AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT NO.22

October 2nd to 8th, 1980

(7 days open; 4 working days)

REFERENCES: Earlier Tank Opening Reports are referred to by the notation 12/4 etc, meaning Report No.12, page 4.

REASON FOR THE TANK OPENING

A serious tube leak developed.

PREAMBLE

The tank was last closed on August 15th following a major shutdown during which the accelerator tube was open for 28 days. Performance immediately after the tank was closed was reported earlier (21/10). Though there was an undeniable setback to conditioning, both tube and column gave little trouble at about 13.5 MV. Until higher voltages can be maintained the success or otherwise of the new spinnings cannot be gauged fully. However it was clear that the eerie stability which deserted us sometime after April had not returned.

Charging current for Chain 2 became very erratic at times and by mid September terminal instabilities had worsened sufficiently for us to plan a tank opening in about a week or so to investigate.

The external stripper, which we realized was in the wrong place (21/11), was removed from its position before the analyzing magnet and installed before the switching magnet which will now be the final charge state selector. In its new position the stripper worked very satisfactorily when first tried. A beam of 100 MeV $^{79}Br\ 9^+$ was analyzed and put into the stripper. Charge state 20^+ was selected by the switching magnet for an ion-solid experiment.

While the machine was operating at 13.1 MV a spark occurred (the machine was sparking about hourly). Suddenly additional sparking started at ever decreasing terminal voltage until a spark at 4 MV induced the experimenter to notice that the H.E. tube vacuum was 1×10^{-5} torr. The machine was turned off. Some time later the H.E. tube pressure was seen to be at 2×10^{-4} while the L.E. was 1.2×10^{-7}, with all pumps working except the H.E. ion pump which had tripped. Such a gradient across the tube led to a certain amount of disbelief but the pressures were established as real and the leak was indicated to be in the tank.

We began pumping out the gas and the tube pressure improved steadily. The gas was all out late in the afternoon by which time the L.E. pressure was 4.6×10^{-8} and H.E. 1.5×10^{-6}. The leak was clearly near the end of the H.E. tube.

THE TANK OPENING

Exploratory tour:

Before attempting to find the tube leak the column was examined for possible causes of instability. The ring immediately above the top terminal spinning was loose and almost certainly contributing to instability. Several 'stringers', which tie the intermediate heater plates to the column at two places in each unit, were loose on posts, even though shakeproof washers were fitted. Three years ago we reported (9/5) a reason for changing the original stringers which were .040" nickel wires. We fitted instead ¼ inch aluminium rods in 3 units each side of the terminal and later we recorded (10/4; 11/4) that, because there was no evidence of accelerator wear on corona points, ¼ rods were put in throughout the column. Since then we have noticed that the rigid rods tend to loosen and suspect that these instances cause instability.

We found a lot of trouble with the chain stabilizing idlers just put into the machine in July. The idlers with an ANU shaft and bearing system fitted nearly two years ago (14/2) had consistently performed well (19/2). Consequently all the remaining idlers were converted to ANU versions at the last tank opening (21/6).

At this present opening some of the new idlers were in very bad condition; pulleys were loose and there was spark erosion on shafts. The two year success of the prototype sets remained a mystery in the light of the undeniable failure of those fitted only two months ago.

AND SO TO WORK!

The vacuum leak

A leak detector was set up on the H.E. pump manifold just underneath the tank. The leak was very quickly pinpointed at a feedthrough on the upper of the two unconnected heater plates in Unit 26. Before opening the tube to replace the heater plate the entire H.E. tube was leak chased, with special attention to Unit 19, however no other leak was detected.

The tube was let up to argon extremely slowly in order to minimize loss of conditioning which occurs with turbulence. The heater plate was changed and other matters attended to while waiting for good enough vacuum to test the two new seals (eventually found to be successful).

The H.E. base pressure had now returned to mid 10^{-8}. It is possible that a small leak has been present at the failed heater plate for some time.

Stringers

The original NEC 0.040" stringers were adequate and had only been supplanted by 0.250" ones for speculative reasons. The 0.040" would corona in air along with adjacent corona points, but this was not the case for 0.025" rods. The loose stringer rods which we found caused us to remove all the rods from the H.E. column and replace them by 0.065" phosphor bronze wires which probably will not corona. It was especially convenient to perform this change-over at this time because all the rigid stringers above unit 26 had to be detached at one end to allow the tube to be lifted when changing the heater plate.

Stabilizing idlers

The ANU prototype idlers used 7.5 mm long contact brushes between the bearing housing and rotating axles. The production devices contained brushes 4.5 mm long. On the assumption that length of the brush in the cylinder housing affected its r.f. contact efficiency the longer brushes were fitted to the production devices. Plans are under way to install spark shields around the chains as is done in MPs and the 25URC.

