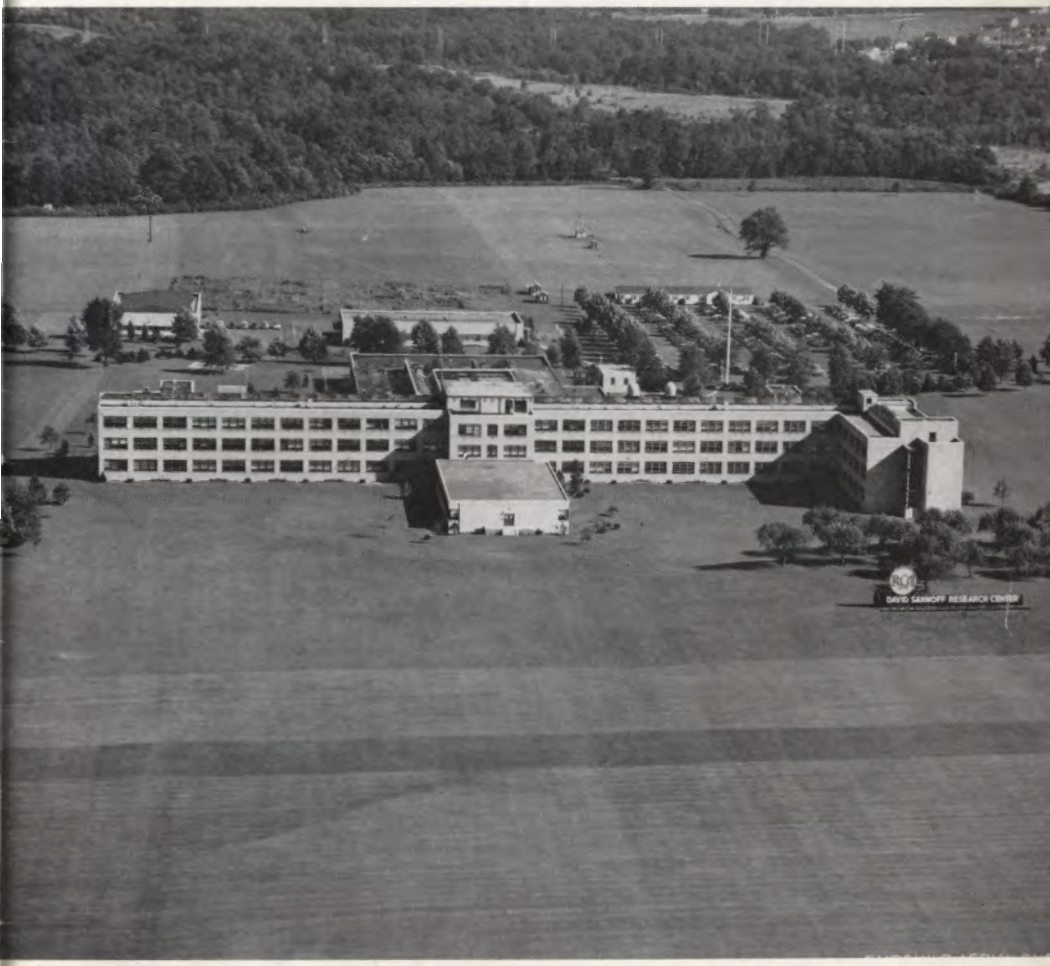
THE RCA LABORATORIES



DAVID SARNOFF RESEARCH CENTER

PRINCETON, NEW JERSEY

Just as research produces the best results only when there are good people to do it, so it functions best in a well-planned environment. RCA's conviction that research is the key to progress has been the motivating force in the creation of all of RCA's laboratories, in their current programs, and in their future plans.

This booklet has been prepared to show the special facilities and physical conditions which go to make up the seat of RCA research, the David Sarnoff Research Center. In the following pages we have tried to present our ideas of what a research laboratory should be, not only in its physical construction, but also in the facilities which it affords for individual service and for group communication and interaction.

The David Sarnoff Research Center is the embodiment of these ideas of many people. We hope that this distillate of our experience in providing for and fostering research will be of interest to others concerned with organized scientific inquiry in modern industry.

E. W. Engstrom
Vice President in Charge
RCA Laboratories Division

THE RCA LABORATORIES DIVISION

RCA research began with the organization of the Corporation itself. In 1919 the first group began its work in Riverhead, New York, which today constitutes a unit of the RCA Laboratories Division. Research activities grew as units of the operating division of the Corporation. Early in the 1940's, these several units were brought together into the RCA Laboratories Division to form an integrated research organization covering the interests of the Corporation.

A first step was the transfer in 1942 of the major portion of the activities to newly constructed research laboratories in Princeton, New Jersey. Available laboratory space and service facilities are now half again as great as they were in 1942 as a result of a succession of additions. The Princeton facilities were dedicated in 1951 as the David Sarnoff Research Center. Today the staff of the RCA Laboratories Division numbers nearly one thousand.

