AUSTRALIAN NATIONAL UNIVERTY

DEPARTMENT OF NUCLEAR PHYSICS

14 UD TANK OPENING REPORT # 81

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REASON FOR TANK OPENING

The tasks for this opening were the installation of the gas stripper and to replace foils in both strippers.

PUMP OUT 19-8-97

Pump out tank, open doors and start ventilation system.

SUMMARY OF WORK

20 to 25-8-97

The usual tour revealed that the machine was quite clean and that there were no obvious problems.

And so to work.

The HV test found no faults. The machine did not require the usual pre-work clean with RBS and water. The spark mark survey found very few spark marks. Then all three terminal sections were moved for gas stripper project access and to allow removal of the foil changer. The removal all equipment, either made obsolete by, or, requiring modification for the gas stripper installation, was carried out. The two foil changers were removed and the charging chains, pulleys, idlers and inductors in the terminal were inspected and all found to be in good condition.

26 to 27-8-97

The trial installation of the gas stripper (no gaskets) in order to check for unforeseen problems went well. This allowed planning for modifications to existing equipment where required, to prepare shopping lists for the local purchase of fastenings and to ensure all positioning devices had sufficient adjustment to allow alignment.

28 to 29-8-97

The gas stripper, turbo pumps, lower ion pump, and vacuum tube components were installed and aligned.

1-9-97

The upper ion pump, which is partially supported by springs, was installed.

2 to 5 -9-97

The PFA gas tubes that ran the sublimer pumps in the old terminal were removed and the new PFA fiber optic carrier tube was installed. The fibers were run to the terminal and the electrostatic lens was installed and aligned. Final preparations were completed for the installation of the terminal control boxes.

8-9-97

The terminal control boxes were installed and vacuum system service clearances checked.

9 to 15-9-97

The wiring of all equipment was completed. Care was taken with the electrical ground bonding of all components. Foil changers were installed and testing of the vacuum system, including leak chasing, pump operation and base pressure reduction, were completed.

16 to 18-9-97

Final wiring details were completed and computer control tests were completed. The upper and lower shafts were run. The lower shaft vibration was found to be excessively vibrating the foil changer and, after this situation was improved, the terminal was closed.

19-9-97

The column was re-ringed, blown down and given the usual four person wipe down. The HV test found no problems. The chain charging and metering tests were performed. The machine was closed and pumped overnight.

ALIGNMENT

The existing stripper canal was optically surveyed prior to it's removal and a beam spot position analysis carried out using the unbroken foils, which had been removed earlier. The information gathered during these checks showed that the beam was 2.5 mm off center.
The old equipment was removed and the new stripper installed without gaskets. The object of this exercise being to ensure that all the parts fitted together in place and that the stripper canal was within range of optical alignment. Once this was proved to be achievable the installation was assembled with gaskets and the stripper canal aligned.

UPPER ION PUMP INSTALLATION

The upper ion pump bolts directly to the gas stripper vacuum tube assembly. The assembly is supported, at the bottom, by a bracket that allowed radial and axial adjustment. The top is located by a set of radial adjustment screws bearing on the topmost flange. The center of gravity of the pump is cantilevered 300 mm off the beam tube centerline. It was anticipated that the lcantilever would deflect the beam tube supports adversely effecting alignment. Rigid brackets would be difficult to use as they would require accurate adjustment, in concert with the tube adjustment system, so as not to leave parts with residual stresses. A pair of adjustable tension springs were used to negate the effect of the couple induced by the pump mass. A dial indicator was positioned and set to zero opposite the pump tee prior to installation of the pump. The pump was supported and maneuvered into place on a lab jack and then bolted to the vacuum system. The lab jack was released, while, simultaneously the spring suspension turnbuckles were tensioned using the dial indicator to monitor progress. Finally, the pump springs were adjusted so that the dial indicator was zeroed thus ensuring that the vacuum tube remained in it's optically aligned position.
photo

FIBER OPTICS INSTALLATION

The 1/4" PFA tube was drawn through the HE end of the column. Fishing line was attached to a brass plug that was made to be a running fit in the PFA tube. High pressure nitrogen was used to blow the brass plug down the PFA tube, from the terminal, thus pulling the fishing line through the PFA tube. The pair of optical fibers were then attached to the fishing line and gently pulled through the PFA tube The fibers were run through the bulkhead fittings in the RF shielded terminal boxes and terminated in their respective Group 3 controllers. The bottom terminations were completed at the tank feed through.
Electrical contact between the inside of the PFA and the optical fibers is achieved by inducing a sharp curve at least every 500 mm. This is achieved in three different way according to the position within the machine.

1. Between the bottom of the column and the tank feed through the PFA tube is cable tied to a post that has a group of three pins placed every 500 mm. The tube is bent around the pins so as to cause three changes of direction within 50 mm thus ensuring that the optical fiber is forced into contact with the inside of the PFA tube.

2 Inside the column the PFA and the fibers pass through radiused off center holes in two removeable elecrode plates in each unit casting, one above and one below. The plates were rotated, one against the other, causing two sharp changes in direction per casting. The resultant horizontal displacement of 45 mm, over the casting depth of 100 mm, used considerable tube length and slack was allowed for during the initial installation so that the tube and fibers were not stretched at all when the bends were induced.

