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Replacement of the PLUTO reactor top shield plug in 1983 – a lesson in pre-decommissioning, decommissioning

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Introduction
The decommissioning of Harwell's two 26 MW(th) Materials Test Reactors (MTRs) started as soon as operations ceased in 1990. Initial defuelling, removal of the balance of plant and most of the surrounding buildings and facilities was completed by 1998. Several different dismantling plans have been proposed, but until now, the option of early removal of the reactor top shield plug in the decommissioning sequence has not been seriously considered.

The drive to produce accelerated decommissioning plans for the Harwell Site (and MTRs) between 2004 - 07 forced the reactor decommissioning methodologies to rely heavily on remote handling techniques and increase the shielding for access to the reactors' internal components. Early physical removal of the top shield plug was not a viable option. However, these programmes have been postponed and reactor internal dismantling is now unlikely to occur before 2027. Any further delay will make top plug removal a more plausible option, as activity levels decay.

In 1981, there were operational needs for rig access to the full core height in PLUTO. The solution was to totally replace the top shield plug with a new design that had more penetrations, including ones that avoided the horizontal through tubes. Two years of planning, design, procurement, testing and training followed. The replacement was carried out successfully on 5th November 1983, with the high active operation being controlled remotely from the Emergency Control Room, and lasting only 15 minutes. The reactor had been shut down on 28th October and reached full power again on 18th November. In essence, this was a pre-decommissioning, decommissioning operation.

The 1983 top shield plug replacement operation is described, and photographic records of the event are included. The original calculated and measured radiation levels are presented. Although radiological protection standards have improved since then and would influence a modern scheme design and operation in a different way, lessons can be learnt that will influence future decommissioning projects with similar tank-type reactors.

Background
In the early 1980s, the Windscale AGR was closed. There was still a need to carry out CAGR fuel pin studies and PLUTO was identified as a suitable replacement, provided the full core height could be accessed. PLUTO's vertical rigs were constrained by horizontal through tubes which were originally designed for rig experiments but were almost exclusively used for neutron beam work. As PLUTO was expected to run for more than another ten years, a new top shield plug was designed with more and larger holes and ones that avoided, wherever possible, the horizontal through tubes. A new top plate was also procured.

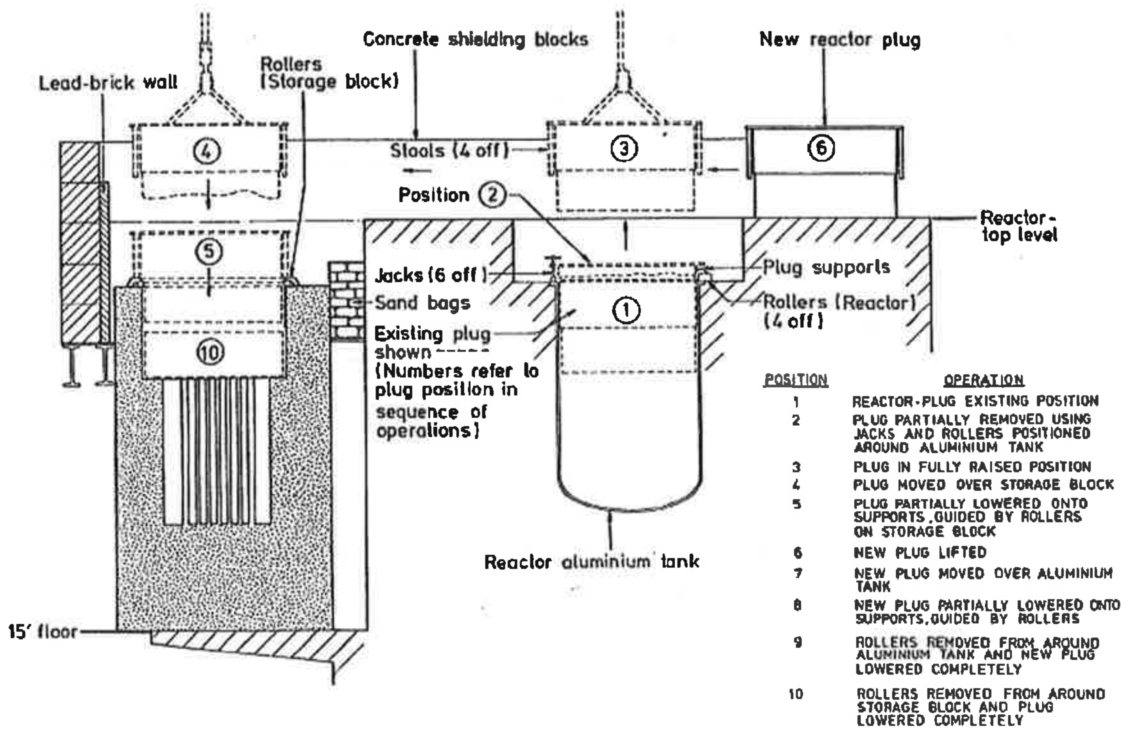
The old plug was highly radioactive on its underside (stainless steel plate, 19.1 mm thick, backed by 2 mm thick layer of cadmium). Neutron streaming up the side wall of the plug (12.7 mm thick stainless steel) meant that this too was extremely radioactive, to a height of about 420 mm. Initial measurements put the activity levels at least as high as 33 Gy h^{-1}. Measurements inside the reactor were at about 200 Gy h^{-1}, from various other sources inside and including the Reactor Aluminium Tank (RAT). The old top shield plug was too large and radioactive to dispose of and so was incorporated into a new Rigs Storage Block built next to PLUTO. A method of transferring the old plug to its new location and installing the new plug was devised.

Planning the transfer operation

The large shape and size of the plug and its activity levels meant that the Polar Crane would have to be controlled remotely. Background levels in the Containment Shell were calculated to be so high during the transfer operation that no staff could be present and all operations would have to be managed from the Emergency Control Room. Dose levels at the Site fence were considered to be too high to allow Public access and the UKAEA Police would have to use control checkpoints.

A revised scheme relied on a shielded pathway between the top of the reactor and the new Rigs Storage Block location. The new plug would provide shielding at one end of the pathway and shielding blocks were stacked to form the shielded channel. The sequence of operations was:

- lift the top shield plug out of the RAT with the (remotely-controlled) overhead Polar Crane;
- traverse it across the reactor top to the new Rigs Storage Block;
- lower it partially into the new Rigs Storage Block;
- pick up the new top shield plug already on one corner of the reactor top;
- traverse it to the RAT;
- lower it partially into the RAT.



Replacement sequence for the top shield plug

What appears at first sight as a casual gesture towards dose management was in fact an engineered system that was based on a comprehensive assessment of different exposure pathways using the best available computer models and many different safeguards.

The methodology used to plan the replacement operation was structured to ensure a safe method of work, with contingency arrangements, and attention to control of lifts so that there would be no damage to other reactor components (especially the RAT) and that there were no significant radiation fields outside the Containment Shell. The plan that was put to the Reactor Safety Working Party provided pragmatic solutions to the following aspects:

- the magnitude of the radiation from the top-shield plug underside and wall;
- the magnitude of the radiation from the open RAT;
- the condition of the gap between the top shield plug and the RAT;
- preventing the RAT from being inadvertently lifted with the top shield plug ;
- the possibility of adhesion of the two mating flanges;
- the possibility of overloading the crane in the lifting operation;
- the likelihood of either of the top shields not hanging vertically and jamming, particularly in the RAT;
- difficulty of negotiating the step in the RAT/top-shield plug walls;
- the possibility of some or all motions of the crane failing.

Radiation levels

The underneath and sides of the top shield plug were considered to be the most highly active surfaces to be exposed but the RAT also made a significant contribution. Attempts to take TLD measurements of the underside of the plug failed as contributions from sources in the reactor swamped the results. A shielded holder gave an indication of values of about 33 Gy h^{-1}. The bottom stainless steel plate was drilled to produce swarf that could be analysed through gamma spectroscopy. The most important contributors to dose (specific activities and gamma emission) were the longer-lived nuclides: ^{51}Cr, ^{59}Fe and ^{60}Co. Activity distribution appeared to be less in the central region of the shield compared with positions over the reflector, possibly as a result of shielding by CCAs and the presence of rigs.

Based on the known Cr and Fe content of this stainless steel (18% and 73%) and the specific activity of ^{51}Cr and ^{59}Fe, the calculated neutron flux in the surface layers of steel in the region around the core was about 6 x 10^{11} n cm^{-2} s^{-1}. Using this value and the measured specific activity of the ^{60}Co *(*185 MBq g^{-1} stainless steel) indicated a ^{59}Co content of 1120 ppm. Recommendations were made that for the radiation calculations a uniform specific activity for ^{60}Co of 222 MBq g^{-1} stainless steel be used for the whole of the underside of the top shield. The contribution from ^{51}Cr and ^{59}Fe in terms of photon energy per gram of steel was small compared with ^{60}Co and was bounded by using the ^{60}Co specific-activity value.

