AUSTRALIAN NATIONAL UNIVERSITY
DEPARTMENT OF NUCLEAR PHYSICS
14UD TANK OPENING REPORT No. 49
Three openings:
5th to 25th February 1985 (21 days open; 15 working days).
5th to 8th March 1985 (4 days open).
26th March to 4th April 1985 (10 days open; 8 working days)

REFERENCES: Earlier Tank Opening Reports are referred to by the notation (38/4) etc, meaning Report No. 38, page 4.

REASON FOR THE FIRST TANK OPENING

The opening was scheduled to attend to several things, particularly replacement of the nylon actuator tubes found to be in such a sorry condition at the last opening (48/7).

PREAMBLE

The 14UD was last closed on 10th January and was used above 13 MV for a few days, then between 7 and 9 MV. After a spark the H.E. column current metering became erratic. The terminal triplet was not working correctly and we attributed this to the fault in power wiring in the terminal, detected but not pursued last time, (48/7).

A defective column post, (48/3,7), though airfreighted to N.E.C., took nearly 5 weeks to arrive; also, it arrived broken at the damaged ceramic, (48/7). After it had been examined, we had a letter from Robert Rathmell, expressing N.E.C's first impressions about the damaged ceramics and pointing out that they have not heard of any other pelletrons having this problem. Robert said that the cracks were most likely caused by spark punctures of the ceramic and that, once a ceramic has been cracked, there is a slightly higher probability that other sparks will follow that path; what caused the ceramics to crack after 10 years is not clear, but ceramic surfaces coated with SF6 breakdown products, and titanium boiled off spark gaps, could give rise to the first surface failure. A letter from us, in advance of Report No. 48, informed N.E.C. of the circumstances in which the chains were left running with no charging volts, leading to a negative buildup on the terminal and successive discharges down the ungraded column. Robert felt that this occurrence fitted the scenario of cracks forming in ungraded posts and seemed the most likely explanation so far. On the comforting side he went on to say that, even though the post we returned broke in transit at one of the cracked ceramics, that ceramic would have been strong enough in compression to support the required weight of the column; a ceramic would have to be very badly fractured to fail in compression.

We believe that the ceramics might also have been electrically stressed unduly by our operation at higher gas pressure than was customary in the early days. Over the 18 months up to early December 1984 we operated at 105 p.s.i.a. in order to reduce corona currents which, since the installation of the new design N.E.C. corona points, have been higher than with the old type (41/8). The lower currents, by the way, equivalent to those we used to get with the previous point to plane gaps, were also desirable in order to reduce breakdown product production rates and allow us to use only two chains. This was felt necessary at a time when chain links were cracking due to breakdown

product attack.

While we were aware that the higher gas pressure resulted in greater electrical stress across a ceramic during a spark, we judged the risk worth taking because of the lack of any ceramic failure over the life of the 14UD. We did not count on the very dangerous situation of negative sparking of the machine (48/1). Following the discovery of cracked ceramics we returned immediately to about 85 p.s.i.a. instead of about 105 p.s.i.a. which we had used as a matter of course since late September 1983.

For our own part, we now intend to examine post ceramics carefully and regularly. We anticipate that our news will prompt other Pelletron owners to inspect their posts.

We ordered 8 replacement posts and N.E.C. immediately despatched 4 they had on the shelf so that we could put them in at this tank opening.

Some of the grey dust, which we found so plentiful on shiny surfaces at the last opening, (48/7), was analyzed by Keith Fifield, using Rutherford back scattering of 1.9 MeV protons. Keith found mainly iron and sulphur, with no evidence of fluorine. Analysis of breakdown products previously, (1983), yielded the same composition. The present result is consistent with the notion that negative sparking dispersed a lot of accumulated material from the immediate vicinity of the points.

OPERATIONAL TIME.

During the 26 days since the last closure, the 14UD operated for 249 hours. This was 43% of elapsed time, excluding the days for gas transfer (42/2). Such an abysmal uptime, the worst on record, and only half our average, was not due to the accelerator. Because of summer holidays there were few takers for the machine; of the 24 "gassed-up" days, 11 were not scheduled. We stated unequivocally (42/4) that, in our assessment of operational time, all that we deduct from elapsed time is the time taken for tank openings. This is all very well, but we would care little for our machine's feelings if we didn't stand up for it at times like this. We therefore point out, just this once, that the 14UD operated for 79.8% of scheduled time.

THE FIRST TANK OPENING.

Sniffs at the last two openings were not trusted; on this occasion a reliable, well-calibrated nose assessed the atmosphere in the newly opened tank and pronounced it to be as free from acrid smells, pungency etc as one could hope for.

Exploratory tour.

