ORIGINAL

AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT NO.14

Four openings: November 28th to December 6th (9 days; 7 working days)
December 7th (1 day)
December 18th (1 day)
January 4th (2 days)

PREAMBLE:

The 14UD was last closed on August 30th and during the 90 days between then and this opening the accelerator performed excellently. The analyzing magnet was unstable for some time because of coil insulation troubles due to it being run at high current when the cooling water chiller had failed.

This opening was a scheduled one in order to change foils and carry out general service before Christmas and also to install a new chain in the empty No.3 position. Other work, already prepared for, would be carried out in the 9 days allotted, depending on progress.

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THE FIRST TANK OPENING

EXAMINATION:

The initial ritual inspective cruise up and down the column revealed a small quantity of sand on the castings accumulated at the bases of the posts. There was also an accumulation on tube section flanges and there was a characteristic light grey deposit on the rings. The blank (pointless) faces of column point assemblies were some orders of magnitude cleaner than in the days before oil was removed from the tank gas (Report No.10). The tube corona point assemblies were cleaner than the column ones as has always been the case. The usual patch of brown on the terminal opposite the triode needles was about 6 inches by 12 inches and was fairly dry. The stabilizing triode needles seemed very dull and clearly needed changing although their dullness had not affected their performance.

Corona point assemblies used as washers to hold a strapping wire across the centre third of a post in Unit 19 were loose and drooping. The quarter inch diameter aluminium stringer rod in Unit 19 between tubes 1 and 2 and the column post had eroded at the post; the holding screw was lying on the casting. The rigid rod was not drooping since it was held tightly on the tube, but there was a quarter inch gap between the eroded end of the rod and the post bracket.

These contact failures in Unit 19 were the probable cause of the poorer voltage stability when operating in single stripper mode. With the second stripper in, there presumably was sufficient radiation locally to "reconnect" the various failed contacts.

SHAFT BEARINGS:

All 30 bearings in the HE shaft alternators were replaced after 6,300 hours service. Report No.9, page 4 describes brushes fitted in casting 27 to shunt spark currents past the bearings and Report No.12, page 4, the failure of the brushes. New brushes, 55% carbon and 45% copper were fitted and will be reported on after

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sufficient hours running. The LE shaft was listened to with a stethoscope and the section in Unit 6 was found to be vibrating due to misalignment; it was realigned.

STRIPPERS:

The terminal foils were renewed. When the foil unit was taken out it was found that screws supporting and aligning the cantilevered foil train were loose. There was clear evidence that the beam had been way over to the edge of the foils and partly hitting the frames because of the misalignment.

The centre third of Unit 19, where the HE stripper occupies the final third, had been shorted to the stripper to reduce electron extraction from the foil (Report No.13, page 2). We reported that the collimator in the stripper had shown resistance of the order of kilohms to local ground and we were thus unable to use it as an electron suppressor. Measurements were repeated at 5 kV resulting in a value of about 400 megohms. Accordingly we installed a fixed 5 kV suppressor supply connected to the collimator in the hope that it would provide adequate electron suppression. The centre third of Unit 19 was once more back in use and should produce a gain about 350 kV. The second stripper has now been used and the suppression arrangement is satisfactory. The post electrodes in the lower third were strapped with 0.040 inch copper strip and the corona assemblies were removed.

Pneumatically operated reversing gears were fitted to both strippers.

CHAINS:

A new chain was installed in No.3 position. It was stretched by leaving lead weights on the motor pivot for 48 hours and two more links were removed after stretching. Chains 1 and 2 were cleaned with alcohol and all three chains were oiled manually by the time-honoured method of caressing them with oily hands until they had a uniform, faint film. Oil is transferred to the driving and terminal pulley rims and they do not need oiling, but get a careful harmless smearing just in case. In casting 25 for Chain 3 only, both up and down stabilizer idler systems were replaced by an ANU design in which a brush removes charge from the inner race. It is hoped this will reduce bearing failure. The idlers are fixed to a shaft which runs in two sets of bearings instead of having each idler fitted with a pair of bearings running on a fixed shaft, as in the NEC design. Any improvement in lifetime will be reported at a later stage.

