View of the Laboratory from the main entrance.

TECHNICAL AND ADMINISTRATIVE SERVICES

Technical and Administrative Services

RADIATION PROTECTION

Personal Dosimetry

The six-monthly issue of thermo-luminescent dosimeters (TLD) to lightly exposed persons continues as a successful routine service, and has been extended to include those exposed to fast neutron radiation as well as beta gamma radiation. A new holder, designed and supplied by AEE Winfrith, is gradually replacing the 'home-made' holder originally used. The dose response of Li^7 F/Teflon discs (the standard whole body beta gamma sensitive TLD used at the Laboratory) to Co^{60} gamma radiation has been measured over the whole of the usable dose range i.e. up to a mega-rad.

The two element dosimeter (neutron track film plus slow neutron sensitive TLD), designed to overcome the neutron spectrum dependent response of the track film alone, is now issued to all personnel exposed to the prompt leakage radiation of Nimrod – the use of the track film alone being discontinued.

At November 1970 regular dosimeter issues were as follows:

Beta gamma films (monthly issue)	460
Beta gamma TLD (6 monthly issue)	160
Fast neutron films plus slow neutron TLD (monthly issue)	310
Beta gamma TLD plus slow neutron TLD (6 monthly issue)	180

As in previous years the personnel engaged in the maintenance and repair of Nimrod continue to be the most heavily exposed group at the Laboratory but none, however, is expected to exceed the permitted dose for the year.

Environmental Health Physics

There have been no new problems associated with the operation of Nimrod: the X2 extracted beam blockhouse has continued to be the main cause of significant prompt leakage radiation particularly when operating at lower than normal proton energies. There has been no significant change in the pattern of induced activity either in or near the machine or the extracted proton beams.

There have been no requirements during the year to handle work involving significant amounts of loose contamination in the Radioactive Workshop (R52) but there has been an increase in the unsealed source usage of the Radiochemistry Wing of R34.

Radiation Studies

During the year the angular distribution of the lower energy secondary particles emitted from targets in extracted beams was examined in detail. Measurements with activation detectors and film, thermo-luminescent and pressure dosimeters were made around targets of Cu, 'Heavy alloy' (mainly W) and Al bombarded by 7 GeV protons (Nimrod X3 beam) and also around a Cu target with 24 GeV/c protons (CERN PS e7 beam). The dose and secondary particle production data obtained show excellent agreement, for angles up to about 3°, with both the predictions of the Ranft-Trilling empirical extrapolation formula and Ranft's calculations from the thermodynamic model. Differences at larger angles arise from using models of proton-proton interactions to predict yields from proton-nucleus interactions.

A high-resolution gamma spectrometry facility has been developed, using a 25 cm^3 Ge(Li) crystal and a Victoreen-SCIPP 1600-channel analyser. The system is to be used for studies of radio-nuclide production in well-developed hadron cascades and to assist the work of isotope identification in operational health physics. Computer programmes have had to be developed to simplify handling the spectral data. Analysis of these data is carried out using the SAMPO routine of Routti (LRL Berkeley), which has been modified for use on the RHEL IBM 360/75.

These fields of study have both increased the understanding of problems of shielding design, residual activity patterns and radiation damage around Nimrod, and have formed part of the RHEL contribution to the Radiation Problems Group of the CERN 300 GeV Design Study.

Correlation and interpretation of the results of activation detector measurements in the stray radiation field outside the shielding of Nimrod have continued, and methods of dose estimation from such measurements have been critically assessed.

Radio-biological Pion Irradiation Facility

A low momentum beam line, which is intended primarily for radio-biological and dosimetric studies using stopping negative pions, was built during the summer. This beam line (π 11) lies at 94° to the Nimrod X3 extracted proton beam and shares a target with the π 8 and K15 beam lines. π 11 was designed by the Radiation Protection Group who have set it up and measured the beam parameters, which have largely reached the required values. Preliminary tests showed that the beam can provide dose rates in the stopping pion peak of 20 rad per hour, of which less than 15% is due to beam contamination. Preparations for the first biological experiment are now well advanced.