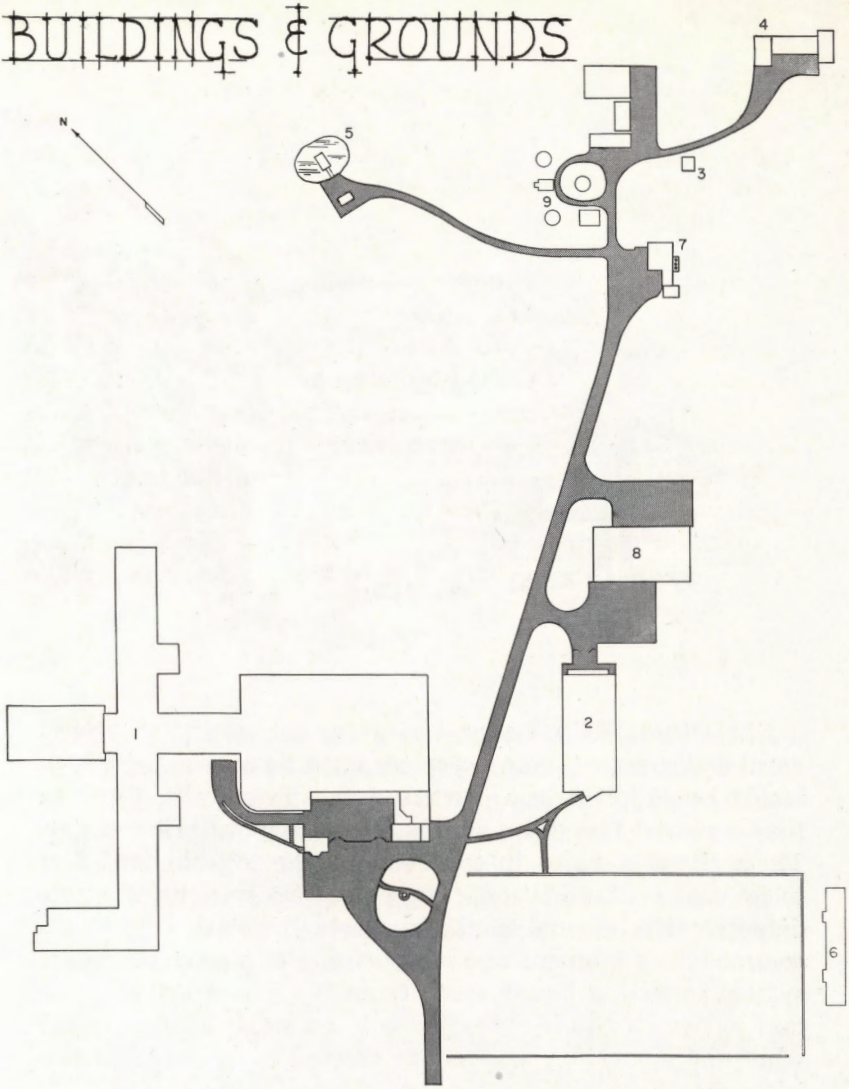
The purpose of the research programs instituted at the RCA Laboratories is to lay the foundation for advances in methods and devices in the fields of radio, television, and electronics. The work is directed not only toward the creation of new products and services, but also toward improving current techniques of production and operation. At the same time, the RCA Laboratories are occupied with fundamental research, work which is concerned with basic properties or processes rather than results of more specialized studies of an applied or developmental nature. All of the work of the Laboratories Division has its importance, but the research which brings to light fundamental discoveries is the most valuable of all.

Research at RCA Laboratories is the product of many people of various backgrounds. It comes from the blending of the talents and ideas of scientists and administrators, of technicians and craftsmen. This fusion is best seen in the technical staff, where electrical engineers may work with chemists, or physicists with mechanical engineers. Within each group there is a wide range of activities which may engage the research man. The physicist may be immersed in a highly theoretical study, or he may be absorbed in a problem in applied physics. This variety of projects applies equally to the chemist and the electrical engineer, whose current project may involve a component, a device, or a whole system. There is tremendous diversity in the tasks to which these research scientists apply their talents, and through all of this work runs the stimulation of interchange and cooperation between groups as well as individuals.

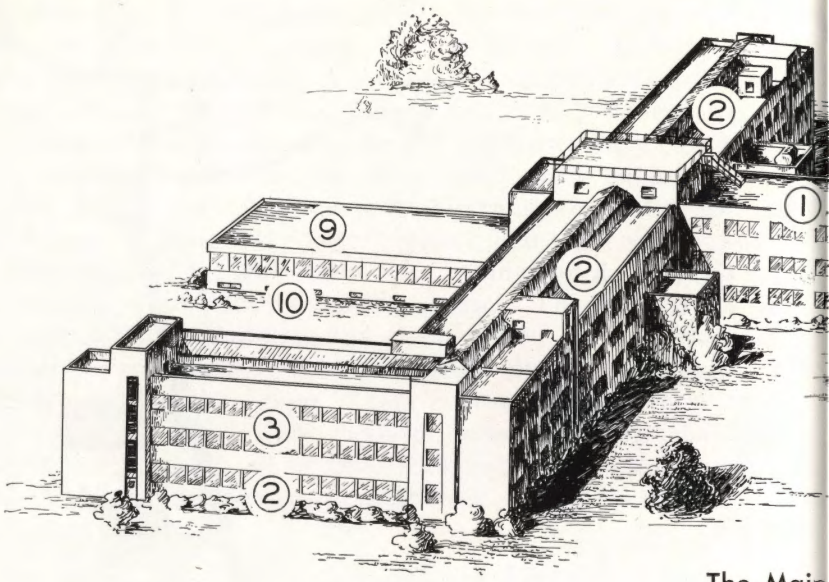
The work in the RCA Laboratories Division is separated into seven general areas. Each area constitutes a research laboratory. The Director of Research administers them, while the Research Services and Laboratory Services Departments perform ancillary functions in support of the operating research groups. The Industry Service Laboratory assists RCA licensees by providing practical information on RCA developments and inventions of interest.

Located south-east of U. S. Route 1 and north-west of the Pennsylvania Railroad's main line, the David Sarnoff Research Center occupies a 287-acre tract about a mile and a half from the heart of Princeton. This location has the advantage of being removed from the congested metropolitan industrial areas of New York and Philadelphia while at the same time offering convenient access to the manufacturing and operational divisions of the Corporation. Another of the attractions of Princeton as a location for a research laboratory is its educational and research activities. This university community, with all its attendant advantages, offers a congenial environment for staff members in their after-work associations.

