AUSTRALIAN NATIONAL UNIVERSITY

DEPARTMENT OF NUCLEAR PHYSICS

Mrs Lunch

14UD TANK OPENING REPORT NO.11

April 3rd to May 10th 1978
(37 days; 27 working days)

PREAMBLE:

The tank was last closed on February 1st and the performance of the 14UD during the 61 days from then until this opening was very satisfactory for the first two weeks, after which, as reported in the addendum to Report No.10, the excessive lost charge returned and the machine was not responsive to the hitherto successful treatment of running the control needle system in and out a few times. The machine became unstable above 13 MV, though, later on, voltages in excess of this were attained. Further problems occurred; 20 days after closure the upper shaft motor became open circuit on all three phases following a spark and this meant loss of pumping in the mid-section; also no heater plates operated in the L.E. column. The lost charge problem had reduced the usable terminal voltage to about 12 MV and experiments which could run at this voltage, or below, were continued.

The major shutdown for the installation of the H.E. stripper, and other matters, would have been advanced, and the present problems attended to, but preparatory work was not completed and on early opening would have been uneconomical. The 14UD limped on valiantly, in spite of its troubles, but during these weeks some very satisfactory beams were produced by the sputter source, among them 830 nA Mg on the L.E. cup (measured when the beam was optimized at 250 nA 7^+ on target). There were also satisfactory beams of Ni; Fe; ^{12}C and ^{13}C. A resume of particles accelerated is included; the list dates back to last October as no list was given in the last report.

Heater Plates

In Report No.9 it was pointed out that the new ANU connections between the heater transformers and the heater feedthroughs had resulted in reduced contact resistance and the original currents of 110-120 amps throughout the machine had risen to 120-140 amps. Since Report No.9 NEC has cautioned against currents > 100 A and they refer to their early measurements of ANU heater plates which indicated about 75 amps using a clamp-on ammeter in conjunction with a Simpson meter. (ANU measurements have all been with the same clamp-on and, if not absolute, are certainly relative); recently the clamp-on has been compared with two others, one a more sophisticated 400 cycle instrument (the 14UD alternator frequency is 330 cycles). NEC measurements were made after 45 minutes running time when the heater plates had stabilized to a higher resistance and lower current. ANU measurements have, until recently, been more casual because they were made merely to determine whether individual heater plates were still operating or had succumbed to either thermal overload or crimp-lug failure. The difference in heating time was shown not to account for the apparent discrepancy. The currents observed were accepted as normal and correct because nothing had been changed since NEC handed over the machine.

Bearing in mind NEC's view that heater plate currents of 75 amps are normal, and their disapproval of currents in excess of 100 amps, some tests were made while also taking into account our own comments about hot spots on heater plates and consequent electron introduction into the accelerator tube (report No.9, page 7). A spare heater plate was sandwiched between two spare tube sections; the bottom was pumped and a window was put on the top in order to observe the temperature of the heater plate which was driven by a standard spare transformer fed by a 400 cycle portable alternator; the voltage on load being 130 V, precisely that which was used by NEC in their bench tests. The transformer secondaries were cleaned and paralleled with massive T-pieces as used in the 14UD; also the connections to the heater plate feedthroughs were made of identical copper straps to those used in the machine. The heater plate current stablized at 130 amps and the plate could be seen to reach a deep cherry red when viewed through the window. It was then felt that the new higher currents should be reduced to something like 80-90 amps. Short of increasing the primary turns there were two alternatives: one to drop the primary volts by introducing a 30 ohm 30 watt resistor in series with the primary of each transformer, requiring an appropriate mounting in every casting; the other alternative was to use resistive leads between the half-turn secondaries and the heater plates; the resistance necessary being 4.2 milliohms. Building leads of stainless steel, (resistivity 70) or copper, (resistivity 1.7) calls for conductors of massive, rigid bar on the one hand and a length of 16 gauge wire on the other - equally intolerable solutions. Connections of steel, (resistivity about 11), allow feasible dimensions, but then there would have to be plating, or rust tolerated. Brass (resistivity about 7), allows connections of practical dimensions, the only unknown being the performance of brass in such a function over long periods. Brass takes on an outer coppery coating in the 14UD but, as exhibited when old shorting rod contact assemblies were taken apart, brass and copper surfaces in tight contact remain clean. Brass straps of 20 gauge sheet, 18.5 mm wide, were tested on the experimental setup and found to produce 88A while remaining quite flexible; therefore a complete set was made to replace the longer of the two copper straps which yielded such high currents when fitted six months ago (Report No.9).

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THE TANK OPENING:

The tank was opened late on Monday, April 3rd, and a brief cruise up and down the column disclosed three obvious facts: 1) the column was remarkably clean and dustfree, a condition observed in the two openings of Report No.10 since the closure following the sand-mining and column-cleaning of Report No.9; 2) the pyrotenax feeding the upper shaft motor had burnt completely through and there was burn damage to the leads in the connection box on the motor; the cover on the feedthrough screening box had slipped partly off and the failure was attributed to r.f. entering the circuits; 3) Oil. Report No.10 described how a new phenomenon of moist oil on the terminal, and on the positive face of the column points, was observed during the two tank openings to which the report related; the oil had occurred again. The terminal had been cleaned on the previous occasions, but now the build-up on the point assemblies was heavy, and, as the oil began to dry, the deposit was beginning to flake. On the floor of the tank, in a small natural valley, a pool of a few ccs of oil had formed. This point is directly below the control corona path. The rest of the floor was completely clean and dry. Since the last closure there had been, for the first time, no chain oiling system whatever in the tank and the only sources of oil were grease in various bearings, and the minimal film wiped on shorting rods from time to time. If oil was being introduced by the gas handling system at least it was leaving no traces on the gas entry baffle. In any case, a complete overhaul of the gas-handling system had been planned and was begun at once.

Oil was found in the compressor and traced to the Kinney pump.

