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Development Meeting on the Manufacture of Telecommunications Equipment (including low-cost receivers for sound broadcasting and television)

Vienna, 13 - 24 October 1969

DRAFT REPORT[1/]

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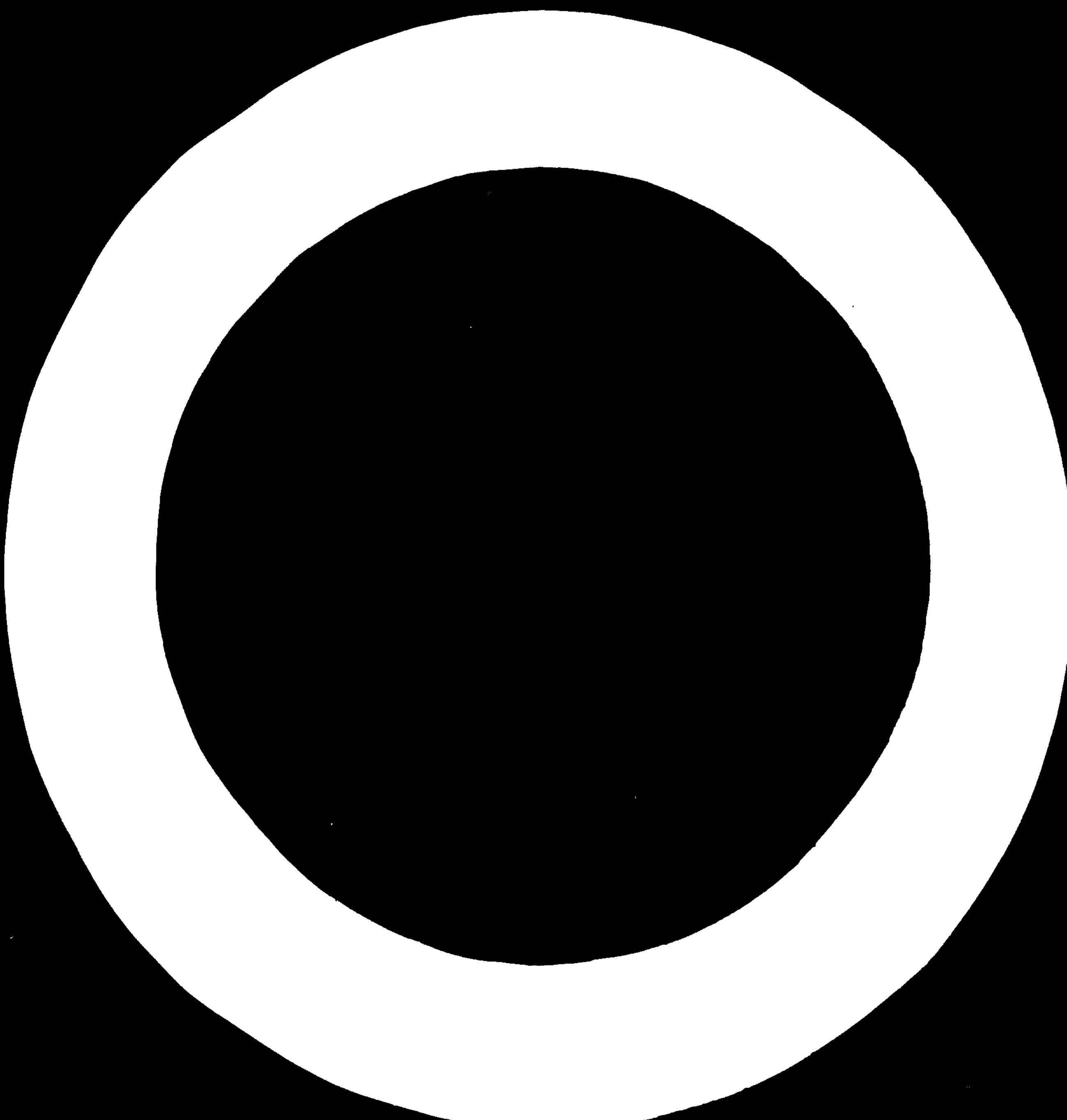


INTRODUCTION

The Development Meeting on the [illegible] of Telecommunications Equipment (including low-cost receivers for sound broadcasting and television) was held in Vienna from the [illegible] to [illegible] October [illegible].