BUILDINGS & GROUNDS



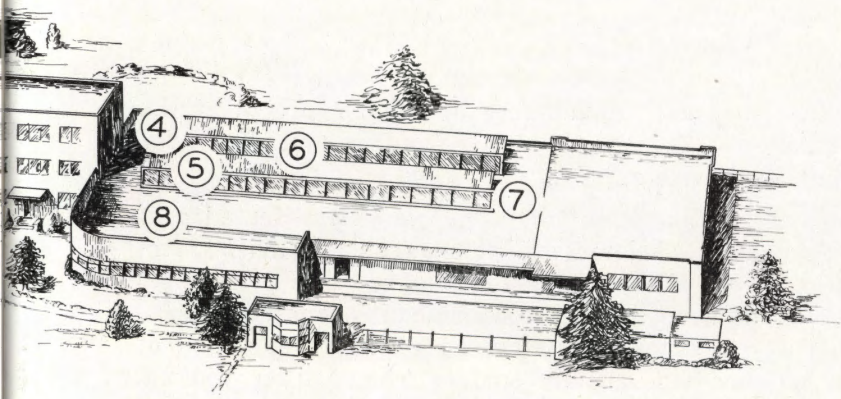
Making up the David Sarnoff Research Laboratory are two buildings for general research (1) and (2), the High Temperature and Pressure Laboratory (3), the Systems Research Field Laboratory (4), the Acoustical Research Field Laboratory (5), and a temporary building (6), which houses Foreign Patent Operations and the *RCA Review*. The other major outbuildings include the steam plant (7), the garage and maintenance building (8), and the sewage disposal plant (9).



The Main

Since these RCA Laboratories are set in an essentially rural environment, many services must be originated which would be supplied in an urban area. Two wells, three to four hundred feet deep, supply all the Laboratories' water. The wells are sealed in concrete for the top hundred feet to prevent contamination. There are two systems of waste disposal: the normal sanitary waste disposal system accommodating kitchens and lavatories, and a separate waste system removing liquid waste from the laboratories. Sanitary system waste is conveyed to the sewage disposal plant while the laboratory wastes are treated in outside neutralizing chambers and ejected into the storm drains. A gas-fired incinerator consumes other refuse.

Two sixty kilowatt diesel generators are available to supply emergency power. The steam plant's low pressure boilers generate the steam for the vapor vacuum system which heats all the buildings through convectors along the window walls. Tempered fresh air is circulated to each laboratory at the rate of two complete changes per hour except for special areas which are air conditioned. Large



Laboratory

steel frame windows with hinged ventilating sections admit adequate natural light and draft-free ventilation, with venetian blinds being used for light control. The main laboratory lighting system consists of indirect, incandescent fixtures giving a light level of 25-30 foot candles at the bench level. Fluorescent lighting is installed throughout the model shop, the tube model shop, and the drafting room.

The main building of the David Sarnoff Research Center is a three-story and basement structure housing the administrative offices (1), the research laboratories (2), and the patent department (3). The library (4), the photographic studio (5), the drafting room (6), the model shop (7), and the cafeteria (8), are housed in a one-story and partial basement portion of the main building. Extending north from the center section of the main building is a one-story and basement wing housing the tube model shop (9), and the recreation room (10), beneath.

The three-story structure was chosen for economy in the main service runs and for the easy communication

which it affords among the various groups. The three-story building also requires a minimum of elevators. Two small automatic passenger elevators and one large, combination freight and passenger elevator are provided. A hydraulic freight elevator adjacent to the outdoor freight loading platform conveys materials and equipment to and from the basement. Small floor shops are located at the same place on each floor, as are laboratories and offices, for economy in service supply.

The construction of all buildings is of reinforced concrete foundation, skeleton steel frame, concrete arches, and brick exterior walls. The steel frame supports a roof slab having about three inches of Vermiculite concrete insulation. The gypsum plank pitched roofs have one inch of insulation beneath smooth surface composition roofing. The structural concrete floor slabs have three inch porous concrete fill with one inch cement topping on which is laid a floor covering of 3/16 inch asphalt tile with rubber cove base.

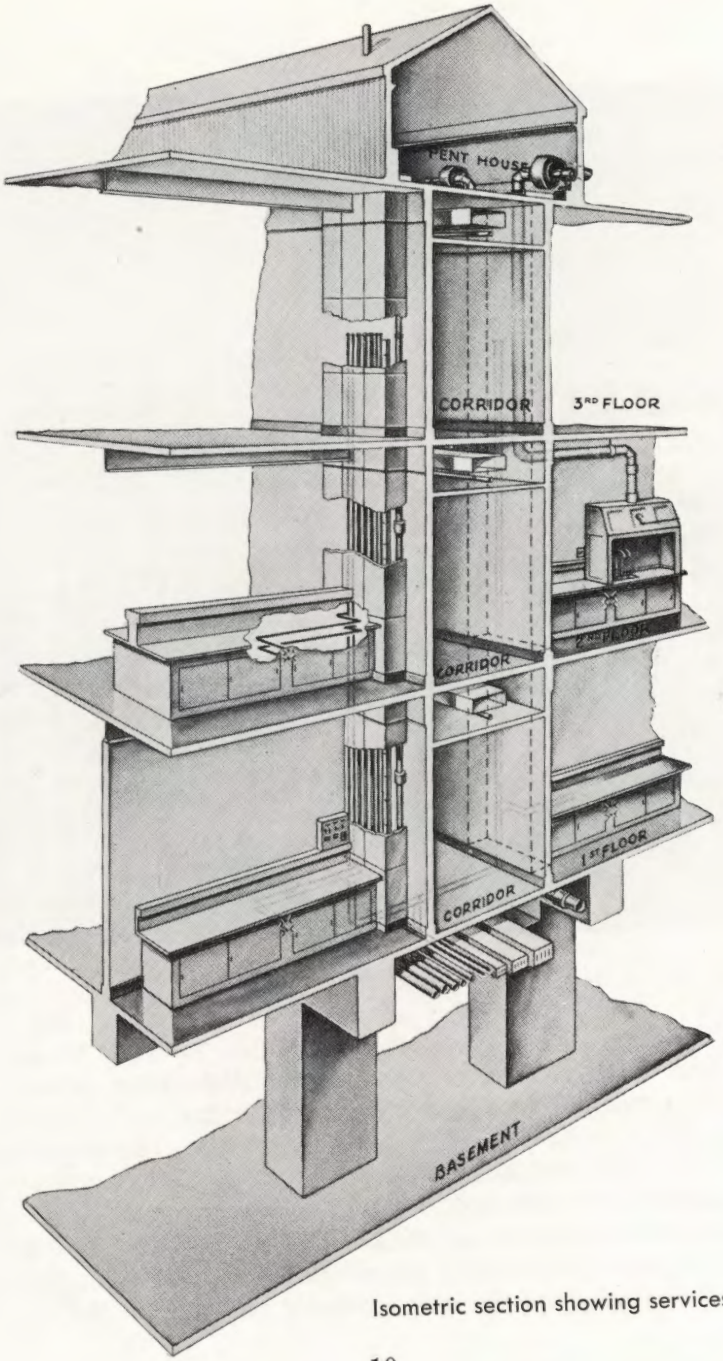
The center portion of the main building is about ten feet higher than the rest of the building and houses the two 4,000 gallon flow-through tanks which form part of the water distribution system, the elevator machine rooms, part of the fresh air distribution system, and laboratory space. The roof of this area is covered with copper sheathing necessary to establish an electrical ground.

