AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14 UD TANK OPENING REPORT # 109

25th August to 5th September 2008

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REASON FOR TANK OPENING

The emergency light in the top of the tank requires testing.

The platform motion safety light system was repaired so requires testing in the machine as the platform is set up.

The Terminal Ion pumps need to be removed for reconditioning so the tube requires venting.

The Terminal Stripper requires a new inventory of foils.

Eight refurbished Column Posts are ready so they will be installed in the units deemed to have the most worn posts.

Perform electrical and mechanical tests and inspect all idlers, chains, pulleys, bearings, shafts and resistors.

Clean the machine column and walls.

PUMP OUT 25-08-08

- Pump out tank, open doors and start ventilation system.
- The ventilation system was run overnight and the Oxygen monitor was used to check air quality before entering the machine.

SUMMARY OF WORK: 26-8-08 to 5-09-08

26-08-08

- The emergency light at the top of the tank and the platform safety lights were successfully tested.
- The High Voltage tester was used to perform the usual 30 kV gap test.
- The column was wiped with RBS and water.
- The shafts and chains were run and the only item of interest found was a slight clatter in Unit 19 idlers. This was noted for latter attention.
- The tube was let up during the initial tests.
- The Terminal Ion Pumps and the Terminal Stripper were removed.
- Outside, the High Energy slits were removed, as a unit, for installation of newly manufactured Tantalum jaws.
- Charging Chains 2 and 3 were inspected and issues to do with elongation of the rivet holes were found in Chain 3. These were noted for attention after the post installation.
- Unit 5 received four refurbished posts, but not without problems.
  While placing the third post of four it was found that there was a post-to-post difference in length. Since the tolerance is + or – 0.001" a period of measuring ensued. All refurbished posts were within specification and it was discovered that an original factory reclaimed post was 0.003" too long. That is not the whole story and it will be addressed in the Column Post section of this report.

27-08-08

- Once the crew were happy that the post length issue was understood then Units 5 and 9 received their new posts without further problems.
- Units 6 and 11 are the only ones left with original posts.

29-08-08

- The Terminal Ion Pumps and Terminal Stripper were reinstalled and the leak head was fitted to the Stripper roughing port.
- The tube was evacuated over the weekend.

1-09-08

- While work on the tube vacuum was being done outside the tank the Chains again received attention.
- Two links were removed from each of Chains 2 and 3 as the above mentioned elongation had reduced motor leg clearance to an unacceptable 20 mm.

- Meanwhile, as a result of over the weekend pumping, the tube pressure was found to be 2 x 10^-6 torr in both the LE and HE tubes
- Unit 5 had new ring screws fitted.
- The Gas Stripper Turbo Pump Trap heaters were turned on to expel accumulated contaminants and, as expected, the vacuum pressure reached 4.4 x 10^-4 in about one hour after which the heaters were turned off.

2-09-08

- Overnight pumping found the tube pressures recovered well to LE 3 x 10^-7 and HE 6 x 10^-7 torr.
- The terminal area was thoroughly helium leak tested and the rest of the tube was checked at each flange joint.
- The lower Terminal Ion Pump was started at 10:00 and, by 10.30, achieved 2ma at 1 X 10^-5. It was turned off at 11:45 at 1.2 mA and 8 X 10^-6.
- The upper Terminal Ion Pump was started at 11:55 and shut down at 16:40 at 1.3 mA at 8 X 10^-6 .
- The terminal was cleaned and the inductor clearances checked. Chain 2 upside inductor had too much clearance and was reset using the gauge.
- The resistors were reinstalled in Unit 9. New ring screws and stringer lugs were installed. Two resistor leads and nuts were replaced in U9 due to poor banana plug contact and alerted by spark marks on the connecting wire loop.
- The shafts were turned on to power the 300 l/s pump in top of the tank:
- LE = $5x10^{-8}$, LE Mid =$1.5x10^{-7}$, Term Upper = $1.5x10^{-7}$, Term Lower = $4.3x10^{-7}$, HE Mid = $1.5x10^{-5}$, HE = $7x10^{-7}$. Note the poor vacuum at the HE Midsection ion pump.