THE GAS HANDLING SYSTEM:

The suction side of the Kinney was not contaminated with oil. The oil deflector baffle, in the body of the Kinney, had fallen from its position and was possibly the main cause of oil in the gas. A support bolt was missing and was nowhere in the pump; since this was the first occasion that the pump had been opened up it was concluded that the bolt had been omitted at time of manufacture.

Filter material in the oil mist eliminator had failed over about a square foot and the entire unit had shifted sufficiently for there to be a free path of exhaust gas past the filter. The oil separator labyrinth, (the next element downstream from the Kinney), contained about a gallon of oil; the diaphragm valve separating this trap from the Vapoilsorb tank was damaged, presumably because of the oil on it. The Vapoilsorb tank had a continuous patch of oil down one side of it from entrance to exit pipe. The pipework from the Vapoilsorb tank to the suction side of the compressor had no obvious oil contamination.

The compressor strainer element is fitted with a fine copper mesh; this was torn off and large pieces of the material were found on the input valve of the compressor. The compressor rings and pistons were contaminated with oil and dust and the rings were seized in their grooves. The first intermediate stage heat exchanger was grossly contaminated with oil and rust; the second intermediate stage heat exchanger was contaminated to a lesser extent and the third and final exchanger to the smallest extent.

The following reconditioning procedures were carried out:

The oil baffle in the Kinney was repaired. A new oil mist eliminator filter was bought from Kinney and a water cooling coil installed. The oil mist eliminator chamber will be solidly mounted on the floor and separated from the pump by a bellows to minimize vibration-induced failure of the filter element. Replacement diaphragms for valves were obtained. Vapoilsorb chamber and the pipework assembly below the chamber were cleaned. The compressor was fully stripped and cleaned and de-greased new rings were fitted. All the heat exchangers were degreased, flushed with acid in order to remove rust and oil and then sealed under dry nitrogen. The high pressure pipework was modified to allow gas to be taken directly from the top of the storage vessel into the normal filling pipework. The gas going into the accelerator will be monitored for hydrocarbon content with a residual gas analyzer. Dust filters on filling lines have been cleaned and reinstalled.

In future, when all oil has been eliminated, it is intended to change operating procedures to minimize the amount of oil introduced to the SF_6 by the Kinney. Up until now the Kinney has been used to pump SF_6 from atmospheric pressure in the accelerator in order to minimize any air drawn into the compressor by running the compressor input below atmospheric pressure. In future, the compressor will be used to reduce pressure in the accelerator tank to as low a value as practical.

Shaft leaks on the compressor will be compensated for by pressurizing the chamber around the seal with SF_6 to about one atmosphere.

Following the discovery of oil in the tank gas, literature relating to SF_6 was unearthed from various archives and examined. A report from Sala and Spalek, Nucl.Instr.& Meth. 122 (1974), mentioned that oil in tank gas has been found to give rise to lost charge problems, as well as deposits on corona planes. We make conventional excuses for aberrations in the somewhat diversified filing arrangements for our earliest documents relating to the 14UD.

While oil in the tank gas seems certain to be the cause of heavy and uncontrollable lost charge experienced over the last month or so, the quantities found in the tank were really very slight. An estimate indicates that, if all the oil lost from the Kinney had gone into the gas, the concentration would have been no more than the order of parts per million. When one considers the amount of oil deposited on the terminal and column point assemblies from our contamination it becomes clear that 'parts per million' is a significant contamination. The patch on the terminal was, at most, an area of 40 x 40 cm and was a mere film in thickness. Distributed on the positive sides of over 500 column point assemblies was an oily layer of about the same concentration as the terminal, totalling a very small quantity. Oil on the tube point assemblies was distinctly less than on the column; the positive sides of the tube points were noticeably discoloured but the total quantity was considerably less than on the column assemblies. There is clearly an 'oil gradient' across the radius of the column, and it is emphasized that oil is only deposited at the three locations where corona occurs; terminal, and tube and column point assemblies. For instance, no oil occurs on any part of the terminal other than immediately opposite the corona stabilizing needles; nor is oil ever seen on rings or inductors.

The SF_6 was analyzed with a residual gas mass spectrometer. The gas in equilibrium above the SF_6 liquid was found to be free of oil contamination; however, it contained about 3% air. A sample of liquid drawn from the bottom of the storage vessel had unmistakable oil contamination. This disparity in oil concentration provides, at least in principle, an avenue to allow oil-free SF_6 to be supplied to the accelerator if the pure gas from the top of the storage vessel was used. It is assumed that, in a normal filling operation, where liquid is drawn from the bottom of the storage vessel, the violent boiling of the SF_6 carries oil with it. The gentle,slow evaporation taking place in the storage vessel should attenuate the low vapour pressure fraction of oil in the gas phase.

We began operating in this way at an arbitrary rate of about 3 psi/hour and and found that the storage temperature varied from 11°C to -3°C, this range being, during these late autumn days, approximately the ambient temperature in the vicinity of the storage vessel which is shaded by the 14UD tower itself.

The residual gas analyzer persistently retains oil peaks in the region of pressures down to 2×10^{-8} torr, even after bakeout above 100°C. The analyzer is, nevertheless, the device by which the oil content is monitored. At 41.1 psia the gas being let into the accelerator showed no signs of oil. It is our intention to scavenge as much SF_6 as possible from the storage vessel and put this clean gas into the accelerator. In principle we should be able to reduce the pressure in the storage vessel to about 10^{-5} torr, which is the nominal vapour pressure of the oil. This process, so far incomplete, cannot be pursued continuously for more than a day, with an inactive day afterwards, so as to keep the storage vessel above the safe operating temperature of -12°C. The oil needs to be retained in the storage vessel from which it can be removed manually, with such expedients as rags and degreasing agents.

Oil in the gas was, of course, most unwelcome, but recently the lost charge effects had become accentuated and had risen to be the No.1 problem with the accelerator; the discovery of a tangible cause was most acceptable.

POINTS:

Dust particles had adhered to the heavier concentration of oil on the column point assemblies and they were distinctly messy; consequently every column point was removed washed in alcohol, rinsed in cleaner alcohol and then replaced. The tube assemblies were held to be in fair enough condition to escape removal and washing.

