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NIL SINE LABORE

The Design of Martlesham Research Centre

Part 1—Basic Design Requirements and Design of Buildings

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This first part of a 2-part article outlines the guiding principles adopted in the design of the Martlesham Research Centre, discusses the production of the Schedule of Requirements and describes the overall design of the buildings.

INTRODUCTION

The Director General of the British Post Office (BPO) had seriously considered moving the research activities of the Engineering Department from Dollis Hill, London, into the country as early as 1958, and a site was bought by the BPO for this purpose in the new town of Harlow in Essex. Discussions were held between the Engineer-in-Chief and the Ministry of Public Buildings and Works, and an architect was briefed to prepare a model. However, the staff at Dollis Hill showed little enthusiasm for moving to Harlow and, on the grounds of lack of consultation, appealed to the Director General against it. Harlow was eventually abandoned as a new site for research laboratories and, in 1963, the project was dropped.

The need for more space and better research facilities continued to grow, however, and the idea of moving Research Department out of London was revived in 1964. A new search for a suitable location was instituted and a joint working party, consisting of the official-side and staff representatives, visited areas where likely sites were available. The chief criteria were that

(*a*) the site should not be more than 2 h journey from the City of London, with good rail and road routes to London generally,

(*b*) the site should have good potential for the development of research laboratories without space or environmental restrictions,

(*c*) the site should be in an area attractive to the staff, offering a wide scope for leisure interests, and

(*d*) the local authorities should welcome the new arrivals as an asset to their area; naturally, it was hoped that the local population would also prove friendly.

The vacant airfield at Martlesham Heath, 9·6 km east of Ipswich in East Suffolk, was finally chosen. Ipswich is about $1\frac{1}{4}$ h from London by train, and there is now an excellent trunk road. The small East Suffolk towns offer many attractions in the Arts and in sport. The University of Cambridge, University of Essex at Colchester and University of East Anglia at Norwich are all within easy reach, and there is an excellent technical college, Ipswich Civic College. The local authority, Deben Rural Council, were pleased to be wholly helpful. A new small division of Research Department, R10, was set up to be responsible, in co-operation with the Department of the Environment (DE), for the planning of the new research establishment, and preparations for the move of Research Department from Dollis Hill and its outstations to Martlesham were put in hand during early-1965.

The move of the BPO Research Department was part of the Government's plan to disperse some of the major elements of the Civil Service out of London. By moving this modern unit of high technology into East Anglia, the BPO has helped the area by providing a wide range of openings in a number of fields of technology that had not hitherto been available in Suffolk. Although the staff involved in the move had to come from London, graduate staff for further expansion has partly been drawn from East Anglia, and supporting staff almost entirely so.

It has taken 10 years to build the new Research Centre, shown in Fig. 1, move Research Department out of Dollis Hill and re-establish it at Martlesham.

THE SITE

The site of the Martlesham Research Centre originally belonged to a college of Cambridge University. The RAF acquired Martlesham in the early days of flying, and it became an important airfield for both the RAF and the USAF. When it was relinquished by the Services after the last war, a property company bought the whole airfield for small-scale industrial work and much of it was still derelict when the BPO became interested in 1964. At this time, there was Government pressure for new towns in East Anglia, and a new village and small industrial estate for light engineering was planned for the west side of the Martlesham Heath site with the BPO Research Laboratories on the east.

Owing to uncertainty over land values, the BPO took a long-term lease on 0·4 km^2, on which the new research centre has been built. More recently, a belt of the surrounding agricultural land has been acquired outright by the BPO and leased back for farming on a 7-year agreement. This will provide expansion space for future field experiments and should prevent the encroachment situation that eventually forced the closing of Dollis Hill.

The proposals for a new village have now become fact, some 12 years after the plans were drawn up. A housing estate with shops, banks, a public library and other essentials of village life is being built opposite the research centre.

† Mr. Floyd was Head of the Division responsible for the planning of the Martlesham Research Centre, and for organizing the move from Dollis Hill, from the beginning in 1964 until his recent retirement

FIG. 1—Martlesham Research Centre

GUIDING PRINCIPLES FOR THE DESIGN OF THE NEW BUILDINGS

Before design work on site development and new buildings could be commenced, it was essential to state the broad aims that the designs should satisfy. Many recent buildings were visited by members of R10 Division, modern laboratories were inspected, some in great detail, and talks were held with architects and engineers who had been engaged in design work of a related nature elsewhere. As a result, the following guiding principles were drawn up for the design of the BPO Research Department laboratory buildings.

(*a*) The complex of buildings must be suitable for a self-contained research unit with its own administrative and support services.

(*b*) Air-conditioning should be installed from the outset to give the best environment for future equipment and staff; experience of adding air-conditioning to a completed building not originally designed for it had shown how expensive and unsatisfactory it can be.

(*c*) The building must have a high built-in resistance to mechanical vibration and be resistant to its transmission in the structure, whether the source is inside or outside.

(*d*) Flexibility should be provided in the way space can be used. The sizes of laboratories, including offices for research staff, must be determined by demountable partitions that can be moved readily without structural alterations to the building.

