chain slippage. All looked fine

2.1.20 1-08-12 Wednesday

- We fitted the 6.4mm tubular electrical conductor between the U1, T1, Gap5 electrode and the resistor end spark cap of the beam focus system feedthrough.
- We capped off the not yet used conduit and BNC fitting holes on switch housing of the terminal cup.
- The pipework required for the reintroduction of the chain oiler systems was roughed in.
- The fabrication and painting of the new support bracket for the HE object slits was completed late in the day.

2.1.21 2-08-12 Thursday

- The re installation of chain oiler systems was completed. The reservoirs were topped up with vacuum pump oil and tested satisfactory.
- Some adjustments to the wedge action height adjuster support of the LE in tank 300 l/sec ion pump were made so the pump presents to the new tank cup manifold flange at the correct height.
- The installation of the object slits is underway. This will include the alignment and calibration.
- The U22 shaft was checked for run out. It has only 0.003” run out at mid height. It was wrongly “remembered” to have a problem when it should have been the shaft in U23.

2.1.22 3-08-12 Friday

- The beam tube components above the tank were all reinstalled. This followed the decision that the telescope was no longer required for any LE alignment tasks.
- We found that the P300 ion pump flange connection to the new NEC tank cup manifold required a thick copper gasket. Their flanges nearly touched without tightening when a normal gasket was used. The culprit being the pump flange.

- An alignment check of the HE quad was desired. The method of most accurate alignment requires the beam tube through the magnet to be withdrawn so a target can be located within the magnets pole tips. It requires the chopper below to essentially be removed to facilitate this. We chose the only slightly inferior method to place a target in the ends of magnets beam tube and view the target whilst displacing the tube to the extent of the clearance it has within the pole tips. The axis can be suitably determined from this. Both the entry and exit of the tube were aligned.
- The beam current wiring was in place from the tank slits to the outside termination box. These were checked for continuity.

2.1.23 6-08-12 Monday

- We cleaned the metal pellets of all three chains using auto paint shop cloths and acetone.
- The new tank cup operated very nicely with the existing solenoid control, (50psig set on the supply regulator).
- We opened, then cleaned and closed units in the LE and most of the HE column.
- Found a significant spark tracking mark (snail trail) on the surface of the U#10 perspex alternator shaft. It was removed for further inspection.
- Crook removed and replaced the o-rings in both shorting rod mechanisms.

2.1.24 7-08-12 Tuesday

- The snail trail marks on the U#10 shaft were polished off in the lathe. Its end flanges were bead blasted. It was assembled and reinstalled.
- More cleaning of units in the HE column was undertaken.
- The wiring of the tank slit current readouts is being undertaken.
- It was noted that there was a snail trail on the U#1 shaft and it was removed for repair.
- The shorting rod spring contact block mounted on the underside of U#25 was found a little loose. Investigations found that one tapped thread was essentially stripped/spark eroded away. This hole was tapped one size larger and a fastener with a modified head was used to fix a new spring contact block.
- The re-alignment of the HE chopper was turning into a significant investigation and challenge to rectify. The upper electrode plates were found to be not parallel (~15mm at the top and ~18mm at the bottom) and not vertical to some degree. The separation on the lower pair was ~10mm. The approach to alignment was to “average” the gaps about the optical axis. No other action would be taken and we would “Suck it and see”.

2.1.25 8-08-12 Wednesday

- We completed the wiring of the tank slits, their current readout wiring (RG316U cable) and the tank cup position read back.
- More tidying up the routing and securing of the new conduit for the tank slits, tank BPM and new tank cup.
- The lower changing system inductors were cleaned and checked with the setting gauge.
- At the bottom of the machine we remounted a couple of the chain metering wiring spark gap type attachment discs with silicon rubber sealant/adhesive as the existing double sided tape with foam mountings had deteriorated.
- The terminal carbon stripper was reinstalled with a complete inventory of useable foils.

- The in tank P300 ion pump electrical feedthrough on the underside of the tank lid is enclosed in die-cast box. The lid was removed and inspected for any signs of fresh spark activity from the conductor facing the inside of the lid. At a previous tank opening the gap to the lid from the feedthrough conductor was increased. This proved to be a suitable improvement as no evidence of spark activity is now evident.
- All the HE beam line was closed below the accelerator tank.
- Pumping from L5 through to and including the accelerator tube commenced. A small stumble as the new LE ball valve was actually closed when its control box displayed it as open. We vented up to the closed valve so it could be safely opened before roughing down again. Pumping progressed but with the improvement of the LE vacuum appearing to be quite slow. It was possibly a leak in the LE. It was thought best to close the Weisser valve in the terminal, separating the LE from the HE.
- The pumping situation was left as noted overnight -
    - The HE was open to the L0 turbo pump and improving.
    - The LE was being pumped with the roots type pump from L5 (source valve closed)