All tube and column points were quite sharp and no assembly in the machine needed replacing. The NEC Type 2 point assemblies (3 sewing needles soldered onto discs) continue to perform vastly better than the original single gramophone needle held by a grub-screw.

STRINGERS: (Tube to column d.c. connections)

Report No.9, page 5, refers to a test of 'thick stringers', and Report No.10, page 4, suggests some success with these; accordingly all remaining stringers of 0.030 inch nickel wire were removed and replaced by quarter-inch aluminium rods. It will, of course, be difficult to assess the effect on corona points, but the empirical observations made so far justify the effort.

CHAINS:

The chains appeared to be in good condition, but slightly tacky to the touch, and not moist with oil. There were no dents and the nylon links seemed as new. Every pellet was examined and cleaned with alcohol.

In the terminal two d.c. idlers, about the usual crop, had lost a contact spring and these were renewed. We feel that d.c. idlers, and their method of contact, could do with a bright idea because they are a regular source of failure.

In the castings every stabilizing idler was examined and several were found to have defective bearings. All defects were repaired and, on this occasion, no stabilizing idlers had lost tyres, but one idler was off altogether.

The nylon rims of the charging pulleys were faintly moist and there was no evidence of drying out, or crazing.

Prior to button-up the chains were oiled by hand in the fond and mystical way which has become the traditional province of one of the authors. No oiling system was left in the tank, it having been established that careful cleaning and manual oiling will last for an average tank closure. An ideal oiling system has been thought about deeply, but a system which requires no oiling of chains is obviously desirable, and is under consideration.

CORONA STABILIZING UNIT

The unit was disassembled and examined for oil or any kind of contamination. The inside of the tube, and the concentric conductor, were quite clean. The mushroom was faintly oily and was sandblasted, then polished.

VACUUM SYSTEM:

Valves:

Fast-acting ball valves have been designed and built in the department for the main purpose of protection against loss of SF_6. The valves have apertures of about 50 mm compared with about 25 mm for the NEC fast valves and are opened by the operation of a switch, as distinct from the manual re-setting of the heavy spring with the NEC valve. Preliminary tests show that the ANU valves hold pressures of the order of 10^{-8} torr, but their performance under operational conditions has yet to be determined.

It was intended to insert the ANU valves in the tube close to the top and bottom of the tank, however, only the L.E. valve was installed because the one intended for the H.E. developed mechanical problems which could not be fixed before the tube had to be closed.

The mechanism of the ANU valve, which allows the terminal stripper to be removed without letting the tube up to air, was taken out and the aluminium seats were renewed; this was not through necessity, but because the tube had to be up to air for the H.E. stripper to be installed. A guide bush in the valve, which had come loose, was removed since the valve operated correctly without it.

Pumps:

An optical baffle was put in the L.E. midsection sublimer pump as well as a stainless steel screen in order to prevent titanium from entering the tube. When this pump was opened it was found that both sublimer pellets were in good condition. The last time a sublimer was renewed in this pump was February 1976, and then only one of the two. A 10 litre/second ion pump was installed on the stripper housing in the new H.E. midsection.

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ELECTRON SUPPRESSION EXPERIMENT:

In Report No.9, page 6, observations were made on electron suppression and the sublimers in the midsection pump. At this opening a bias supply was built to operate on the sublimers and installed in the midsection; the output voltage was variable and made to be controlled from the main console in order that, under operational conditions, the effect of biasing the sublimers could be observed. The new baffle in the pump will also assist in reducing the number of electrons entering the tube. Results will be reported later.

HIGH ENERGY STRIPPER:

This was installed in the lowest third of Unit 19 and involved the first removal of a tube section since the departure of NEC staff. The new stripper has 270 positions, (115 in the terminal stripper), and every 10th position was left empty for ease of finding blanks on the occasions when no H.E. foil is required. A reverse option was fitted but not engaged because of unsatisfactory operation of the connection to the foil counter. A similar option on the terminal stripper was fitted, but not engaged for the same reason. The new 270 foil band was not installed in the terminal stripper because of lack of adequate preparation time.

A combination of original rings and one of the new NEC contoured casting covers, intended for castings near the terminal, arrived fortuitously in time to be modified and used.

A 10 litre/sec ion pump was installed in the H.E. stripper.

MISCELLANEOUS:

A Faraday cup was put in the tube just after the object slits.

The L.E. midsection alternator was removed and the flexible coupling below it found to be split at the fixing bolts. This was due to a slight mechanical misalignment. A replacement with a casting flaw, all we had, was put back and hoped for.

The brass 'resistive' heater plate leads, mentioned in the preamble, were fitted at every position. It is hoped that the lower operating current will eliminate electrons producing hot spots from heater plates in Units 10 and 11.

A discharge problem that had required shorting out Unit 21, was traced to 'snail' tracks in the white powder on the rotating shaft of that unit. The tracks wiped off easily with alcohol and elbow grease.

All shaft sections and control rods were thoroughly cleaned and polished. It was noticed that the shaft section in Unit 15 had a faint pattern of tracking marks over most of its surface; the marks did not respond to cleaning, as similar marks did elsewhere. No such indelible marks occurred on any other shaft or control rod in the machine.

The greenfield tubing to the L.E. midsection sublimer pumps, and from alternator to the electronics box, was replaced by pyrotenax. (The supply to the new midsection was run in pyrotenax.)

The leaky heater plate referred to in Report No.10, page 1, was removed without hesitation following the confidence gained in removing the tube section for the H.E. stripper and replaced with a spare, which had previously been vacuum tested.

New tank gas pressure and temperature monitoring equipment was installed.

Irregularities in the location of the platform seals at every button-up, resulting on more than one occasion in a partly uncovered o-ring, or an improperly positioned top fixing plate, led to the installation of new seal-plate guides in the housings; these guides bring the sealing plates to the correct position automatically. The platform was levelled and new spacers fitted under the support posts to bring about more precise agreement with the sealing plates as they reach the top.