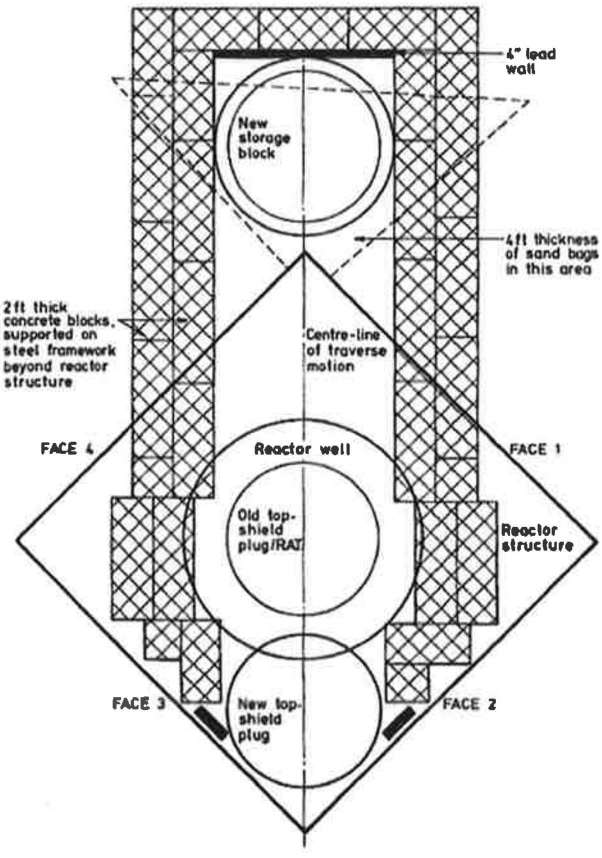
The side wall of the plug was more difficult to sample, but a hole was drilled in the top flange of the top shield directly above the gap between the shield and the RAT wall. A small introscope was inserted in the hole and down the gap. It was found that both surfaces appeared to be quite clean, giving confidence that the plug removal was possible. A narrow strip of spring steel was passed down through the hole until the bottom of the strip was level with the underside of the plug. The strip was irradiated at 0.5 MW for 30 minutes, and by comparison with a piece of the same steel calibrated in GLEEP, the neutron flux in the gap was calculated and extrapolated to 25 MW operation. The flux at the bottom of the gap was 9.3 x 10^{11} n cm^{-2} s^{-1}, which compared reasonably well with the 6 x 10^{11} n cm^{-2} s^{-1} calculated for the stainless steel plate. Integrating the flux up to a height of 420 mm above the bottom of the shield plug (above which the flux and hence activity was negligible), and assuming the ^{59}Co content of the stainless steel sidewall was 1500 ppm, the equivalent uniform source strength was 47.4 MBq g^{-1} stainless steel. For the radiation calculations, a value of 48.1 MBq g^{-1} for the activated height was used.

The RAT was believed to be exposed to a fairly uniform neutron flux of ~10^{13} n cm^{-2} s^{-1}. Above the water level the flux fell off rapidly and in line with the measured flux in the gap between the top shield and the RAT. The plan was to over-fill the RAT to increase shielding from the RAT itself but there were limitations on the maximum height possible. Just around the plug reduced diameter, the RAT wall thickness increased to 31.8 mm. The important requirement was to obtain the ^{59}Co content of this aluminium. The specification for the RAT material was 99.8% Al, 0.075-0.15% Fe, 0.05-0.15% Si, and 0.01% max. Cu. The inter-space hole was used to sample the RAT but because of the choice of drill and shroud tube material, there was considerable uncertainty about the sample analysed. In the absence of better information, radiation calculations were based on the value of 187 ppm. The activity of the aluminium due to cobalt in a thermal-neutron flux of 10^{13} n cm^{-2} s^{-1} was 651 MBq g^{-1} aluminium. This figure was used for the aluminium below heavy-water-surface level. Above the normal water level, the flux was assumed to fall exponentially. At a point 780 mm above the water level, the flux would be 10^{-4} times the value at water-level. This fall-off in activity matched the fall-off in thermal-neutron flux measured up the gap at the side of the top shield plug.

Shielding Design

The Winfrith Shielding Group had used the RANKERN code to determine the dose rate at the Site fence, 40 meters away. With no shielding, the dose rate would be about 17 mGy h^{-1}. Hand calculations produced a very similar value of 16.5 mGy h^{-1}. The dose rate on the reactor top, 1.2 m from the side of the exposed top shield and just below the bottom level was calculated to be 8.8 Gy h^{-1}. These values drove the strategy of retaining the old top shield plug within the Containment Shell, using it as the top shield for a new Rigs Storage Block and locating the new block in a position that minimised the amount of crane movement with a highly activated component.

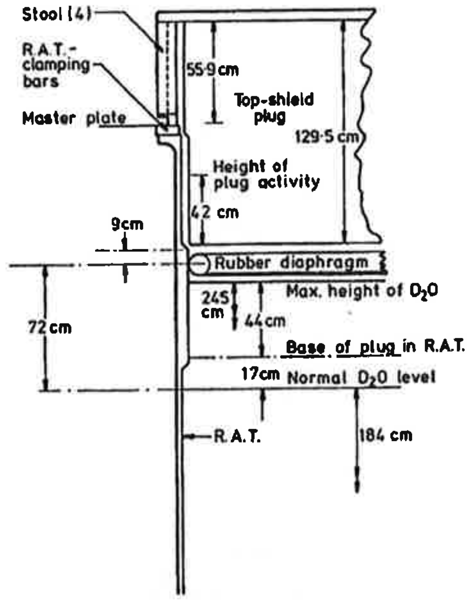
The shielding requirement was for a wall thickness equivalent to 1.2 m of concrete. The walls were made up of 0.6 m x 0.6 m concrete blocks, which were supported by additional steelwork – some of which was already needed to support the new Rigs Storage Block. The shielding route formed a trough and was closed at one end by blocks and at the other by the new top shield plug. The calculated dose rate at the fence was then expected to about 0.1 µGy h^{-1}, with no scattering element included. The blocks were stacked two high by two deep on the reactor top and extended three blocks below the reactor top. The new Rigs Storage block was surrounded by two by two blocks and gaps were dealt with around the rig galleries by combinations of concrete blocks, lead blocks and sand bags built up to fill spaces. Some parts of the flooring had to be temporarily removed. The blocks on the reactor top were not put in place until the reactor had shut down and all fuel elements, absorbers and vertical rigs had been removed from the RAT.



Shielding configuration

Additional shielding and precautions were needed for the RAT as although direct radiation would have only minimal effect because the Containment Shell would be evacuated, the scatter caused by the steel roof, the crane and the air would give rise to significant radiation at the boundary fence. If access was needed to the crane while the RAT was unshielded, for example as the result of a drive or electrical failure, radiation levels there would be very high. The least complicated method of improving shielding was also the most effective – the heavy water would be raised above the normal level. As the heavy water was contaminated with tritium (about 200 GBq l^{-1}) there was a concern about extreme tritium concentrations in the air of the reactor building. The solution was to fit a rubber diaphragm just above the raised water level. The plan was developed in conjunction with the plug lift. The plug would be raised 810 mm and supported on four stools, bolted to the flange. 480mm of plug would still be in the RAT and radiation levels were expected to be still acceptable. The diaphragm would be inserted through a large diameter reactor top hole (7V3) and positioned using guide ropes through other holes (7V4). This operation (and the retrieval through the new plug) would put operators most at risk and was carefully managed; finger dosimetry was worn. Once inserted, the diaphragm would be inflated to produce a vapour-proof seal. Open-hole doses for this operation were in the range of 200 – 500mGy h^{-1}.

The consequences of the planned shielding arrangements, including raising the water to a level of 2.45 m was that the radiation dose constraint at the Site fence of 50 µSv would allow up to 50 hours of operation with the top shield plug removed. There was confidence that the operation would be easily completed in this period and the margin was adequate for any recovery operations needed to make the arrangement safe if equipment failures occurred.



D_2O height variation

Potential failures of the Polar Crane

The position of the new Rigs Storage Block was on a radial line from the RAT. This meant that once the Polar Crane was aligned, only the transverse and the hoist/lower motions were required. The failure modes considered were:

- electrical failures of the motors;
- failures of the controls or wiring to the motors;
- failures of the drive trains;
- failure of the brakes, including failure to release;
- mechanical failures of the motors, bearing seizures or shaft breakage;
- gearbox failures including gear tooth breakage or shaft coupling failure;
- rope or clamp failure.

Emergency arrangements were put in place to lower the load and traverse the crab without the load, using additional remote mechanisms and pull-blocks. These operations would have to be carried out by operators working from the crane walkway in radiation levels of up to 66 mGy h^{-1}, which were assessed as accepable but very time-restrictive. Further improvements were not considered necessary as the crane had worked well for 25 years, carrying loads comparable to the 22 tons of the top shield plugs. In addition, a NDT survey by an Independent Third Party of all the crane's principle moving parts was carried out. Only a very minor defect was found, in a relay coil which showed signs of over-heating. The crane was subjected to the standard overload test of 32¼ tons.

Pre-replacement preparations

Preparations for the replacement operation included fixing the Polar Crane alignment, rehearsal of operations using the new top shield plug, installing additional CCTV equipment and lighting, adding ventilation to capture any escaped tritiated vapour should the diaphragm fail, adding gamma monitors at the crane gantry in case recovery operations were needed and positioning the shielding. Emergency operations were planned and rehearsed.