We found almost none of the grey powder which we usually see on shiny surfaces, though there was quite a bit of gritty substance in evidence, mostly on the terminal and on rings in its vicinity. The plane sides of the column corona point assemblies held a little surprise

for us, the nature of which we haven't seen since the discovery in May 1982 of bright pistachio on the tube points and rich chocolate on the column, (35/2). We now found, on the backs of the column points, against a background of unsullied, dusty whiteness, the three traditional patches under the needles gleaming golden - not yellow, or brassy, but undeniably golden. The effect was more elegant than the hitherto admired combination of pistachio and chocolate and it was hard to believe that these very same assemblies had looked so drab only a few weeks before. We draw no conclusions at all from colours on corona assemblies, having seen so many, but we sometimes wonder if the more attractive ones blossom to such levels of delicacy in a nicely smelling tank.

Cracks in post ceramics in units 15 and 16, which we noted had worsened somewhat at the last opening, were examined by Bob Turkentine and the older author. B.T. thought they hadn't changed and the O.A. thought there was a new crack in the Unit 16 ceramic.

In the upper terminal we found that the flexible metal conduit, which shields wires from the distribution box to the lens and sublimer variacs, was badly spark damaged. As mentioned earlier, we diagnosed wiring problems at the last opening, but decided to suffer them rather than raise the upper spinning at the last minute. If we had, one look at the wiring would probably have persuaded us to lower it again after disconnecting the circuits involved from the alternator. This length of flexible metal conduit, or greenfield tubing, was the last of such original 'spark protection' material remaining in the tank, apart from power to the chain motors which move and must be flexibly coupled. We had converted all the original power wiring to pyrotenax and for control functions we ran bundles of conventional wires pulled into copper pipes which were terminated onto boxes and units with water fittings.

And so to work!

CHARGING SYSTEM:

Chains:

In view of the fact that we are returning to lower pressure for the insulating gas (see preamble) the consequent higher corona currents would mean that the two chains would have difficulty in achieving full voltage; we therefore decided to put the brand new chain we had on hand into the No. 3 position which has been empty since November 1983. We now also judge that the SF6 purification system will protect the chain from premature chemically induced failure. We had a full set of stabilizing idlers in readiness, though insulators for the cross-over inductors in the terminal had to be made from Delrin to replace the original nylon ones found to be internally spark-damaged (43/5,6; 44/4). Various bits stolen for the lower inductor assemblies also had to be replaced. Remembering our discoveries concerning inaccurately hung chains, (41/5; 42/5), together with the highly successful stabilizing idler lifetimes which followed careful chain alignment, (47/5), we were careful to begin the chain installation by establishing

the positions of the pulleys.

The terminal pulley was set vertically with its axis midway between the metal posts. Its axial position was re-established at its previously recorded measurement from the edges of the metal posts. A pair of plumb-bobs were hung over the terminal pulley and used to set the lower pulley; this once again required moving the motor pivot bracket, this time back towards its primeval position. Mystery one! The chain was hung and its position checked with respect to the holes in the idler castings. A net discrepancy required an axial correction for both pulleys back towards the primeval position. When the idlers were being installed there was still a problem in getting adequate adjustment to set them correctly. The chain was removed and the bottom pulley checked against the pair of plumb-bobs. The pulley had not been set accurately enough, that is, by plus or minus half a string diameter, 0.25 mm. Resetting the bottom pulley resulted in successful adjustment of all idlers.

The new chain had hourglass links (41/4,5) and is the second such chain to be installed in our machine.

A partial link inspection was carried out on Chains 1 and 2; 100 links in each chain were examined for defects and none were found. Defects in chain links have not been seen since November 1983 when cracks were found in Chain 3 (42/4). No chain was then put back in that position. The last failure of links, prior to that, was in Chain 2 in October 1982. A replacement was not put in this position until February 1983 and this has now run for over 11,000 hours. In February 1984 the Chain 1 then in use consisted of odd salvaged lengths. We took it out and put in a new chain which has now run for nearly 5,000 hours.

When the metering insulation on Chain 3 pulley was tested by meggering, we found a low resistance which was hard to trace. Eventually we discovered that the flexible rubber coupling between the motor and the charging pulley changed resistance when under shear and its resistance fell to about 200 ohms; thus the resistance varied with angular position of the pulley. We confirmed that there were no fragments of metal hiding away to mislead us and the coupling showed 50 megohms, or more, when relaxed. Careful alignment of the motor with respect to the pulleys to eliminate all but compression stress on the rubber eliminated this problem. The symptom was also noticed, to a lesser extent, on Chain 1. A realignment cured this too.

Idlers:

The down d.c. idler of Chain 1 had a rough bearing, which we changed. This failure might have been due to the improper assembly of the two bearings into the wheel without an inner race spacer washer to prevent stress across the balls. All the stabilizing idlers for Chains 1 and 2 were in good condition and those for the reinstated Chain 3 were all new.