Monitors constructed with corrugated Transite walls run along the roof for the full length of the laboratory wings. Extending over the main corridor, they serve as a terminal for the vertical service ducts and house the exhaust blowers from fume hoods in the laboratories below. The Transite is easily perforated to provide outlets to the outside for cables, conduits, and ducts, and replacement panels are easily installed. The monitors also accommodate special equipment such as power supplies, delay lines, and wire services which carry signals generated in one area to another laboratory area where they can also be used. Conduits perform this service between the main building and outbuildings. The monitors also permit easy cross-connection of services rising in the service ducts.

SERVICES

Basement service lines.

The main laboratory services are distributed horizontally on the ceiling of the basement corridor with branches extending vertically into the service ducts. The electrical services included are 120-208-volt, 3-phase, 60-cycle, unregulated power housed in a four-conductor, metal-enclosed bus duct of commercial design. Plug-in bus duct switches provide taps for lighting panels, furnaces, and other heavy duty electrical equipment. Regulated power with the same

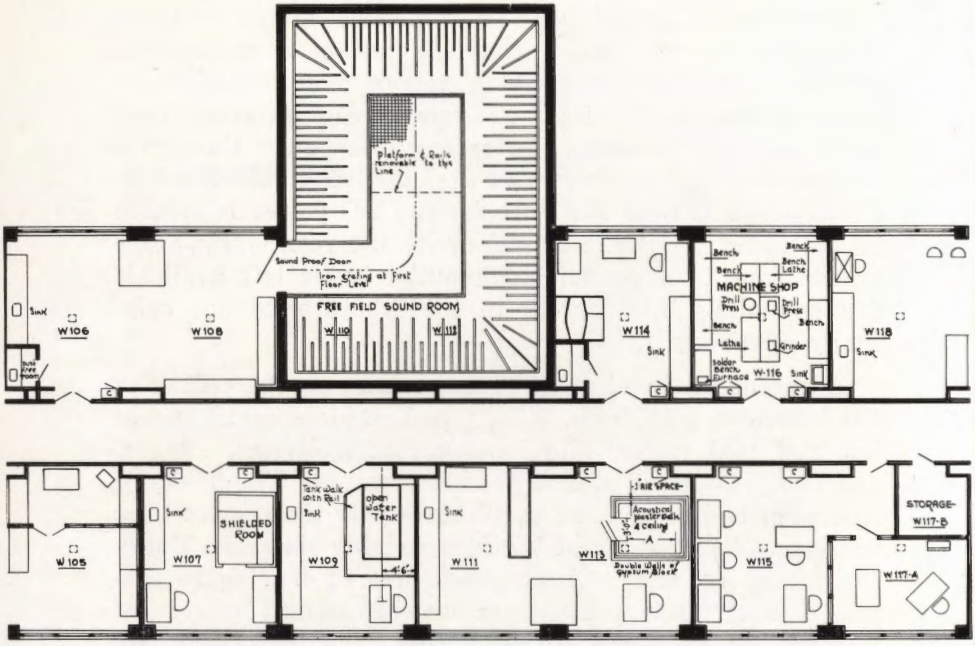


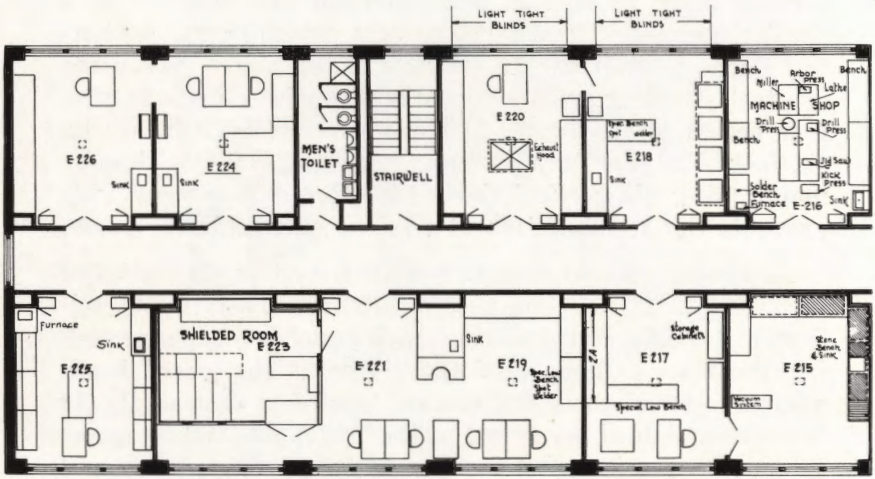
Isometric section showing services.

characteristics is provided in the same manner as the unregulated power except that the voltage is maintained within ±1 volt of 120 volts by means of automatic regulators located in the switch gear room. Similarly, bus duct switches afford means of extending this power through a vertical bus duct in the service duct to all laboratories. The 115-230-volt, 3-wire bus duct for the DC power is treated in the same manner. The 420-cycle, 120-volt, single-phase power runs in a conduit with outlet boxes left available for extending this service to the laboratories not originally requiring it.