SAFETY

As in previous years the surveillance and inspection of potentially hazardous situations and apparatus has been the main accident prevention activity of the Safety Group. Tours by parties of safety professionals augumented by a member of the Safety Committee have continued. Publicity displays and "Safety News" sheets have emphasised new and existing sources of hazard. A completely new edition of the Safety Handbook was prepared during the year for distribution to all staff and visitors.

During the year reported injuries involving Laboratory staff totalled 126 (1969 total 126) of which 11 (15) resulted in lost time, the average absence of the latter being 18·8 (20·1) days. The causes of the accidents were:–

Handling goods	25
Stepping on or striking objects	28
Falls of persons	22
Use of hand tools	21
Machinery	4
Falls of objects	9
Electric shock	1
Miscellaneous	16

A nationally used method of representing injury incidence is to compute the Injury Frequency Rate which is defined as (number of injuries x 100,000)/(number of man hours worked). The figure of 100,000 is the number of working hours in an average man's career. The Rutherford Laboratory figures are 4·57 (4·61) for all injuries and 0·4 (0·55) for lost time injuries.

The number of items registered with the Safety Group and requiring periodic inspection increased once again, the total being 4,407, a 13% increase on 1969. The figure was made up as follows: lifting tackle 2,341, lifting machines 392, pressure vessels 975, high voltage equipment 408, breathing apparatus and safety equipment 139, fire prevention 49 and safety valves 103. The latter were included in a new service introduced during the year to test, set and register all safety valves used at the Laboratory. The total number of inspections of registered items was 7,780 (1969 total 6,498).

ENGINEERING SUPPORT SERVICES

A large fraction of the Laboratory's engineering and technical staff are integrated into the project teams that execute the Research and Development programme described in the foregoing sections of this Report, and their contributions to these projects are, whenever possible, included there. In addition, there are several units which provide support services to the Laboratory at large; the year's work in this field is reviewed below.

Experimental Equipment — Manufacture and Installation

Development of winding techniques for superconducting magnets continued and 26 coils were made for d.c. superconducting quadrupoles. Methods suitable for a.c. dipole magnets have also been examined, as have constructional techniques for superconducting energy storage systems. Fabrication methods for cementitious insulated magnets have been carried to the stage where a magnet has been successfully constructed by a commercial firm.

Power supplies for the XM9 and RX3 magnets of the Nimrod X3 extraction system, consisting of a 21 kA and a 10 kA regulator with the associated generators, switchgear etc., were installed in the magnet room area; supplies have also been provided for the homopolar generator which will be the permanent current source for XM9. Experimental Hall 3, as described elsewhere in this Report, is now entering phase II of its development and 75 additional magnet power supply rectifiers, of ratings up to 200 kW, have been installed.

Electronic Services

170 different printed circuit boards were designed. Many of these were special termination boards for wire spark chambers. The precision required cannot be achieved using conventional methods (e.g. etching) and it was necessary to use optical line generation and chemical milling techniques. Manufacture of electronic units to a total value of over £300,000 was undertaken. About two-thirds of this was done outside, the remainder in the Laboratory's prototype and small production shops. The largest single job done internally was the bench check-out unit for the Nimbus E satellite experiment.

The new film measuring machine HPDII, incorporating a laser light source, has been commissioned. New input and digitising electronics were developed for this machine. Other support has been provided for maintenance of the operational film measuring devices and data aquisition equipment used in experiments on Nimrod.

Figure 135. Experimental Halls 1 and 3.

Figure 136. Building R1. Main office and laboratory block.

Buildings — Construction and Provision of Services

The major building schemes initiated during the year have been associated with Building R1. Additional plant rooms and storage spaces for track analysis and data processing activities have been provided by extensions to the east wing. A large ground floor extension on the south-east corner will house the IBM 360/195 central computer which will replace the present 360/75 late in 1971.

Improvements to services have been carried out in several areas. Air-conditioning plant has been installed or upgraded in the scanning laboratories, parts of the bubble chamber area and the Nimrod magnet hall. Heating and water supplies in the R18 and R56 extensions and at The Cosener's House have received attention, as have cooling supplies to R8, R9 and the Atlas Laboratory. Electrical installation work has also been called for in these and other areas.

