AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14 UD TANK OPENING REPORT # 85

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REASON FOR TANK OPENING

The machine had been in continuous use since the last opening (TOR#84) ten months ago. It had almost become urgent to renew our inventory stripper foils, and whilst there had been no serious problems, it was high time that the machine received attention.

The tasks for this opening were:

Renew the foil changer inventory.

Install the computer controlled foil changer drive.

Perform routine maintenance inside the machine including a complete chain idler and shaft bearing check.

Replace the charging chain pin retaining screws with drive screws.

PUMP OUT 15-6-99

Pump out tank, open doors and start ventilation system.

SUMMARY OF WORK

16-6-99

The platform was deployed and the initial cruise down the column found the machine clean. It was noted that there were only 19 spark marks. The HV gap test found no problems. The column rings and terminal were wiped down with RBS and water. The alternator shafts were run while the platform crew listened for signs of trouble. The LE shaft had no unusual symptoms, save the slight noise at the terminal alternator (TOR84), but five bearing sets in the HE shaft were noted for closer inspection.

The chains were run and chain #3 was found to have a large (+/-15mm) horizontal oscillation, across the pins, between idler stations.

And so to work

17,18-6-99

The idlers and all chains were checked for wheel and bearing condition. This lead to a number of each being replaced (complete listing is under heading "IDLERS") and all the idlers were adjusted.

The terminal was opened to permit replacement of the 20 year old foil changer pneumatic drive with the new electric drive. Only after the new motor was tested was the foil-changer removed, for the reloading of the new foils. David Kelly from the Electronics Unit, and Alistair Muirhead from Nuclear Physics, installed the new foil-changer drive and associated electronics. During this period of access to the terminal Alistair noticed there was an exploded nylon pad the EMI/RF proof boxes and an aluminium bulkhead.

The chains were inspected for signs of wear in the links, pellets and pins. No problems were found.

21,22-6-99

The foil changer was successfully removed after some problems operating the "Weisser Valve". A foil frame got caught between the clapper and knife-edge. Fortunately, we were able to dislodge the frame and close the valve. In future, no foil frame will be put in the positions adjacent to the removable links at the 000 position.

David Kelly returned to fit a different chip into the foilchanger board within the GP3 box.

The shaft bearings that were earmarked (no pun intended), earlier in the opening, were now removed for inspection and bearing renewal. All of the bearings chosen for attention turned out to be slightly noisy when spun by hand. These bearings were replaced and the shafts reinstalled.

It was found that some of the shafts had loose clamp screws. All shafts were checked and the loose ones retightened and then realigned. There was no evidence of wear due to the loose clamps.

23,24-6-99

The foilchanger was refitted, pumped and tested for correct operation using computer control. The new system allows one to select any foil by its number.

Unit 8 had a displaced column ring on post C, at gap 12. There was no evidence of sparking so the displacement may have occurred after the tank was opened.

The Triode uses seven needles. One had been melted down to the base while the others were dull. The exchange set was fitted.

The service platform interlock failed for the up direction. It was decided, after a brief unsuccessful hunt for the problem, that the bypass would be fitted so that work could carry on The column and tube resistor leads were inspected and fourteen replaced even though the spotting was only slight and none were burnt.

25-6-99

The charging chains had been slated for pin screw removal during the last few openings. This job had been put off each time because it was regarded as desirable rather than necessary. The screws were replaced during this opening

28-6-99

The HE column metering wire standoff at Unit 28 had become unglued from its double-sided foam adhesive strip. New foam adhesive was fitted.

The redesigned EMI/RF box locating pads were refitted on the second attempt. The boxes were then closed, the terminal cleaned, and the upper and mid terminal spinnings were closed.

29-6-99

The terminal inductors and DC idlers were set and after cleaning the lower terminal spinning was raised.

Unit 13 had a loose stringer screw at post #2 and this was rectified. There was no evidence of sparking.

30-6-99

The column was wiped with RBS and water and the HV gap tests found no problems.

The chains and shafts were run and charging tests carried out. Column and tube metering circuits were tested and the machine was closed.

SHAFT COUPLINGS

During replacement of the rotating shaft bearings, in Units 20 through 28, some more loose perspex shaft clamp screws were found. The discovery of loose joints during TANK OPENING 84 was covered in TOR84.

The discovery of more loose joints, whilst not surprising, was indeed fortuitous. All the joints throughout the machine were checked.