TANK VENTILATION SYSTEM:

It has been discovered that the column remains remarkably clean since the elimination of sand-mines in the castings and considerable enthusiasm has arisen for cleanliness and cleanly disciplines in the tank. A large and powerful fan has been fitted six or seven feet above the upper tank door; effective filters are incorporated and the fan blows into the tank by way of a wind sock of dacron sail material, imposing positive pressures at all times, thus blowing out at cable inlets, entrance ports and the bottom door, preventing dust from entering and producing a strong down-draught which takes away any particles blown off the column.

CLEANING:

Every tube and post electrode was blown with dry nitrogen tapped from the liquid nitrogen storage vessel and dust dislodged was mostly caught by a large funnel on the end of a vacuum cleaner. The floor and ceiling of each unit was then wiped with a Tac-Rag.

All covers and rings were wiped with a Tac-Rag, now accepted as the only way to remove the blue-grey bloom which covers them all.

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SOME OBSERVATIONS:

As mentioned earlier in this report, the leaky heater plate in Unit 9, and referred to in Report No. 10, page 1, was replaced. It was noticed that a surprising amount of dust was lying on top of the flange near the sealing surface; the black and white photograph enclosed shows the dust distinctly. There was no dust on the heated aperture itself and presumably conditioning transports the dust to the "safe" position it now occupies.

The heater plate, uncovered in Unit 19, incidental to the installation of the H.E. stripper, showed a similar dust pattern. In this plate, however, the titanium aperture was blue, indicating that it was probably hot when a vacuum failure occurred - this may well have been the occasion when the fast valve bellows was burnt through by the beam in 1975. On the blue surface small, white star patterns, about 1 mm across, could be seen and it can be speculated that these are dust-conditioning remnants. (Unfortunately photographs were not taken of this effect).

The existence of dust in the accelerator tube poses three questions:

1) Does the titanium nitride/oxide layer on the high energy tube heater plates limit the gradient?

2) What role does dust play in causing tube conditioning and ultimately limiting gradient?

3) Where did the dust come from?

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The first question cannot be attacked without the complete re-building of sections, or all of the H.E. tube, and such a procedure would undoubtedly introduce additional competing effects.

Evidence concerning the effect of dust in the tube, and conditioning, while clouded by other effects, is nevertheless still meaningful. At this tank opening extra care was taken to confirm that no major leak had arisen because of misplaced gaskets in the heater plate and H.E. stripper installation. Checks were made by roughing the tube to from 10 to 60 microns after each step in the total installation and then refilling the tube with dry nitrogen. The process was repeated about 8 times and was valuable from the point of view of leak chasing diagnostics.

Since the tube was pumped with a carbon-free roughing unit only to modest vacuum and filled with dry nitrogen, the chemistry of the tube surfaces should not have been altered during each cycle.

When volts were finally put on the machine vigorous tube conditioning commenced at about 8 MV; this is 3 to 4 MV lower than on occasions when the tube has not been opened, and 2 MV lower than when the tube has not been subjected to several roughing cycles. It took 2 hours to condition to 10 MV. This behaviour is consistent with redistribution of dust within the accelerating tube. If all the mobile dust can be conditioned to "safe" locations the maximum gradient should not be lowered.

The source of the dust is entirely conjectural; some probable origins are as follows:

1) included between manufacture and installation.

2) included during installation.

3) brought in with back-filling gas.

4) sucked in by major leaks.

5) settling during optical alignments when the tube is open.

None of these processes can be eliminated. We assume that stringent precautions are taken during manufacture and shipment, and that bottled nitrogen and the blow-off from our liquid store are dustfree. The cleanliness of the tank during installation of the tube is uncertain and the cumulative hours of optical alignment over the years cannot be dismissed. With the tube open at both ends substantial convective flow occurs. This could easily transport large quantities of dust.

With the exception of major vacuum failure the possible causes of dust in the tube can be dealt with in such a way as to greatly reduce the chances of contamination.

The colour photograph shows a marked discolouration of the heater plate clamping screws; the heads of one pair of screws are blue, and those of the other pair brown. These colours are probably due to local heating because of contact resistance and the effect is consistent with the injection of x-ray producing electrons produced by the heater plates. While it is hoped that the reduced heater currents eliminate the electron problem there is a feeling that the former hot spots (now warm spots) may not be consistent with optimum operation of the accelerator tubes. If the titanium aperture plate were fastened to the feedthrough rods by a tack weld, the contact resistance problem would be eliminated, however, the method might increase the heater plate current sufficiently to require higher resistance in the leads.

Stripper foils:

It has been observed for some time that the only change in thickness of stripper foils removed from the 14UD terminal has been in the neighbourhood of dust particles stuck to the foils. At these places a thinned halo appears around a more dense dust particle. In the absence of carbon build-up, in principle achievable only in a carbon-free system, such imperfections might be a limiting factor in foil lifetime. Indeed, the occasional 'super' foils, which operate for more than 24 hours with 500 nA of MgH_3^- incident, may, by chance, be dustfree.

A final limitation on foil life must be thinning of the foil due to sputtering. The stripper assembly now displays a clear pattern of sputtered carbon from the foils. The downstream components of the assembly are discoloured with clear shadow lines from the foil. There is no discolouration on the upstream side of the system.

FURTHER REMARKS ON TANK GAS:

In the top half of page 4 we described gas sampling and analysis, also the method of gassing up we intended to use in order to leave the oil behind in the storage vessel. At the date of writing these additional notes, May 23rd, 12 days after gassing up was begun, the storage vessel and accelerator tank have been equalized in pressure at about 91 psia. The purity of gas entering the accelerator tank was checked frequently and the filling rate adjusted in order to prevent contamination. Now that all the liquid has been consumed from the storage vessel there is no longer a source of turbulence which could mix oil into the gas being transferred.

The graphs enclosed show the mass spectrometer response for various samples in log scale. The top trace displays the many dominating peaks characteristic of oil contamination; this sample was taken from the liquid phase in the storage vessel. The oil peaks predominate over the SF6 peaks which are at 32, 35, 51 and 54 amu.

The next trace, No. 2, is for a sample of commercial gas adulterated with 5% air, by volume.