3-09-08

- Unit 10 was closed and all Terminal functions were tested.
- The reverse stop position cam in the Terminal Foil Changer motor was rotated anticlockwise a small amount to better align the reference marks. The three micro switches were found to be slightly loose so the clamp screws were tightened.
- The Terminal lower spinning was closed.
- The Corona Needle assembly rod tension was found to be satisfactory.
- It was noticed that the a few pellet-to-pellet gaps, on Chain 3, were as much as 7.4 mm. Since a new chain is 5.4 mm it was investigated further. Generally the gaps were in excess of 6.5 mm so the pin was removed from the worst gap set and was found to be badly worn. Immediately thoughts turned to likely spare chains as Chain 3 was not looking a good prospect for lasting till the next opening. It had operated 77,100 hours.

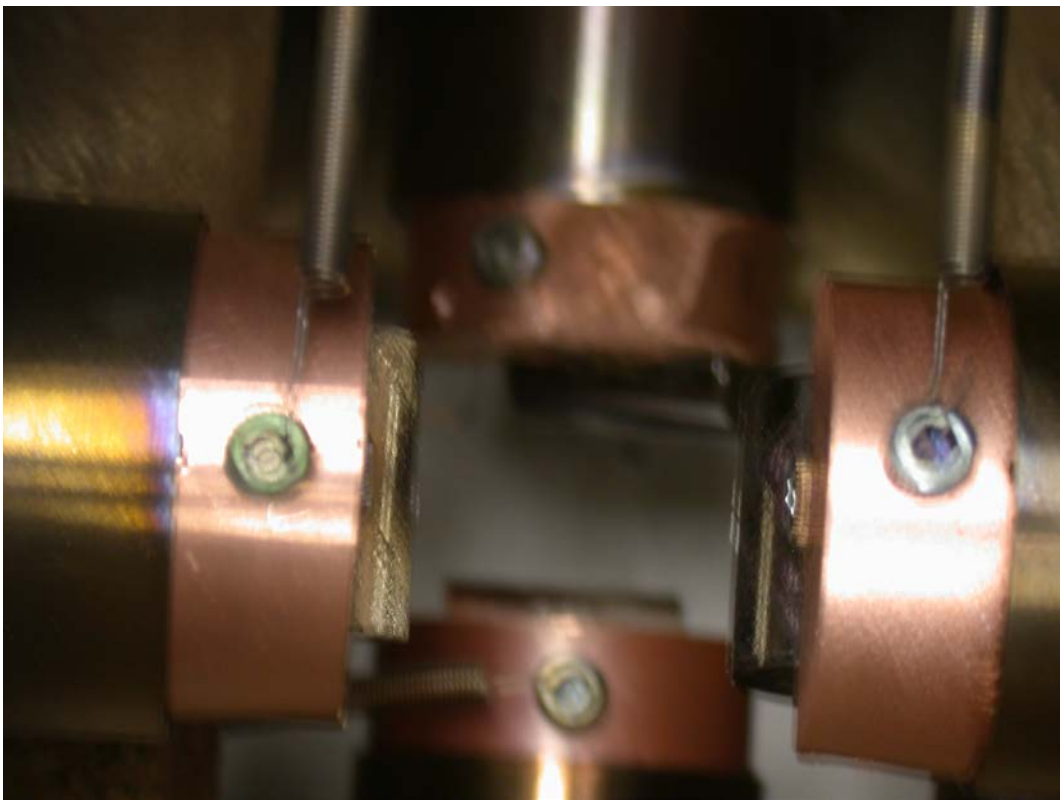
An old spare chain was found to be much less elongated and was selected to carry the torch over the next 8 or so months. This was the chain removed two years ago from the #1 position and had about 56,000 hours.

4-09-08

- The Corona Needle assembly was changed because one needle had been melted.
- Below the platform the machine was cleaned, inductors set and the Chain 3 brush was checked for length.
- The column was wiped down with RBS and water and the HV gap test was done.
- Charging tests found a periodic discharge on Chain 3 that increased in frequency with increasing charging voltage and current. Oiling the chain by hand and resetting the charging inductor eliminated the problem.
- Metering tests were done and the machine was closed.