The crane alignment was set to the planned path of the top shield plug. Microswitches were placed so that a cam would actuate them when the exact crane traverse position was reached and light an indicator in the Emergency Control Room. The crane ropes were painted white at particular reference levels and could be seen by CCTV cameras that looked along the line of the transfer. Two additional orthogonal cameras were set just below the crane rail to give an overview. Each plug was fitted with three cameras at 120°, which looked downwards over the sidewall. The crane operator could see whether the plug swing had finished and have confidence that the plug would be lowered correctly.

Rehearsals used the new top shield plug and demonstrated that the plug could be inserted into the Rigs Storage Block and onto its stools. The two lifting frames had features at their top to guide the crane hook into position and the engagement and disengagement was practised. The rehearsals also allowed repositioning of cameras and other equipment to ensure the best views were available to a crane operator in the Emergency Control Room. An arrangement of guide rollers would be fitted to the top flanges of the RAT and RSB so that the crane driver could manoeuvre the plugs without damaging the RAT walls if the alignment was not precise.

The fitting and operation of the rubber diaphragm (also known as the "padling pool") was practised, as it was a vulnerable part of the operation. Three were made, one was used for testing and handling trials in a mock-up and two were available for the replacement operation – one was a back up in case the first failed. The endurance of the rubber was expected to be about 5 hours in the RAT. If the diaphragm failed or tritiated vapour concentrations became too high in the Containment Shell, the team were prepared to use air-line breathing equipment for the re-entry phase.

Installing the new Rigs Storage Block (RSB) that would accommodate the old top shield plug

Extra structural steelwork around the RSB would support the 0.6 m x 0.6 m concrete shielding blocks

Checking the new plug fits in the RSB. Side-wall stools are attached so the plug is not fully lowered

The ECR: Crane Operator's CCTV and remote controls

View from auto-camera - old top shield plug is prepared

Video link screen-shot - old top shield plug is prepared

Initial Lift of the old top shield plug

The reactor was shut down on Friday 28th October 1983 at 0900 hours. Over the next four days the rigs, VCRs, the fuel elements, control absorbers and adaptors were removed. The CCAs were decommissioned and unloaded and the D_2O system drained down. The RAT was kept at a slight depression to prevent uncontrolled escape of tritiated vapour when pipes were disconnected.

There were doubts about whether the old top shield plug would come away easily from the RAT. Rather than just relying on the crane, eight screw jacks were fastened to the flange using holes and tappings that had been prepared during earlier shutdowns. The lifting frame was attached to the crane and a load cell was included to make sure the crane was not overloaded. Several of the jacks seized because of an inappropriate design, but the crane was able to free the plug, without overload. Additional bracing bars were fitted to the RAT flange so that it would not distort when loaded with more water than usual. Radiation levels rose significantly when the plug had been raised to about 760 mm, from the RAT itself and source blocks that were still in the horizontal holes shining up the side-wall gap. Shorter stools were used so that the plug was raised just 559 mm; the radiation levels were still up to 50 mGy h^{-1} next to the gap. The guide rollers were fitted.

Other pieces of equipment were installed on the crane when it was not in use. It was aligned to the top shield plug pathway and final checks were made on views and camera controls when controlled from the ECR. The recovery mechanisms for the crane were fitted and tested with the new top shield plug hung from the Polar Crane. Most of the areas around the Reactor top and towards the new RSB were sheeted out so that if there was mobile contamination on the old plug then decontamination would be easier. Because of the widespread interest in the operation, colour CCTV was relayed to monitors in the Research Reactors Division B521 Conference Room. All the preparatory work and testing that could be done was complete by the end of Friday 4th November.

The Replacement of the Top Shield Plug
As the dose rates outside the Containment were calculated to be high for non-Classified staff, the operation was planned for a weekend with strict limits on the numbers of those involved. Progress had been better than expected so the replacement took place a day earlier than planned, on Saturday 5th November. The first operation was to make sure all safety and operational personnel were ready and that communications and control between the Health Physics staff, the Police and the Operational team worked. The Police established road blocks to seal the areas around PLUTO so that unauthorised access was not possible. Health Physics teams were set up as direct support and at external monitoring positions, where they could record the dose levels during the transfer.

The diaphragm was fitted but initially the mechanism used to thread the diaphragm ropes through the 7V holes caught on obstructions underneath the plug. Two sleeves that had been fitted into old safety rod holes projected approximately 200 mm below the plug base. The sleeves had not been seen on previous CCTV inspections and had to be removed. With the diaphragm finally in place, the D_2O level was raised to 2 m, just at the underside of the membrane. The radiation through hole 7V4 when the RAT was empty was 500 mGy h^{-1} but dropped to 7.5 mGy h^{-1} when the water level was at 2 m. As the water provided additional shielding, the shorter stools were changed for the longer ones. Radiation levels from the plug side wall then ranged between 20 – 40 mGy h^{-1}.

The teams left the Containment Shell between 09:45 – 10:00; the standby diesel-generator was started and run disconnected (off load), ready for connection in the unlikely event of mains failure. Key staff assembled in the ECR. At 10:30, the replacement of the top shield plug began.

The replacement was achieved without any serious set-backs. There was no need for any emergency intervention. The old plug was lifted until white paint markers on the crane ropes were level, indicating a correct traversing height. As the plug moved along the shielded trough towards the RSB, it passed over two high-level radiation monitor chambers, one on the edge of the reactor well, the other on top of the shielding towards the RSB. Their amplifiers could be read by CCTV. The maximum radiation level detected (at a distance of 1 metre) from the plug was 11 Gy h^{-1}. Peak levels measured on the crane gantry walkway next to the Shell wall were 2 mGy h^{-1}.

The three cameras on the lifting frame were useful in helping the crane operator position the old plug above the RSB by equalising the gaps around the base. Minor adjustment was required but the plug was set down on the stools in the RSB. At this point, the crane gantry gamma monitor directly above the RAT only read 200 μGy h^{-1}, showing the increased water level had successfully reduced the radiation. The assumptions on cobalt content of the aluminium were considerably lower than the most pessimistic prediction or the activation had not reached as far up the RAT or shield plug as assumed. The maximum at the nearest section of Site fence was 3 μGy h^{-1}.

10:30
Lift of plug from RAT begins

10:31
Top shield plug is clear

10:32
Traverse to RSB

10:33
Positioned over RSB

10:34
Lowering into RSB

10:36
Installed & crane hook clear

10:40
New plug lifted over RAT

10:43
Lowering into RAT

10:45
New plug installed into RAT

Health Physics monitor new and old plug positions

11:35
Re-occupation of reactor top

Fixed position video and auto-stills cameras

Overview, showing sheeting to aid decontamination

Present-day view of PLUTO reactor top

The crane was remotely unhooked from the old top shield plug frame and hooked onto the frame for the new plug. It was positioned over the RAT and was lowered slowly, using the 120° cameras and guide rollers to attempt to centralise itself. The new plug did tip sidewise and then was slightly raised. It was left hanging on the Polar Crane until re-entry was possible; the radiation hazard was greatly reduced and the decision was that it could be introduced into the RAT more effectively with closer supervision.

Two Health Physics surveyors entered the building and proceeded to the reactor top carrying radiation monitors and contamination-monitoring equipment. No significant contamination was found, and the remaining staff were admitted to the reactor building at 11.35 hours.

On re-entry, the team lowered the new plug on to the 760mm stools and drained down the RAT. The diaphragm was removed. Measurements were made of the gamma radiation inside the RAT at different levels. The high-range monitor saturated as it was lowered into the RAT, indicating the full scale deflection and a radiation level of > 100 Gy h^{-1} at a depth of 2.75 m. This value was probably driven by the source blocks in the horizontal tubes. Measurements using TLDs of the underside of the old top shield plug in the RSB gave a range of 10 – 60 Gy h^{-1}, which compared favourably with the shielded measurement of 33 Gy h^{-1}.

There was no personnel contamination as a result of the preparatory shutdown work or the top shield plug change. Contamination levels were kept below 4 Bq cm^{-2} within the Containment Shell. No member of the team exceeded an investigation exposure threshold (10% of annual limit). The collective whole body dose recorded by the 64 members of staff throughout the four weeks of the whole shutdown period was 0.165 man Sv. Included in this value would have been exposures from essential maintenance work carried out in the same period. The maximum individual exposure was received by a Health Physics operator whose record was 5.5 mSv for the four weeks.

Over the next two weeks both the New Rigs Storage Block and PLUTO were put into commission. By 11:55 on Friday 18th November 1983, PLUTO was started up and reached full power at 15:15.

Lessons for decommissioning
This replacement operation was a success because the reactor team had access to a well-trained team and coherent supporting services such as shielding analysts, health physics, engineering design and manufacturing capability. Many of the components were designed and built using facilities that existed at the time on the Harwell Site. There were ample opportunities for training and testing before the actual active operation. Emergency equipment and response was tested beforehand but was not needed on the day. The safety and regulatory arrangements seem much less stringent than are in place today, but they were adequate.