2.1.26 9-08-12 Thursday

- Early starters evaluating the vacuum through the accelerator and believed we were without leaks and the LE was connected to the L5 turbo.
- The HE pumping continued with pumping from the Line 0 (goes to the target area) turbo.
- The U#1 shaft was refitted after being polished in the lathe. We could still see evidence of the snail trail.
- A drop of oil was applied to the plain bushings within of carbon stripper motor drive and the motor was reattachment.
- The three chains were hand oiled ready for operation.
- We cleaned and closed the LE units of the accelerator.
- The leak tester was connected to the backing line of the gas source turbo at L5.
- The many new or disturbed above tank components were leak tested and their gasket joints were leak tight.

2.1.27 10-08-12 Friday

- The leak tester was operational on the gas source turbo. The new hardware inside and above the top of the tank was leak tested. Some a repeat test and no leaks were found.
- The gas stripper backing line traps were baked for 20 minutes initially plus another 1.5 hours. Monitoring the L5 gas source turbo pump backing pressure, it degraded badly, near tripping the pump system off. The pressure degradation turned the corner and was improving so the heaters on the terminal traps were turned off.
- The tank wall was wiped down with a noticeable higher level of material (black) gathering on the chamois when wiping the tank below the level of the terminal
- A second crew set up below the tank with a borrowed leak tester unit to test the HE beam line and systems. They found a leak on the top flange of the bellows below the HE quad.
- It is a challenging seal to get right as the seal faces are narrow and it is in an awkward to access location. It took two attempts to get this joint correct.
- The crew stayed late until they were confident to leave the pumping to continue over the weekend.

2.1.28 13-08-12 Monday

- The shafts were turned “ON” on Saturday.

- We inspected the previously noted U23 shaft whilst in operation. It had a run-out of 0.025”at mid length. It was removed for assessment in a lathe.
- The shaft bearing assembly in the top of U23 was noisy and it was removed for bearing replacement. We found and replaced the lower bearing carrier as it was worn and loose on the bearings OD. This is likely a result of the above mentioned shaft issue imposing a wiggle on the bearing in this housing.
- It was time to open the Weisser valve and connect the carbon stripper space to the LE and HE vacuum. This required the carbon stripper manifold to be pumped with the mini rougher and then the Weisser valve in the terminal was opened.
- The HE beam line and systems below the tank to Line 0 were all leak chased. No leaks were found.
- With the shafts running the gas stripper system was powered up its vacuum gauge read back was operational. The gas stripper system was still isolated from the accelerator vacuum but was being evacuated by the mini vacsorb. Oddly the readout on the mini convectron gauge housing is indicating P>1 torr. This will require investigation.

2.1.29 14-08-12 Tuesday

- The U23 shaft was being trued up in the lathe. It was skimmed along its length as well as the clamping surface for one of the end flanges. The machining and polishing were done at low speed to minimize heat induced stress. The clamp surface now being slightly reduced in diameter required a special cylindrical spacer shim to compensate for the diameter difference.
- The inside of the lower spinning was cleaned by reaching in with a cloth on a stick and acetone.
- The P>1 torr reading in the gas stripper vacuum was now understood when it was discovered there was an error in the plumbing into the gas box where the O2 and the stripper canal vacuum line were crossed over.
- With this error corrected the gas stripper system was evacuated using the mini vacsorb and opened to the stripper canal vacuum of the accelerator.
- We completed testing of the terminal functions including foils forward/reverse, 60 l/sec ion pumps, 20 l/sec, turbo pumps, gas fine valve ops, O2 and SF6 solenoid ops and terminal lens operation. Some tests allow them to be viewed at the terminal and others viewed as operational from the computer screen.
- The O2 and SF6 bottles where opened to their control solenoids. Neither of these had the pipework purged and the small dilution with air was considered acceptable.
- The U23 shaft was re-installed and ran beautifully smooth.
- The terminal was closed and the LE units now uncovered were cleaned.

2.1.30 15-08-12 Wednesday

- The HE units uncovered when the lower spinning was moved back to its operational position were opened, cleaned and closed.
- All the casting covers were put back in place.
- The HE end of the column was meticulously blown down.
- A stringer was found loose on the tube end in U18, T2. This was rectified.
- Time was given to testing of the CPO system.
- We conducted more tests of the computer control system and retested the terminal functions and mid-sections pumps etc.
- We wiped down the column, vacuumed the platform and the inside bottom of the tank.
- We tested the charging systems, chain operation and metering.
- The 14UD was closed and the pump down started at 16:35.