Mechanical Manufacturing Services

Mechanical manufacture ran at a rather higher level than last year; 850 jobs were undertaken in the Laboratory's workshops and 1,350 externally, the value of the latter being in excess of £350,000.

Helium Recovery

Large quantities of helium are used in the Laboratory — in liquid form for superconductivity studies and in gaseous form in spark chambers. Recovery of 'waste' helium continues to be an important activity. Some 75,000 litres of liquid helium were issued during 1970, an increase of about 50%. Nearly three quarters of this was recovered for re-liquefaction.

ADMINISTRATION

Housing

The demand for furnished accommodation has continued to be high, both at the Laboratory and at CERN. The local demand has substantially exceeded the capacity of the Laboratory-owned houses and flats. Numbers of staff at CERN have increased (following a drop last year) as a result of preparations for the Laboratory's experiment on the ISR. 24 flats (half of which are privately owned) are now occupied.

Office Services

The acquisition of new equipment (suitable for A3 size printing) and alterations to the Reproduction area have made it possible to execute internally a higher fraction of the jobs undertaken, as well as a higher number of jobs in absolute terms. Among the documents printed internally were 31 Preprints, 14 Memoranda, 15 Stores Catalogues and 4 Theses.

Finance

In the financial year 1970/71, the total Laboratory expenditure was £8·05 million, of which £1·1M was for capital items and £6·95M was recurrent. Corresponding figures for 1969/70 were £7·3M, £1·1M and £6·2M. The total expenditure is conventionally subdivided in the table below, the figures in brackets being for last year.

	£ million
Staff Expenditure (salaries and wages, SET, insurance, travel etc.)	2·91 (2·51)
Research and Development (see below)	4·40 (3·72)
Plant and Equipment (chiefly major components such as beam-line magnets)	0·71 (0·86)
Building Works	0·03 (0·21)
	8·05 (7·30)

The £4·4 million R and D expenditure can be further subdivided to show the cost attributable to each Division and to certain other items. This breakdown is shown in the pie chart (figure 137).

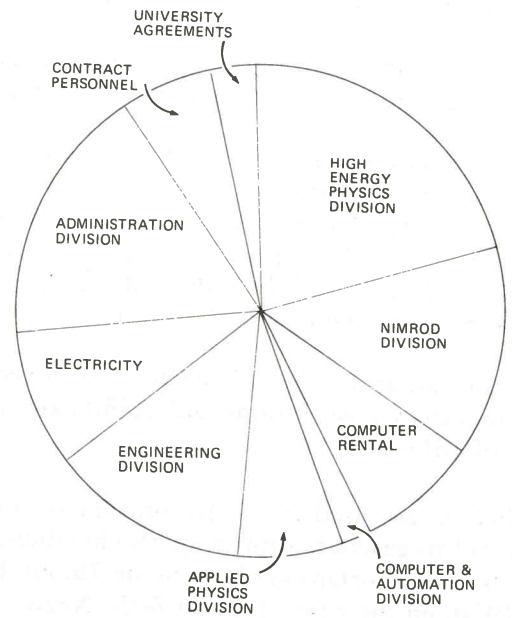

Figure 137. Breakdown of the £4·4 million R & D expenditure.

Administrative Computing

The year under review has seen a further expansion of the use of the Laboratory's computer for administrative calculations and record-keeping. Salaries of monthly paid staff are now calculated by computer, and crediting of individual bank accounts is done by writing a magnetic tape to be read by the clearing Bank's computer in London.

Extensive revisions of programs have been necessary to cater for the introduction of decimal currency, and the opportunity was taken to incorporate several improvements which had become desirable in the light of operational experience. Training of administrative staff in computing techniques by attaching individuals to the computer section has continued. The intention is to enable the staff who will be using programs to modify and update them themselves, thus leaving the computer section free to develop new programs. The Laboratory is also playing a full part in the SRC Administrative Computer Committee at which the main topics discussed have been personnel records and the use of terminals.

Table 19

Staff Numbers 1970

The staff position at the beginning and end of the year.