Adjacent to the electrical service lines on the ceiling of the basement corridor are the piped services consisting of hot and cold water, illuminating gas, hydrogen, oxygen, and compressed air at 100 pounds pressure. The banks of hydrogen and oxygen tanks which supply the service lines are stored in a section of the Inflammable Materials Building which has one wall composed only of fencing to provide a safety factor. These services are tapped by vertical lines in service ducts located within each laboratory bay against the corridor wall and extending from the basement through the roof to the monitor. The ducts house the vertical distribution of all laboratory services. Local piped services such as helium and nitrogen are handled in a similar manner. These service ducts, which carry ventilating ducts as well as the services noted above, are made of steel studding with removable Transite panels to give free access to the lines. The ducts measure 22 inches by six feet. The monitors are exhausted continuously thereby maintaining all vertical ducts at reduced pressure. This prevents the accumulation of noxious and explosive gases.

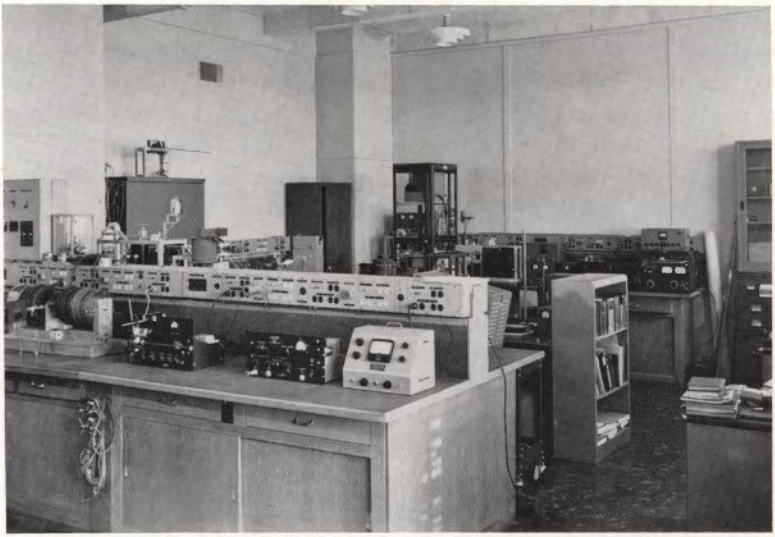
A zoned, rate-of-rise fire alarm system is installed throughout. The system uses a 165° fusable link and bellows to set off a coded alarm which punches a tape, recording the time and place of the alarm at the guard headquarters. Breakglass stations are located in each of the 34 fire zones. Added personnel protection is insured by emergency showers installed in the halls at critical points and by the provision of fire blankets and CO_2 extinguishers where there are known hazards.





Typical floor layouts.

THE INDIVIDUAL LABORATORY



Each laboratory is designed to be an essentially self-contained unit in which the research man finds virtually everything necessary for the prosecution of research. The laboratory is identified with the occupants' names outside the door and is equipped with work benches, desks, chairs, a table, wardrobe, storage cabinet, and telephone. This basic unit is modified to suit varying conditions depending upon the nature of the research carried on and the facilities required for it.

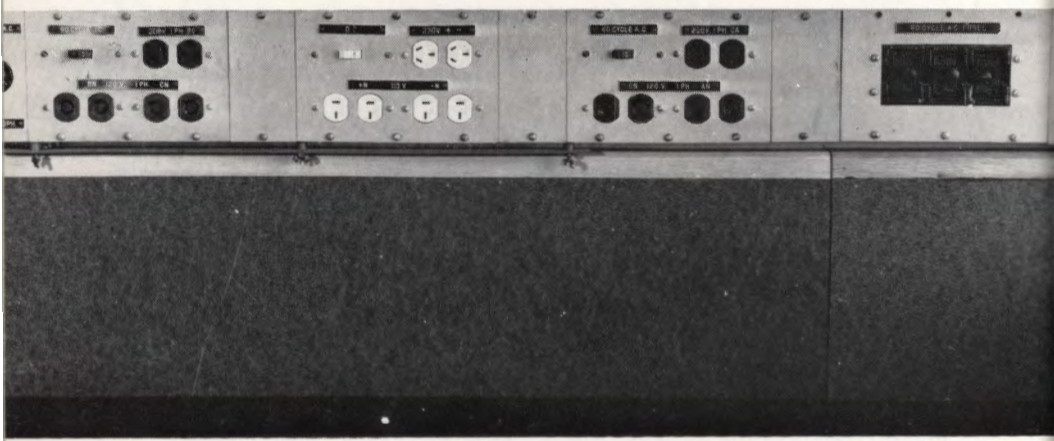
Although the basic laboratory is 18 feet wide and 22 feet deep, the bays are constructed on six foot modules so that their width may be any multiple of six feet. The ceilings are 13 feet high with steel beams exposed on the under side of the floor slabs. Acoustical treatment of the webs of the exposed beams reduces noise reverberation time and produces satisfactory acoustical conditions. The entrance to each laboratory from the corridor is through five by seven foot double hollow metal louvred doors. Each door

is provided with an individual cylinder lock which is submaster keyed as required. All locks are on a grand master key.

The partitions dividing the individual laboratories are of three inch gypsum block plastered on both sides, with vertical five inch steel beams placed approximately six feet on centers. These beams are tack welded at the top to the structural steel floor beam and secured at the floor with expansion sleeves. They provide a means of supporting the normal electrical and piped services which extend from the service ducts along the walls behind the laboratory benches.

The electrical services are provided from the vertical distribution in the service ducts through fused switches assembled in a single box which feeds the electrical service trough. This service trough measures 3 by 6 inches and is in 6 foot long sections. Each section has its own fuse block and a number of switched and polarized outlets. These are 120-volt, single-phase outlets identified as to phase, 208-volt, single-phase outlets, and 208-volt, 3-phase outlets. The DC power is also available on the electrical service trough and is 115 volts, plus or minus, and 230 volts, plus and minus. The electrical service trough can be modified to supply services such as 1,000 kilocycle

Electrical service trough running above laboratory benches.



crystal-controlled frequency or a 24 volt supply. The service trough can be installed in lengths of 6, 12, or 18 lineal feet along any wall.