(*e*) Essential laboratory bench services (for example, electricity, telephone, gas, water, chilled cooling water, drains, chemical drains, compressed air, and special gases) must be easily made available, wherever needed, whatever the configuration of partitions. Service feeds must not be dropped from overhead; they can be dangerous with electric vehicles running about the laboratories.

(*f*) All floors of laboratories and corridors must be level and without steps. Goods lifts large enough to take small vehicles should give access for heavy equipment to all floors.

(*g*) A high standard of illumination should be provided from flush ceiling fittings so that a standard height of apparatus racks (3·2 m) can be used without obstruction.

(*h*) Substantial workshop services are needed with supporting drawing offices and stores. There must be space for future developments in mechanical technology. Preferably, workshop services should be provided in a building separate from the laboratories.

(*i*) All staffed accommodation must be in accordance with the standards defined by the report of the Working Party on Engineering Accommodation (WPEA) as agreed between the BPO and the Council of Post Office Unions. These agreements apply to all types of staffed rooms.

(*j*) Support services needed, preferably in a specialized administration building, are

(*i*) a technical library with ample reading-room facilities and book storage space for the future,

(*ii*) two lecture theatres, one large and one small, well appointed and suitably equipped for international telecommunication conferences,

(*iii*) a central conference room, with sufficient smaller conference rooms of various sizes dispersed around the building, some amongst the laboratories,

(*iv*) restaurant facilities able to provide 1000 lunches daily with sufficient amenities to cope with official occasions as well; rooms suitable for tea points are also needed, especially in accommodation far from the restaurant,

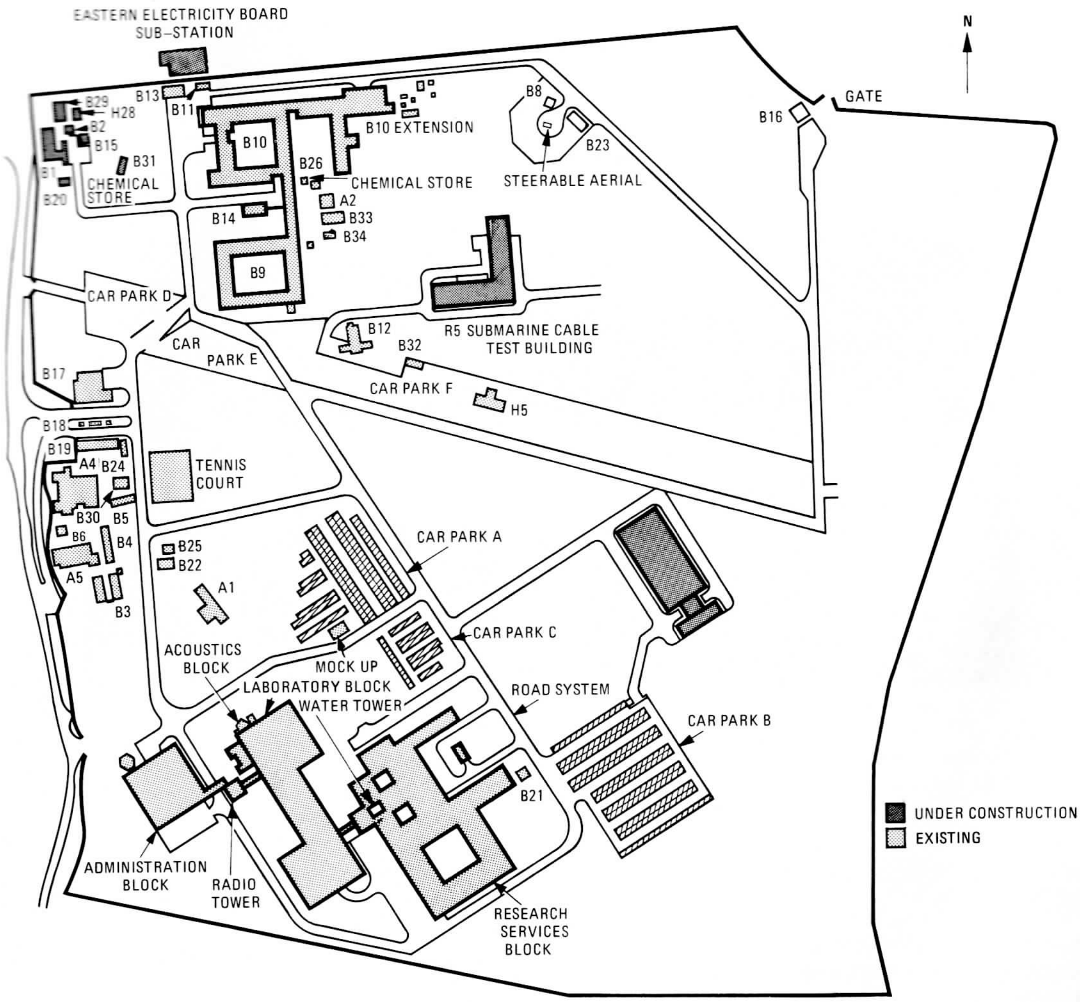
(*v*) welfare facilities suitable for social events, large and small, during evenings and weekends, and

(*vi*) a building layout such that social events are practicable without endangering security in laboratory areas.