The calculated dose levels were in line with measured values. However, the actual radiation levels from the RAT with a higher water level was less than expected, at about 60 – 100 μGy h^{-1}, because the precise material properties of the tank were not known to sufficient accuracy. Attempts to take samples increased uncertainty as the sample appeared to be cross-contaminated with the sampling tool. There was an assumption that the more easily accessible aluminium at the top flange may be different from the sample taken at the step in the side wall. Operational reasons meant that not all source material could be removed from the reactor and this prevented measurements of the RAT activity profile at lower levels before it was refilled.

The RAT cobalt content was discussed at the DIDO Operators' Meeting in Julich, in June 1997. At that time the inventory calculations for the MTRs assumed the concentration value was 5 ppm. The Julich team commented that they had taken a very small sample from the plenum plate and the measured value of cobalt was less than 1 ppm. This value is in line with a sample taken from the top of the RAT in PLUTO and also matches the generic value given to the Reactor team by metallurgists who specialise in aluminium alloys, after the Julich meeting. The current calculations for the Harwell MTRs have been reworked using the lower figure.

Accurate knowledge of the actual composition of key reactor components can be critical to the decommissioning methodology that is chosen. The amount of knowledge retention practised by a decommissioning project can have a significant effect on the cost and viability of decommissioning and waste management.

The replacement operation described in this paper did not solve the problem of what to do with a highly radioactive top shield plug as it was simply reused. The decommissioning challenge is whether the plug can be dealt with safely after removal and can be processed to an appropriate waste stream. Available infrastructure, both in terms of useable equipment and trained staff has to feature in the overall plan and in some cases, early plug removal may not be the best solution.

When Stage 2 decommissioning for DIDO and PLUTO was completed in the mid 1990's, the plan for rig disposal was just to remove samples and make rigs inert. As there was no waste facility for the activated rig components, they were put back into the MTRs and the associated storage blocks within the Containment Shells. Over 450 rigs, plugs and thimbles were reinstated. Most of the MTRs' support buildings were decommissioned, including the DIDO High Activity Handling Cell. The View Cells and external storage blocks in the Active Handling Bays, the office blocks and the DIDO AHB were demolished. In the Shells, all ancillary equipment was removed and the Polar Cranes were disconnected and isolated from power supplies; the crane hooks were removed. The plan was to start decommissioning in the late 2030's, when a National ILW Store was expected to be available and the majority of benefits from radioactive decay would have occurred.

Accelerated decommissioning plans identified that once the rigs were removed, the top shield plugs became the most awkward single item to decommission, from both the physical size and the radiation perspectives. The approach to early decommissioning has been to leave the plug in situ and extract the other components inside the biological shielding through an engineered shielded access route through a side wall. Remotely-operated equipment would be able to size-reduce the lower plug shield plate from within the biological shielding to minimise the complexity of dealing with the plug. As the plans for decommissioning DIDO and PLUTO move to future years, there will be a point where the removal of the top shield plug could be a cost-effective solution, but it may not be for another 30 years.

Knowledge Management

This paper has been prepared from material extracted from the UKAEA's Records Management Service and the UKAEA's Imaging Resource Centre. Four Archive boxes, approximately 200 photographs and a VHS tape were retrieved. The archive material covered the period 1981-1984 and included design, procurement and safety documents. Operational records included the Health Physics log books and the Reactor Manager's annotated check list cards for the Long Shutdown, 28th October – 17th November 1983, which included the retrieval operation.

Although this activity occurred only 25 years ago, the MTRs decommissioning project records passed between the last four Decommissioning Project Managers contain no evidence that this event occurred. Original records from the old Research Reactors Division have been archived but there is no comprehensive or integrated database of information that might be important to decommissioning teams decades in the future. The Archive boxes contained files that by chance had associated information but their actual contents could not always be inferred from the file titles.

Although adequate records for decommissioning exist, information retrieved, as in this example, could have a profound impact on the front end decommissioning engineering stage in future plans. Information needs to be managed in a more efficient way or it will be simply lost forever.

An exercise was started last year to capture information sources for all three of the Harwell Reactors and rebuild the knowledge that has been lost. The UKAEA electronic data management system is the host for long term managed decommissioning records and the existing metadata of records for Harwell Reactors will be improved.

Replacement of the PLUTO reactor top shield plug in 1983 - a lesson in pre-decommissioning, decommissioning

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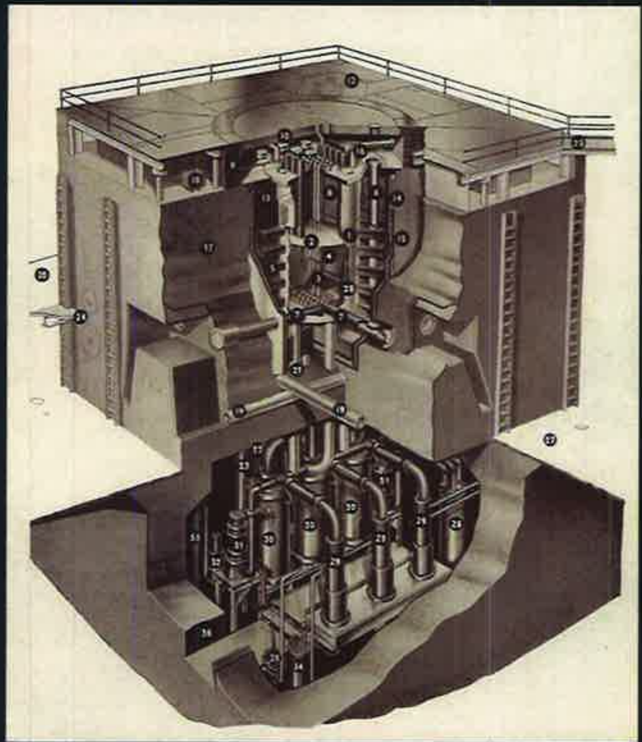
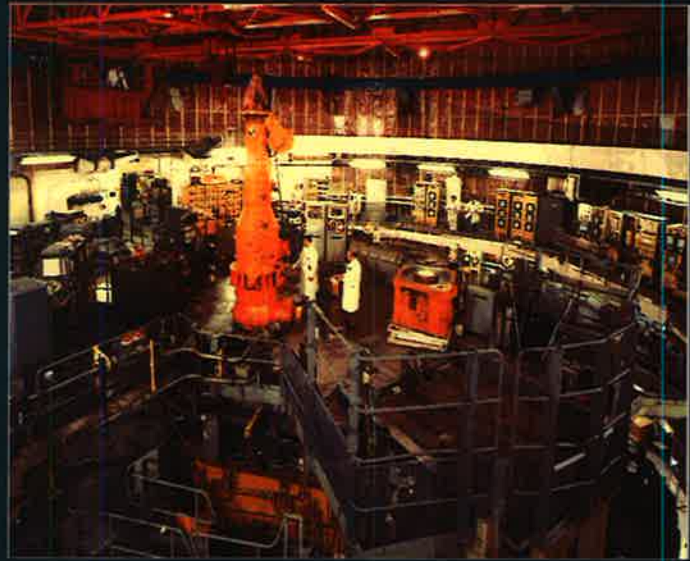
PLUTO





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Why was it done?

- In 1981, CAGR fuel pin studies could not be continued at WAGR, due to closure;
- horizontal tubes in the RAT prevented full core height access to vertical rigs;
- more use of vertical holes for rigs rather than horizontal applications – horizontal holes mainly used for neutron beam work;
- another decade of work anticipated for PLUTO.

Constraints & solutions

- Old top shield plug too active and heavy and there was no disposal route – decided to incorporate in a new Rigs Storage Block alongside PLUTO;
- very high dose rates at fence and at reactor top during removal – decided to build a shielded path for the transfer, using concrete blocks, and raise water level in RAT;
- dose rates at crane cab too high to endure – remotely operated crane controlled from the ECR;

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Radiation levels

- 33 Gy h^{-1} under plug;
- 17 mGy h^{-1} at fence 40 m away (no shielding)
- 8.8 Gy h^{-1} 1.2 m from the side of the exposed top shield plug.
- After additional shielding, design values:
- 66 mGy h^{-1} at crane walkway;
- 50 µGy h^{-1} at fence 40 m away, giving up to 50 hours of operation.