3 The terminal required yet another approach as the loop runs from box to box. The required set of sharp bends was induced at the appropriate intervals by slipping a "W" shaped clip over the PFA tube. The PFA tube was cable tied, wherever possible, both for mechanical support and to hold the bends in place.

LOWER TERMINAL ALTERNATOR

During final tests it was discovered that the vibration of the lower alternator, although reduced last opening (TOR 80), caused the foil changer to vibrate at a low frequency. The new position of the foil changer left it cantilevered to a greater extent than previously. The amplitude of the resultant vibration was, not only dangerous to foils, but probably would have caused mechanical damage, due to metal fatigue, in the future. The best remedy would have been to fix the vibration in the alternator but it was realised that this probably would not have been achievable during the remainder of this opening. The fitting of a horizontal strut between the foil changer and a terminal post tube was easy to do in the time available and increased the stiffness of the installation sufficiently to permit safe reliable operation. The alternator was earmarked for closer inspection next opening.

UPPER TERMINAL ALTERNATOR

The upper alternator and mounting bracket were removed for modifications, previously noted during the mock up, designed to provide clearance for the upper turbo pump. No problems were encounted and the alternator was promptly reinstalled and aligned.

"SPARK PROTECTION (A Modernised Terminal for the ANU 14UD)

When the terminal of the 14UD discharges, a lightening like surge of voltage and current will destroy unprotected electrical devices. Modern developments in shielding from electromagnetic pulses[1] have made accessible commercial solutions to these problems. Since the commissioning of the 14UD in 1973, all but the most robust electrical equipment failed and was eliminated from the machine. Enclosing all wiring in metal pipe or conduit adequately protected the wiring and voltage doubler power supplies.

To fully exploit the new equipment, sophisticated power supplies and computer control were essential. The inventory of electronics comprises: the NEC turbo controller, NEC ion pump controllers, 4 Glassman High Voltage supplies for the lens and 1 for the 2 l/s ion pump, the GP Convectron Gauge, DC supplies, the Group 3 Control Net Device Interfaces, DC valve motor and read-out. A version of "double shielding" was adopted featuring all equipment being housed in one of two large copper plated steel boxes and the Group 3 interfaces separately housed in additional RF shielded boxes within these. All wiring to and from the Group 3 box does not leave the outer shielded box and penetrates the Group 3 box via pi-filter feed throughs. Wiring leaving the outer box is in flexible metal conduit grounded at the box wall and at the load device. The coax in the conduit is grounded only at the power supply and the center conductor has a spark gap at the load end. The mains power wires from the alternators are attached to MOVs near where they enter the outer shield box. All wire penetrations are tightly grouped at one corner of each box to limit circulating currents in the box walls. Ventilation is provided by RF honey comb units near the tops and bottoms of each box. Temperature monitoring in the Group 3 box has never exceeded 26 degrees Celsius. The access doors are sealed with RF woven wire gaskets and held by 4 quick release clamps. All electronic units are mounted on a copper plated frame that hinges in the outer box and is grounded to it near the penetration window. An RF ground link between the outer boxes and the 14UD structure is also near the penetration windows. Spark hardening has also been incorporated in all the power supplies. For the Glassmans, an additional copper ground plane has been added under the circuit board. The DC rails and ground have been close coupled with capacitors and fast diodes and the voltage monitoring circuits are protected by transorbs. The NEC turbo pump controller has had its grounds concentrated on the front panel, a filtered mains socket installed, varistors close coupled at the output connector and DC rail to ground modifications similar to that on the Glassman supplies. The NEC ion pump supplies will soon be replaced by Glassmans so their modifications will not be listed. All units are voltage controlled by the Group 3 interface and communicate by shielded twisted pairs with the shield grounded at the unit.

Two Group 3 control modules with ADC, DAC and DIO boards control pumps, pressure reading, the gas stripper and the terminal lens. The modules communicate with the VME crate via a Group 3 loop control module and plastic fibre. The gas valve is operated by a DC motor and protected by limit switches at each end of the travel. A motor

software driver has been added to the crate control process which accepts a percentage output target value and moves the motor to that position. The read back is provided by a multi-turn potentiometer.
All of the controls have functioned well apart from the gas valve. There has been an intermittent problem when driving the valve open. It sometimes fails to move but will after repeated attempts. Also the valve itself appears to have a seating problem. In the fully closed position, it does not shut off gas-flow completely and leaks for a considerable time after an isolation valve is closed. When the pressure from the isolated gas is sufficiently low, the tube pressure recovers and enough gas remains for the gas stripper to be controlled.
The terminal lens control has proved to a great advance over the old system providing smooth control and allowing the beam to be easily optimized. Since the installation of the new equipment, the 14UD had sparked about 30 times with 60% above 13 MV. There has been no interruption to the computer control let alone any damage to electronic equipment."

INITIAL PERFORMANCE

Apart from the sparks mentioned in the above paragraph there have been few problems. Considering the extent of the modifications, and the time that the tube was open, performance has been excellent. The machine conditioned to 12 MV fairly quickly but required shorting rods to condition further. The fine valve (Granville Phillips) was unpredictable in operation and caused the rescheduling of experiments. Providing nothing crucial fails the machine will be capable of supporting experiments till next opening, so the fine valve can wait till then.