The third trace is a sample from the top of the storage tank, i.e. gas phase. Clearly it is free of oil peaks, but it indicates about 3% air.

The fourth trace is the gas entering the accelerator vessel when at 81 psia.

The fifth, (bottom) trace is the same sample as the fourth, but amplified by a factor of 100.

Clearly SF6 peaks dominate the spectrum. The high mass (48 - 240 amu) portion of the spectra are compared in the second page of graphs. The top trace, and its linear version directly below, show the oil contamination. The bottom two traces show no sign of oil at 80 psia.

The remaining gas will be taken out of the storage vessel and put into the accelerator by means of the compressor; the storage vessel will then by opened and cleaned.

D.C. Weisser.

T.A. Brinkley.

23rd May, 1978

Enclosures:

Black and white photograph of dust on heater plate.

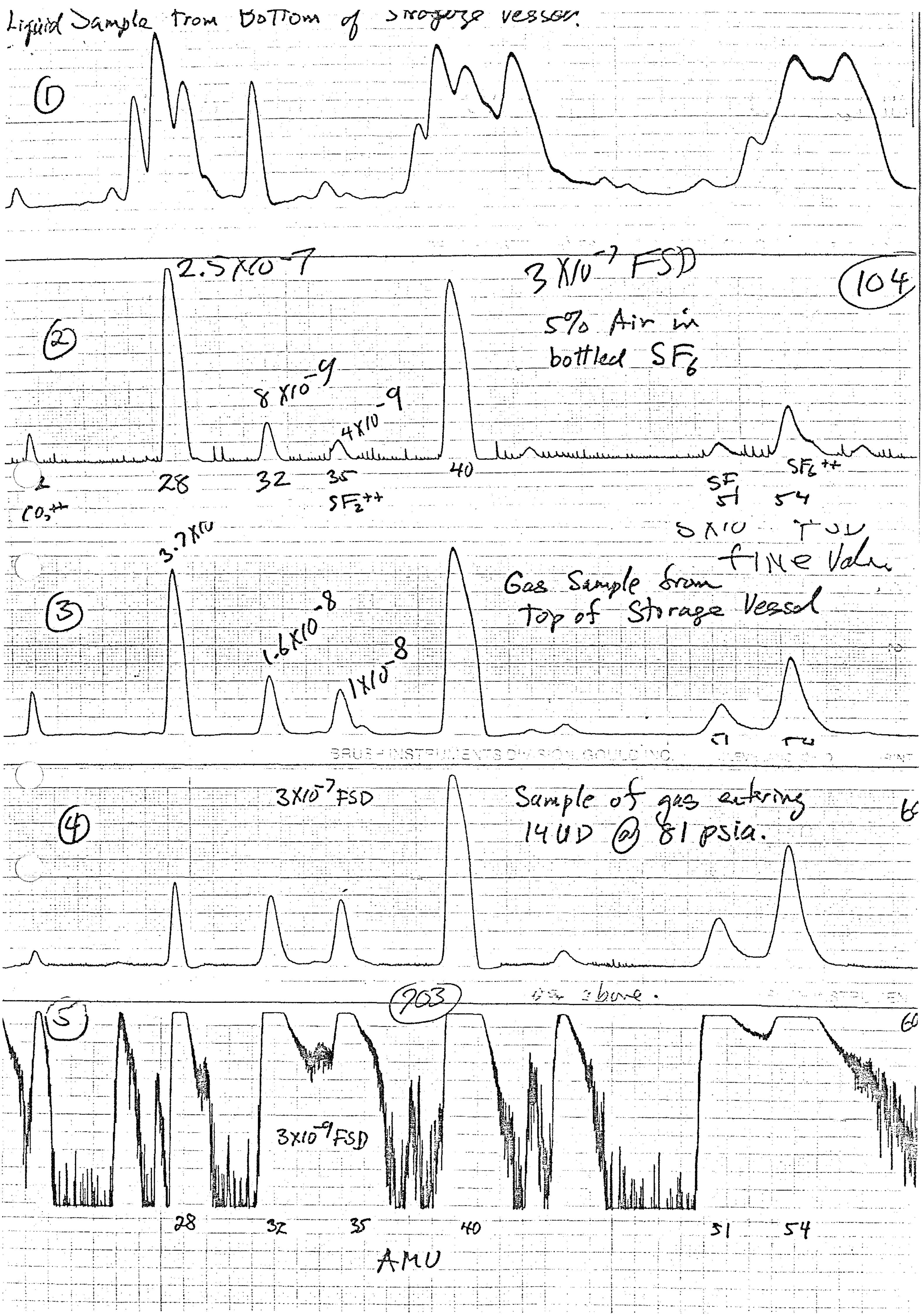
Colour photograph of heater plate screwheads.

Photograph of carbon foil.