CASTING COVERS:

We omitted to include in Report No.12 that a contoured casting cover was fitted at casting 15. At this entry we found, on the contoured cover at 15, 10 spark marks, though there were none at the rounded joins between halves of the covers or at the rounded screw access holes. Their minor stress points had not preferentially suffered spark damage.

Since the attainable voltage had been steadily improving before the introduction of the new cover, and had not worsened since, we fitted more contoured covers and now have them at three castings each side of the terminal. While we continue to prove to ourselves that a column as immaculately free from particulate matter as possible lends itself to high voltage performance, we are at present satisfied with the justification for changes of surface shapes at critical places and have ordered, and received, new upper and lower terminal spinnings. We intend, early in the new year, to have a major shutdown and remove low energy beam transport components, and take off the top of the tank; then the existing upper

and lower terminal spinnings will be removed and the new ones put in. After this not insignificant exercise we shall report our delight, satisfaction, disappointment, or even less favourable emotions in proportion to our estimate of the return for the investment of both money and effort.

MISCELLANEOUS:

In preparation for control of various functions and parameters planned for the future, 12 additional nylex pressure tubes were fitted from HE base to the terminal, ready for use.

Another sand mine was stumbled upon when one of the authors, blowing nitrogen into the depths of a casting, promptly received a cloud of grit in his face. Mines seem to become less cohesive with time because, undoubtedly, this recess had often been blown before without any reproach from its contents.

CHARGING TESTS:

Immediately prior to button-up the usual checks of inductor settings were made and the chains were run to observe their mechanical stability, then run in darkness with increasing voltage applied to the inductors to observe onset sparking and its uniformity. Though sparking occurred satisfactorily for the new chain there was no charging current at first, and then less than half that of the other chains. After confirming that metering circuits were functioning correctly the test was repeated and charging current increased slowly until it was the same as for the other chains. The phenomenon was attributed to conditioning, that ubiquitous effect which provides solutions to similar problems throughout the accelerator and the sources which conveniently go away of their own accord when there are more pressing matter to attend to.

BUTTON-UP.

By working continuously on Wednesday the doors were closed by 8 pm and the tank roughed all night. Next day, when at about 20 psia SF_6, it was clear that there was a significant leak on the tube. The gas was taken out again and the doors opened by about 3 pm.

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THE SECOND TANK OPENING.

The residual gas analyzer was already operating on the LE end of the machine and needed only to be set to helium to serve as a leak detector. Although the only part of the vacuum system disturbed during the first opening was the terminal stripper, it did not leak. A whiff of helium in the feedthrough box of the upper sublimer put the gas analyzer off scale. Eventually one of the 12 sublimer feedthroughs, but not the one in use, was identified as leaking. The torrseal put on a long time ago had lost its bond and peeled off easily, and a new dose was applied. Since the pump feedthroughs had not been touched in any way the injustice with which random leaks can occur was noted sadly.

The doors were closed on Friday morning and after gassing up to 60 psia the LE pressure was 1×10^{-8} and HE about 4×10^{-8}.

Late on Friday the 14UD was given to the experimenters who ran Be with about 9 MV on terminal. We were happy to find, once more, the superb stability described in Report No.12, page 4. The accelerator ran for 3 days like this and then the gas

was increased to 88 psia so that high voltage conditioning could begin. The entire column went readily to 13.4 MV and then shorting rods were used in order to run a limited number of units in the million volt plus region without high terminal volts. The first beam using high voltage was ^{7}Li at 52 MeV and with 13 MV on terminal.

A day or so later the lower shaft began to trip out and would only run for a short time after resetting. On Thursday measurements outside the tank revealed low resistance to ground and a short between two phases at the power feedthroughs. This could be the pyrotenax feeding the motor, or the motor itself, and opinions in the darkroom evoked a few bets which later the pyrotenax factions, who had banked on memories of past failures, paid up grudgingly to the motor enthusiasts.