	Opening Strength 1.1.70	Changes during 1970		Closing Strength 31.12.70
		Gains	Losses	
PROFESSIONAL				
Senior and Banded Staff	23	2	1	24
SO class	65	14	5	74
Research Associates	48	29	28	49
Exp. O. class	116	13	11	118
Engineers I, II, III	99	13	5	107
ADE	5	0	1	4
Total Professional	356	71	51	376
ANCILLARY				
SA and SSA	51·5	13	18	46·5
Draughtsmen	41	4	2	43
Technical class	200	7	14	193
Non-Techs. and Stores	44	0	2	42
Executive	30	6	6	30
Librarian	1	0	0	1
Clerical	47·5	11	9·5	49
Secretarial and Typing	29	12	8·5	32·5
Photographers	4	0	0	4
Photoprinters	5	1	1	5
Machine Operators	67·5	16	14·5	69
Asst. Hostel Manageress	1	0	0	1
Telephone Operators	2	0	0	2
Total Ancillary	523·5	70	75·5	518
INDUSTRIAL				
Craft	178·5	31	21	188·5
Non-craft	134	31	25·5	139·5
Apprentices	34	8	12	30
Total Industrial	346·5	70	58·5	358
GRAND TOTALS	1,226	211	185	1,252

The figures listed under "changes" include new entrants, resignations and promotions. Staff on sandwich courses, and those working part-time are counted as half.

Staff Relations

The most important item of business has been the finalisation of the Productivity agreements at both National and Local level. The negotiations between Management and Unions were both long and difficult, but well worthwhile. There is now a Joint Consultative Productivity Committee. Participation of shop stewards in Laboratory affairs has grown as a result of new arrangements whereby every shop steward serves on at least one of the many committees with Trades Union representation. This development is most welcome as it brings more of the shop stewards closer to the everyday problems encountered in a research laboratory.

The Safety Committee has been reconstituted to include both Trades Union and Staff Association members. Another area in which representatives of both the industrial and the non-industrial staff were involved was the setting up of the Death Benefit Scheme. This is financed by voluntary deductions from salaries or wages, and its purpose is to provide an immediate cash payment to next-of-kin.

Joint discussions and negotiations, both formal and informal, take place under the umbrella of the Local Joint Committees, the Consultative Committee for industrial employees and the Whitley Committee for non-industrials. Both bodies have met several times during the year, including Annual Meetings, chaired by the Director, at which the previous year's work of the Laboratory and its future prospects are surveyed. The Annual Meeting was the first of its kind for the Consultative Committee, the members of which considered it to have been a most successful innovation.

There has been a substantial increase in Trades Union membership within the Laboratory, a trend welcomed by both sides as leading to more representative discussions. Several Unions now have schemes whereby subscriptions can be deducted from wages; a similar system for Staff Associations has existed for some time.

Training

The number of Rutherford Laboratory Staff who received day release and evening training concessions during the academic year 1969/70 showed yet another fall compared with the previous year, from 185 to 159, but this figure still represents 13% of the whole staff of the Laboratory. The continuing fall in numbers is almost certainly a consequence of the much reduced recruitment of junior staff in the last year or two. The 138 students who sat examinations achieved an overall pass-rate of 79%, which is well above the national average for part-time courses and higher than any previous figure for the Laboratory.

One full-time student from the Laboratory completed his studies this year; he was awarded the Diploma of the Oxford Polytechnic in Mechanical Engineering and earned exemption from the Part II examination of the CEI. Six other members of the staff attended full-time courses; three attended Honours Degree courses in Applied Physics, one an Honours Degree course in Electrical Engineering and two HND courses in Mechanical Engineering. One of these students held a Laboratory Award and the others received unpaid leave, although they returned to the Laboratory for industrial training where appropriate.

The majority of short courses on technical and management topics attended by Rutherford Laboratory Staff were run by the AERE Education and Training Department, in fact 231 out of a total of 292. Staff also attended courses run by Universities, Polytechnics and Technical Colleges, the Cranfield School of Management Studies, PERA, the Industrial Society, the Welding Institute, ASLIB and a number of commercial firms, as well as courses run centrally by SRC.

Three members of the staff of the Laboratory were registered as Research Students with Universities or the CNAA and will be allowed to submit theses based on work done in the Laboratory.