The Meeting was organized by the [illegible] Industries [illegible], (Industrial Technology Division) of the United Nations Industrial Development Organization. Its purpose was to provide, through the presentation of papers submitted by experts and by [illegible], a thorough review and analysis of the economic, administrative, technical and organizational problems involved in the [illegible] of domestic production facilities for telecommunications equipment in the developing countries.

The substantive items on the agenda were:

I. Administrative and financial matters

- Factors leading to choice of equipment to be manufactured (political and economic)
- Determination of capacity and location for starting or expanding production
- Negotiations with government authorities on import, tax concessions, protective tariffs, repatriation of capital and licence fees
- Requirements for skilled and semi-skilled labour
- Sources of finance and special problems of joint ventures
- Cost areas and their control
- Starting up timetable

II. Technical matters

- Review of specifications for receivers and telecommunication equipment
- Design requirements for reliability and maintainability
- Review of future development in broadcasting, telecasting and telecommunications

III. Manufacture

- Decisions on whether to make components or to buy them locally, or to import them
- Problems of material handling and production [illegible]
- Layout of production and test equipment
- Organization of personnel

IV. Distribution and servicing

- Packing and storage
- Marketing
- Installation
- Servicing organization

V. Training

- Policies and practice of training of professional, technical, administrative and manipulative staff

Participants from eighteen developing countries were present. Eight were from African countries, seven from Asian countries and three from South America. In addition the Meeting was attended by 29 participants from the telecommunications sector of ten industrially developed countries and by representatives from the following international agencies: the International Electrotechnical Commission, the International Telecommunication Union, the World Meteorological Organization, and the United Nations Educational, Scientific and Cultural Organization. The complete list of participants, members of UNIDO responsible for the management and organization of the Meeting, representatives from international agencies, authors and papers are given in Annex II and Annex I.

To supplement the work of those participants primarily interested in the production of low-cost radio and television receivers, and to familiarize them with modern techniques of production organization and control, a visit was made to the firm of Kapsch and Söhne located in Vienna.

The Inaugural Session of the Meeting was opened by Mr. N. K. Grigoriev, Director of the Industrial Technology Division, who welcomed the participants and introduced the Executive Director of the United Nations Industrial Development Organisation, Mr. I. H. Abdel-Rahman.

In his Inaugural Address the Executive Director stressed the prime importance of the telecommunications industry to an economy. He made the point that this industry acts both as a key and as a pace-setter to almost the entire range of industrial and technological development. He expressed the desire that the Development Meeting should serve a dual purpose: that of helping participants to formalize ideas in this sphere of manufacturing activity and the eventual crystallization of these ideas into tangible, viable projects.

The participants were then welcomed by Mr. G. V. Soskuty, Chief of the Engineering Industries Section of the Industrial Technology Division. Mr. Soskuty gave details of participants, made a brief review of the papers received and discussed in general terms the items on the agenda.

The importance of an efficient telecommunication system in the infrastructure of an economy is taken as basic for the purposes of these discussions. For the developing countries of the world the means by which this vital element of the infrastructure is created involve an exceedingly complex cluster of factors operating on the organizational, political and economic levels. Furthermore, these factors have to be examined against a background of national development strategies and priorities. However, the implementation of these strategies and priorities frequently presents problems which cannot readily be resolved within the context of the development strategy of one particular nation, but need to be examined in the wider context of the international development. This in turn raises further problems of an organizational and political nature in an area which is often of peculiar sensitivity.

The factors which influence the decision whereby a developing country is likely to endorse or expand the local manufacture of telecommunication equipment may be summarized as follows:

a) The inability of the existing manufacturing or procurements systems to respond to the particular needs of an evolving economy;

b) The strategic necessity of having a nationally based industry;

c) The elimination of private monopoly; ..

d) Other considerations of national economic policy such as i) employment in specific locations; ii) labour training; iii) import substitution; iv) the kind of technological fall-out which would benefit already existing or projected industries.