2.1.31 16-08-12 Thursday

- The gas up of the14UD was undertaken and conditioning of the machine commenced at around mid-day.
- There was concern very early when the shafts were turned on. Powering up the terminal communications and the vacuum readout from the terminal gas stripper was poor, 21mTorr.
- Conditioning was being undertaken and progressing slowly.

2.1.32 17-08-12 Friday

- It was decided that on Monday the tank gas pressure would be reduced to see if there was a correlation with the gas stripper vacuum reading.

2.2 Tank Opening #117 B

2.2.1 20-08-12 Monday

- The gas stripper vacuum reading stayed in the range of 22.8 to 22.36 mTorr all weekend and into Monday morning.
- The removal to storage of the SF6 was commenced and there was an immediate improvement in the gas stripper vacuum readout.
    - Tank 106 PSIA = 22.16 mTorr
    - 89 PSIA = 18.84 mTorr
    - 49 PSIA = 5.71 mTorr
    - 13.9 PSIA = 0.84 mTorr
- We continued the pump out and would enter the accelerator on Tuesday to investigate what looked like a leak into or near the gas stripper system, on the accelerator side of the closed variable leak valve.
- The 14UD was vented with air, the porthole doors were opened and the fresh air ventilation system was run overnight.

2.2.2 21-08-12 Tuesday

- Gas tests showed the atmosphere within the 14UD was OK and compliant with the Confined Space regulations and was safe to enter.
- The platform was deployed and we proceeded to open the terminal and investigate why the gas stripper vacuum gauge reading was poor.
- We sprayed with alcohol the pipework joints in the gas box whilst watching the gas stripper vacuum gauge. No response was seen.
- The leak tester was connected to the gas source turbo pump backing line.
- NO response to helium sprayed on the gas stripper system!
- Isolating the gas stripper system from the stripper canal of the accelerator and the gas stripper vac deteriorated to 6.41 mTorr over a 5 min time frame.
- We relocated the leak tester to the terminal of the accelerator and connected to the gas stripper system pump-out port for greater sensitivity.
- We found a leak through the pumping port valve of carbon stripper manifold.
- STILL POOR VACUUM + NO LEAK ON THE GAS STRIPPER SYSTEM
- Desperation along with a number of other contributing observations, we decided to revert back to the single O2 gas system. See detailed chapter later.
- The gas box was removed and a start was made to reconfigure it back to its original geometry.

2.2.3 22-08-12 Wednesday

- The leaking pumping port valve of carbon stripper manifold was replaced with a Varian 90^{o} valve. The leaking valve was a metal seal type. It was also noted that there was a partial failure of the mechanical structure of the seat pressure adjuster on the swing-over handle, possibly contributing to reduced sealing pressure.
- The gas stripper box was reinstalled and was being pumped with the leak tester connected to its pump out port.
- A pressure rise in the gas stripper system was noted when it was isolated from the pumping from the leak tester.
- This and the previous day had become somewhat of a blur with various leak testing and theorising being discussed without making enough notes.

2.2.4 23-08-12 Thursday

- Further to the noted pressure rise as a test we left the gas stripper system isolated and logged overnight the gas stripper vacuum. The pressure degraded and settled at ~100 mTorr.
- I quote the expressions of many gathered in the control room “F@*#”.
- With the leak tester connected to the gas stripper system we found a leak in the gas stripper box. It would take ~3 mins to show up and would peak at ~6x 10 $^{-8}$ Torr..
- Various arrangements of leak testing from different ports with various valve settings and it was determined that we had a leak between the solenoid valve and the box bulkhead fitting of the O2 gas inlet.
- The box was removed and the leak replicated on the bench. The leak was isolated to the Torrsealed pipe thread fitting inserted into the solenoid valve or the Swagelok tube connection of the same fitting, or possible the solenoid valve body.
- With this subassembly removed from the box and attached to the leak tester we applied a covering of Torrseal® over the existing sealant. This did not eliminate the leak.