(*k*) The buildings should help to create a friendly non-restrictive atmosphere that will encourage co-operation by discussion and exchange of ideas amongst staff.

SCHEDULE OF REQUIREMENTS FOR THE MAIN NEW BUILDINGS

The first duty of R10 Division was to draw up the Schedule of Requirements for the new building as a brief to the architects of the Ministry of Public Buildings and Works (now the DE), who were to act as agents to the BPO. All major capital buildings for Headquarters departments of the BPO were



A1—R10 administration offices
A4—Offices
B1—R7 laboratories and offices
B2—R7 workshop
B3—R1 plastics extrusion
B4—R2 laboratory
B6—Sub-station/store
B8—R6 aerial laboratory
B9 }
B10 } —Laboratory and offices
B10 Extension—Laboratory and offices and transistor factory
B11—R7 waveguide test building
B12—R5 cable test building
B13—Boiler house
B14—Computer building
B15—R7 waveguide laboratory
B16—R7 waveguide terminal
B17—Telephone exchange
B18—Gatehouse
B19—Sub-station
B20—R7 annex
B21—R1·4 annex
B22—R10 annex
B23—R6 field laboratory
B24—Security building
B25—Recreation building
B26—R3 laboratory
B29—R7 laboratory
B30—R1 building
B31—R3 laboratory
B32—Gas-cylinder store
B33—R3 laboratory
H5 —Cable-engine test block
H28—R1 store

FIG. 2—Site plan

then provided under the authority of the Buildings and Welfare Department of BPO Headquarters (this is now the responsibility of the Operational Programming Department of Telecommunications Headquarters).

Since no major laboratory buildings, especially those of the complexity and magnitude required by Research Department, had been built by the BPO for many years, there was no internal experience of modern laboratory design to help in drawing up the Schedule of Requirements. This massive document had to be prepared in accordance with strict BPO practice; it is designed to give the architect a clear expression of the detailed needs of the client, but it also exposes the client's statement of requirements to strict examination and defeats any attempts by clients to seek more area or facilities than the "authority to proceed" originally intended. The use of every room and the number and grade of staff using it must be stated, together with the function of the room relative to near-by rooms and lines of work flow. In the case of laboratories, it must detail the general function (chemical (wet), electrical (dry), or mechanical), the services needed (drains, fume-chamber outlets, chilled water, power socket outlets, internal cabling for coaxial links or computer connexions), the telephone connexions, and many other items related specifically to current research projects.

The magnitude and detail of the data needed in the Schedule of Requirements brought the first firm realization of the real size of the job Research Department had undertaken in agreeing to specify the new laboratory complex. The specifications had to satisfy the needs of Research Department at the date of opening, which was expected to be 5 years after the signing of the Schedule of Requirements; in fact, it was nearly 9 years. The needs of every division in Research Department had to be discussed and projected into the future; changes in grading and numbers of staff had to be estimated years in advance. The situation was further complicated by accommodation agreements drawn up nationally in the early-1960s between the BPO and the unions, embodied in the reports of the WPEA. The WPEA had laid down standards of accommodation to be met in new BPO engineering buildings throughout the country on a basis of "area-