Shafts that were found loose were retightened and reset using the dial indicator. They are listed as Unit # T (top of shaft) or B (bottom of shaft)

U2TB, U4T, U6TB, U7TB, U9B, U13TB, U15TB, U16T, U17TB, U20TB, U28B.

CHARGING CHAINS

The chain histories are recorded in separate files, one for each chain and a separate file for ordering information.

The records show that,

Chain #1(m)(formerly named L) was installed new 1st Sept 89. The chain was removed 10th May 90 because 47 links were spark damaged. Run time was 3071 hours at that time. The chain was refitted 19th June 90 with 46 new links. The chain had 40330 hours.

Timer reading 15380.

Chain #2(l) was installed new 25th Feb 92. The chain had 32165 hours.

Timer reading 15379.

Chain #3(m) was installed new 28th April 89, this chain was supplied under warranty in exchange for 2(j). The chain had 43210 hours.

Timer reading 15379.

Experience, here and elsewhere, has shown that button head screwed pellet pins may rotate in the link pressing wearing out the pin bore. The correct installation is made using drive screws that, upon insertion, expand the pin causing it to lock firmly into the pellet pin bore. This ensures the bushes inside the nylon links take all rotary motion, between the pellets, thus preserving the pellet pin bore.

The pin screws, in the 14UD, had been liberally loctited during assembly, unintentionally but fortunately, causing the loctite to wick in between the pin and pellet. This had effectively prevented rotary motion between the metal parts. Because of this, none of the button head screw retained link pins had worn loose in the pellet pin bores.

The button head screw retained link pins were removed, regardless of being loctited, and replaced with drive screw retained pins. Our historic stock, of drive screws, have domed heads, rather than the flat ones on the rest of the chains.

One pin (two screws) in chain two was accidentally missed and will need to wait till next time.

Chains one and two were shortened by one link and chain three by two links.

Alan Hayes, of the neighboring E M E Department, who have an NEC 5HDS/4 pelletron., had designed and made a chain pin drive screw press. The press is a portable, hand held and screw operated device that, once aligned and clamped to the pellet, inserts the drive screw as the operator winds the jacking screw.

diagram

The press was used, very successfully, inside the machine to install the final pellet pin thus saving the use of hammer, dolly and bad language, amongst the tightly spaced components, in the bottom of the machine.

CHARGING CHAIN IDLERS

Chain #3, U19 down side single idler was found to be chipped and that the bearings were worn out. It was noted that the chain induced damage, around this idler, was off center and, that it was one of the yellowish colour wheels that have been in stock for many years. It was not known when it had been fitted.

Idlers were checked for bearing and wheel condition. There were only thirteen new idlers in stock and all were the yellowish type. They were selectively fitted in place of idlers that were deemed to be most worn. The positions of new wheels and bearings were recorded in the platform book.

TERMINAL FOIL CHANGER

The pneumatic foil-changer drive was removed so that the new computer controlled electric foil-changer motor could be fitted. This work was done prior to removing the foilchanger so that testing would be completed before the new foils were committed.

While Alistair fitted the motor David Kelly fitted the new electronic board inside the GP3 box and completed the shielded wiring between these components.

photo

The new motor operated the foil-changer correctly but David Kelly found that the board contained a chip with the wrong number of foil positions. The chip was replaced.

The foil-changer was now prepared for removal to Bob Turkentine's lab for foil repopulation.

TERMINAL RF ENCLOSURES

The computer driven controls inside the terminal are protected from RF surges by being housed in copper/nickel plated mild steel boxes. The bottom of the boxes sat on four 13mm thick nylon pads. The top surface of the boxes had two similar pads. The top pads were pushed upward against the terminal plates by jacking screws that are accessed inside the boxes. The axial force yielded by these screws is exerted on both sets of end pads thus jamming the boxes in place between the terminal plates. The boxes would probably sit within the space safely, particularly as they are electrically grounded with 25mm wide by 20g copper straps, and also have conduits attached. During service, however, the heavy racks of equipment, inside the boxes are swung out on hinged frames and this results in them becoming unstable. In any case it was believed to be better to have objects as heavy as these are mechanically restrained.

Some of the nylon pads had been damaged by high energy discharge to ground on the terminal decks. The energy had bypassed the grounding straps, and, in two cases, had exploded the nylon pads as it traveled through the nylon to ground. Two other pads showed signs of tracking damage but had remained in one piece.