Chains

The last of the three chains we bought three years ago was put in No.3 position left empty at the last Tank Opening (21/10). Once installed we found that the chain had a substantial twist which corrected at the terminal pulley when the chain was turned slowly by hand, but reappeared away from the pulley. The chain was removed and our last spare one put in; this had no twist.

The twisted chain was hung in the tower. From the top end to about the centre we found a progressive twist of almost 180 degrees. From the centre to the bottom of the chain there was no twist.

The twist can perhaps be attributed to the fact that the chain had been stored on an 8" diameter spool for three years. The chain with no twist had remained on its 10" NEC spool for two years.

The chain has now been hanging for three weeks with the weight of the straight half tensioning the twisted half and there has been no reduction in twist. We have written to NEC for advice, but as yet there has been no time for a reply.

COLUMN: Terminal spinnings.

The new upper and lower terminal spinnings which were put in some weeks ago in pristine condition, were examined for spark marks. The upper spinning had three marks, one at six and a half inches from the top and two at nine inches. On the lower spinning there were only two marks, one at eight inches and the other at sixteen and a half inches from the bottom. There was no evidence of new spark marks on the rings adjacent to the spinnings and this is our first evidence that the new contours are having the desired effect.

COLUMN: Equipotential rings

For some time we have found an increasing number of loosened screws which press rings onto column post electrodes. This leads to accelerated spark damage to both screw threads and post electrodes. We have made it a discipline to remove and replace loose screws with longer ones which go deeper into the thread and remain much more mechanically stable. Loctite is not being used on the replacements.

MISCELLANEOUS

No foils were changed, and, in fact, only the lower terminal spinning, which covers the terminal charging pulleys, was lowered. No unit in the L.E. column was opened, though, of course, all point assemblies were checked visually and the ANU rigid rod stringers were all tested for looseness through the rings using a lever.

SF_6 STORAGE VESSEL INSPECTION

All the SF_6 was pumped into the accelerator tank to check on losses and to allow inspection of the storage vessel. The gas lost since June 1st, 1978 (28 months, 14 filling cycles) is 3,345 kg, or 16% of inventory. This loss is in part due to some leaks already repaired in external SF_6 driver actuators. The size of the loss agrees with our nominal operating loss estimates which, up to now, were thought to be conservative.

The paint on the inside of the storage vessel was entirely without evidence of deterioration. The ball bearings left in a cage inside the tank to indicate rust production displayed only patches of rust. We infer from this that our current purification procedures are adequate to avoid attack on unprotected steel.

However, 2 kgs of rust powder were found in the storage vessel and it was assumed that this material was blown from the SF_6 boiler back into the storage vessel when these were let up to air.

ION SOURCES

The lithex source.

The lithex source was let up to argon and its pumps turned off 11 months ago (20/6). In the event of alpha particles being required it will be started up again.

The sputter source

The sputter source, which has been so docile since its inception that it is treated casually, like an old friend, caught both authors unawares. When the rear plate was taken off there was a cascade of burning cesium which fell onto the source table. The plate was hastily put back and clamped and the source was refilled with argon while the tantrum, and what to do about it, were considered.

Since the only cesium we have ever before had in the source body was the normal trifling surface accumulation, the significant quantity inside could only have come from a leak in the reservoir. We conjectured a dislodged frit, a cracked weld or the more likely possibility that the older author's feeble wrists had failed to screw the reservoir lid on properly.

The source was left for about an hour so that the cesium could further cool and solidify. A stainless steel dish, containing about an inch of liquid paraffin, was mounted under the source and we put on protective face masks. When the rear plate was gingerly pulled back a few globules of burning cesium dropped into the liquid paraffin and were extinguished.

The complete ionizer assembly was put into a nearby work box containing argon. We were able then to take a better look at the source body in which we found a small pool of blackened cesium. This was treated by covering it with liquid paraffin from a squeeze bottle after which it was scraped gently with a plastic ruler (metric) out of the source into the dish.

The source body was cleaned with water and then alcohol after the cesium had been removed. Then the ionizer was disassembled. The screws in the reservoir lid could be tightened by about a quarter of a turn. There was no cesium left in the reservoir and after being cleaned it was pressure tested under water. No cracks or leaks were evident and just a few bubbles drifted through the frit at 90 p.s.i.

A different reservoir was loaded with cesium and the lid screws were graciously tightened by the younger author wearing a trace of a condescending smile.

Next day the source ran out of beam. When the rear flange was opened more burning cesium fell out and the condescending smile changed faces. We put the flange back and refilled with argon. Then we took out the ionizer feedthrough and squeezed in liquid paraffin to cover the cesium. When the flange was taken off again everything was quiet and the source was scraped as on the first occasion.

We eventually determined that the latest batch of copper seals for the reservoir lid had not been annealed and the knife edges were not entering the seals as deeply as always in the past. After another cleanup, and using new seals, the source was put together again and there were no more leaks. The next time the source was opened there was no trace of cesium inside. It is possible that the faulty seals had become sufficiently annealed to account for the ability to tighten the lid screws a quarter turn as mentioned above.