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THE THIRD TANK OPENING

The 14UD ran for four more days with no lower shaft, which meant no lower terminal pump and no illumination on the HE stripper counter. The tank was pumped out again on the following Monday. The pyrotenax was unmarked and the shaft motor had a short between two phases. We had not intended to lower the platform but, because of an instability which was reported just prior to the third opening, we decided on an exploratory cruise past the column and lowered the platform with one light and none of the usual luxuries, such as dust-absorbing carpets and telephones. Nothing undesirable was found anywhere on the column and the doors were closed without the ritual of tac-ragging the rings, now invariably applied however brief the tank opening, because we decided that invariability was a relative quality, and not to be taken dogmatically. However, the failure to be relentlessly thorough gave rise to misgivings as to consequent "eerie stability".

The imminence of Christmas, and its various enthusiasms, encouraged slow and careful conditioning for a day or so while an experiment was set up unhurriedly in case there was time to begin it before the holiday. All units were conditioned, in groups of from 3 to 8, up to 1.05 MV/unit over a period of three days. (Note that after the holiday, the machine immediately achieved 14.22 MV stably, and sparked at 14.25 MV). When a test beam was put through the accelerator, and analyzed, "eerie stability" was evident. This excused, if not justified, our dictum that invariability, in terms of tac-ragging, is relative. We recommend, however, that tac-ragging is never omitted unless it has been carried out thoroughly in the very recent past when build-up of dust particles on the rings has been eliminated. It seems that a brief tank opening, when filtered air is blown constantly through the tank, does not constitute much of a problem so far as an already clean column is concerned. Booties, from size green to size blue, were worn at all times.

LOADING FROM HIGH ENERGY STRIPPER:

Following the biassing of the centre tube section in Unit 19 it remained to be seen whether the electrons from the foils had been suppressed. The method was a complete success and the gain of 350 kV by leaving the section active was accomplished.

For an ^{18}O beam on the HE cup (i.e. not analyzed, and therefore including all charge states) the values were as follows:

	MV	Lost charge	HE cup current
HE foil in	12.73	30 microamps	9 microamps
HE foil out	12.83	25 microamps	7.3 microamps

The 5 microamps additional loading is probably due to beam scatter and not foil electrons. The residual 25 μA of loading is associated with beam losses in the low energy tube.

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The final button-up was the 10th of the year. The last two do little for our statistics, but there was a period of two months, and two periods of three months without an opening; also there was a one day affair when an opening was required by no more than the necessity to change foils.

OTHER MATTERS:

Condition of the tubes:

Stimulated by a letter of enquiry from Dr. Münzer of Munich we studied in detail the tube section removed from Unit 19 which we took out when the high energy stripper was installed. This section had experienced the full life of the machine, some five years, and it was assumed to be typical, also it had displayed no symptoms to suggest that there was anything wrong with it.

The resistance of the various insulating gaps was measured at 5 kV, first with the tube open to room air and then with dry nitrogen in it. With air the resistance was lowest, about 2×10^9 ohms, across gaps marked by electrode discharges. These marks were dark smudges on the ceramic adjacent to 'splat' marks on the electrodes. With dry nitrogen in the tube the gap resistance rose uniformly to 500×10^9 ohms. In order to observe the effect of hard vacuum for the same test, when we were in the tank the gap resistances of the centre tube section in Unit 15 were measured after taking off the corona point assemblies. The resistance of all gaps was 50×10^9 ohms. We have drawn no conclusions about the apparent factor of 10 lower resistance under vacuum than under nitrogen; the test instrument was at the limit of its range and the tests were separated by over a month. The resistance under vacuum is adequately high and uniform to assure satisfactory performance.

Residual Gas Analysis:

A Vacuum Generators Micromass 2A residual gas analyzer has now been installed at the low energy pumping manifold. Several spectra are included. Our experience of interpreting the spectra is quite meagre. The effects of an SF_6 leak can be seen clearly (#4 and #5), likewise the difference when the sputter source is using ammonia (#3) and oxygen (#2). The isolated machine spectrum (#1), shows a large H_2O (mass 18) peak. The large ratio of 28 to 32 suggests that the 28 may be mostly from CO rather than N_2. We shall continue to monitor the residual gas spectrum in order to gain a firmer understanding.