Photos

The nylon pads were located on the box skin by a nickel plated 38 mm diameter spigot that were re-entrant into the nylon to a depth of 3 mm. Worse still, the edge of the spigot was quite sharp thus enhancing the field during discharge.

Simply changing the pad material from nylon to metal would be one solution; however, it was felt that having more than one ground path was not desirable. The existing ground straps must have coped with many of the discharges, but obviously, some large energy events were jumping the 10mm path through the nylon in preference to travelling across the surface of the box to the ground strap. The badly damaged pads were approximately 1 m, surface distance, from where the bonding straps were connected to the terminal plate. David Weisser suggested that a designed spark gap be incorporated into the new pads.

Drawing

Two types have been used.

The type used at the bottom of the boxes is aluminium with a radiused annular surface facing the terminal ground plate. This stands on a 6 mm polypropylene disc held at the center with double sided tape. The radiused annular part forms a spark gap of approximately 3 mm to the terminal ground plate. The jack type, used at the top of the boxes, is made up of NEC corona point spark gap with the same polypropylene discs help in place with double sided tape.

It was recognized that aluminium was not the best choice of material for a spark gap, it was noted also, that the ground plane was aluminium plate and therefore that the new pads were only half of the problem. It was decided that aluminium would not be too risky in this case. The performance of this modification will be noted with great interest during future openings.

SHAFT BEARINGS

The shafts were run early in the opening so that the scheduling of bearing replacement could include this time consuming task. The platform crew listened at each casting and found that Units #23,#24,#25 and #26 would be worthy of further investigation. These were removed and disassembled outside the machine. In each case the upper bearing of each pair was dry sounding when spun by hand but by no means close to destructive failure. Since so much of the lower HE shaft was dismantled anyway, it was decided to replace all the shaft bearings from U19 to U28. The balance of the machine will be done next time.

All the shaft bearings were changed during the opening of Nov 95. The upper shaft has done 15898 hours and the lower 19626 hours.

RESISTOR LEADS

The leads that join the tube and column resistor pairs have, in the past, been found with spark damage. Many had sustained strikes that had burned part of the way through the wire. The damage sites appeared as black spots that, upon closer inspection, revealed many broken strands within the wire.

The leads replaced during this opening had very slight spotting with no burns or broken wires. It was not known whether the slight spots lead to larger spots forming later, on those sites, or whether the sparks remain totally random, but, they were replaced simply because spares were to hand and time was available.

TRIODE NEEDLES

The Triode had one of its seven needles melted off while the rest were dull.

Photo

There were no operational symptoms of this needle wear/failure.

The spare Triode assembly, made of sewing needles that were soldered onto the head, was fitted and the damaged set brought out for refurbishment.

PLATFORM SAFETY SYSTEM

The usually reliable platform interlock system failed during this opening.

The system, now approximately twenty five years old, was designed to prevent the platform being driven past if an obstruction, human or otherwise, protruded into the tank. Driving upward the operator can usually see if there is a problem, but, driving downward was usually an act of faith, particularly when operating the platform, from the platform, to allow personnel access to the chain drive motors in the bottom of the tank.

The interlock system uses two photoelectric cells (ex building lift and already old) to monitor a one meter chord of the platform rim adjacent to the tank ports. One cell, complete with light source, covers the upward direction and a second covers the downward direction. When either light beam is broken the appropriate photocell opens a relay, inside the platform control box, thus preventing platform movement in that direction.

The first problem, during this opening, was that the platform failed to go downward. The downward light source had failed. This was fixed immediately and the platform continued downward.

Then the platform failed to go upward within minutes of the repair job. The upward light source was still working and it was thought that the reed relay, within the photocell unit, could be heard operating while interrupting the beam by hand. This problem could not be solved quickly, therefore, it was decided that the interlock system be bypassed so that work on the accelerator could continue. The failure was noted in the platform book and the unit was repaired soon after the machine was closed.

Diagnosis was undertaken by Alistair who quickly discovered that the up and down voltage outputs of the photocell unit were different. Alistair enlisted the help of David Anderson (electronics unit) who found that diode DA605 had shorted. This was replaced, along with the precautionary replacement of an associated capacitor, and normal operation was restored.

INITIAL PERFORMANCE

The machine was used initially at 10.5 MV and ran very well. Once the machine was pushed up to 14.5 MV it sparked a couple of times.

The machine, at the time of writing, has been closed for a week and has run well at between 14 and 14.5 MV.