HIGH ENERGY SLITS

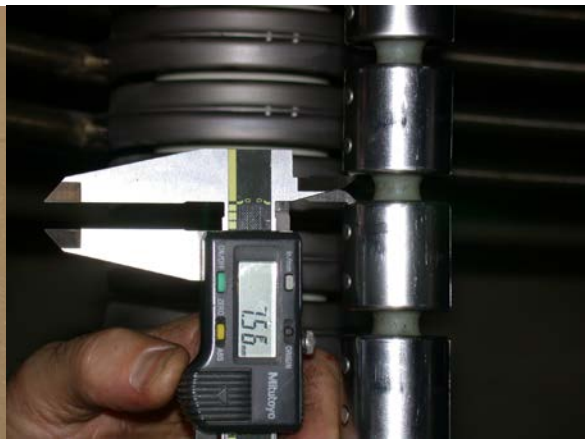
The High Energy slits were vented to atmosphere separately from the tube. The old slits were composed of a Ta rod silver-soldered to a copper block. Because they had been exposed to high beam intensity with the water-cooling off, two of the silver solder joints failed allowing one of the slit jaws to move one mm into the beam path.



The jaws were checked for radioactivity and were found to be emitting over 100 micro sieverts at their surfaces reducing to 10 micro sieverts at a distance of 30 cm. They were carefully removed using long pliers and wrapped in lead sheet for storage in the Radioactive Materials Locker.
They will be remeasured in 90 days and disposed of if they are found to have cooled down, otherwise they will be checked after a further 90 days.
Newly jaws, made entirely of tantalum, were fitted and the unit reinstalled in the high energy beam line.
The Taylor Hobson telescope was set up on the Analysing Magnet alignment cup and zeroed on the stripper canal in the terminal.
The slits were wound in, in turn, and set to zero where each dial gauge was zeroed. Finally, one of each opposing pair was set to zero using the dial gauge and then the respective opposing jaw was wound in until the opposite dial gauge moved slightly. This demonstrated that contact between each pair of jaws was made at zero. It was thought probable that the slits are set within 0.002” of zero.

CHARGING CHAIN 3M
During the initial mechanical tests it was found that Chains 2 and 3 would require shortening by two links.
Chain 2 was shortened, however, while shortening Chain 3 it was noticed that a few of the nearby pellets had overly large gaps between them.
The worst of these was 7.5 mm while typically the gaps were generally greater than 6.5 mm. The widening of pellet to pellet gaps, from the 5.5 mm gaps in new chain, shows the cumulative effect of wear in the pins and pin bushes to be quite extraordinary and alarming.
The pellet that measured 7.5 mm was removed and the pin was found to be scored to depth of at least 0.010” on the loaded side. The pin hole in the Teflon bush was elongated and the bush had deformed within the hole of the nylon link. The bush was also had several cracks through its thickness.