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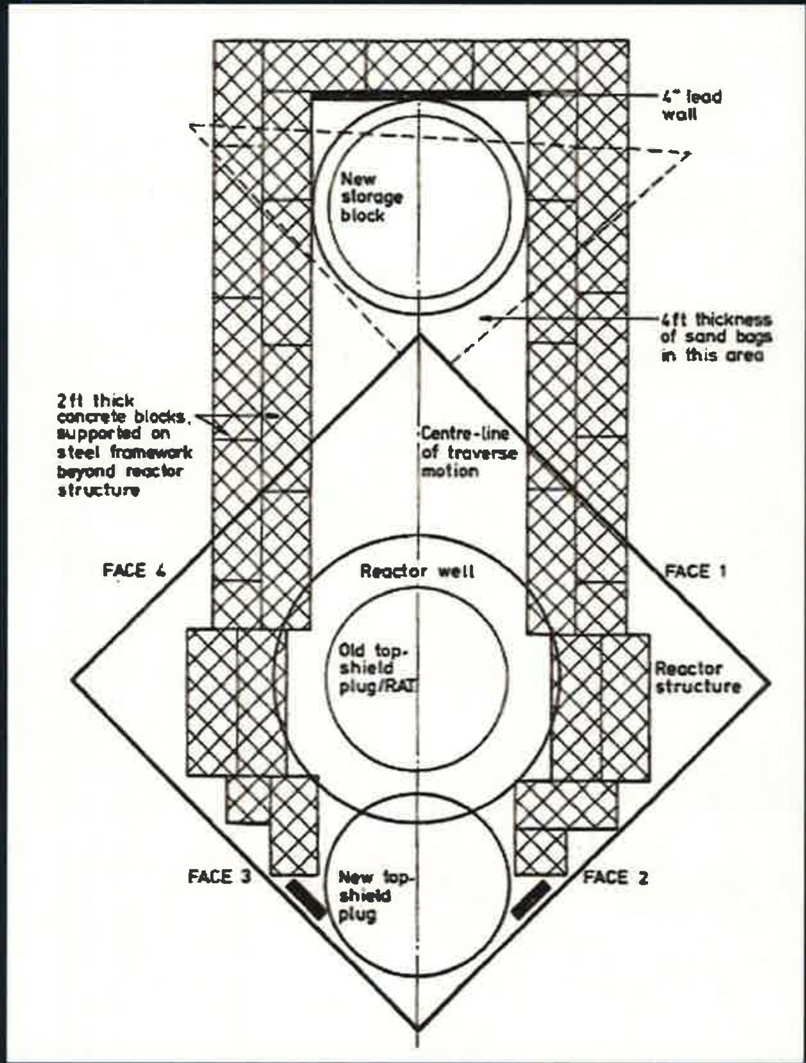
Shielding configuration



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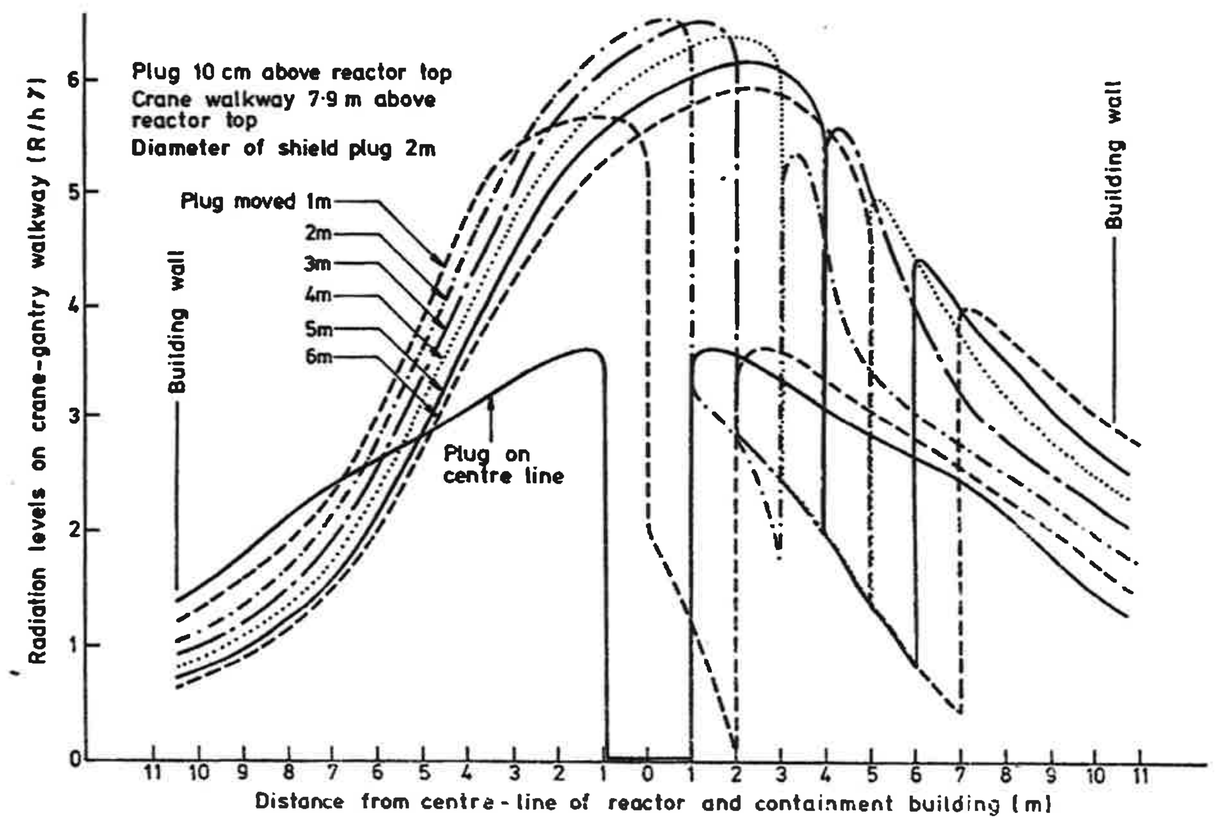
Contours for the crane as plug moves



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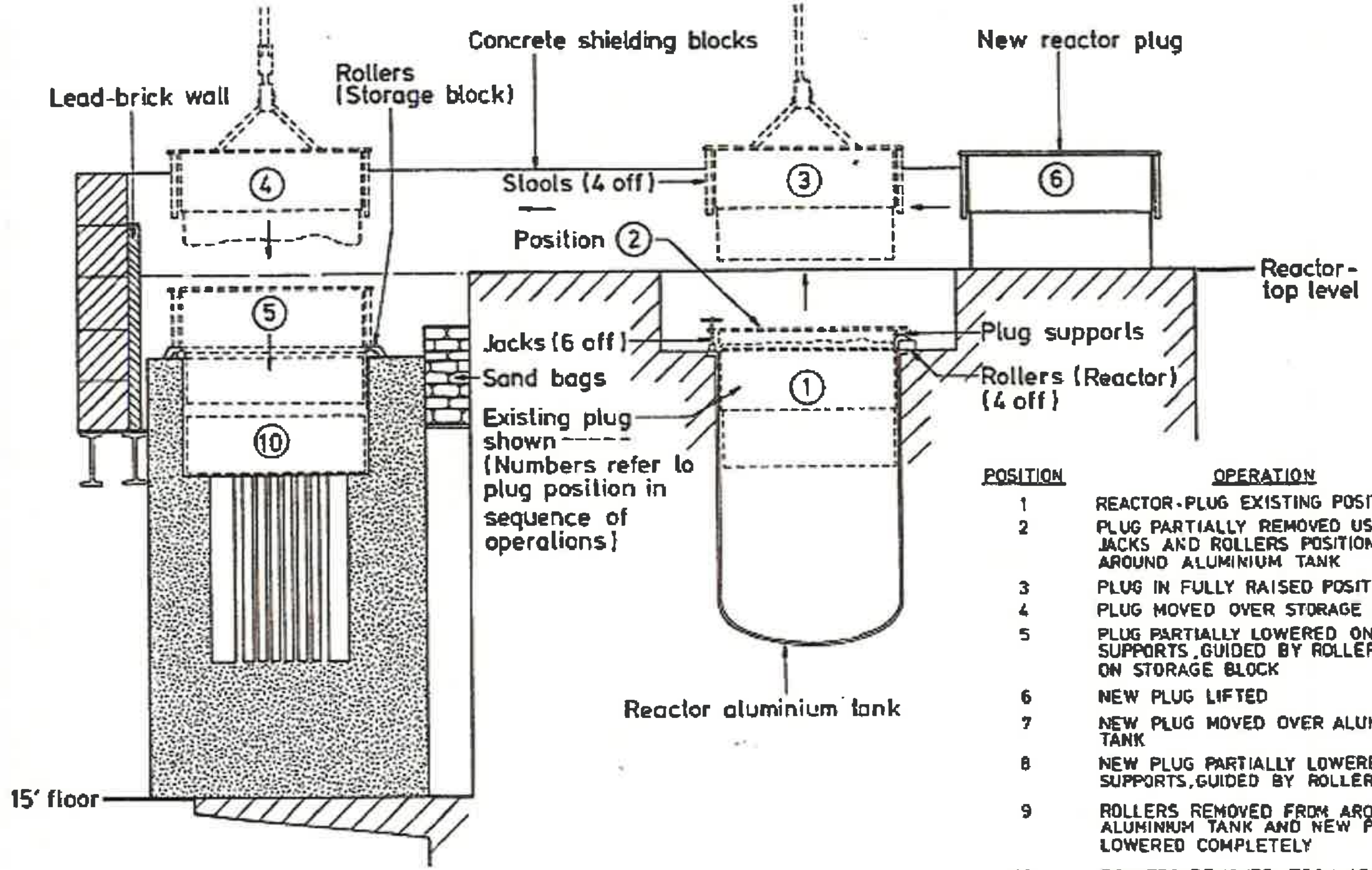
Replacement sequence