In addition to training concessions awarded to permanent staff, 32 Craft and Student Apprentices received training in the Apprentice Training Scheme run jointly with AERE. All 9 apprentices who completed their training during the year joined the staff of the Laboratory, 6 as Craftsmen, 2 as E III's and one as a Draughtsman – the first Draughtsman to qualify within the scheme. Two Student Apprentices not yet out of their "time" were awarded Honours degrees in Mechanical Engineering by the University of Cambridge, one with First Class Honours.

The Rutherford Laboratory acted as host establishment for an SRC Central Induction Course held in January 1970. This is likely to become an annual event during December or January, since this enables the visitors from other SRC establishments to visit Nimrod during the annual shut-down.

During the academic year the Laboratory provided industrial training for five members of its own staff attending sandwich courses and for 41 college-based students in Applied Physics, Applied Chemistry, Applied Mathematics, Computer Science and Electronics. This brings the total of college-based students who have received industrial training in the Laboratory since 1961 to 266.

Liaison with Schools (*Ref: 44, 47*)

Two years ago 9 science masters spent a month at the Rutherford Laboratory, working with individual groups on a variety of projects. They were encouraged during their visit to look around and see whether any of our activities could be transplanted to the schools as school projects. The objective was to provide a continuing contact between the schools and the Laboratory, and also to make the boys from the schools aware of the fact that any big project is made up from a large number of component activities, in one of which they were themselves participating.

The idea is interesting, but it has its difficulties. The project must on the one hand not be so sophisticated that it is beyond the ability of a sixth-former: on the other hand, it must not be dull, so that the project becomes boring. The other problem is that of time: the amount of time that masters and boys can devote to a project is limited, and in general small compared with a full time laboratory worker.

Some seven projects have been undertaken by schools. These include:

High Energy Particle Flux Measurement (Chipping Norton School).

The objective is to measure, for radiation protection purposes, the high energy component in a high intensity background of neutrons and gamma rays. The method uses fissionable elements in contact with thin foils (mica, mylar); tracks of fission products are counted in the foil following an etching procedure. The school have undertaken to investigate a variety of techniques for developing and counting the tracks.

Studies of Bearings in Vacuum (Burford School).

Equipment has been lent to the school for a study of bearing performance in vacuum—a useful introduction, of course, to vacuum physics as well as to bearing problems. This project is drawing to a close, and may be replaced by the construction of heat pipes or of vortex pumps. This collaboration is of interest because it has involved the interaction of several individuals within a group at the Rutherford Laboratory with several masters at the school: the master responsible for technical drawing has taken interest in design studies current here, the craft master is studying various technical aspects of current practice, and in several ways a community interest is growing.

Thermal Expansion and Thermal Conductivity of Resins at Room and Liquid Nitrogen Temperatures (Abingdon School).

The superconductivity programme at the Laboratory requires the development of suitable resins for coil encapsulation and collaboration has recently been initiated between ourselves and Abingdon School. The boys have been invited to devise their own method of measurement of thermal expansion at room temperature, and have shown considerable ingenuity in developing their own techniques. They will in due course develop methods suitable for measurements at liquid nitrogen temperatures. This collaboration shows considerable promise.

Figure 138. Visitors during the Open Days.

Exhibitions On account of the large amount of preparatory effort needed for the Open Days, the Laboratory contributed to only one exhibition during 1970 — the Physics Exhibition held in London during March. Four items were shown:— Superconducting magnet technology in high energy physics, including bubble chamber and proton synchrotron applications; a high speed electronic analogue wattmeter developed originally for monitoring the performance of the Nimrod magnet power supply; cementitious insulation techniques for electromagnets, offering the promise of improved resistance to irradiation damage; a flat-top field pulsed magnet for fast beam switching, involving current changes of several hundred amperes in times of less than a millisecond.

Open Days On Thursday and Friday, July 2nd and 3rd, the Laboratory was open to invited guests. These were the first Open Days for four years, and about 300 people came each day. Nimrod was closed down for the occasion, and there were 22 exhibits. Eight of these were located in Hall 3 and there was a linking introductory exhibition in the reception marquee. A press preview was held on July 1st and on July 4th, a Saturday, staff and their families were able to tour the Laboratory during the afternoon; the attendance was estimated as 1,500.