The laboratory benches, normally placed along the dividing walls under the service trough, are of special design, the top measuring 32 inches by 6 feet with a foot high splasher at the back. The bench top is 36 inches from the floor and is covered with ¼ inch tempered Masonite or Chemstone as conditions require. The top overhangs the base cabinet by 8 inches, affording ample knee space for comfort in taking notes or working seated at the bench. The top also overhangs the end of the bench, and the spaces between the benches are covered with a panel. The piped services are extended from the vertical risers in the service ducts and run back of the benches, terminating in valved outlets in the service panels between the benches. Bench space can be provided in lengths of 6, 12, or 18 lineal feet, and a service outlet in the center of each laboratory floor permits installation of an island bench. The lower portion of the bench comprises drawers and storage space equipped with shelves and sliding doors. An outlet in the lower part of the bench provides 120-volt, single-phase power for oscilloscopes, soldering irons, and the like.

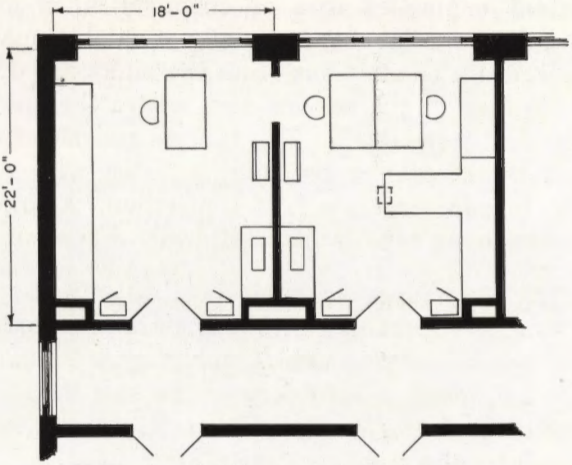
The bench top is cut out for laboratory sinks which are acid-resistant enamelled iron or chemical sinks of soapstone or other similar commercially available materials. The branch drain connections from the sinks are of chemical lead running to the service duct where they enter the vertical Knight-ware drain. The faucets consist of a combination hot and cold water mixing valve with a goose neck spout terminating in a hose connection. A cold water faucet of the same type is also included.

Where circumstances require chemical exhaust hoods, the benches will accommodate commercial fume hoods which are exhausted through Transite pipe in the service duct. The blowers are located in the monitor and exhausted through its walls. Electrical blower controls are in the laboratory adjacent the fume hood.

Where research men are working with sensitive equipment or low level electrical signals, the laboratory bays are modified by the installation of small shielded rooms or cages to exclude signals from outside sources. Constructed entirely of copper plates and mesh upon wooden frames, each structure is actually made of two concentric boxes or cubes connected to each other only at the point where they are grounded.

For special investigations, any bay may be converted into a furnace room. When this is done, additional services such as CO_2 and forming gas may be provided. The all-electric furnaces used are capable of sustained operation at temperatures up to 2,500°F., with automatic control to about ±10°.

Individual laboratories are specially modified for research requiring the purification of substances and experimentation with them under immaculate conditions. In work on electronically active solids, for instance, where an impurity of less than one part in a million may be ruinous, an air conditioning, filtering, and purification system is used. Double doors and partitions are also installed to insure strictly controlled conditions for the critical requirements of this work. As an added safeguard, the rooms are pressurized at different levels, so that the opening of a door between two adjoining rooms causes a flow of air from the more critical to the less critical room.



Typical laboratory bays.

MODEL SHOP

Equipment in the model shop ranges from delicate, watchmakers' instruments of high precision to large lathes and jig borers. Whole sections of the model shop are devoted to the making of the wide variety of electrical and mechanical devices needed by the research groups. Welding, grinding, sheet metal work, and plating are segregated into separate sections of the model shop in which all the necessary equipment is concentrated for each type of work. Cabinet making and finishing are also included in the services offered by the model shop's craftsmen.

DRAFTING ROOM

For the most part, equipment is fabricated by the model maker from rudimentary sketches. In the case of complex apparatus, detailed drawings are made in the drafting room. The room is excellently lighted, and the acoustical "cones of silence" installed at ceiling level give the same absorption as a ceiling of commercial sound absorbing material without interfering with the lights or the fire alarm system. The porous, paired truncated cones were designed in the Acoustical Research Laboratory. An adjunct to the drafting room is the well-equipped print room.

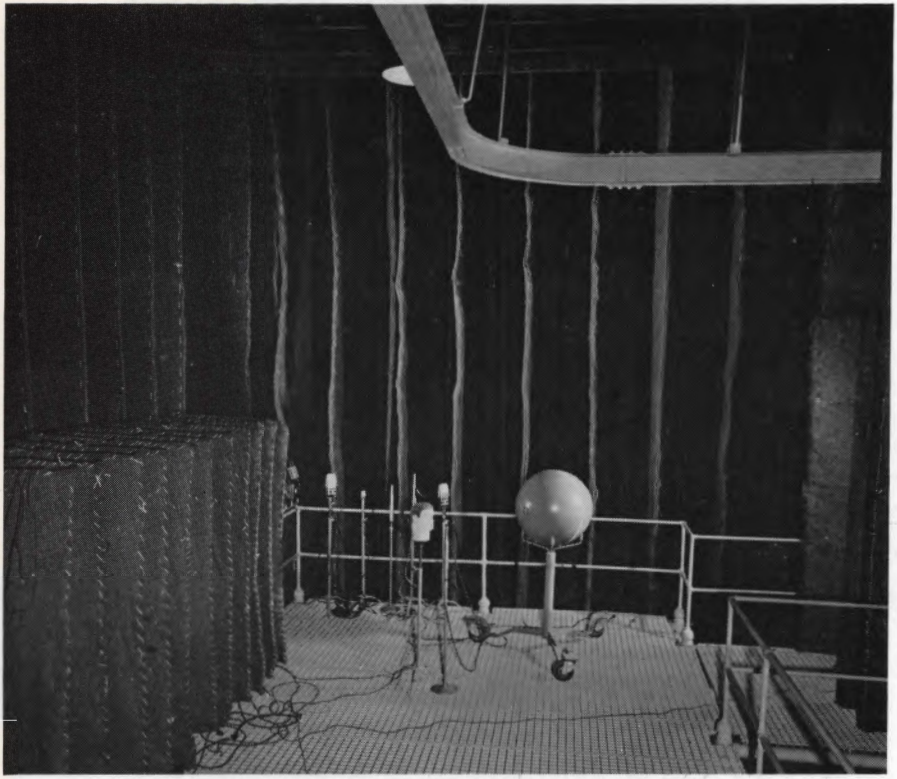
TUBE MODEL SHOP

The modern tube model shop is equipped to produce virtually any experimental tube the research man may need. Equipped to perform spraying, electro-plating, cleaning, firing, pumping, and exhaust, the tube model shop can carry through the entire operation, from the processing of the basic metals to the final treatment of the completed device. The tube model shop is air-conditioned to maintain a maximum of 50 per cent relative humidity. The air is filtered mechanically and then passed through electrical precipitators to protect critical surfaces from contamination.