POSITION	OPERATION
1	REACTOR-PLUG EXISTING POSITION
2	PLUG PARTIALLY REMOVED USING JACKS AND ROLLERS POSITIONED AROUND ALUMINIUM TANK
3	PLUG IN FULLY RAISED POSITION
4	PLUG MOVED OVER STORAGE BLOCK
5	PLUG PARTIALLY LOWERED ONTO SUPPORTS, GUIDED BY ROLLERS ON STORAGE BLOCK
6	NEW PLUG LIFTED
7	NEW PLUG MOVED OVER ALUMINIUM TANK
8	NEW PLUG PARTIALLY LOWERED ONTO SUPPORTS, GUIDED BY ROLLERS
9	ROLLERS REMOVED FROM AROUND ALUMINIUM TANK AND NEW PLUG LOWERED COMPLETELY
10	ROLLERS REMOVED FROM AROUND STORAGE BLOCK AND PLUG LOWERED COMPLETELY

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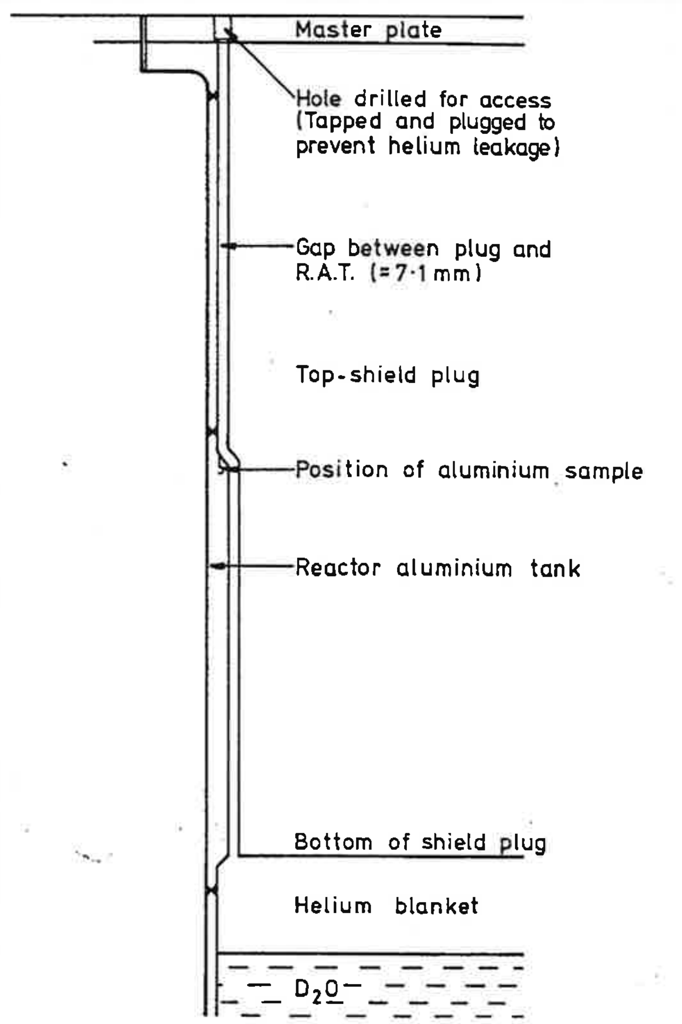
Sampling the RAT



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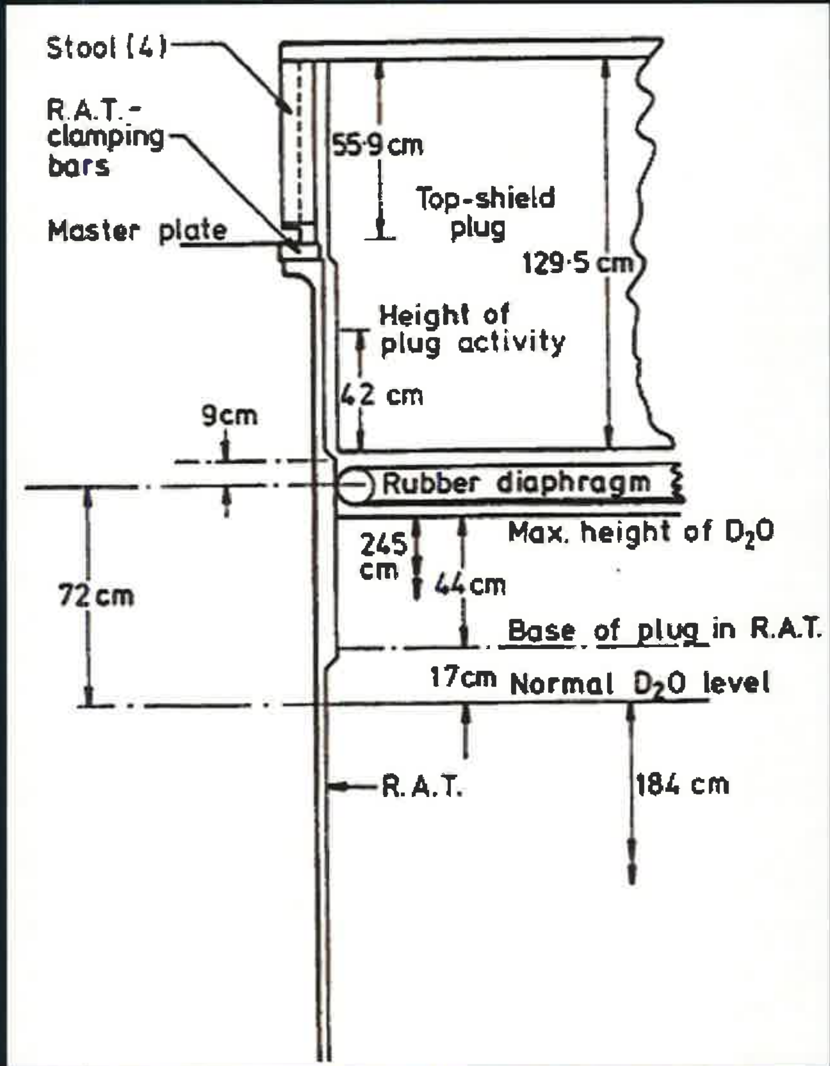
Height increase in D_2O



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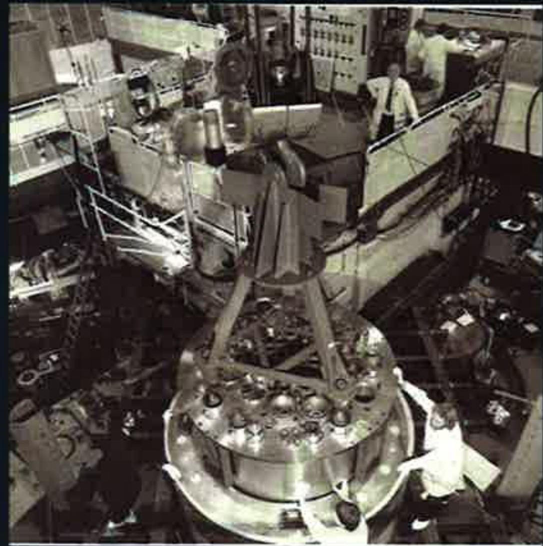
Preparatory work – checking the new plug

Installing the new Rigs Storage Block (RSB) that would accom-modate the old top shield plug

Extra structural steelwork around the RSB would support the 0.6 m x 0.6 m concrete shielding blocks



Checking the new plug fits in the RSB. Side-wall stools are attached so the plug is not fully lowered

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Preparatory work – getting ready for the lift

The ECR: Crane Operator's CCTV and remote controls

View from auto-camera - old top shield plug is prepared

Video link screen-shot - old top shield plug is prepared

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The lift – moving the old plug

10:30
Lift of plug from RAT begins

10:31
Top shield plug is clear

10:32
Traverse to RSB

10:33
Positioned over RSB

10:34
Lowering into RSB

10:36
Installed & crane hook clear

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The lift – moving the new plug