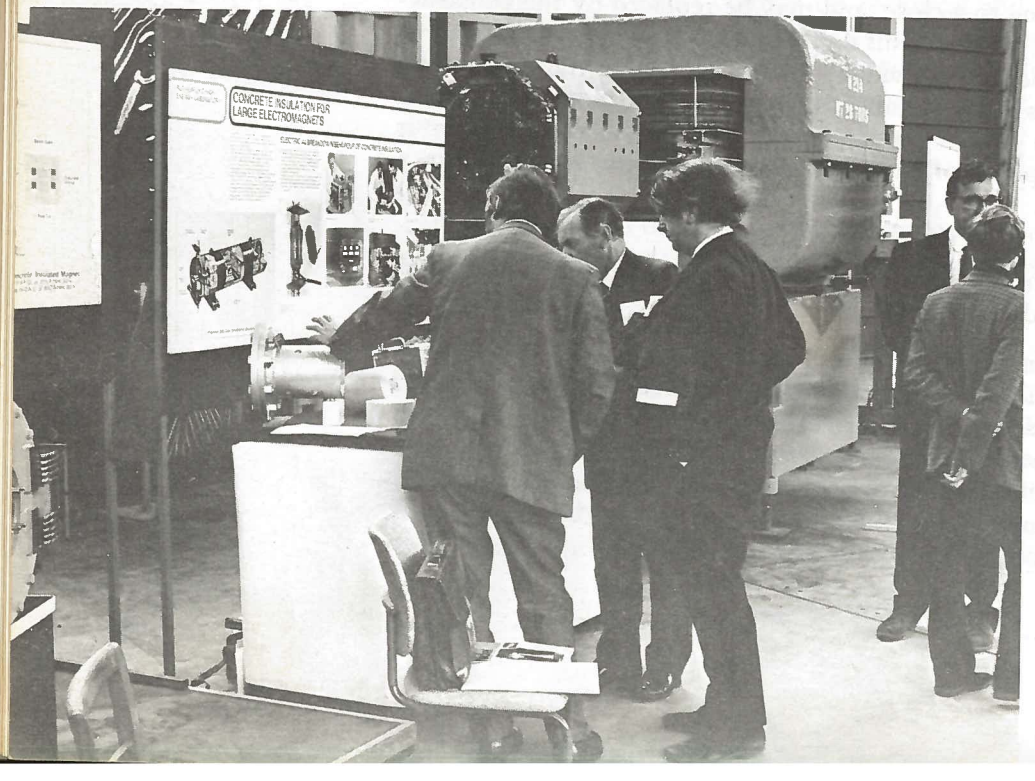

Figure 139. One of the many exhibits during the Open Days.

Figure 140. Visit of the Minister of State.

Visits

Mr. G. T. Fowler MP, Minister of State, Department of Education and Science, visited the Rutherford and Atlas Laboratories on January 28th. He was accompanied by Sir Brian Flowers. During his visit, the Minister saw Nimrod, the $\pi 8$ experiment in Hall 3, the 1·5 m Bubble Chamber, the Film Analysis equipment and a selection of items from the fields of applied physics, instrumentation and engineering. Mr. Fowler met representatives of the Staff Associations and Trades Unions, and also local press reporters.

In October, the Laboratory was visited by four members of the Russian Delegation on Plasma and Fusion Research, who had been spending several days at the Culham Laboratory. In figure 141, the Director is seen shaking hands with Dr. L. I. Artemenkov, leader of the delegation, at the conclusion of their visit.

Conducted tours were arranged for groups of students, members of professional and learned societies, and others with an interest in the Laboratory's work. These groups totalled 1,086 individuals, significantly fewer than last years record figure of 1,652 on account of Open Days.

A series of internal conducted tours was arranged for junior and intermediate grades of staff. The various Divisions of the Laboratory took it in turns to present their work in non-technical terms, each tour lasting about 1½ hours. A total of 430 staff attended.

Figure 141. Visit by members of the Russian Delegation on Plasma and Fusion Research.