COLUMN SUPPORT POSTS (See also page 9)

In the first few days of the tank opening, the 4 new posts arrived from N.E.C. Discs to fit in the gaps between the end ceramics and the castings, to take the weight of the column, were to follow separately. We checked the ceramic faces on each end of the posts and determined that on an average 3mm would have to be machined from the discs in the form of a taper to accommodate, individually, the non-parallel ceramic

faces. The corrections needed for given posts varied from 0.6mm to 1mm across 60mm. We made two wedges for each post, each wedge with half the error, putting one on each end of the individual posts. The correct post lengths were determined by a vernier from wedge to wedge. Each wedge was given a spot of araldite on its inside edge to prevent it from rotating while being installed.

We had another look at some of the ceramics suspected at the previous opening, but not confirmed as being cracked. One which had yielded a high current on the resistance tester at 7 kV was seen to have a crack which was difficult to notice because it was white, not dark as usual. Whatever the colour of this crack, we were led to it by voltage testing, though not all cracks found visually showed up under volts.

After our worst posts were replaced by the four new ones, the list of posts with shorted ceramics remaining in the machine was as follows:

L.E. column: 4 units, each with 1 ceramic shorted.
Unit 14 has 2 ceramics shorted.

H.E. column: 1 unit with 1 ceramic shorted.
2 units, each with 3 ceramics shorted.

We therefore have 2 H.E. units with only 15/18ths post gradient and we have left the tube sections in these units tied by the stringers to the usual third-of-a-post positions.

Still finding more cracks made us very despondent until, out of the blue, the gloom was all gaily blown away by our old friends at N.E.C. We discovered a variation of their evergreen starheaded screw trick, so original and beautifully thought out, that we were quite unable to keep straight faces: the captive nuts in the corona brackets on the new posts have a different thread to the screws in all our corona assemblies! Of course, we only have to replace screws in 17 of our 532 corona assemblies and be sure to keep them apart when we renew points; but, if once we slip up, and get the assemblies all mixed, N.E.C. will be just that many points in the game ahead of us. Each time we put a new post in the corona assembly position the fun will compound itself and we can see this little jest reminding us of our friends for a long time to come.

Foils.

The foils in the terminal stripper were renewed. The Weisser valve, (5/3; 26/5), held almost perfectly, though there have now been about 20 operations since the seat was last renewed in June 1981.

Rotating Shafts.

Noise in the lower shaft motor led us to investigate the bearings. After some discussion it was decided to replace the bearings in the existing motor rather than disconnect it from the shaft coupling and heave two weighty motors, one out of and one into the bottom of the tank. (This decision got us into trouble; see second opening, this

report). We have never done this before and accepted the advice that it was a practical thing to do. The motor has received no attention since it was put in during December 1978. In its 6 years of service it operated for 29,744 hours. This excellent record prompted us to check on the chain motors and there is no record of any of these receiving any service since installation. There are hazy memories that one of them had new bearings, but this is not confirmed and, in any case, the other two have certainly had nothing done to them. The hours for positions 1, 2 and 3 are 39,000, 42,000 and 32,000 respectively.

Points.

A full set of N.E.C's Type 4 assemblies was installed in September 1983 (41/2,7) and has operated for 7,650 hours. The points have become dull - a word which is not very quantitative; suffice it to say that one's finger would not get pricked easily on most of them, but the needles would be detected if one sat unknowingly on an assembly, points upward. We have found in the past that needles in this condition appear to function well and to some extent ease the situation since the Type 4 assemblies gave significantly higher currents than their predecessors and led us to discover that point to plane gaps had been reduced for both tube and column assemblies (41/8). (See page 8 of this report)

Miscellaneous

The intermittent reading of the H.E. column corona current led us to find an equally intermittent short circuit of the shorting rod to ground in the machine; however, when we took the rod out, and put it back once or twice, the short refused to return. We concluded that something had fallen from somewhere onto something and then fallen off again. The external seal/clamp and internal guide tube were rebuilt for luck.

The spark-damaged wiring in greenfield tubing was replaced by wires run in copper pipe, connected at the unit and junction box by water fittings. The terminal triplet Y variac had failed and was replaced. A shorted turn on the lower sublimer variac was repaired.

Cleaning.

In July 1976 (4/5) the younger author made a determined move in the direction of cleanliness in the tank. A piece of indoor/outdoor carpet was tailored into four quadrants which we would always lay on the platform as soon as we got in. One reason for the carpet was that it would deaden the inescapable clatter echoing in the tank plus the intolerable crashes of noise from hardware being dropped onto the platform. It also ameliorated the wince of pain when kneeling on the non-slip ribbed surface of the steel platform. The main purpose was that the carpet would collect dirt, grit and dust which found its way into the tank; any not removed by vacuum cleaning prior to button-up would be brought out with the carpet. In addition, booties would be worn by everyone in order to keep the carpet clean. This devotion has always been enforced by the younger author whose flair for in-tank decor and dress has never been disputed. At this opening he acknowledged the observation by Bob Turkentine that the carpet had had its day and was

now contributing, by its own disintegration, more grit and fragments than it was absorbing. The time had come to investigate other styles of carpet, with more modern attributes; also, after nearly nine years, one gets tired of the same old thing. The carpet was not to be put back in the tank, under any circumstances, even if we opened again before we could refurnish. No-one contemplated defying this edict.