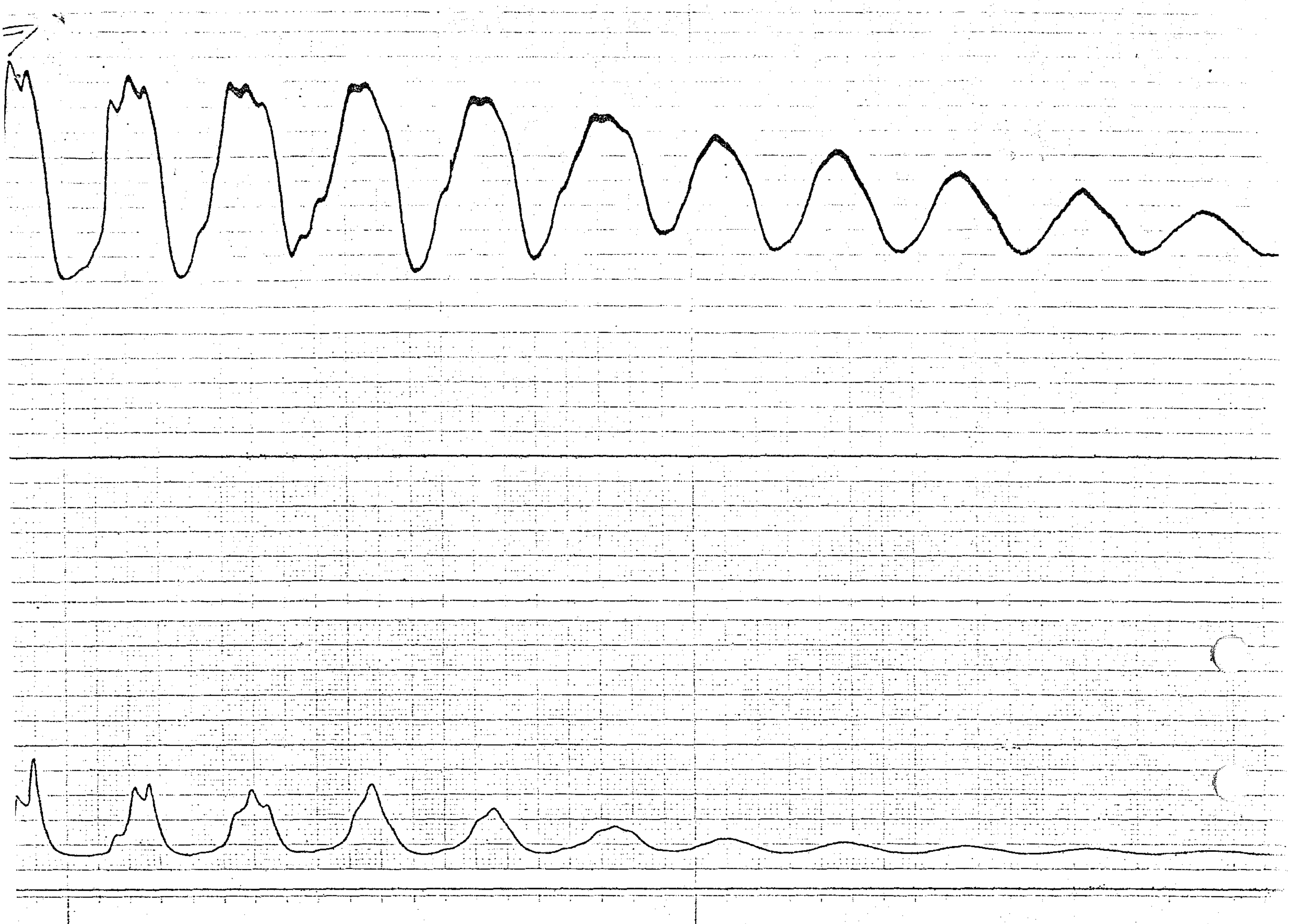
Photograph of H.E. stripper installation.

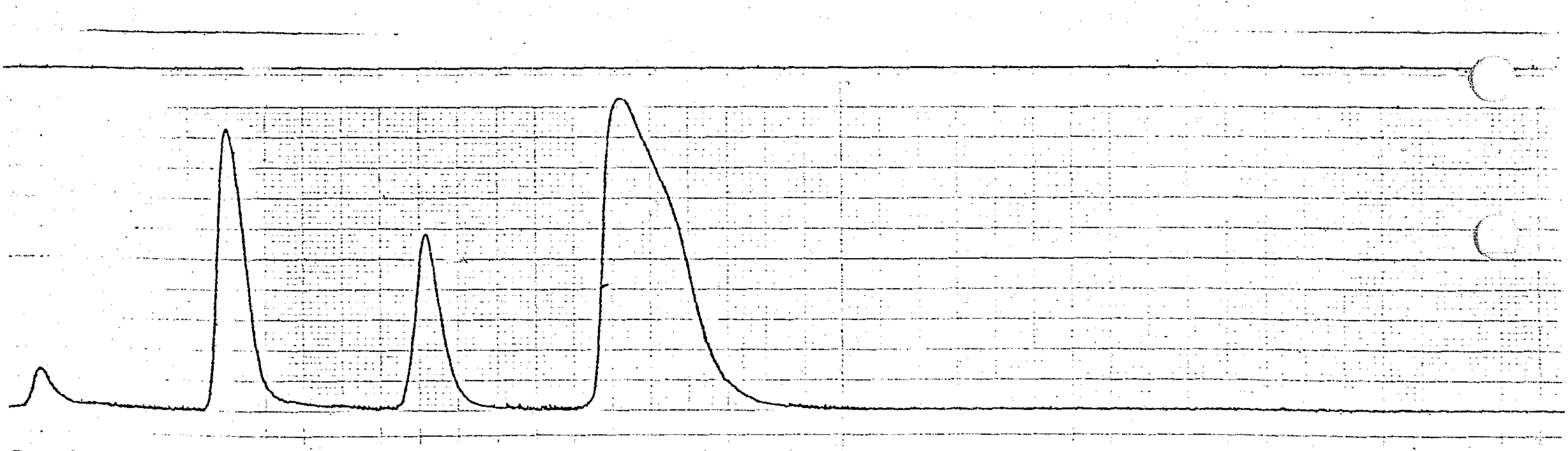
2 sets of graphs of SF6 analysis.

Accelerator user schedules.



Liquid Sample from Bottom of Storage vessel.
1
2.5X10-7
3X10-7 FSD
104
2
5% Air in bottled SF6
8X10-9
4X10-9
2
28
32
35
40
SF 51
SF6++ 54
CO2++
SF2++
3.7X10
Fine Valve
3
Gas Sample from Top of Storage Vessel
1.6X10-8
1X10-8
BRUSH INSTRUMENTS DIVISION GOULD INC.
3X10-7 FSD
Sample of gas entering 14UD @ 81 psia.
4
as above.
203
5
3X10-9 FSD
28
32
35
40
51
54
AMU