Worn Pin



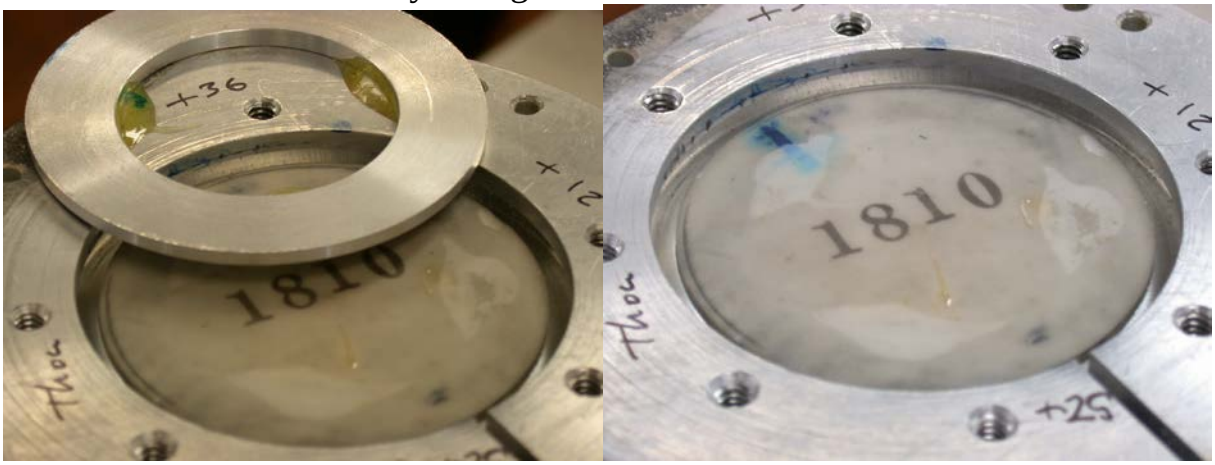
Gap measurement

It was obvious that Chain 3M was very tired at 77143 Hrs and, since we had a lower hour spare on hand, was replaced. There was some confusion about the identity of the spare but, after much diligent detective work, the correct identity was found, it is “L” at 59370 (56000) Hrs. Further investigation found another spare, Chain 1K also at 14700 that records had alluded to, but 3L had already been installed by then.
The crew were reminded that careful tagging of parts is a necessary procedure, particularly, when finding stored parts many years later.

These photographs show an accumulation of material in the space on the unloaded side of the pin diameter. On right the material has been removed. Note the radial cracks in the bush.

COLUMN POSTS
Unit 5 was chosen to receive the first four of the refurbished posts.
Position D Installed Post #228 removed #350

Position C Installed Post #243 removed #515
Position B Installed Post #2044 removed #292
Position A Installed Post #295 removed #1810
There was a scare when replacing #1810 in position A. The casting was jacked apart until there was sufficient clearance to slide #1810 out of place. When the new post #295 was slid in beside #1810 it was noticed that there was excessive clearance between the castings.
It was thought that #295 may have been short so a session of measuring posts ensued.
The four new posts were found to be absolutely on spec at 19.250" = or – 0.001". In fact, the original fitment posts were typically 0.003" over but this did not explain the much larger clearance noticed when liberating #1810.
It was soon realised that one end cap on #1810 was loose and that the titanium electrode sprung the cap off as the end load was removed. This gave the impression that the post was approximately 0.035" longer than it actually was when loaded.
The post #1810 must have been subject to an error reclamation strategy when originally manufactured. It was probably not accidental that it was placed high in the column where loads are at a minimum.
Since there would have been a fair amount of labour and materials already invested it was reclaimed by fitting accurate



aluminium spacers to each end. These spacers were attached to the ceramic using "Epoxy" and were machined square so that they would accurately transmit the casting loads between the castings and the post's ceramic elements.
The actual aluminium end caps are unique in design and of a type not previously discovered in our machine. The normal end cap overlaps the ceramic to ensure transfer of load to the ceramic.
Once the post situation had been understood then the remaining four new posts were fitted to Unit 9 with no problems.

Whilst the ABCD positions of the new posts were not recorded it is known that posts #s 297, 344, 224, 317 were installed in Unit 9 and that Post #215 and three unmarked posts were removed.

TERMINAL ION PUMPS

The terminal ion pumps were removed early in the opening so that reconditioning could be done in parallel with other work. As expected, they were very flakey consistent with 45000 hours of operation at 10^{-6} torr. Most of their hard work occurred on their first operation so we expect much longer lifetime for the built pumps. The pumps were stripped down to empty shells and then acid cleaned, rinsed and baked. There was some trepidation whether the new elements were the correct ones. They indeed were perfect thanks to information from NEC, Gamma Vacuum and Stanton Scientific. NEC bought the pumps from Physical Electronics who were sold to Gamma Scientific though the design and origin is Perkin Elmer.