10:40
New plug lifted over RAT

10:43
Lowering into RAT

10:45
New plug installed into RAT

Health Physics monitor new and old plug positions

11:35
Re-occupation of reactor top

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Additional photographs

Fixed position video and auto-stills cameras

Overview, showing sheeting to aid decontamination

Present-day view of PLUTO reactor top

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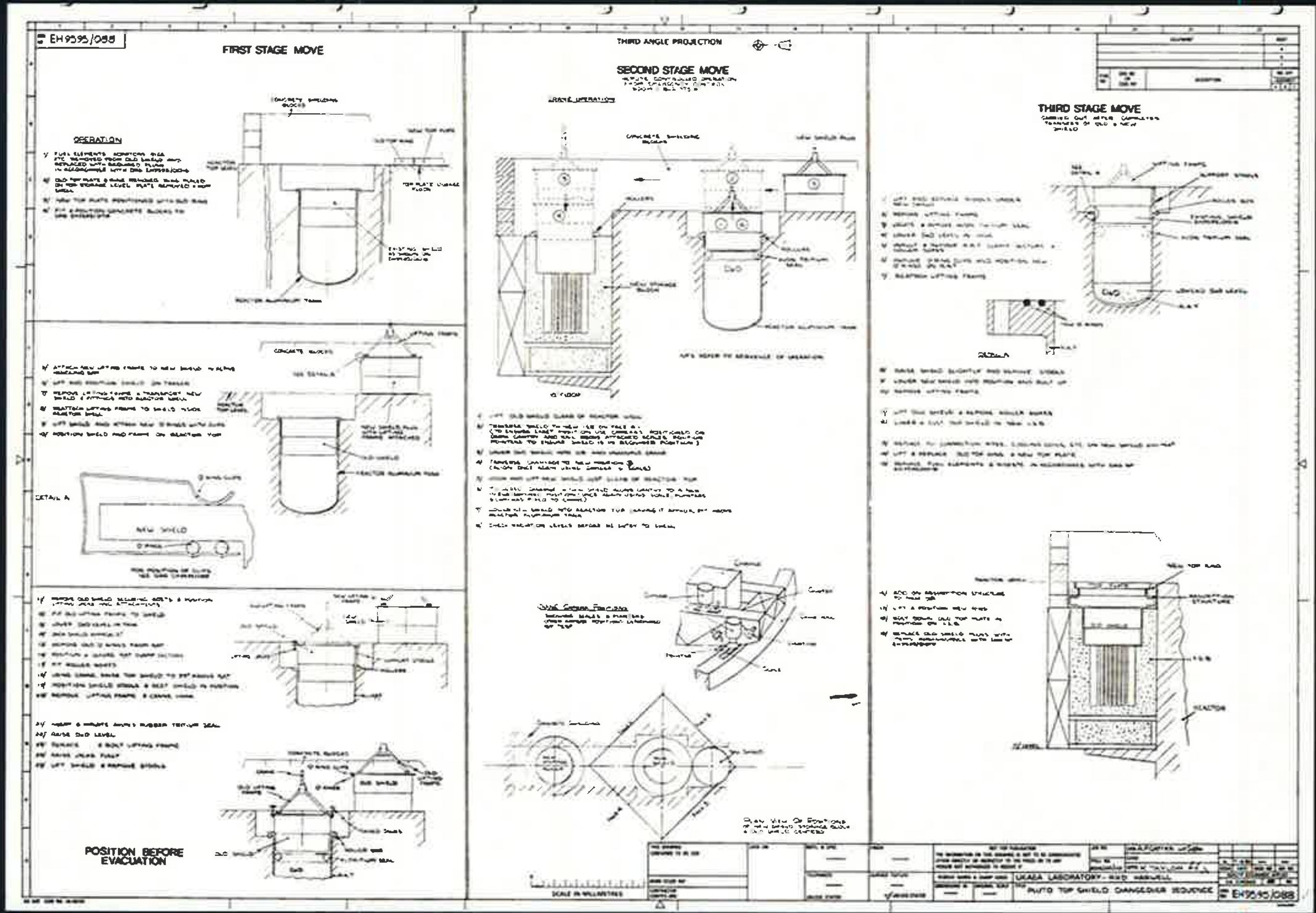
Original drawings – change-over sequence



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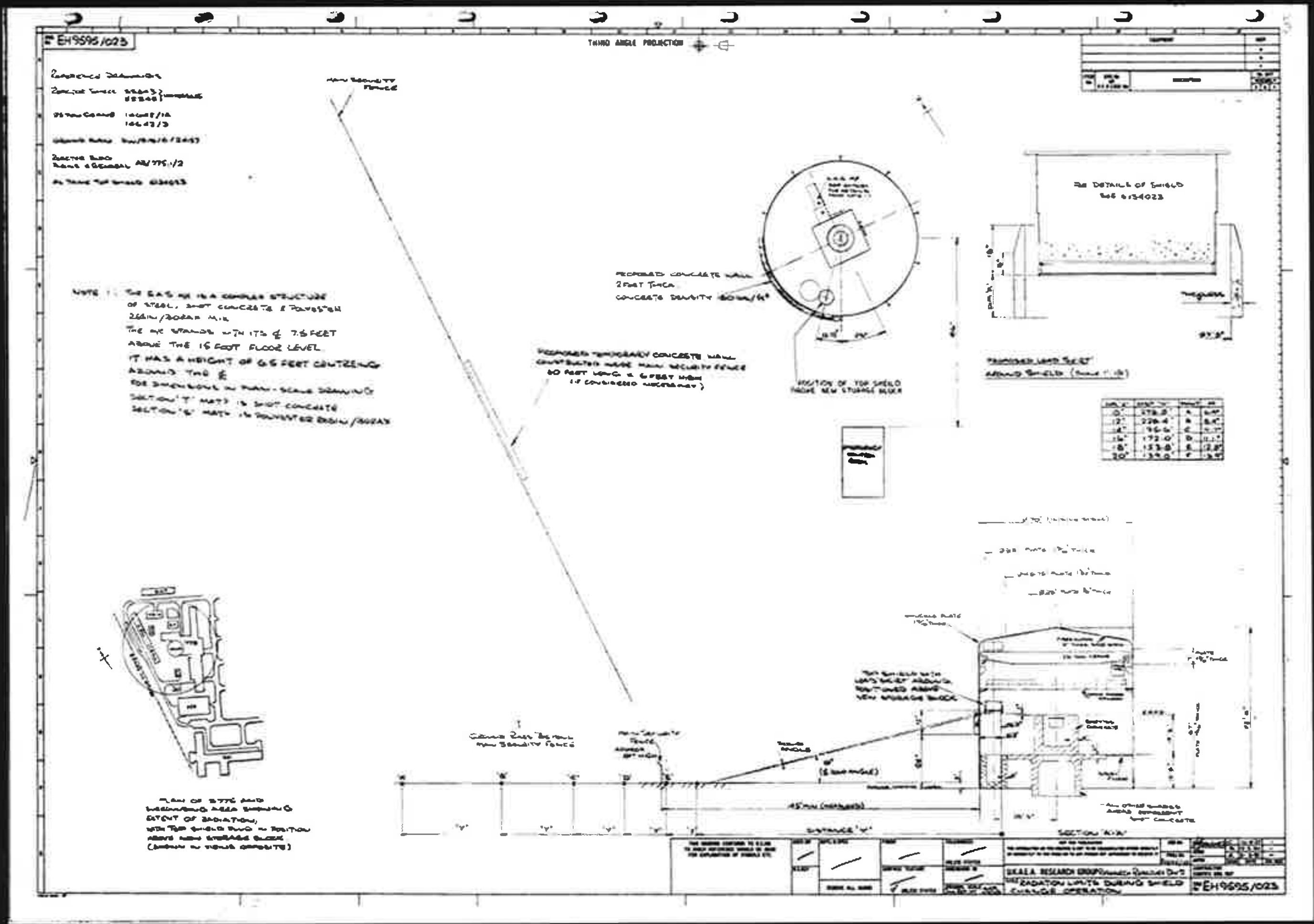
Original drawings – radiation limits



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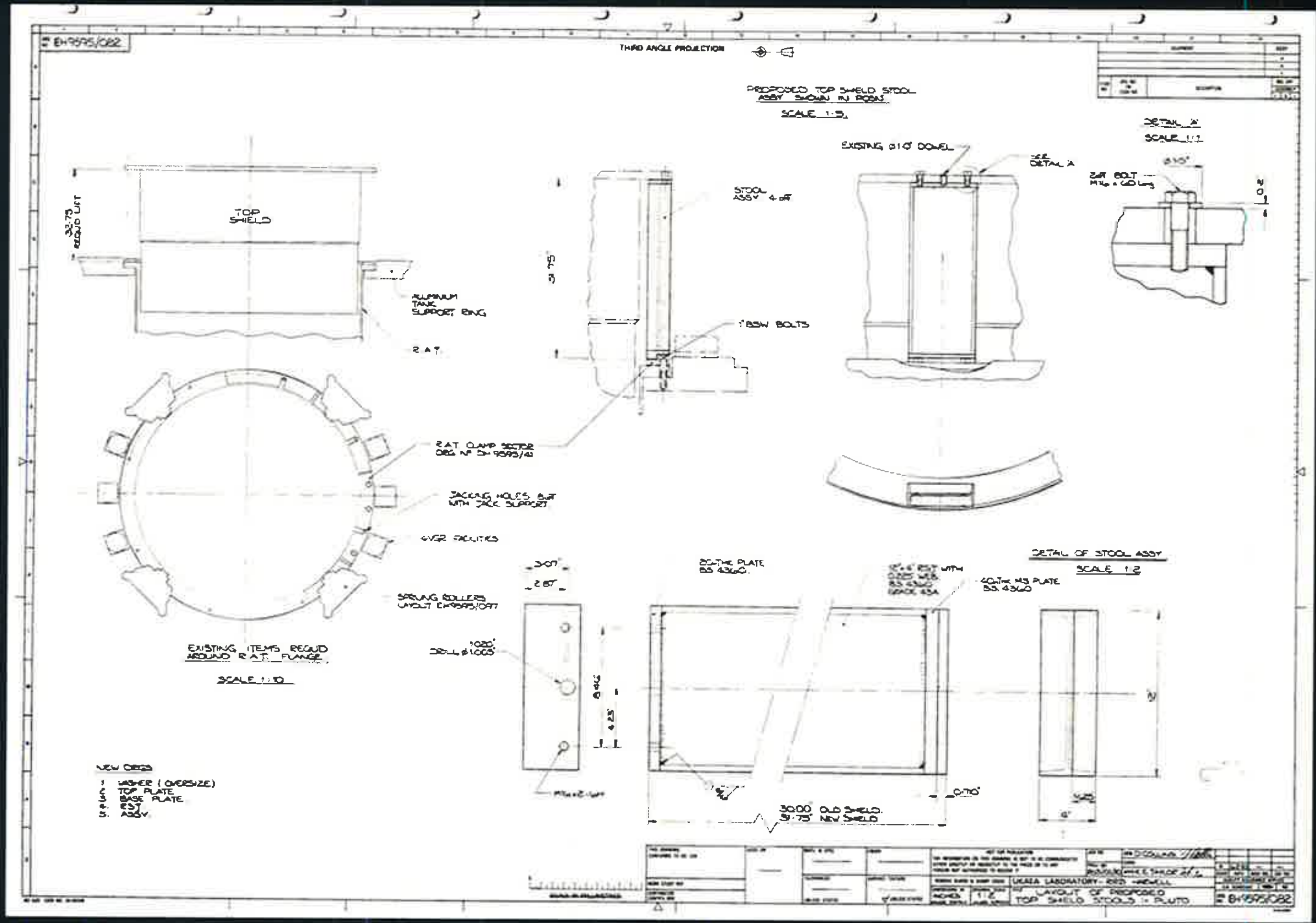
Original drawings – the stools