2.2.5 24-08-12 Friday

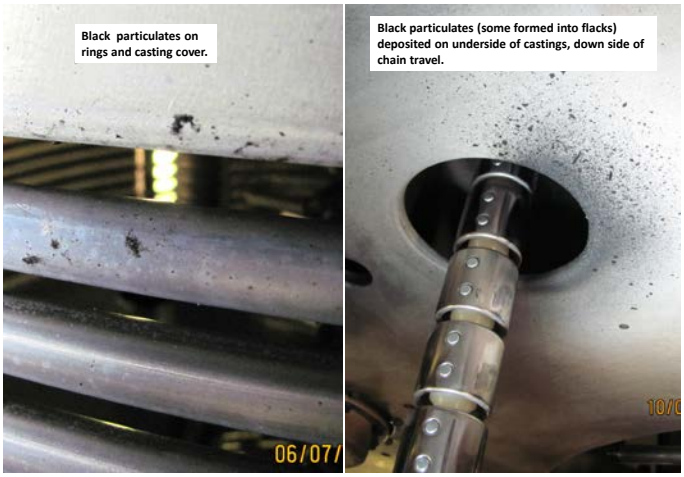
- The option of removing the solenoid valve had been discussed and in light of finding the valve actually leaked “through” and with the fine valve providing a helium leak tight closure we chose to remove the solenoid and replace it with a piece of tube.
- Leak testing of the box with the more abbreviated plumbing was completed on the bench, subsequently it was reinstalled in the accelerator and again leak tested from its pump-out port. No leaks were detected.
- The column was wiped down.
- The HV grouped ring tests were completed.
- The GVM was run and listened to and sounded fine.
- The usual chain charging system tests were conducted prior to closing the tank.
- The tank was closed and ready for the start of evacuation late Sunday

3 Chains, Chain Transport System

The three chains were inspected whilst operating. This included travelling the length of the HE column and looking and listening to casting idlers.

The three chain drive motor, travel/stop legs were measured for clearance to the tank bottom and deemed to be fine. Chain #1 = 52 mm, Chain #2 = 50 mm, Chain #3 = 52 mm.

4 Black Particulates from Chain Wheel Sheaves



BLACK PARTICULATES FROM CHAIN WHEELS, TO#117A

A lot of black dust/particulates were noted in the HE end. Wiping the surfaces of the HE rings, lower terminal spinnings, the tank wall with a cloth or bare hand would gather black particulates.

Significant accumulations were mostly on the underside of the castings of the “down” side of the chains and largely at the castings with chain stabilising idlers. There were also accumulated deposits on the up DC idlers, the inductors and HE rings as well.

The black dust looked to be chain wheel sheave plastic, abraded and mobilised by the three chains.

There was much celebration at TO #113 when the last chain oiler was removed and we expected to enjoy a cleaner machine into the future. Oil free operations were the result of the introduction of conductive wheel sheaves supplied by NEC.

We now had dust but no oil and this dust was believed to be destabilising and limiting the maximum operating voltage of the accelerator.

We had photographed and reported dust on the castings around the chain holes in previous opening TO# 110 where the chain was running conductive sheaves and no oiler.

Conductive sheaves with oil had performed fine for near 40 years. We were going back to oilers for the chains with the view lubrication should prevent the abrasion and generation of particulates. Also, if any dust were produced it may be trapped and not distributed as widely.

The oiler reservoirs and pipework was reinstated in the tank for the three chains!!

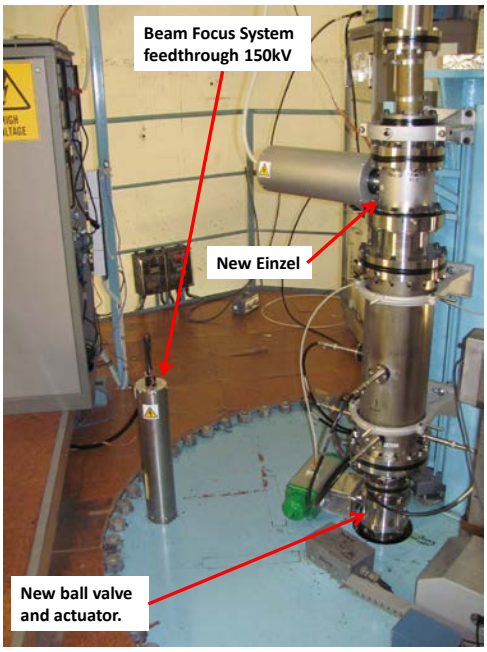
The outer surface of the chain pellets were cleaned of particulates and then hand oiled ready for operation.