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Even when aware of the dangers of cesium it is surprisingly easy to run into a completely unexpected mishap.

The cesium has always been handled and loaded in a robust glove box filled with argon. Falling into a cold reservoir it quickly cools to solid. With the reservoir lid on, and only the very high impedance outlet of the frit, the assembly is safe. This has always been the situation on the countless occasions when the ionizer assembly has been withdrawn from the source in the past.

Users who have never encountered burning cesium in the source would be well advised to set up a safety procedure with appropriate equipment on hand (and over the face).

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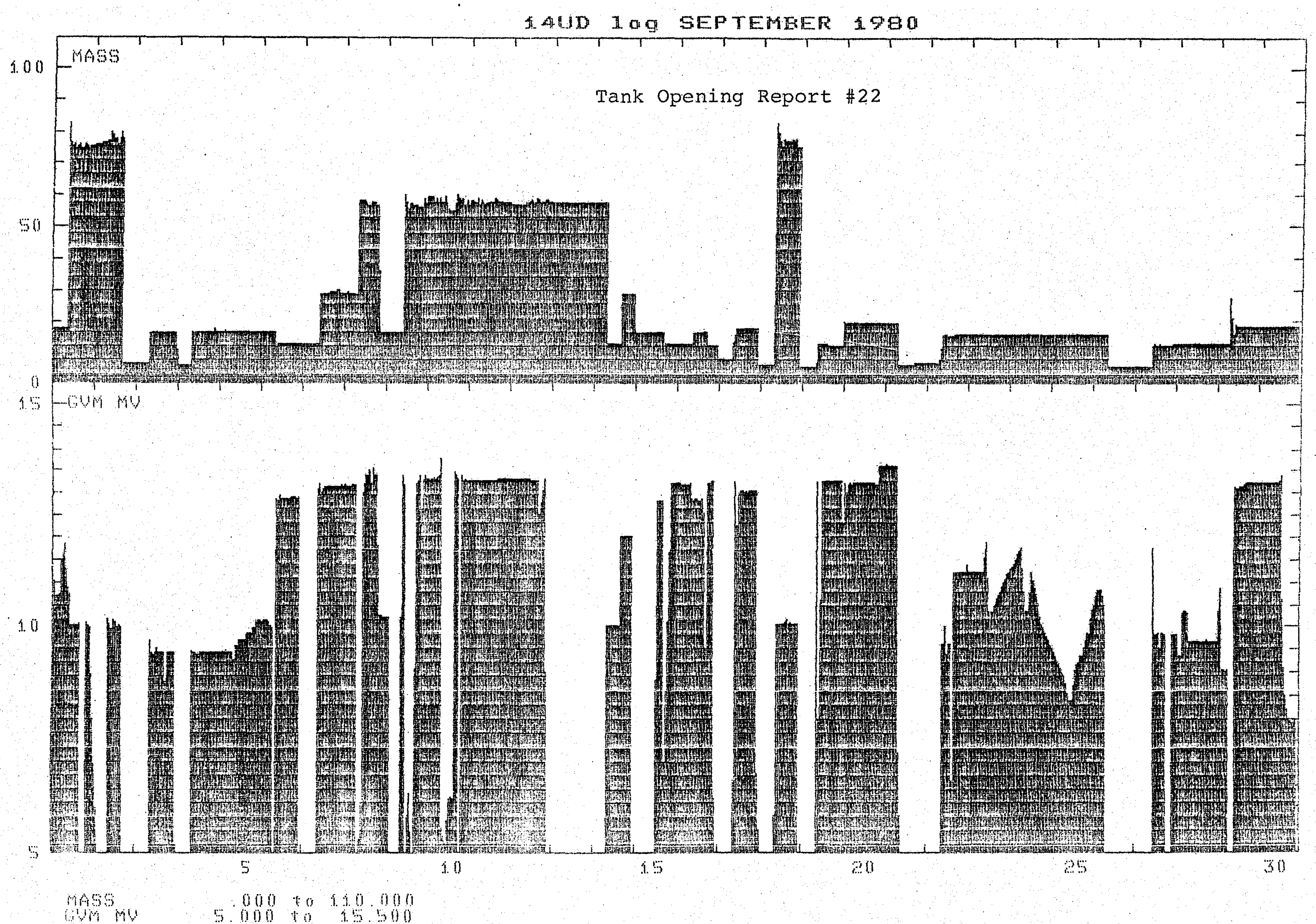
MACHINE PERFORMANCE

Eerie stability returned immediately and has remained for the three weeks since button-up. The machine is now conditioned to 13.8 MV.

D.C. WEISSER

T.A. BRINKLEY

October 27th, 1980.


14UD log SEPTEMBER 1980
Tank Opening Report #22
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