Button-up.

Following the usual tests, the machine was closed after the second longest opening since the new terminal spinnings were installed in June 1980.

Initial performance.

From the beginning there were problems with holding voltage. The experimenter sat up all night in an unsuccessful attempt to get to 12.5 MV. There was one big spark which seemed to get into everything - it even tripped the tower lift and after it the lower shaft, new bearings and all, would not come on. The next morning all phases of the shaft motor were found to have a dead short to ground. The mere fact that we had never before changed shaft motor bearings in situ, as mentioned above, didn't prove anything; it could easily have been a coincidence that we had the shortest life of a shaft motor on record just statistically.

We looked in the windows and saw some indeterminate activity somewhere below Unit 24, but could not be specific about it. Diagnostics with shorting rods led us to the conviction that there was something very wrong in Unit 28.

To be on the safe side we checked the dewpoint and measured the comforting value of -60 C. We decided that, rather than devote time to voltage conditioning with rods, it would be better to go straight back in the machine because, in any case, we needed the lower shaft to illuminate the foil counters, if nothing else.

The terminal triplet "Y" did not work again, in spite of the complete rebuild and testing of its variacs.

The Second Opening.

The lower shaft motor was confirmed as having all phases shorted to ground, though there was no evidence in its connection box as to why. It was taken out and the reconditioned one was put in in two hours. When the failed motor was disassembled, it was found that the thermistor had shorted to ground. As well, there were winding to winding shorts. It was conjectured that the plastic insulation on these had failed due to chemical attack. Breakdown products striking in a new place? It is possible that the act of replacing the bearings cracked the insulation already attacked, causing the short circuits. In future, any motor as long in the tooth will be rewound if its bearings fail.

Searching the column, we were concerned at the amount of black discolouration which we found in Unit 14. Unable to attribute it to any other cause we assumed it had originated from the spark-damaged wiring found in the upper terminal during the earlier opening and had been electrostatically deposited.

The lower units were all examined carefully, with particular attention to the suspect Unit 28, but no points had grossly failed and no stringers or rings were off, though one or two rings were not so tight as they ought to have been.

Confronted with such a blank situation we decided to distrust our visual assessment and see how the lower units reacted to voltage tests. It was immediately evident that the column corona points in Unit 28 were performing much worse than their appearance led us to expect.

We then tested each column point in the entire machine by applying volts across adjacent rings, positive towards terminal. In Unit 28 and elsewhere, the tests revealed cases where the spark gaps fired before corona started. This was especially true for Units 28 and 14, and in some cases Unit 13. Tube and column points alike in these units were badly worn, nevertheless, visual inspection is not adequate to identify the problem. All points in Units 28 and 14 were replaced and the lower two thirds of tube points in Unit 13, together with the lower 8 column points in Unit 13. This took up all the spares we had.

Our measurements concerning the points belied the validity of our comments on page 6 about dull needles appearing to function well.

The problem with the terminal triplet Y was found to be a loose screw on the barrier strip in the terminal connection box. Evidently our thorough tests of the previous opening were not accompanied by as thorough tightening of all the things we loosened.

We attended to a few minor matters, then the machine was closed again. The tank was left roughing over the whole weekend and gas-up was carried out on the following Monday, 11th March.

After reaching 85 p.s.i.a. we ran volts, the small recirculator having been on for two hours. This was a mistake because our rule now is (though only the younger author knew it) that the large recirculator must have been on for two hours before starting to put volts on. The machine went up to 12.98 MV without a murmur. A little later it began to spark badly at random volts. There was high lost charge, due partly to loading. Eventually the experimenter ran without very much trouble at 13.25 MV, using double stripping.

The machine continued at this voltage for 8 days, but not without troubles. First of all, the tank cup would not move completely out of the beam path; as a consequence, scattered beam increased machine loading.

On 19th March the lower shaft motor, put in as a replacement 10 days earlier, expired as suddenly as its predecessor, apparently from the same ailment, since the demise followed a spark and the winding also measured a short to ground from outside the tank. We now began to wonder whether the earlier failures of this motor were due to the natural causes we had assumed, or if something more sinister was at work, in which case it must be tracked down before it could strike again.

We scheduled another opening.

POST MORTEM (See also page 4)

While the gas was being taken out on Monday, 25th March, the younger author took the opportunity to begin a systematic dissection of the corpses of the four posts recently removed from the machine. Enlisting the enthusiasm of Gerald Clarkson, who loves taking photographs, he began with the post taken out of Unit 16, (the first cracks to be noticed (48/3) which led to the discovery of the bad post which was returned to N.E.C.).