5 New Hardware Installed

New hardware installed during this tank opening included the following

LE Einzel	(above the tank)
LE ball valve	(above the tank)
Tank Cup with housing	(in tank)
SF6 gas as a stripper gas in the terminal	(in tank)
Terminal Cup	(in tank)
HE cup	(below the tank)

Object slits (below tank)

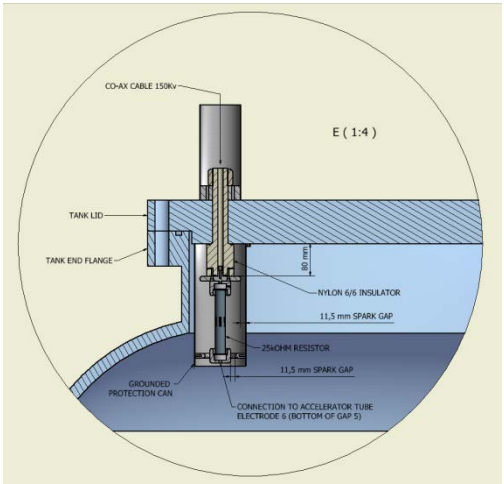


TOP OF TANK (LEVEL 4.5) –
NEW EINZEL, BALL VALVE AND BEAM FOCUS SYSTEM F/T.

6 Beam Focus System - Tank Lid Feedthrough

Overview:

A new system of controlling the beam focusing lens at the entrance of the accelerator is being developed. This involves the provision of +150kV onto the 6th tube electrode (5 gaps) of the first tube in unit 1.



This provides a similar voltage gradient across the first 5 gaps as is achieved when operating the accelerator at maximum operational terminal voltage, equivalent to ~1MV per unit. It will provide a tunable lens in the first acceleration tube at the entrance of the machine.

Previously the nominal focusing gradient was achieved by always keeping the first two units "live" and maintaining the ~1MV per unit across them. To achieve this when operating at lower terminal potentials requires shorting some of the LE "units" deeper into the accelerator to maintain a lens of correct strength. The "live" first two LE units are always bridged with nylon rods to position the steel rods so that they short the necessary units closer to the terminal.

Using the 150kV supply will reduce the need for the laborious changes of shorting rods to match the researchers' required terminal potentials, as well as provide the ability to tune a crucial optical element of the accelerator. The shorting rod systems will be retained for the very important conditioning and diagnostics operations. It may also prove necessary for operation at very low terminal voltages.

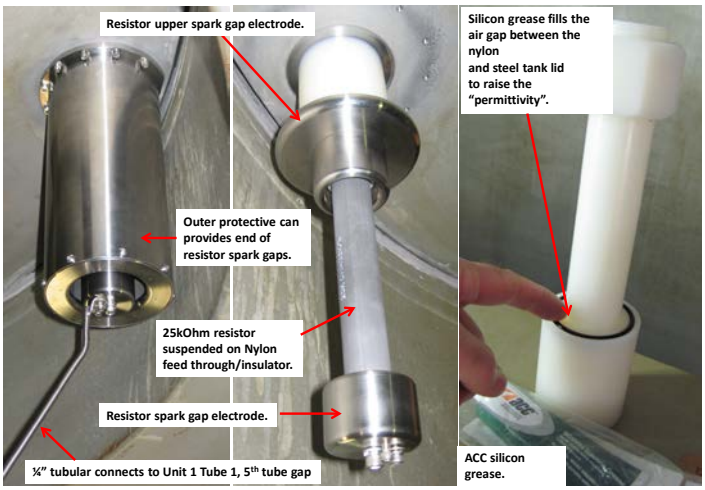
This system required an insulated feedthrough mounted through the tank top flange capable of carrying +150kV from outside of the tank and then a connection made with Unit1, Tube1, 6th electrode. This was designed and manufactured in-house and utilised an existing hole in the top flange.

The installation of Version I of this feedthrough was aborted during TO 116.

The nylon insulation distance was deemed inadequate and was increased to 80mm from the Version I, where it was only 25mm long.

The V II feedthrough hardware had been manufactured in the main workshop and was now ready for installation.

BEAM FOCUS FEEDTHROUGH ASSEMBLY-INSIDE TANK, FITTED DURING TO#117A



7 Tank Faraday Cup (in tank above LE tube entrance)

This unit is an NEC FC18, part 2EA070970.

It has a modified housing with a rotatable exit flange and it also incorporates a 4" dia side port that connects to an existing 300 l/sec ion pump. This unit was fitted with our in house designed RF protection enclosure and configured to default to the "in" position.

8 Gas Stripper System - The Addition of SF_6 Gas as a Stripper Gas

It was decided to add SF6 as a second stripper gas in the terminal of the 14UD as ANSTO has reported an approximately 50% increase in the 5+ charge state stripping yield for actinide-mass-range nuclei when using SF6.

A plan was formed and new hardware had been purchased including Swagelok fittings, a 2.25 litre gas sample bottle and two SMC solenoids (smaller units) for installation during this tank opening.

The box was fitted out with new solenoids for both gases. The Granville Phillips mini-Convectron vacuum gauge and variable leak valve were retained undisturbed. A new read-back potentiometer was also fitted to the variable leak valve drive mechanism to replace a dodgy one.