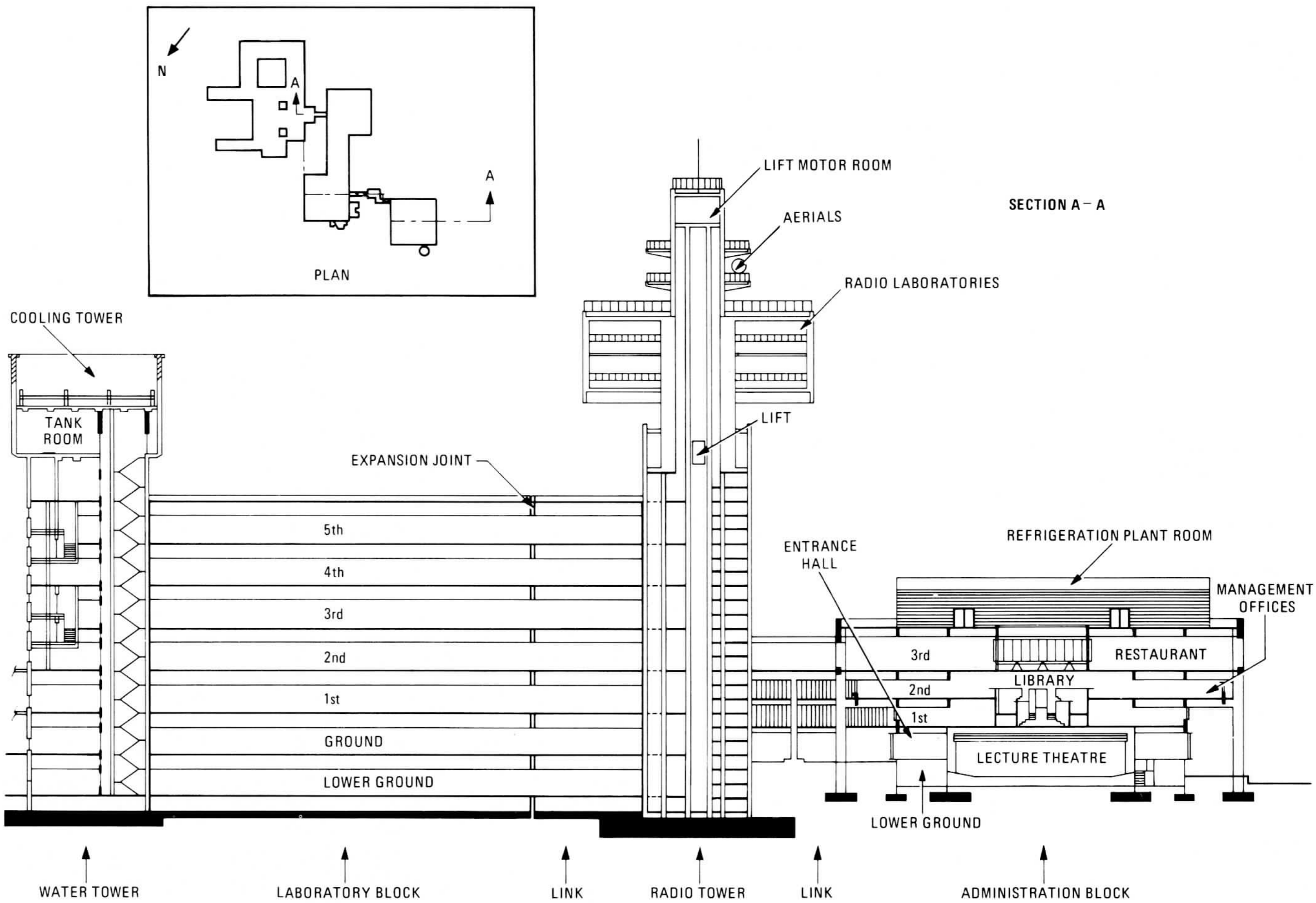


FIG. 3—Vertical sectional view of towers, administration and laboratory blocks

per-man plus additional functional allowances related to his duties". Some attempts had been made to include laboratory accommodation standards in WPEA, but these had never been properly tested in a major new building and, in any case, were conceived around chemical laboratories which are in a minority in BPO research and development buildings.

Early in the design stages, controversy arose over how some of the WPEA statements should be interpreted. The most difficult to resolve was that laboratory staff should all have their personal space allocation not more than 6·55 m from a window, which is 8·08 m from the outer edge of a balcony. This is difficult to justify in a building with high-intensity electric lighting, where a feeling of space is given by high ceilings and continuous windows running almost to ceiling height all round each floor.

A further problem, partly generated by the rapid advance of technology, was how to ensure that sufficient laboratory space was authorized to cover the almost certain future growth in research equipment, independently of staff numbers. This was resolved by dividing all the laboratory areas defined by the Schedule of Requirements into staffed and unstaffed categories. The staffed areas were related to numbers of staff and grades, and followed the WPEA agreements on area allowances. All this staffed area was contained in the 6·55 m belt alongside windows and, on this basis, the 7 floors of the laboratory building can comfortably accommodate the present (1976) staff numbers. The unstaffed area requirements are functional and are related only to work and equipment needs. The very wide laboratory floors have large central areas that fill these functional applications, with some space left for further growth.

For Research Department, an important outcome of the national WPEA agreements was that the local union representatives were in a position to contribute and to co-operate with management in drawing-up the basic requirements for the new Research Department buildings. Although the production of the Schedule of Requirements is a management responsibility, staff morale greatly benefitted from the close involvement of the unions which was organized through the machinery of the Martlesham Move Committee, to be described in a subsequent article.

THE OVERALL DESIGN OF THE BUILDINGS

Several basic designs for the Martlesham complex of buildings were prepared by the architect and R10 Division. The problem presented enormous design difficulties because the complicated engineering facilities needed, and the requirements for flexibility in use of space, were in conflict with the tight budget ceiling imposed by the BPO Board. A speedy completion was also demanded, but, eventually, contractual deficiencies outside DE and BPO control dictated the timing, and the building took nearly 7 years from contract to complete take-over.

The way in which the DE architect, Mr. Stanislaus Spielrein, met the requirements can be seen in the site plan (Fig. 2) and the photograph in Fig. 1. There are 3 main buildings of different character and heights: the main laboratory block, the administration block and the research services block. At every common floor level, the buildings are linked to 2 massive towers by lightweight steel-framed glass-panelled multi-storey bridges. These towers are primarily to house lifts, and they cater for all staff and goods transport between levels (see Fig. 3). The architects' term for this is *vertical circulation*.

The Towers

The need for batteries of lifts outside the laboratory building generated the idea of 2 separate towers, one on each side of the laboratory block. Other important uses for those towers developed as the design progressed and they became major features. They are similar in design, made of reinforced concrete, and are 12·2 m square and parallel sided with a cast rectangular-patterned surface to create an interesting appearance. Both have mezzanine floors in addition to those at the laboratory levels and emergency stairways, toilet facilities, and suites of offices for Heads of Divisions.