OHIO
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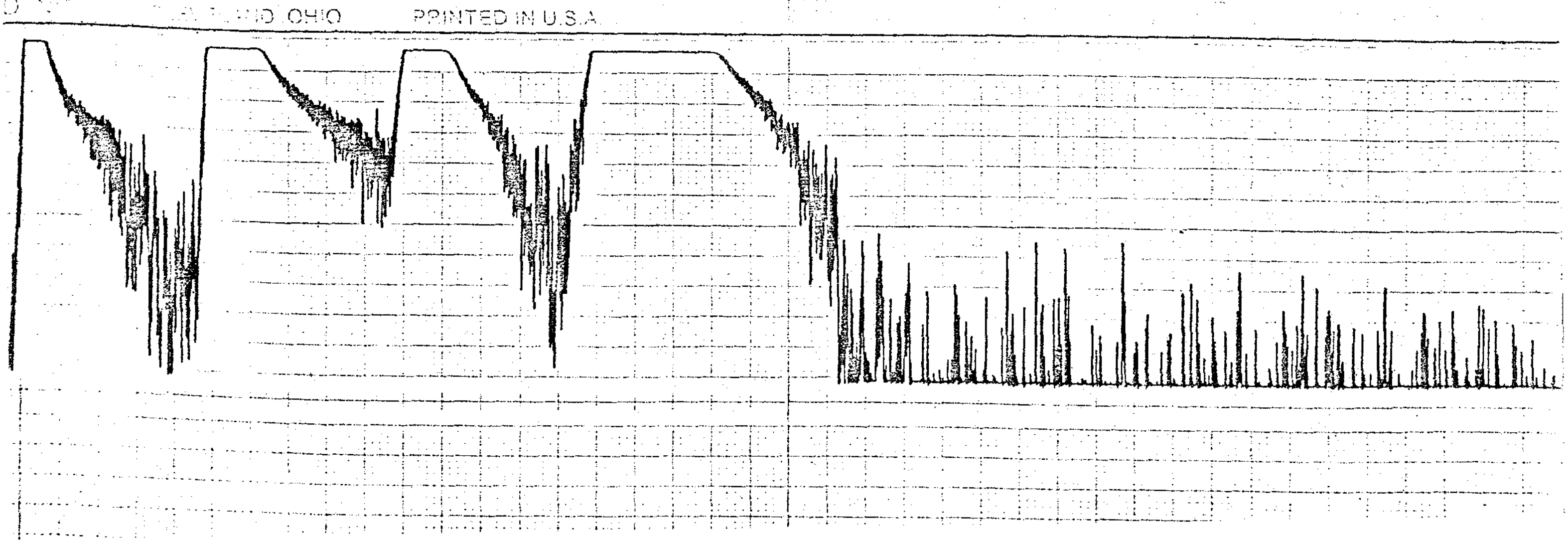

L = LITHIUM 7000V
S = SPUTTER

14UD SCHEDULE - 24/10/77-4/12/77

MONTH	DATE	DAY	GROUP		LINE	
OCT	24	MON	OPHEL, JOHNSTON, ZABEL	L	5	α, 30 MeV
	25	TUES				^{16}O, 80 MeV
	26	WED				
	27	THURS				
	28	FRI	BENNETT, HINDS, ZABEL	L	5	^{16}O, 70 MeV
	29	SAT				^{12}C, 55 MeV
	30	SUN	LEIGH, SIE, JOHNSTON, NEWTON	L	6	^{16}O, 84 MeV
	31	MON				
NOV	1	TUES				
	2	WED	ZELLER, OPHEL, WEISSER, HEBBARD, O'DONNELL		5	48 MeV
	3	THURS	(3)	L		^{7}Li, ^{6}Li
	4	FRI				
	5	SAT	DRACOULIS, WALKER, JOHNSTON	L	1	^{16}O, 95 MeV
	6	SUN				
	7	MON				
	8	TUES				
	9	WED	WEISSER, OPHEL, ZELLER, O'DONNELL	L	5	^{7}Li, 50 MeV
	10	THURS				
	11	FRI				
	12	SAT	FEWELL, KEAN, HINDS, ZABEL	S	6	^{24}Mg, 100 MeV
	13	SUN				
	14	MON				
	15	TUES	ZELLER, OPHEL, WEISSER, HEBBARD, O'DONNELL	S	5	^{7}Li, 50 MeV
	16	WED				
	17	THURS	FEWELL, KEAN, HINDS	S	6	^{17}O, 60 MeV
	18	FRI		L		
	19	SAT				
	20	SUN				
	21	MON	JOHNSTON, DRACOULIS, OPHEL, WALKER	L	5	α, 30 MeV
	22	TUES				^{16}O, 72 MeV
	23	WED				
	24	THURS				
	25	FRI	O'DONNEL, ZELLER et al	L	6	^{16}O, 100 MeV
	26	SAT				
	27	SUN	SIE, NEWTON, LEIGH	L	1	^{16}O, 80 MeV
	28	MON				α, 25 MeV
	29	TUES	HAY, TREACY, NEWTON, SODERBAUM	L	7	^{16}O, 60 MeV
	30	WED				
DEC	1	THURS				
	2	FRI	DRACOULIS	L	1	d, 23 MeV
	3	SAT				
	[illegible]	SUN				

DECEMBER 1977-JANUARY 1978

14UD SCHEDULE

MONTH	DATE	DAY	GROUP	LINE	
77 Dec.	5	MON	JOHNSTON, OPHEL, ZELLER, WEISSER	5	α, ^{16}O, ^{7}Li
	6	TUES			
	7	WED	COMPUTER MOVE R.H.S.		
	8	THURS	ZELLER, WEISSER, OPHEL, HEBBARD, O'DONNELL	5	^{14}N
	9	FRI			
	10	SAT	Sie, Bolitho	1	^{37}Cl
	11	SUN			
	12	MON	ZELLER ET AL	5	^{7}Li
	13	TUES	Yes. deuteron		
	14	WED			
	15	THURS	SPUTTER SOURCE TESTS/COMPUTER ALTERATIONS		
	16	FRI	L.H.S.		
	17	SAT			
	18	SUN	FEWELL, HINDS, ZABEL, KEAN, SPEAR	6	^{24}Mg
	19	MON			^{17}O
	20	TUES			^{28}Si
	21	WED			
	22	THURS	HAY, NEWTON	7	Cu Ni Fe
	23	FRI			
	24	SAT			
	25	SUN			
	26	MON			
	27	TUES	ZELLER	7	7Li, 36
	28	WED	SIE		
	29	THURS			
	30	FRI			
	31	SAT			
78 Jan.	1	SUN			
	2	MON			
	3	TUES	HAY, NEWTON	7	Cu Ni Fe
	4	WED	NEWTON, LEIGH, CONLEY, SIE	1	
	5	THURS			^{16}O
	6	FRI			
	7	SAT	LEIGH, JOHNSTON, SIE, NEWTON	5	^{16}O
	8	SUN			^{19}F
	9	MON			^{12}C
	10	TUES			
	11	WED	DRACOULIS, LEIGH	1	^{32}S
	12	THURS			
	13	FRI			
	14	SAT			^{16}O

14UD SCHEDULE - 16/1/78 - 12/3/78.