The modified assembly was leak tested at the bench by pumping from both “gas inlet” ports and from the port connecting to the accelerator tube. No leaks were detected.

The gas bottle and necessary plumbing was installed in the terminal and the gas box connected.

On re-installation of the gas box, the O2 and vacuum lines were cross connected and thus the mini convectron vacuum gauge when powered up was reading >1 torr, as it was seeing atmospheric pressure of the pipe to the O2 bottle (bottle was valved off). This was rectified and the system evacuated and open to the accelerator. Leak testing was undertaken with the solenoids and variable leak valve were open to the accelerator. The leak was tester backing the ion source turbo pump.

NO leaks were found at this stage.

We closed the accelerator on a Wednesday and thought we could catch our breath!!!

Well not for long.

On the Friday we noticed the gas stripper system vacuum readout with its turbos operating was reading 88 mTorr. With the stripper system turbos off, it would improve to ~22 mTorr. No gas was being admitted during either scenario. A reading of ~22 mTorr was maintained over the weekend.

We suspected we had a LEAK near the gas stripper system and one seen only after gassing up the tank with SF6. This hypothesis was reinforced when we removed some gas from the tank on the Monday. There was a direct response to the gas stripper vacuum improving as the tank pressure was being reduced.

We continued pumping out the accelerator to enter the machine and make good the problem.

Tuesday we entered the accelerator for TO117 part B.

With the tank now at atmospheric pressure the gas stripper system vacuum read 0.33 mTorr and we starting leak testing.

The initial leak testing of the gas stripper system was again with the tester at L5. The gas stripper system vacuum would degrade when it was isolated from the accelerator (no pumping).

With the leak tester moved to the terminal, connected to the gas stripper pump-out port and the gas stripper system open to the accelerator our sensitivity to any nearby leak was improved. This was proven as we now found a separate leak at the carbon stripper manifold pumping valve. The valve was replaced.

No leak was found on or near the gas stripper system but the gas stripper system pressure would degrade when the system was isolated. We still had a problem and it was decided to reinstate the single gas system. The gas box was reconfigured back to its old setup.

What we found during the removal of the dual gas system to change back the single gas system.

Note: The SF6 bottle pressure had increased to 0.536 barG from 0.250 barG (TO#117 A)

Note: The O2 bottle pressure had increased to 0.520 barG from 0.22 barG (TO#117 A)

Note: The gas in the O2 bottle was sniffed with our halogen detector and it was contaminated with SF6.

Note: The computer control was programmed is such that the individual solenoids for both gas species are not open together but during a computer failure or a transition from one gas directly to another gas this may not be the case.

With the box re-installed and the leak tester connected to it in the terminal, quick sprays of helium had no response. But we taped the gaps around the box and any open holes and sprayed helium into the box and waited. We had a slow response leak. It would take ~3 mins to show up and would peak at ~6x 10^{-8} mbar.l/sec from a goodbase of 10^{-10} mbar.l/sec range.

Various configurations of leak testing were performed and it was determined that we had a leak between the solenoid valve and the box bulkhead fitting of the O2 gas inlet.

We pulled the box out again to investigate at the bench. The leak was reconfirmed at the bench with the same response time. Using bagging and taping techniques around the subassembly of concern, we isolated the leak to be the thread of the Swagelok screwed pipe fitting (torr sealed into the solenoid), the Swagelok tube connection or the solenoid body. It was also confirmed using the leak tester that this original solenoid valve leaked through and was not complete barrier in the system anyway. “Toss it in the bin”.

More swearing and we quickly decided rather than bury more time into the investigation of the exact leak location we would eliminate the solenoid and its fittings with a piece of tube in its place.

The piece of tube was fitted. The same taping up of the box, admitting helium and waiting for a response technique was used. No leak was found and the box was reinstalled. Leak testing of the installed assembly was now completed, without any leak as well.

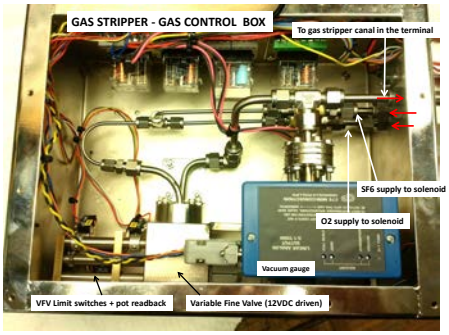
The variable leak valve was operated to establish a “point of opening”. The gas stripper vacuum degradation commenced at about 16% opening. This was considered close to the historical norm for operation.