Water Tower

The tower on the east side, known as the *water tower*, has around its base a 2-storey cruciform-shaped building to provide drawing-office accommodation and, on the lower floor, a boiler room and various stores. At the top, the tower carries a 200 m^3 water tank, cooler batteries for the main refrigerators and smoke stacks for the boilers, all protected by a black louvred surround to an overall height of 53·3 m above the ground. Details of the useful floor area provided in the water tower, and the use to which it is put, are given in Table 1.

TABLE 1

Accommodation Provided by Water Tower

Section	Use	Useful Area (m^2)
Second to Fifth Floors	Divisional offices	368
Plant Room	Air-conditioning plant, electric light and power plant	1029
Cruciform	Boilers, a.c. plant, stores, drawing office	1658

The Radio Tower

The other tower, the *radio tower* (see Fig. 4), is extended upwards at reduced section to support a prominent 2-storey 18·3 m square radio laboratory set at 45° to the faces of the main tower. Above this, the tower continues in a 5·8 m diameter concrete column to carry 2 saucer-shaped aerial galleries. The overall height of the top slab of this column is 73·2 m above ground level. This massive tower is designed to provide a stable platform for microwave aerials in all weathers. Stability calculations were based on a 36 m/s steady wind, which allows for short gusts well beyond this. The calculated weight of the radio tower is 14 000 t, so that any swaying that does occur due to elasticity in the gravel bed beneath the foundations will be extremely slow. Each tower is founded on a 21·3 m square by 2 m thick concrete slab resting on undisturbed sandy gravel at 6·1 m below ground level. This ground is almost ideal for heavy buildings, having a loading capacity if undisturbed of 40 Mg/m^2. No piling was necessary on the site.

Optical measurements in the exceptionally severe gale of January 1976, when the wind velocity approached the design figure for a short time, showed a lateral movement of 200 mm at the top of the radio tower. This was about half the value expected for these extreme conditions. Differential movement between the towers and the adjacent main buildings is taken up by expansion joints at the appropiate places in the connecting bridges.

The accommodation provided by the radio tower is shown in Table 2.

The Laboratory Block

The laboratory building has 7 floor levels at 5 m spacing, comprising a lower-ground level that contains all heavy air-conditioning plant, ground level and 5 upper storeys. The accommodation provided is shown in Table 3, and a typical floor layout plan is shown in Fig. 5. All the laboratory floors have a uniform clear room height of 3·35 m, with hanging ceilings and a services void above. The overall height of the building to the parapet is 35·4 m above lower-ground level. The overall length is 142·6 m and the overall width is 50 m; these dimensions include 1·8 m wide balconies that run completely round the building at each of the 6 above-ground floors, to provide some shade to reduce the solar heat entering the windows below. They also give good emergency exit routes via emergency exit doors that replace windows at

FIG. 4—The radio tower

TABLE 2

Accommodation Provided by Radio Tower

Section	Use	Useful Area (m^2)
Lower-Ground, Mezzanine, and First to Fifth Floors	Divisional Offices	503
Cabin Laboratories (2 floors)	Microwave laboratories and link equipment to Mendlesham	654
Basement	Store	50
Plant Room (near top of tower)	Air-conditioning plant, electric light and power plant	190