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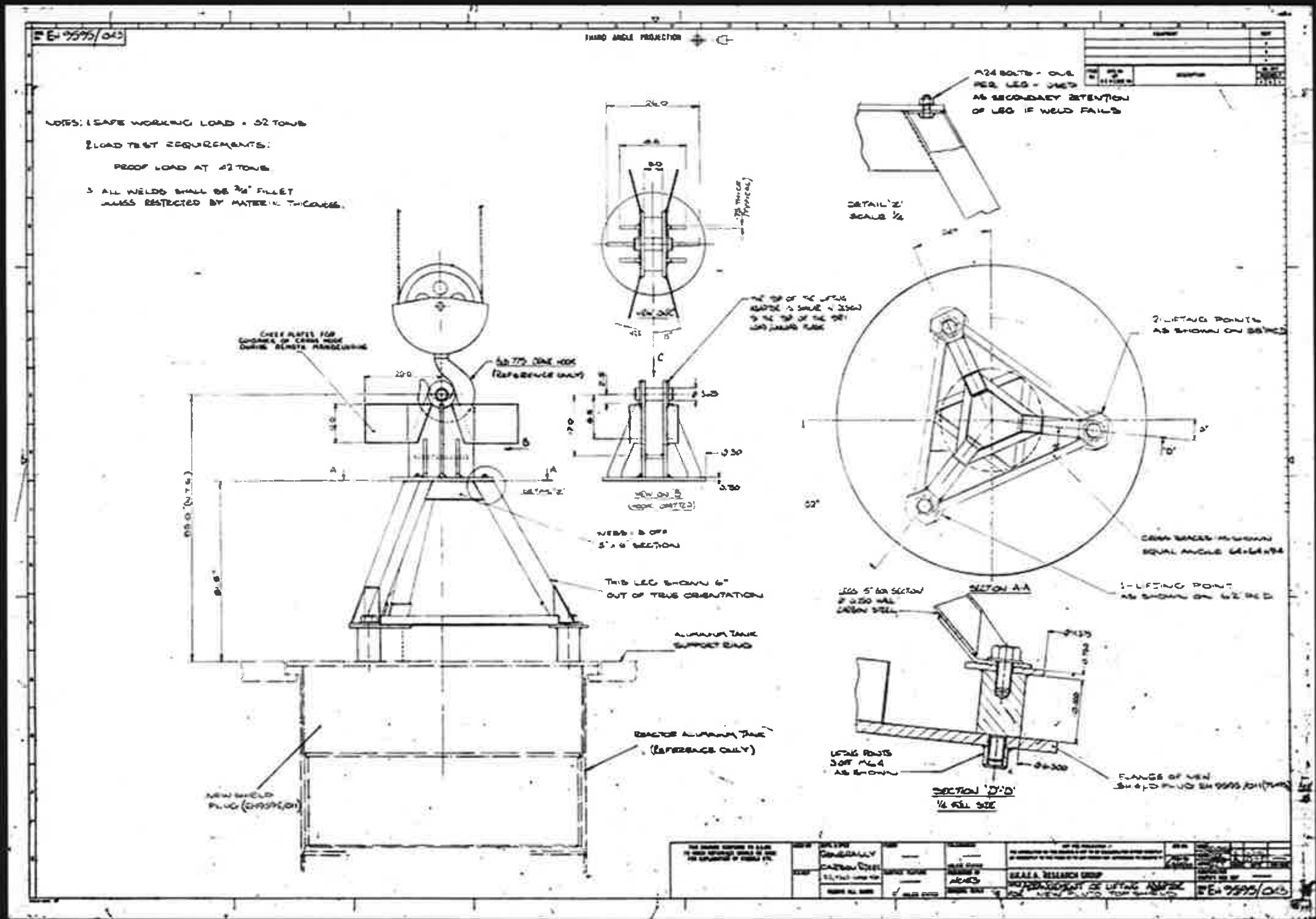
Original drawings – lifting frame



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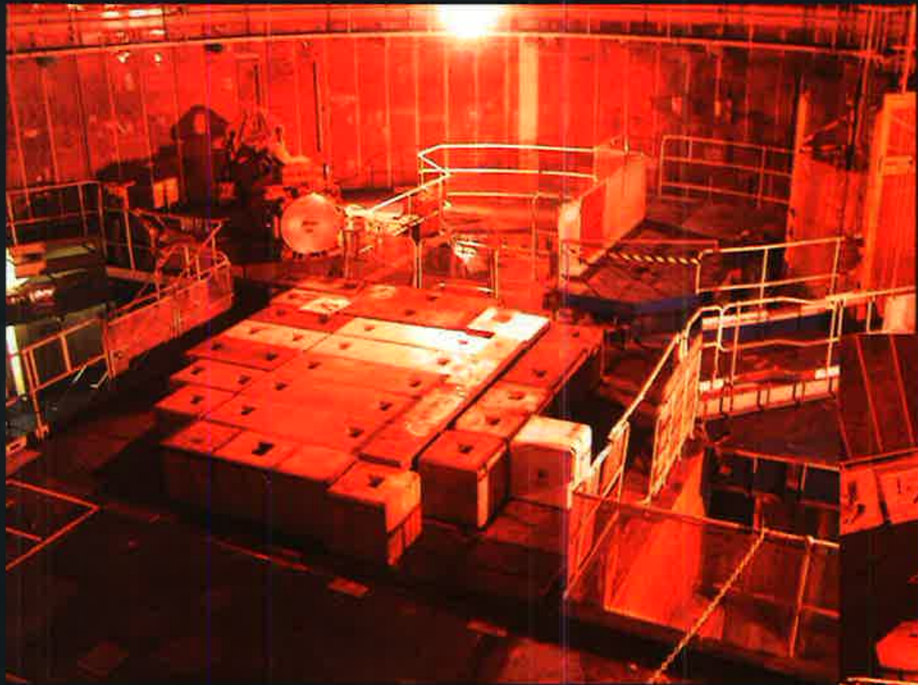
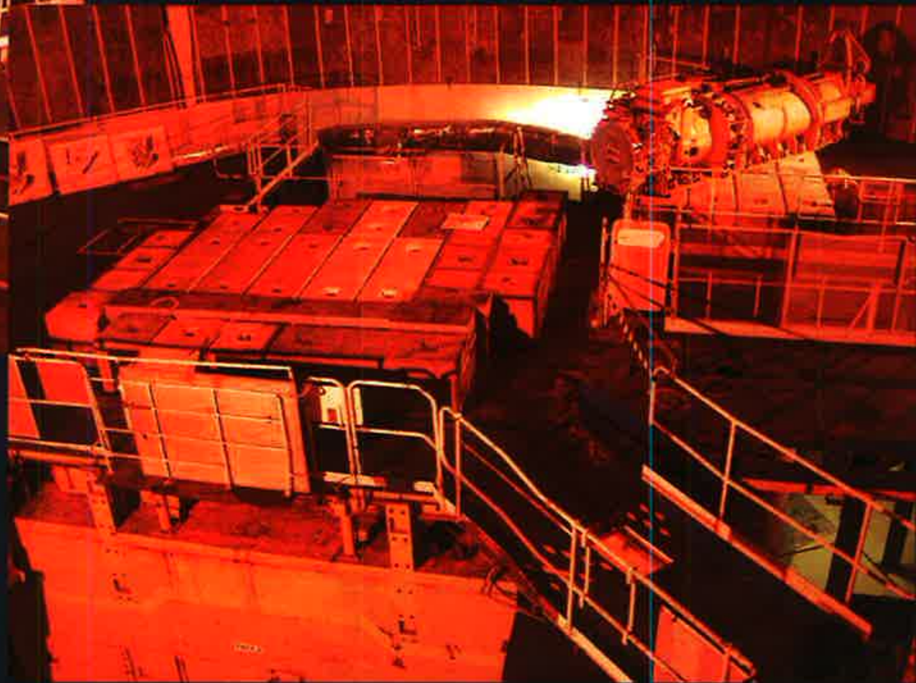
PLUTO today





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