AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

14UD TANK OPENING REPORT NO.33

1st to 3rd March 1982

(2½ days open)

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

REASON FOR TANK OPENING

Broken chain.

PREAMBLE

The 14UD was last closed on 12th February. Following closure, trouble with the LE isolation valve led to a mishap which caused a sudden burst of turbulence in the tube (32/4). Conditioning was lost, as we soon found out at start-up. After a few hours the conditioning level was raised from 7 MV to about 12.5 MV, high enough for the first users. Later, when a 14 MV run was required, the machine would not hold volts. Using shorting rods, the entire column was conditioned in blocks of four units for a day and a half, after which the run continued at 13.7 MV for two days. During the evening of 27th February Chain 3 broke.

OPERATIONAL TIME

During the 14 days since the last closure, the 14UD operated for 288 hours. This was 86% of elapsed time, excluding the days for gas transfer.

THE TANK OPENING

Exploratory tour

There was a small heap of chain on the floor of the tank, and an inductor with a broken insulator. Most of the chain was on the column. In all, there were 21 separate pieces of chain, plus 11 single pellets with a break on each side. In the terminal a length of chain was tangled around the inductors and dangling at each end into the unit below. A section of shimstock contact band on the terminal pulley was wrecked. The link at the end of the "down" side had torn apart and the appearance convinced us that it was at this point that the break had occurred. Part of the surface at the break had a matte white appearance which we at first thought was due to the fractured surfaces being exposed to the tank gas, however, after washing with water, which immediately removes the characteristic white deposit found everywhere in the tank, the appearance was the same. We concluded the whiteness was due to the fracture surfaces abrading each other, or perhaps a fatigue effect prior to the fracture. (Photograph of breakpoint.) All the other 30 or so breaks were clean neck breaks. Chain 3 had operated for 2,600 hours.

A small number of the nylon links from the chain break were examined. A hairline crack, noticed on one of them, was dye-checked and established as a real crack (photograph). There was no time for a more extensive examination.

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One idler was stiff on its bearings and its tyre was somewhat flattened. Another idler had a groove in its tyre.

And so to work!

Since there was no need to change foils, or do much else in the tank, we expected to button up early on the second day. We renewed the idlers, replaced the damaged contact band in the terminal, and then put in the new chain.

When testing how chains are running mechanically we now always cruise up and down the column while each chain is running alone, and listen at idler positions for any evidence of trouble. The new chain ran well, and so did Chain 1. When Chain 2 was run we heard a curious clicking sound at the period of the chain. We stopped the chain, and when it was slowing down had a good idea where the click was coming from. Turning the chain by hand we found that a nylon link had parted on one side of a head. We hesitate to predict how many hours, or minutes, the chain would have run before breaking.

We reported, (31/2), the occasion on which a link was found with one side of the head parted, and the chain was held together by only half a link head. Remarkably, on the next link but one, there was an identical fault. These links became known as 'miracle links'; not only was it a miracle that the other side of the link head had not parted, it was another miracle that the chain had stopped in a place where the fault could be noticed. A photograph illustrating 'miracle links' was enclosed with Report 31.

Finding a miracle link in what we believed to be a youthful, healthy chain, (5,700 hours), we abandoned any idea of buttoning up on the second day and set about making a meticulous inspection of Chain 2, and Chain 1 as well.

Since the miracle links had all parted on the side of the head outward from the pulley, and the fine crack was likewise, we decided that the best place to study the chains was in the terminal. We set up a good fluorescent lighting arrangement with one observer on each side of the pulley with a magnifying glass. Rotating the chain slowly, one observer saw the trailing heads of the links as they turned onto the pulley, and the other the leading heads just before they turned off. We found 22 links which had a fine crack close to where the link neck joins the head. The cracks were randomly distributed, leading and trailing. No defects at all were noticed on Chain 1 (900 hours).

Since our only spare chain was the one used to replace Chain 3, we were confronted with the decision as to whether to take out Chain 2 on the grounds that it was unserviceable, or leave it in for essential use only. We chose the latter course, and marked the heads only of each cracked link; if the chain is used, we can observe progress on the cracks, and can also observe the onset of new cracks. We have nothing to lose if the chain breaks, apart from an unwanted tank opening.

It is perhaps worth recording that in all three cases of miracle links, the two of Report 31 and the new one, the tiny screw in each link head was on the side of the link head which parted. We assume that the purpose of this screw is to lock the teflon(?) bush through which the pin passes.

We removed some pellets on each side of the miracle link found in Chain 2 and replaced them with a well-checked length from the up-going side of the broken Chain 3, which had not fallen far. Since Chain 3 had only 2,600 hours to its credit, or discredit, this seemed fair exchange for the 5,700 hours of Chain 2,

plus its penchant for cracked links. For what it is worth, Chain 2 is the "proud rivet" chain: references (28/2); (28/3); (28/5); (29/1); (29/5).

Points

A few had been displaced by the falling chain; they were reset.

Idlers

There were no displaced idlers or spark shields, and nothing else which could have mechanically interfered with the chain which broke. As mentioned earlier, the faulty two were repaired.

Cleaning

The column was professionally blown with nitrogen, and the tacragging was carried out by a merry throng of students, plus a visiting academic who was allowed to go in the tank, as a special privilege, so long as he worked his passage. He was very grateful, and worked well.

Button-up

The charging tests went well, and Chain 2 was tested with the others. It takes undeniable gallantry to stand in the bottom of the tank, in near darkness, and run a chain with volts on it, and 22 cracked links in it. The older author did not flinch from his duty, but stood a little further back than usual, just in case.

The doors were closed at lunchtime and the tank was roughed until evening when 60 psia gas was put in.

Initial performance

All seemed well when the machine was started; there was one spark at 10 MV and then the machine settled down for the experimenters at that voltage.

T.A. Brinkley

4th March 1982

David Weisser is at Cal Tech for a few weeks.

Enclosures:

Photographs:

a) Matching ends of the link head which was responsible for the Chain 3 break.

b) The miracle link found in Chain 2.

c) Chain length containing the miracle link held to show how the pellet hangs offset. It was noticing such a pellet that led to the discovery of the first miracle link.

d) Dye-checked hairline cracks on a link from the broken Chain 3.