The gas stripper system base pressure reading was less than 1 mTorr. The 20 l/sec ion pump near the gas stripper canal had “come alive” and adding confidence to the vacuum was improving. It was thought dead due to being asphyxiated by the higher than normal gas load.

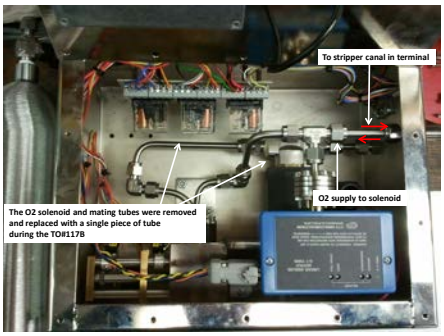
Tests were completed and with the gas stripper vacuum reading looking normal <1.0 mTorr, the machine was closed.

Note: One of us must have upset the black cat or worse, run over one!

Some 12 hours after having gas back in the accelerator, the gas stripper pressure jumped to a reading of ~9 mTorr. The pressure was reading in the range of 0.52 mTorr to 0.22 mTorr was recorded during the tank evacuation and gas up.



GAS STRIPPER BOX – SHOWING PIEWORK FOR BOTH O2 AND SF6 DURING TO#117A



GAS STRIPPER BOX - PRIOR TO MODIFICATIONS DURING TO#117A and B

Important details:

1. One tank pressure related leak was found and removed!
2. SF6 was leaking into the gas reservoir side(s) of the variable leak valve.
3. The above mentioned if a leak could not be found with helium leak testing techniques and with only 1 atmosphere pressure differential!
4. The SF6 bottle valves may allow gas to leak IN under tank pressure. The bottle was left in the accelerator and its pressure will be checked at the next TO.
5. We still have the poor gas stripper vacuum reading that appeared some 12 hours after gassing up the accelerator and it hasn't gone away.
6. Other than that all is peachy and fine!!

9 Terminal Faraday Cup (above the HE tube entrance)

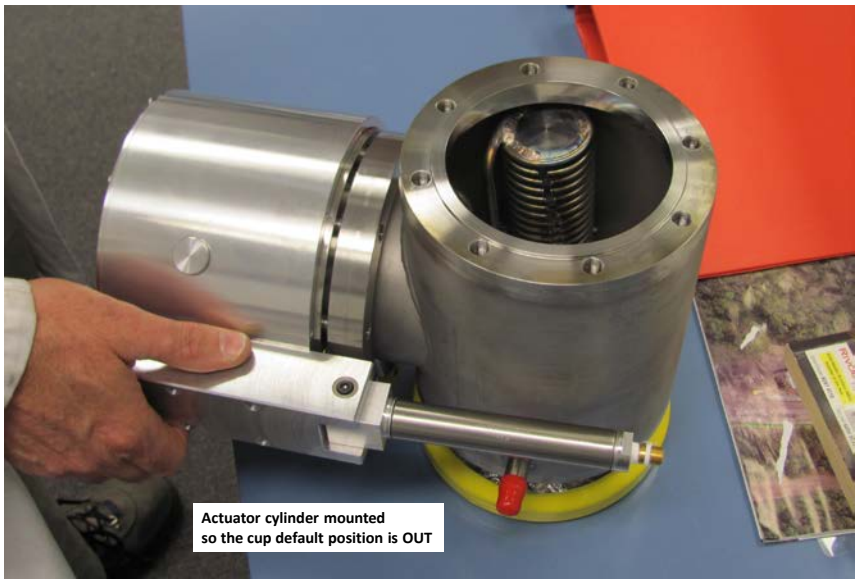
NEC head assembly, model FC18 pressure rated, part #2EA052950

NEC FC Housing, NEC6" flanges, 9"OAL, part #2EA038370

This unit was fitted with our in-house designed RF protection enclosure. This protects the position read-back switches and wiring. This cup is configured to default to the "out" position.

The terminal faraday cup bolts to the top of a short piece of 4" beam tube. These two pieces fit between a pair of bellows above the HE tube and bellow the terminal lens. The beam tube piece was an existing piece, with its own support system, but it was now 9" shorter to accommodate the new cup. The support structure required extending by 3.5" to position the tube clamp at the correct height on the shortened tube piece.

The log amp and suppressor supply will be fitted during the next tank opening as they were not available at this time.



TERMINAL FARADAY CUP – WITH ANU WIRING ENCLOSURE

10 HE Faraday Cup

This is an NEC FC18, 6” NEC flanges, part # 2EA001200

This unit was fitted as delivered from NEC. There is no ANU RF protection enclosure fitted and it is configured to default to the “in” position.