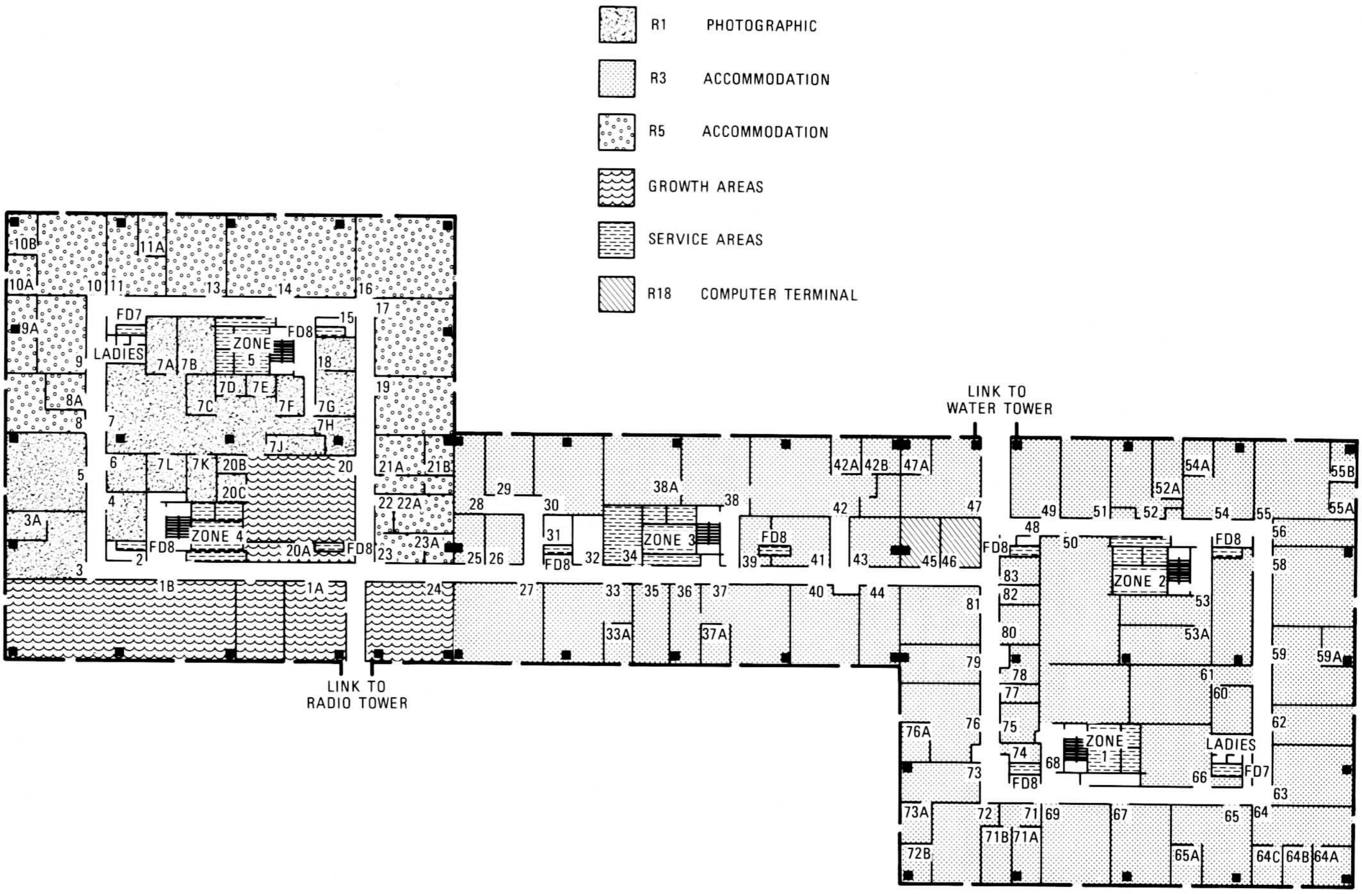


FIG. 5—Typical laboratory floor plan

TABLE 3

Accommodation Provided by Laboratory Building

Floor	Useful Area (m^2)		
	With Windows (for staff)	Without Windows (for special equipment)	Air-Conditioning and Services Plant Circulation Area
Lower-Ground	790	108	4250
Ground	2900	1231	1214
First	2900	1300	1050
Second	2900	1140	1214
Third	2900	1064	1295
Fourth	2900	1269	1140
Fifth	2700	480	1180

10 m intervals. Supporting frames beneath the balconies are enclosed by anodized corrugated-aluminium panelling to give a distinctive horizontal pattern to each floor when viewed from the ground.

In plan, the laboratory building consists of 2 squares having 45·72 m sides, linked at all 7 levels by a rectangular building 45·72 m long by 22·86 m wide. This shape was considered the best practical compromise to meet the following 3 major design parameters:

(*a*) efficient air-conditioning, which demands minimum outer area for maximum internal volume to achieve the maximum fuel economy,

(*b*) large open floors with a minimum of fixed obstructions, and

(*c*) freedom from building vibration and from transmitted noise within the structure.

The 2 squares and the rectangular link are constructed as 3 separate steel frames on individual reinforced-concrete pad footings. The heavy services plant is carried on separate foundation rafts cast in gaps left between footings.

The designs were prepared before metrication in the building industry, but to simplify future work the nearest standard imperial size to 1 m, namely 3 ft 4 in, was chosen for the sub-module on which all dimensions are based. All windows are at 1-sub-module spacing continuous around every floor and, in the laboratory block, are 1·52 m high with double glazing.

The basic structural module between steel pillars is 11 sub-modules long, and there are 4 structural modules to each side of a square. This configuration is shown in Fig. 6, the dimensions being in imperial units for the reason given above. The windows and wall-cladding panels are spaced outside the steel pillars, which leaves a clean exterior appearance, but gives considerable obstruction in those rooms containing the pillars.

The laboratory floors are all designed for a maximum loading of 880 kg/m^2. The floors consist of 150 mm thick poured concrete slabs, carried on neoprene cushions that sit on the secondary steel joists. The slabs are separated by ducts that are closed by heavy-duty duct covers, and sealed at the edges with neoprene gaskets. This form of construction prevents transmission of vibrations from a floor slab into the steel framework (that is, it gives acoustic insulation down to a low frequency), but with the penalty that the floors contribute nothing to the stability of the building.

Stability of the building framework is, however, obtained from 5 vertical reinforced-concrete shafts, 2 in each square end and one in the centre link. These shafts are 8·1 m × 5·2 m in