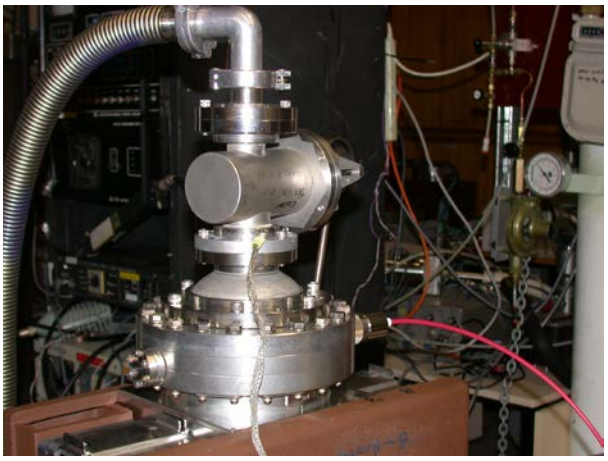
Body ready for cleaning.

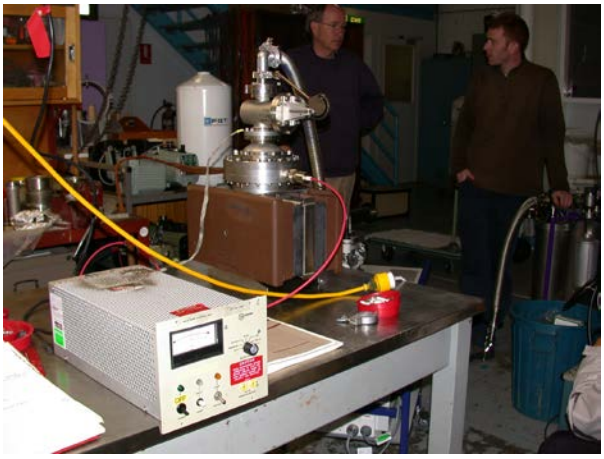
Note spark marks at 2 and matching marks On the body above.

The new elements were fitted, the magnets reinstalled and they were run in turn outside the tank using a spare power supply. They started almost immediately.

These pumps and our rebuild have proved excellent. Once they were proven to be working well they were installed back into the terminal.

The photos show spark activity between the return yoke and the stainless pump body. This is the case for both pumps even though they are in different positions relative to the surfaces in the terminal. The yokes are painted and may not have been in DC contact with the pump bodies. Paint was removed under the screw head on the attachment of the yoke to the body. We may remember this in 10 to 50 years when the pumps next need service.





Once the tube pressures were in the 10^-7 range, at the LE and HE gauges, the lower ion pump was started. It read 5 ma after 5 minutes and 1.2 ma after 1.75 hours when it was shut down. Even though the pumps were exposed to air after being pumped off line, they started brilliantly.
The Upper Ion pump was started at 11.55. It read 1.5 ma 2 hours and 1.3 ma after nearly 4 hours.
The refurbishment of these pumps has been very successful and should restore performance when using gas stripping.

TERMINAL TURBO PUMP TRAPS
The heaters were turned on for the two fore line traps on the gas stripper recirculating turbo pumps. After an hour of out gassing the HE pressure had risen to 4.4 X10^-4 and then started to recover and so the heaters were turned off.
The sublimer pumps were run at 40A for a half hour to help recover the vacuum and overnight the system was back to LE 3 X 10^-8 and HE 3X 10^-7 torr.

MACHINE HOUR METERS 1-09-08

CHAIN 1	CHAIN 2	CHAIN 3	LE SHAFT	HE SHAFT	CH VOLTS
6195	6194	6194	11579	11579	11579

INITIAL PERFORMANCE

The accelerator initially conditioned to 13.8 MV over two days with very few sparks. The first conditioning was vigorous in the HE tube, which was consistent with the poor vacuum at the HE Midsection (U19). The X-ray flux was high for terminal voltage up to 12.25 MV with the vacuum at the HE Midsection a factor of 10 worse than elsewhere. Units 15 to 21 were conditioned, over two days, to 7.3 MV for 6 2/3 units – the SF6 limit. All the shorting rods were removed and the whole machine conditioned to 13.8 MV and then turned over to the experimenters.