The top aluminium flange was removed in order to grind away the the top part of the uppermost spark gap to allow more thorough examination. There had been a great deal of electrical activity between the aluminium/titanium surfaces which rely on mechanical pressure for good electrical contact (Photo 1). Not only were both contact surfaces seriously eroded, but in the volume enclosed by the top flange there was about 1cc of fine grey powder, resembling the grey dust we see on shiny surfaces throughout the accelerator (Photo 2). It was obvious that arcing had occurred between the aluminium flange and the spark gap electrode, spark eroding aluminium from the flange.

The uppermost electrode was ground off carefully, with a fine hand grinder, and it was seen that the crack in the top "live" ceramic extended upwards, through or past the bonded electrode and into the "dead" ceramic within the flange which takes the weight of the column. As well, the thin shorted-out ceramic below the "live" one showed cracks which appear to be extensions of the ones in the "live" ceramic. (Photo 3).

We then sliced four ceramics and found in three cases that the cracks went fully into the volume of the ceramics, some going from one ceramic into its neighbour (Photo 4).
For the time being we summarize the findings from the post mortems as follows:

The powder found in the sparkgap electrode: This is 1). Spark eroded aluminium; 2). acidic breakdown products predispose such an interface to spark erosion; 3). This dust gets into the SF6 space and causing further sparking. In a case where a titanium spacer was attached to its end cup electrode only through 4 rivets, plus the mechanical pressure from the aluminium flange, it was too badly spark eroded at the Ti/Ti interface. This argues that poor electrical/mechanical contact is as least as important as electrolytic action of dissimilar metals.

Spark gap metal work was inspected further, looking for evidence of spark erosion between Ti/Ti surfaces of the intermediate column spark gaps. We found, in the posts removed, that the spot welds at the periphery of the column spark gaps were not, or no longer, welded and that erosion had occurred at these interfaces too. Places that were well welded (welded well?) showed much less evidence of erosion.

The cracks: 1). 3 out of 4 marks on ceramics indicate cracks through the bulk of the ceramic. 2). An increasing number of ceramics are suspect - approximately 10 in addition to the 5 already replaced. 3). Reverse voltage sparking may just be a contributing factor rather than the unique cause of a problem.

The Third Opening.

Shaft motor.

As before, there was nothing to see or smell inside the cover of the lower shaft motor. We took it out and put back the one which had failed before and had just been reconditioned. When checking the wires from the thermistor connections in the motor to the tank wall feedthrough we found that they were spark damaged and the flexible metal conduit in which they ran was burnt through at 3 places. We decided that these wires, inadequately shielded, performed as an antenna, picking up heavy r.f. surges and feeding them into the motor. We removed the wires and discontinued connection to the thermistors. All ventilation apertures in the motor were covered with brass mesh to reduce the amount of r.f. getting into the windings. Similar screening has been used on the upper motor for years.

Column.

In Unit 14 the lower tube to column stringer had come off its post and was hooked neatly up onto the stringer above it; this was the stringer which was completely missing not long ago (48/3). The captive nut in the post had failed; we assume that the stringer sprang away from the post, touched the shaft and was flipped upwards, to become caught by its open eyelet on the upper stringer. The effect of this on a unit would explain a lot of instability. The joint of the phosphor bronze stringer and titanium flange was spark eroded to a depth of 2mm. Similar erosion is evident on the interface between the aluminium post bracket and the stringer. Both surfaces were filed back to bare metal for the new stringer. It is possible that breakdown products are giving rise to troubles in dissimilar metal interfaces.

The lowest column corona assembly in Unit 19 (the lower third of which houses the second stripper) was loose. A strap shorting rings in the dead section, which was renewed last time, was also loose and spark damaged. We made up our minds to ensure, in future, that all spark damaged connections must be filed back to the clean metal before new connections are made.

Noticing that one of the tube spark gap electrodes had drooped onto the one below, we examined every electrode in the machine and found two other cases, both the very bottom electrode in their respective units. The younger author, alone qualified for such surgery through his experience with the posts, took these electrodes out and put in new ones. The failures had been caused by the securing screws running out of thread before they could press the electrodes to the flanges. (During pre-buttonup cleaning, yet another tube flange spark gap was found with its end screw missing. In this case the threaded hole was stripped of thread).

Idlers:

Idlers.

While poking peacefully about on his own, the older author found that one of the stabilizing idlers felt quite rough when turned, but all the others ran freely and had no sideways wobble. This observation was checked by someone more thorough who pointed out firmly that several idlers now have noisy bearings and possibly all will have to be renewed before long. This may be so, however the older author does not employ the criterion of audibility when assessing bearings: it is not always the first to uncover faults.

The present idlers were installed early in November 1983; they have now operated for 7,300 hours without any failures.

Tank cup.

To deal with the problem of the tank cup failing to move fully out of the way of the beam, we let the tube up to atmospheric pressure and took off the 300 litre/sec pump on the top of the column. A gloved hand, inserted through the pump flange on the tube, manipulated the cup back into correct phase with the driving magnets. More than ever, the delicacy of this operation demanded youthful, steady fingers.