MONTH	DATE	DAY	GROUP	LINE		
JAN.	16	MON	X SPEAR, FEWELL, HINDS, BAXTER	6	^{18}O	
	17	TUES	X		60-75 MeV	
	18	WED	X			
	19	THURS	X			
	20	FRI				
	21	SAT				
	22	SUN	~~CONLEY, SIE, NEWTON~~	1	^{13}C	SPUTTER
	23	MON			62 MeV	
	24	TUES	CONLEY, SIE, NEWTON			
	25	WED	SPEAR, ~~FEWELL, HINDS, BAXTER~~	6	^{17}O	
	26	THURS			60-70 MeV	
	27	FRI	~~WEISSER, ZELLER, OPHEL, HEBBARD, O'DONNELL~~		KG	
	28	SAT	Spear	6	~~^{7}Li 52 MeV~~	
	29	SUN	~~ZELLER, WEISSER, OPHEL, HEBBARD, O'DONNELL~~		~~^{6}Li - 39 MeV~~	
	30	MON	TANK OPEN			
	31	TUES	DRACOULIS, WALKER, JOHNSTON	1	^{16}O	

MONTH	DATE	DAY	GROUP	LINE	
JAN	30	MON	VOLTAGE FAILURE		
	31	TUES	TANK OPEN		
FEB	1	WED			
	2	THURS	DRACOULIS, WALKER, JOHNSTON	1	^{16}O
	3	FRI			95 MeV
	4	SAT			
	5	SUN			
	6	MON	ION SOURCE WORK		
	7	TUES			
	8	WED			
	9	THURS	WEISSER, OPHEL, ZELLER, HEBBARD	5	^{6}Li, ^{7}Li
	10	FRI			52 MeV
	11	SAT	ENGLAND, OPHEL, WEISSER	5	D, 18 MeV
	12	SUN	DRACOULIS, JOHNSTON, WALKER	1	^{16}O
	13	MON			95 MeV
	14	TUES	SPEAR, FEWELL, ET AL.	6	^{24}Mg 80-90
	15	WED			^{17}O 60-72
	16	THURS			^{18}O 60-…
	17	FRI			
	18	SAT			
	19	SUN			
	20	MON	ZELLER, WEISSER, OPHEL, HEBBARD	5	^{7}Li
	21	TUES			52 MeV
	22	WED			
	23	THURS	DRACOULIS	1	^{24}Mg 130
	24	FRI	HAY, NEWTON, OPHEL, ZELLER	5	Cu Ni Fe
	25	SAT			
	26	SUN	SIE ET AL	1	~~^{16}O~~ 13C?
	27	MON			59 MeV
	28	TUES	~~Weisser~~	5	11B
MAR	1	WED	ENGLAND	5/6	^{4}He
	2	THURS			33 MeV
	3	FRI			
	4	SAT			
	5	SUN	~~ZELLER~~	5	~~^{14}N~~
	6	MON	Weisser 11B		~~70 MeV~~
	7	TUES	DRACOULIS	1	~~^{28}Si~~ + Mg
	8	WED	ZELLER	5	^{7}Li 52 MeV
	9	THURS			
	10	FRI	CONLEY, SIE, NEWTON	1	^{18}O 59 MeV
	11	SAT			
	12	SUN	~~WEISSER~~	~~5~~	~~11B~~
	13			7	Cu, ~~Ni~~, ~~Fe~~

LITHEX SPUTTER LITHEX

MONTH	DATE	DAY	GROUP	LINE	
D MAR	13	MON	SPEAR	6	^{18}O
	14	TUES			60 MeV
	15	WED			
	16	THURS			S
	17	FRI			
	18	SAT			
	19	SUN			
	20	MON	NEWTON HAY	7	Cu
	21	TUES	ENGLAND	5	^{4}He
	22	WED	~~IRELAND~~ South Australia		33 MeV
	23	THURS	SCOTLAND		
	24	FRI	WALES [illegible]		L
ASTER	25	SAT	BAXTER, MATTISKE	6	^{4}He 25-30 MeV
	26	SUN			
	27	MON	ENGLAND	5	d, 18 MeV
	28	TUES	DRACOULIS	1	9 Be
	29	WED	ZELLER, ~~WEISSER~~, OPHEL, ~~HEBBARD~~	5	^{14}N
	30	THURS			70 MeV
	31	FRI	NEWTON, HAY	7	Ni
APR.	1	SAT	DRACOULIS, YEE	1	^{9}Be 50 MeV
	2	SUN			
	3	MON	~~DRACOULIS, LEIGH~~	1	~~^{24}Mg (28 MeV)~~
	4	TUES	TANK OPENING		
		WED	HE Stripper		
			Ball Valves		
		THURS	Heater plates		
		FRI	New 275 foil assembly		
		SAT	Pos. pressure for SF_6 compressor overhaul		
		SUN			
		MON			S
ANZAC DAY	25	TUES			
	26	WED			
	27	THURS	4 WEEKS		
	28	FRI			
	29	SAT			
	30	SUN			
		MON			
		TUES			
		WED			
		THURS			
		FRI			
		SAT			
		SUN			

SPUTTER LITTLE SPUTTER

SPUTTER