FLOOR SHOP

The shop facilities strike a balance between centralization and de-centralization. The large model shop is available for jobs requiring considerable time or equipment, while the small floor shops in all wings and floors of the building provide a concentration of machine tools such as drill presses, millers, and jig saws for use by the technical staff. Smaller parts may be made here or larger equipment modified by the shops' expert mechanics.

FREE FIELD SOUND ROOM

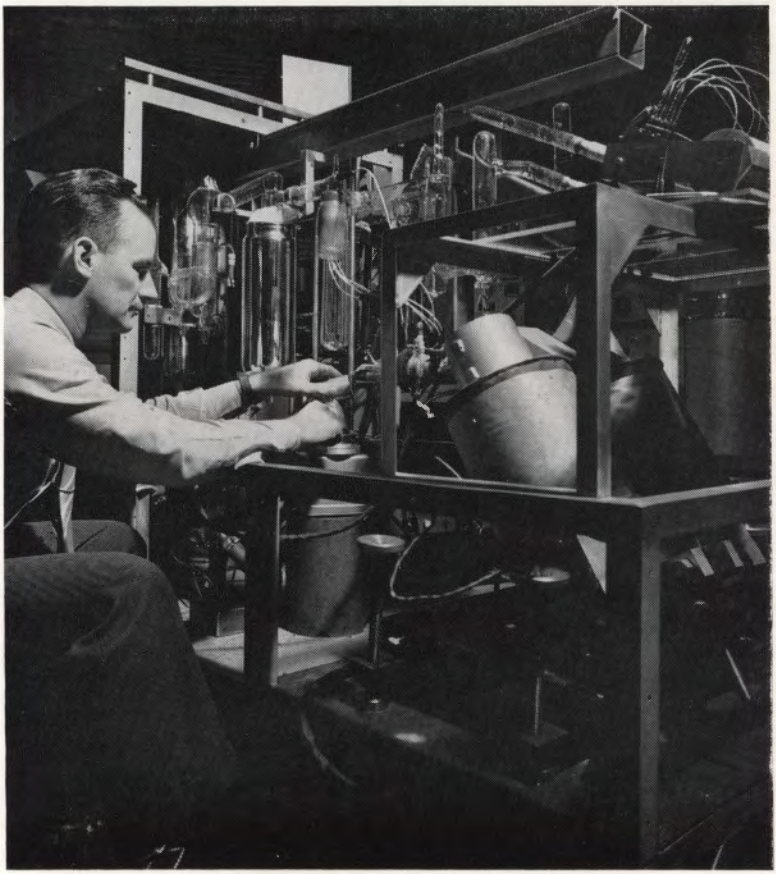


The 36 by 48 foot Free Field Sound Room is designed to simulate ideal, out-of-doors conditions for acoustical experiments. The floor is a 12 by 24 foot steel grid platform vibration-isolated with 6 foot support posts set in rubber. Exclusion of noise and prevention of reflections is achieved with huge curtain baffles extending from the top to the bottom of the three-story space and running from wall to wall at the ceiling and beneath the platform. The four to seven foot wide curtains are made of one-inch rug pad. Measuring equipment is located in an adjoining laboratory with signal lines running to other rooms.

THE RESEARCH ENVIRONMENT

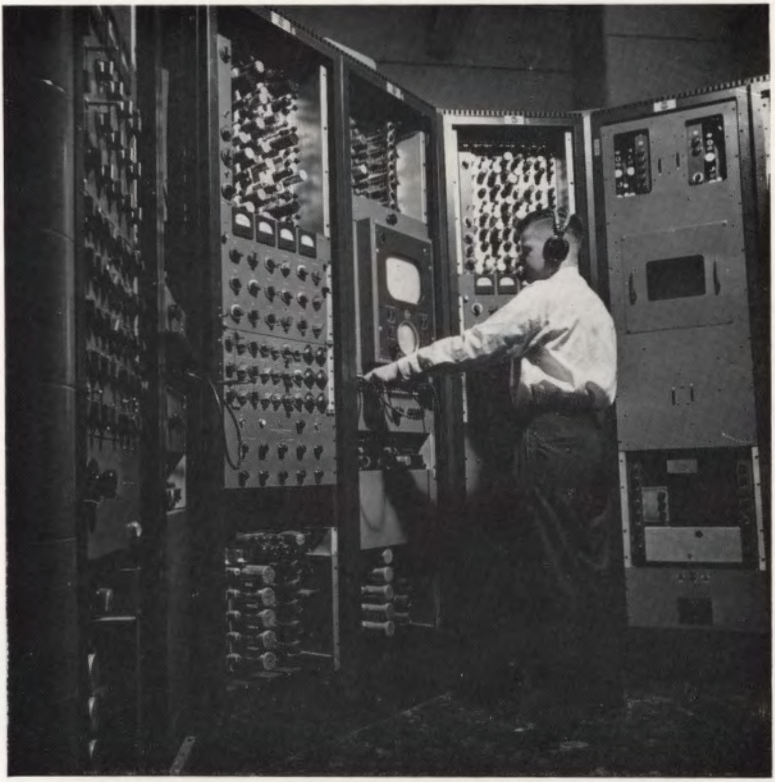
Like the buildings and laboratories in which it is used, the equipment at the David Sarnoff Research Center is tailor-made for research. Besides all the standard apparatus necessary for this type of scientific inquiry — the generators, the transformers, the oscilloscopes and recorders — there is a concentration of special, high-powered tools. It is this equipment that the scientist calls upon when he must uncover facts that no laboratory test set-up could ever give him.