HE FARADAY CUP

11 Tank Slits

The tank slits assembly and its support column was raised 3” to accommodate the taller tank cup manifold. This was achieved by mounting the support column on 3” tall aluminium spacers and retaining it with longer bolts.

It had been noted during TO#116 that the left slit axes mechanism internals were making a noise during operation. The drive motor was decoupled and some resistance to rotation and noise was evident. It was found that the vacuum half (driven side) of magnetic drive coupling

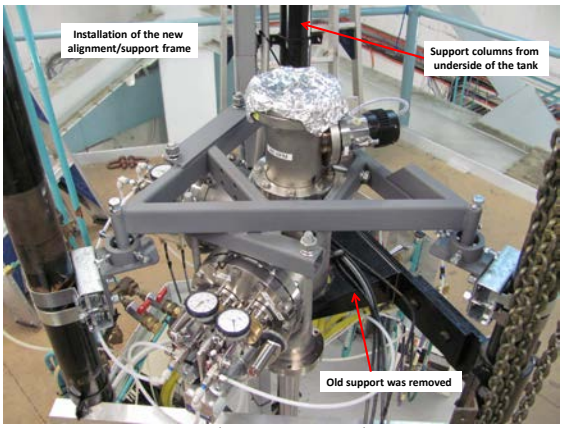
was touching the face of the thin membrane separating the magnet halves. The driven side magnet support shaft was fitted with a spacer washer to increase the magnet clearance from the membrane. It was reinstalled and operated quietly as well as rotating more freely.

The position of the slits was recorded prior to being removed by viewing with the telescope from above the tank.

The slits now elevated by 3" were positioned and its support column clamped down to the top casting before being re aligned and calibrated.

12 Object Slits

This unit from NEC is physically large and our pre-tank opening view of how it would be installed was quickly changed. It also provides support for the beam tube, HE cup as well as the chopper housing and RF boxes above. A new support frame was designed, manufactured and installed in a quite a short time. The age old principals of three points of support and adjustability in X, Y and Z to facilitate alignment where incorporated.



HE OBJECT SLITS (NEC BDS6 #2EA038701) AND NEW ALIGNMENT/SUPPORT FITTED DURING TO#117A

13 Perspex Alternator Drive Shafts

We found snail trail marks on two shafts and another shaft was slightly bent.

The shafts with snail trails were in Units #1 and #10. Both these were removed and the surface polished in a slow rotating lathe with fine grade of wet and dry abrasive sheet. They weren't highly polished as such. The Unit #1 shaft was looked at when reinstalled and with a torch light behind the shaft there was still evidence of a spark track in the perspex.

The slightly bent shaft in Unit# 23 was removed along with the casting bearing set at the top of this unit as it was noisy. The shaft was inspected using a polarized light and some stress was noted along the shafts length. The shaft was annealed at ~190C in an oven overnight, allowed to reach room temperature over several hours and then trued up in the lathe. The bearing set was fitted with new bearings along with the lower bearing carrier that was worn and now loose on the OD of the bearing. All ran smooth and true after re-installation.

We plan to purchase or prepare a stock of spare shafts to be ready for what may be evolving to be an increase of issues with the shafts.

We have replaced a few bearing carriers in the casting bearing sets over the last few tank openings.

14 Bearing Condition Analyser

Paul Frecker of IS Technik visited to demonstrate the Pocket VibrA vibration analyser tool and the associated C-Trend analysis software.

As mentioned, the LE shaft was run and Paul took measurements at the drive motor, casting zero, the casting bearings sets in U2, 4, 6, 8 and the mid-section alternator. He then used these results in a presentation to demonstrate the analysis software.

From this demonstration, the decision was made to procure the device for the department. In relation to tank openings, it will be used to take measurements at each shaft bearing and motor/alternator bearings to track and predict failures before they cause disruptions to machine operations.

4-4-11 AGM	MACHINE HOUR METER READINGS					
READING DATE	CHAIN #1 (**2M)** New @TO111 Swapped from pos 2 @TO#114)	CHAIN #2 (**1N**) New @TO94 Swapped from pos 1 @TO#114)	CHAIN #3 (**3L**) Back in service @TO114	LE SHAFT	HE SHAFT	CH VOLTS
20-08-12 TO#117	16713	16651	16752	30597	18430	15127
16/08/11, TO#116	13710	13649	13749	26003	26003	
CHANGE IN HOURS	3003	3002	3003			
ACCUMULATED TOTAL HOURS	7.732k	25.805k	67.546k			

15 Initial Performance

Conditioning was being undertaken without any shorting rods and was progressing nicely.