Ferrofluidic seal:

The indium seal enabling the source inflection magnet to be swung without breaking joints was replaced by a ferrofluidic seal. As yet there is no isolating valve on the magnet which is let up to argon and then pumped with a vacsorb after reconnection to the source. The device works excellently and recently one of the authors, working alone and therefore unhindered by the other, swung the magnet

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from the lithex source to the sputter source and had beam on the LE cup 27 minutes after closing the valve on the lithex line. This includes disconnecting and re-connecting line flanges, pump-down and changing the high voltage supply cables and interlocks. We claim this as a record for the southern hemisphere.

Tac-rags:

In Report No.13 we said we were enclosing a free sample of Tac-rag; unfortunately the samples were omitted, but are included with this report. Tac-rags are large sheets of muslin-type material treated with a tacky substance which sticks to the hand, but leaves no trace of stickiness on the surface cleaned. The manufacturers state that Tac-rags are free from wax and silicon. The sheets are folded to form a pad about 4 inches square and the pads can be opened and re-folded so as to contain the dirty used areas and present unused clean areas for use. We use about 10 Tac-rags for the entire column when cleaning rings and spinnings only; when the units are open we clean ceilings and floors of each unit as well, and this takes a few more rags.

Heater plate electrons:

Electron loading from the heater plates in castings 10 and 11 has recurred, (Report No.9, page 7). The signature of this problem is an increase in x-ray activity above 1 MeV from a background rate of 200 to 7,000 counts/sec. The lost charge from this source is negligible, as is the radiation compared to that occurring during normal transport of beam.

Analyzing magnet:

During October the chiller for the analyzing magnet failed and, because of improper setting of the trip, the coils ran for about a day at 40°C. Insulation problems developed and the magnet became very unstable. By isolating a coil section the stability was so much improved that the technique of benign neglect was applied for a week or so when it was discovered that there was again full stability when the section was put back in circuit.

A power failure over the Christmas period caused the magnet to trip, but water at 32°C was circulated through the coils. Water leaks developed as a result and the magnet was again unstable. As a temporary measure the magnet is being stabilized by the NRM.

NEW YEAR:

We wish all our readers a very happy one, and much success with and pleasure in their accelerators.

D.C. WEISSER

T.A. BRINKLEY

January 2nd, 1979.

ADDENDUM FOLLOWS.

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ADDENDUM:

THE FOURTH TANK OPENING

On the day of return to work after the holiday, while warm wishes for the new year were still being cheerfully exchanged, Chain 1 broke and put an end to such irresponsible frivolity. The chain had been fitted in October 1975 and had clocked over 12,400 hours running time.

An inductor support was broken and shimstock contact rims on both pulleys had to be replaced. A brand new chain was put in and the tank was closed in a bit over a day and a half after the column had been thoroughly Tac-ragged.

D.C. WEISSER

T.A. BRINKLEY

Enclosures:

Excerpt from Dept. of Nuclear Physics Annual Report, 1978.
Recordings of residual gas analysis.
Sample of Tac-rag.
Photograph of marks inside tube section.
Machine schedules.

14 UD TANK OPENING
REPORT NO. 14

#1

ISOLATED SYSTEM
1.6×10^{-8} TORR

16 18 20 28 32 40 44

#2

^7Li BEAM
O_2 gas
3.5×10^{-8} TORR

16 18 20 28 32 40 44

#3

Be H BEAM
AMMONIA GAS
2×10^{-8} TORR

16 18 20 28 40 44

#4

SF_6 LEAK
6×10^{-8} TORR
Linear

16 18 20 28 40 44 51 54

#5

SF_6 LEAK
6×10^{-8} TORR
LOG

16 18 20 28 32 40 44 51 54

SF_6^+ SF_4^{++} SF_2^+ SF_3^+ SF_4^+ SF_5^+

51 54 70 89 108 127