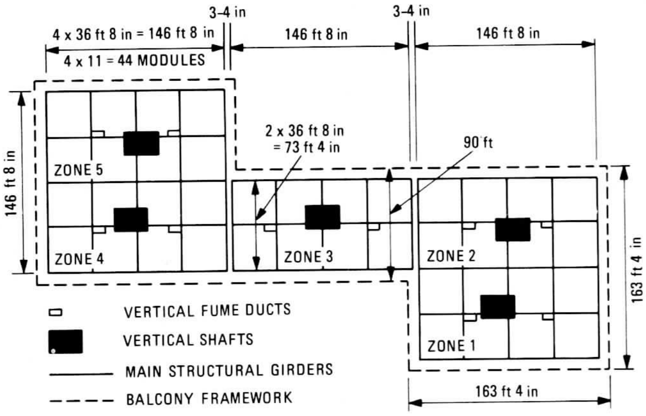


FIG. 6—Arrangement of main structural modules of laboratory block

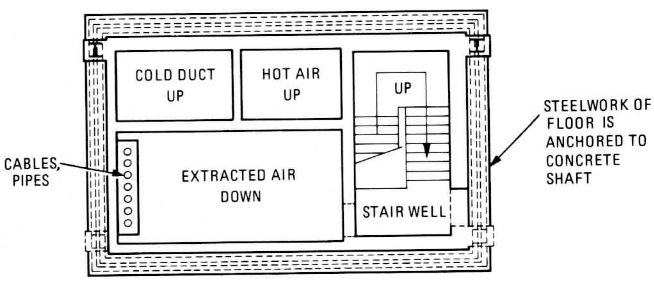


FIG. 7—Cross-section through a shaft

outside dimensions with walls 305 mm thick, they rise to the full height of the laboratory block and rest on independent concrete foundations. A collar of steelwork at each floor level surrounds and grips each vertical shaft, so ensuring the lateral rigidity of the whole steel framework. Fig. 6 shows the location of the 5 vertical shafts in relation to the building as a whole, and Fig. 7 shows a cross-section through a shaft.

Internal diaphragms divide the shafts into 4 vertical ducts. Three are vertical air-conditioning ducts: 2 riser ducts, one of 3·72 m^2 section for hot air and one of 4·18 m^2 for cold damp air, and a third of 13·38 m^2 for a downflow return air duct. This return air duct also contains pipes and power cables. The fourth duct in the shaft contains an emergency stairway to all floors.

For service purposes, the laboratory block is divided into 5 vertical zones each being based on one vertical shaft, as shown in Fig. 6. Structurally, in plan, zones 1 and 2 are built as one square, zones 4 and 5 as another and zone 3 is the link block. Expansion joints link the 2 ends of zone 3 with the squares at all floor levels, to give insulation from sound transmission within the steelwork and allow for differential movement during the settlement period, most of which will occur during the first 5 years. An air-conditioned building should stay at a constant temperature and, once this is achieved, there should be negligible differential movement from expansion.

There are no permanent partition walls on the laboratory floors. The rooms are all made from demountable steel partitions that slot into ceiling grids already in position on a 2-sub-module pattern. The partitions rest on 76·2 mm wide metal strips that in turn rest on the floor covering held from slipping by an adhesive layer. Vertical side columns support the panels (610 mm wide by 3·35 m high by 88·9 mm thick) formed of 2 sheets of plastics-covered steel, separated by a layer of glass-wool insulation. The panels, although heavy, can be fitted into place by 2 men. A completed wall is firm, but can be demounted without damage to the floor or panels. A 2-sub-module wide corridor, also made of demountable partitions, is at present used to divide the outer belt illuminated by windows from the special equipment areas illuminated only by artificial light.

Electrical connexions of all types are taken from wall ducts in the outer wall, with leads under the 3·05 m long benches which butt up to the window. Pipework, including chemical drains for sinks, rises via up-stands through the floor ducts to the laboratory benches. All floors have a distribution network of pipes for chilled water, compressed air, natural gas, and drainage, with hot water from local electric heaters fitted under the benches where needed. External pipework for oxygen and nitrogen runs along balconies to connect gas cylinders by lateral spurs through walls to benches as required. Other gases are provided from cylinders mounted in fire-resistant cubicles in alcoves in corridors outside the laboratories using them.

The Administration Block

The administration block (see Fig. 3) is the administrative centre for the whole of Research Department; it contains a large technical library and reading room, large and small lecture theatres, 2 conference rooms, a Confravision studio, restaurants and kitchen, the Director's suite of offices, Deputy Directors' and secretarial offices and the general management units for the Department. A large glass-fronted entrance hall, with an exhibition gallery projecting into it from above, helps to make this building distinctive and architecturally interesting. It is an attractive place in which to hold technical conferences. The useful floor area provided is given in Table 4.

TABLE 4

Accommodation Provided by Administration Building

Section	Useful Area (m^2)
Restaurant and Kitchen	1700
Welfare and Club Room	150
Lecture Theatres, Exhibition Gallery, Conference Rooms, Entrance Hall, and Confravision Studio	1100
Library	457
Directorate Offices and Administration	1056
Plant Rooms	515

The administration building is a monolithic structure in reinforced concrete, with the general shape of an inverted truncated square pyramid. There are 3 levels, the largest floor is at the top, containing a restaurant to seat over 300, a cafeteria with waitress service and a centrally-placed kitchen, a large coffee lounge, a snack counter, a well-furnished bar and a large games room for use by the various clubs.

Below the restaurant on the second floor is the library which is large and of an unconventional square design having a gallery at mezzanine-floor level surmounted by a large reading area in the form of a square. The library has glass pyramid roof lights in the central part of its ceiling to give some natural light over the lending area which is on the lowest level at the centre of the well of the library. Two book storage rooms with motorized book shelves on rails occupy the space beneath the reading area on 2 sides. Microfiche facilities are provided, and also offices for librarians and translators.