When the 300 litre/sec pump was removed we found more of the fine sand in its throat that we reported earlier (31/3). The pump was taken out of the machine, its electrodes removed and cleaned and the body was blown free of sand; about 5ccs were removed.

Because the tube was at atmospheric pressure, we took the opportunity to do some housekeeping. Foils were renewed in the second stripper for the first time since November 1983, which was the last occasion that the tube had been "up". The vacuum housing was rich with broken foil flakes; these were extracted with a vacuum cleaner. We tremble when we think of the foil flakes further in the tube. The L.E. midsection sublimer pump was taken out, scraped and fitted with new sublimers.

Charging System.

During the charging tests immediately prior to the last closure, sparking was noticed between the pellets already on the drive pulley and the shimstock contact band of Chain 2. The charging currents on Chains 2 and 3 were once again variable and less than that for Chain 1. At this opening we measured the resistance of pellets to pulley and found greater than about 50 ohms for all 4 pulleys of Chains 2 and 3, It was found that the wheels wobbled when turned and that the aluminium adjacent to the contact bands was not flush to the nylon tyres; thus the bands did not touch the pellets reliably. We presume these discrepancies represent an accumulation of errors introduced over the years when the pulleys were re-worked. Wobbles of the order of a millimetre invalidate our so-called "careful" alignment of pulleys and place unnecessary vibrational stress on the chains.

All four pulleys were disassembled so that the sides of the blue nylon "tyres" and some of the aluminium from the pulleys, could be skimmed in order to achieve efficient electrical contact with the chain pellets. When everything was back together again a repeat of the earlier measurements showed that the contact was now excellent.

Cleaning and button-up:

The column was blown with nitrogen entirely by the younger author who wanted to see for himself exactly what he disturbed and where it went. He reported that about 10 post flanges belched out dust and that spattered chain oil, adhering to some posts in the H.E. column, retained the grit and dust which arrived on them.

The charging tests were satisfactory and the doors were closed at 6.15 p.m. after a hard day. The tank was roughed overnight and the next day, Good Friday, it was valved off and left until the Tuesday following Easter.

D. C. Weisser

T. A. Brinkley

9th April 1985.

David Weisser will attend the 4th International Conference on Electrostatic Accelerator Technology in Buenos Aires on 15th April. This report was completed and dated on his last day in the laboratory before leaving (first working day after final closure), enabling him to take with him some copies in the form of computer output.

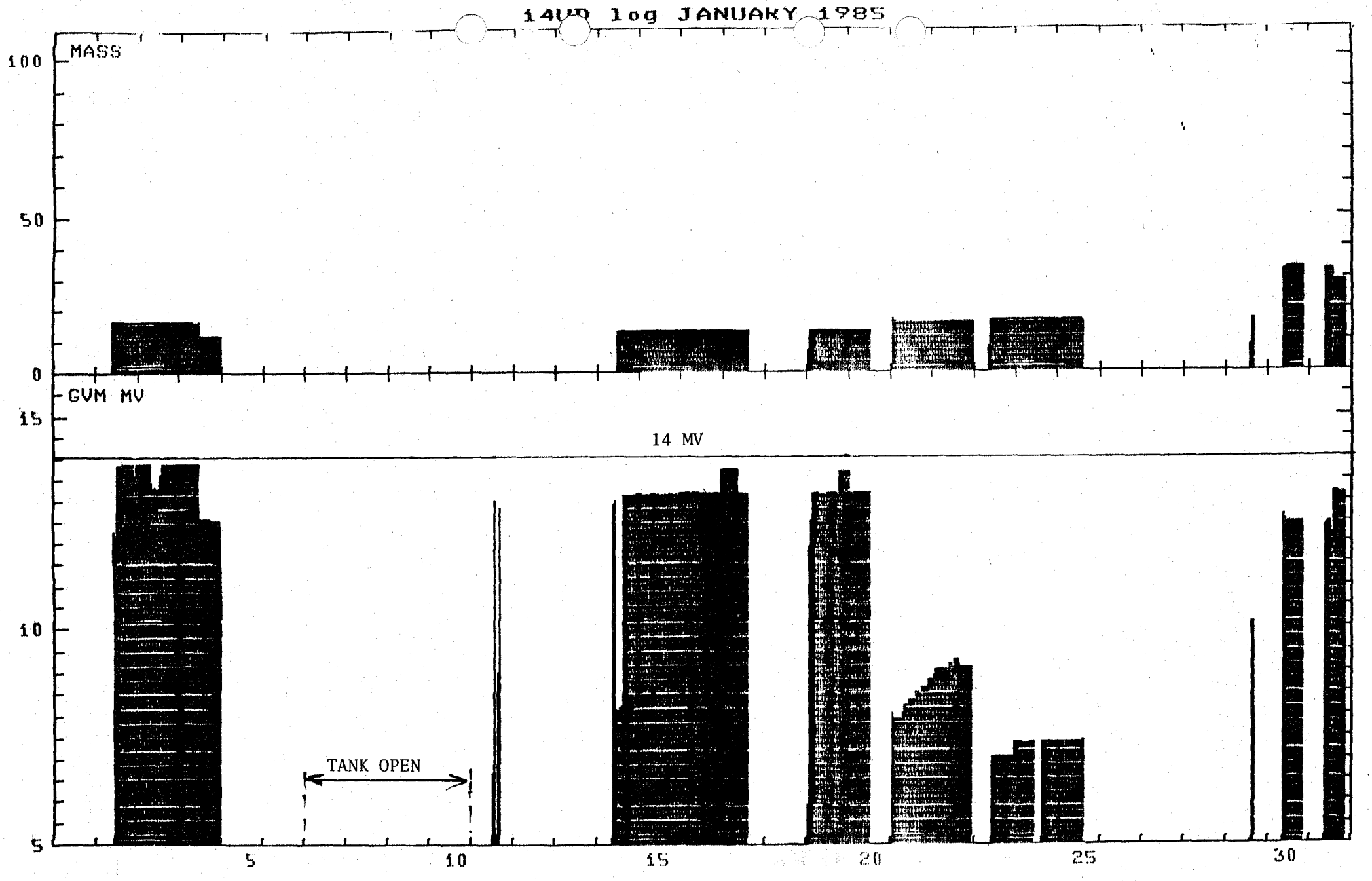
Enclosures:

Plots of particle masses accelerated, and operating terminal voltages.

NOTE: On the plot of terminal voltages we have drawn a horizontal line at 14 MV for easy reference to performance near the nominal voltage limit of the 14UD.

Photographs:

1). Debris found between post flange and top of spark electrode.
2). Debris, with match to indicate scale.
3). Post 3 from Unit 16. Side view of cracks treated with dyecheck.
4). Post 3 from Unit 16. Ceramic sliced to show internal cracks.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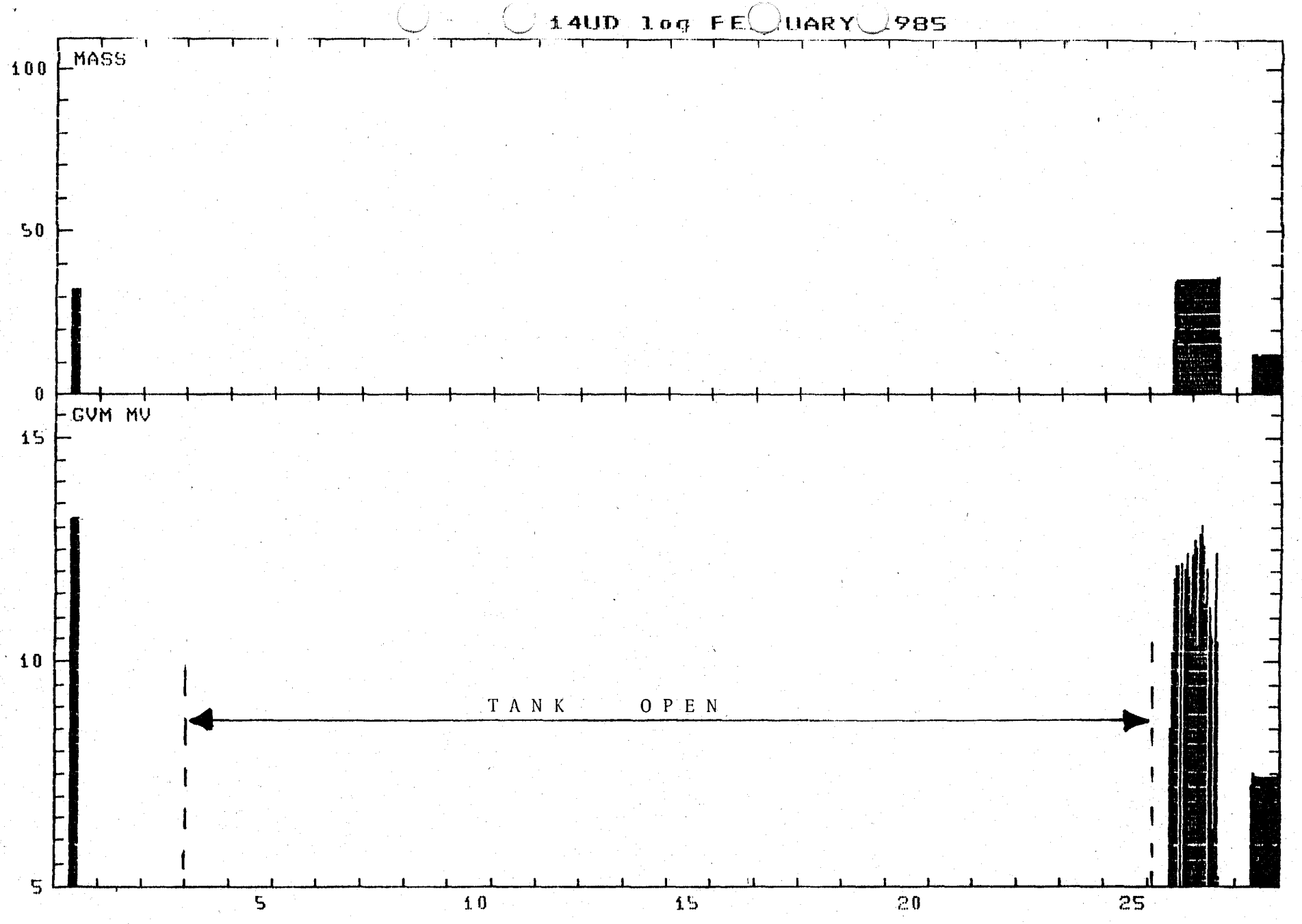
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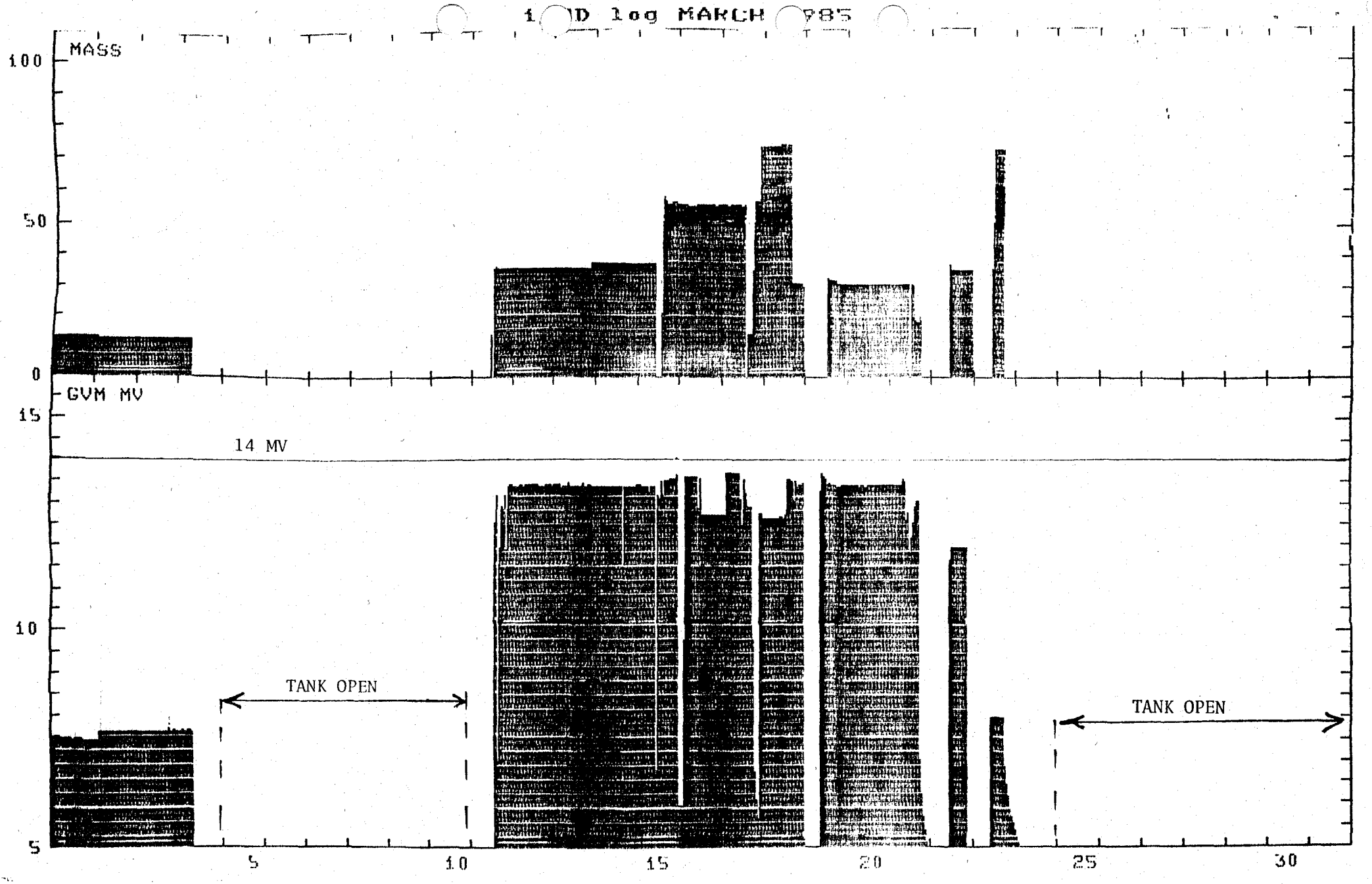
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