The mass spectrometer is readied for another series of test runs.



Training the camera on a test pattern in the television studio.

To see an object — a crystalline form, a metal surface, or a cell of human blood — magnified 300,000 times, there is the electron microscope. Through this instrument, with its auxiliary apparatus for slicing specimens to transparent thinness, the scientist can explore what man has never seen before; he can begin to approach the actual structure of metals, minerals, and the tissue of living things. To supply information about the atomic composition of matter, there is the mass spectrometer, a complicated device which can identify in a substance constituent parts which would not even appear in ordinary testing methods. A helium cryostat offers to the research man a special means for carrying out low temperature studies. Other weapons in the scientist's arsenal include



Monitoring a color signal at the control racks to insure color fidelity.

x-ray diffraction apparatus for getting closer to the real nature of things, and a simultaneous-equation solver. This electronic servant assumes burdensome computational work in mathematical problems, freeing the research man from exhaustive calculations while saving his time and increasing accuracy.

Virtually all the equipment of a television studio, including cameras, controls, monitors, lights, and all the rest, is at the disposal of the research worker in an authentic studio setting. Large tanks, and even an outdoor, man-made pond are available to the underwater sound expert. Outdoor facilities are also provided for the groups working on radio receiver interference and on transmission studies.

Behind these resources are the nine thousand-odd volumes of the technical library, its pamphlets, periodicals, translations, and microfilms. The *RCA Review*, a prominent technical journal in the electronics field, offers a means of disseminating research results to the profession and of keeping abreast of the work done by technical personnel in the divisions and subsidiaries of the Corporation.

These technical tools at the David Sarnoff Research Center contribute to a unique research atmosphere. It is one of free inquiry into the problems of electronics and its related fields. The flexible organizational structure of the RCA Laboratories Division gives a mobility which permits changes of pace and direction for the exploration of new ideas. The individual scientist may work on a series of widely varied projects, and once embarked upon a study,

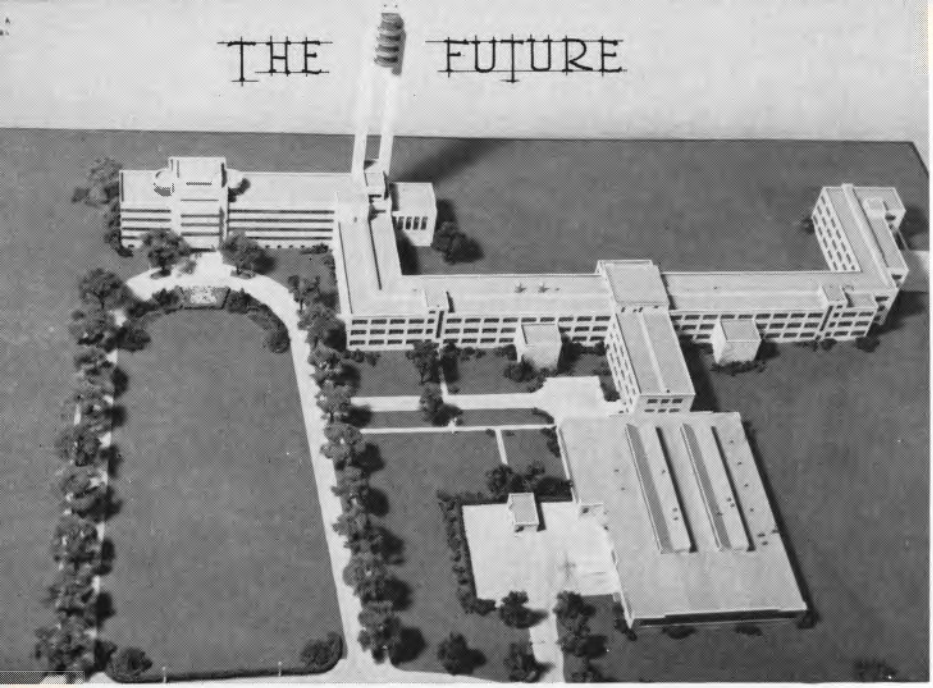
One of the many colloquia conducted at the Laboratories in which the scientist describes his work.

he has independence and latitude in the manner in which he pursues his portion of it. The nature of the problem is, of course, the primary determinant of the way in which it is attacked. The efforts of one man may be sufficient, or the work of a research team may be called for, with a group of specialists in different areas pooling their talents. This group interaction, with its cross-fertilization of ideas, is one of the most fruitful techniques to come out of the modern research laboratory.

Working with other experts, attending colloquia, participating in scientific meetings, and often continuing his higher education with the assistance of the Corporation, the research man pursues his chosen career. The David Sarnoff Research Center is as close to the ideal environment for these ends as care and planning and work can make it.

Developing a high definition kinescope for radar use.

Checking the operation of high speed memory device.



A projected model of the David Sarnoff Research Center.

RCA's faith in research is epitomized in the plans for future expansion of the David Sarnoff Research Center. The character of the additions made will be determined not only by the needs of the RCA Laboratories Division but also by the philosophy underlying the original planning and construction: Research must be carried on with the finest facilities that can be provided.

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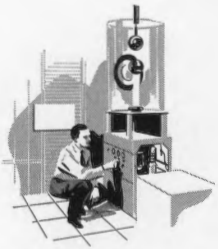

RESEARCH
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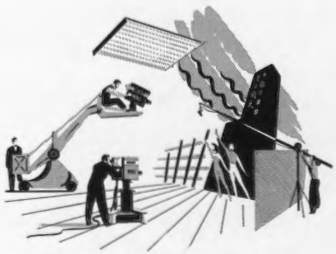
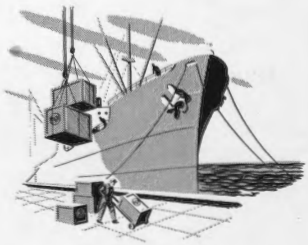
RCA Victor Division

MARITIME RADIO EQUIPMENT
Radiomarine Corporation of America



BROADCASTING AND TELECASTING
National Broadcasting Company, Inc.



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