The large 450-seat lecture theatre is vertically beneath the library. It has a raked floor, a good stage, 3 translation boxes for simultaneous translation at conferences, and sound and projection equipment adequate for all occasions and purposes. A small 50-seat lecture theatre, in octagonal form and also well equipped, opens off the outer side of the entrance hall beneath the main staircase.

The whole of the administration block is air-conditioned, each level being served by a separate plant situated on the ground floor. The restaurant is served by an air-handling plant on the roof above. The kitchens are ventilated by fans exhausting straight out through the roof. Cooking uses gas heating.

The administration building is designed to be suitable for social as well as official occasions. It is structurally separate from the other blocks and access to it is independent of the laboratories. There is capacity in the restaurant for up to 1000 lunches using 3 sittings. Experience shows that about half the staff will lunch in the restaurant, so the restaurant should be able to cope adequately with a site population of 2000.

No enlargement of the administration building is likely to be practicable. It was designed for a maximum site population of 2000, and further building will be needed if the population increases beyond this.

The Research Services Block

The third major building unit, concerned with mechanical engineering and workshops, mostly of single-storey factory-type steel-frame construction, extends from the cruciform at the base of the water tower towards the north and north-east. Extensive workshops are essential to Research Department because improved mechanical technology is often needed to further new electronic ideas. The accommodation provided is given in Table 5.

The single-storey workshops and ancillary rooms are grouped around a small courtyard, which gives the advantage of natural light on the inner side. The drawing offices and part of the research services areas are air-conditioned to ensure a suitable environment for numerically-controlled machines and similar precision devices. These rooms occupy the cruciform structure around the base of the water tower and the wing over the lower loading bay. The air-conditioning here operates from the a.c. system for the water tower.

Two loading bays have been provided for heavy transport. These are located at different levels, one on each side of the services block. The lower loading bay, the larger of the two, is at lower-ground level and underneath the printed-circuit board production area on the south side. It is close to the heavy stores area with easy access to the goods lift in the water tower. The upper loading bay, at ground level, is a continuation of the workshop-floor level, and is also given wide corridor access to the tower lifts.

TABLE 5

Accommodation Provided by Research Services Building

Section	Use	Useful Area (m^2)
Lower-Ground Floor	Storage	1454
Ground Floor	Workshops, ancillary services, R1 Divisional offices	3339
Stand-by Engine Room	0·5 MW diesel alternator emergency set	92

Two features of the workshops, as originally specified, have proved unsatisfactory: the mercury-vapour lighting which gives an unpleasant stroboscopic effect with rotating machinery, and the workshop floor surface where the screed tends to crack and lift from the concrete substrate. The floor surface also seems to have some oil-absorbing property, giving a fire risk. The installation of new lighting is in hand and an additional floor-covering overlay is being tried on sample areas.

A motor-transport workshop and fuelling station, which was included in the original schedule of requirements but later deleted as an economy measure, will shortly be built on the east side of the services area road. This motor transport workshop will be under the control of the Eastern Region of the BPO, because the Research Department vehicle fleet is maintained by the Motor Transport Officer, Ipswich.

CONCLUSION

This first part has described the design principles, the requirements, and the overall design of the main buildings forming the Martlesham Research Centre. Part 2 will describe the services provided and a separate article will describe the organization of the move from Dollis Hill.

Book Review

Mathematics for Electronic Technology. D. P. Howson, B.SC., M.SC., D.SC., C.ENG., F.I.E.E., F.I.E.R.E. Pergamon Press Ltd. x + 270 pp. 93 ills. £5·85 (hard cover); £3·95 (flexible cover).

It is well known that engineers sometimes find mathematics difficult, and this may, to some extent, be due not to the difficulty of the subject, but to the standard of mathematical teaching and text books. It is essential to present the basic notions and techniques in a clear and consistent way, and to show that the mathematical formalism does give a concise description of the physical phenomena that are being studied.

This book is unlikely to remedy any deficiencies in the literature. It is an expanded version of a book reviewed unfavourably in this *Journal* in October 1967. The changes that have been made remove none of the defects of the previous version. The text is as confusing as before and, worst of all, there are now many obvious errors.

The first occurs on p. 2, where it is stated that, if a function is continuous, it has a derivative. Now, the derivative of a function is the slope of its graph, and so, if the graph has a corner, then obviously there is no well-defined slope at that corner. An intelligent student is almost sure to spot this, and his reaction may be to dismiss mathematics as some sort of Mumbo Jumbo, rather than to blame the presentation. There are many other errors in the book. Readers may be amused by pp. 126 and 127, where it is "demonstrated" that the nth roots of unity are $e^{jk\pi/n}$, where $k = 1, 2, \ldots n$. All other authorities prefer the formula $e^{2jk\pi/n}$, since it gives the correct results.

There is a great need for good text books on engineering mathematics, and many students may be tempted to try this book since it is written by an engineer, However, it may serve only to create difficulties in learning and using mathematics. In fact, no one who wishes to learn mathematics, or use it in electronic technology, is advised to read this book.

D. J. B.