Where the expansion of existing facilities is concerned, the operation is likely to be [illegible] of the investment involved and whether this investment can be generated internally or whether recourse to external financing agencies is required.

Where the establishment of new industrial facilities is concerned, factors of a different order are also involved. These may include: a) The initiation of new enterprises without the benefit of previous local experience or knowledge, b) the need to obtain advice from individuals and organisations experienced in the administration of the industrial activity under construction, c) the acquisition of sound technical information from a wide variety of sources with reference to the product in question, d) the accurate interpretation of market potential for the product, e) the realistic assessment of the materials, transport, labour and equipment requirements for the enterprise.

The hazards implicit in this type of operation may be reduced by inviting existing industrial enterprises with their support structure in the form of managerial and technological expertise to co-operate with the Government in the setting-up of the new facility.

Another method is to make use of the "turn-key" type of agreement whereby an enterprise enters into contractual arrangement to undertake the construction of facilities, the installation of plant, the initial supervision of operations, the training of personnel, and the running of the enterprise until an agreed level of output has been attained.

It would appear improbable that any one developing nation possesses the financial and human resources to set up manufacturing facilities for the entire range of telecommunication products. The degree of specialization required, the need to keep up with a rapidly expanding technology and the complexity of the back-up facilities are too great. However, it might well be that certain items of equipment are considered to be of such economic and/or social importance that total reliance on [illegible] manufacture is [illegible] manufacture of low-cost radio receivers. The [illegible] in terms of structural change, increased social [illegible], might be judged sufficiently important to take precedence over the criteria normally applied to private enterprise. [illegible] manufacturing activity in a market economy, has typically the [illegible] of growth as its primary objective. Developing economies, for a variety of reasons, are inevitably characterised by the [illegible] importation and a limited range of [illegible] from one particular [illegible], their domestic industry [illegible] materials. [illegible] the [illegible] of foreign firms [illegible] the [illegible]. [illegible] intervention might well be justified [illegible] in this instance the promotion of [illegible] growth [illegible].

[illegible] specific [illegible] available. [illegible] it may [illegible] by providing the necessary [illegible] private enterprise.

Nominally, because this is a primary function of private enterprise and where a situation for the creation of profit exists, private enterprise should be attracted to it. Such an incentive srructure will normally include such components as: i) low interest loans ii) customs exemptions iii) tax holidays iv) capital repatriation concessions v) protective tarrifs vi) guaranteed orders vii) export premiums. The other option is to step in with public investment.

However, the conclusion may be reached that the inadequacy of private investment is not directly related to the degree of profitability of a specific enterprise. Lack of available capital may be the cause. In this case the direct provision of funds would be a powerful incentive, but there may also be a case here for direct government action in the setting up of publically owned production facilities. Finally, it is possible for private enterprise to have the necessary capital at its disposal, but to be unable to take on the risk because of technical and/or organizational inadequacy. In this instance it might be advisable to set up state-owned production facilities and assume directly the managerial and technological risks.

These are instances where government enterprise in the area of production can be amply justified and where the resultant operation can conform to the traditional criteria of commercial profitability. There are, however, instances where government intervention may be justified for projects which are not immediately profitable.

<u>Criteria for the establishment of a new manufacturing process</u>

The decision to invest in a new manufacturing process is governed to a large extent by the criteria of financial viability and social desirability.

Financial viability is determined by the existence of an adequate market demand for the product and on the technical feasibility of the operation. Excessive market surveys are not mandatory in the early stages of the operation but investment is consequent upon the prospect of satisfactory market demand for the eventual product and reasonably reliable data need to be obtained.

In deciding whether to establish the manufacture of a new product consideration must be given to the possibility of a long-term guarantee for the product. The requirements to be met before such a long-term guarantee can be assured are cheap and easily available special basic materials, ability to manufacture locally the most important components, an adequate and qualified technical staff, and modern equipment.

These factors are considered to be of approximately equal importance. An objective evaluation of production feasibility may be made by using the following equation $S_T = S_1 : S_2 \cdot S_2 \cdot S_3 \cdot S_4$

where S_T represents the overall long term guarantee on an area

S_1 is the ratio of the amount of available cheap materials to the total amount of required materials (materials guarantee)

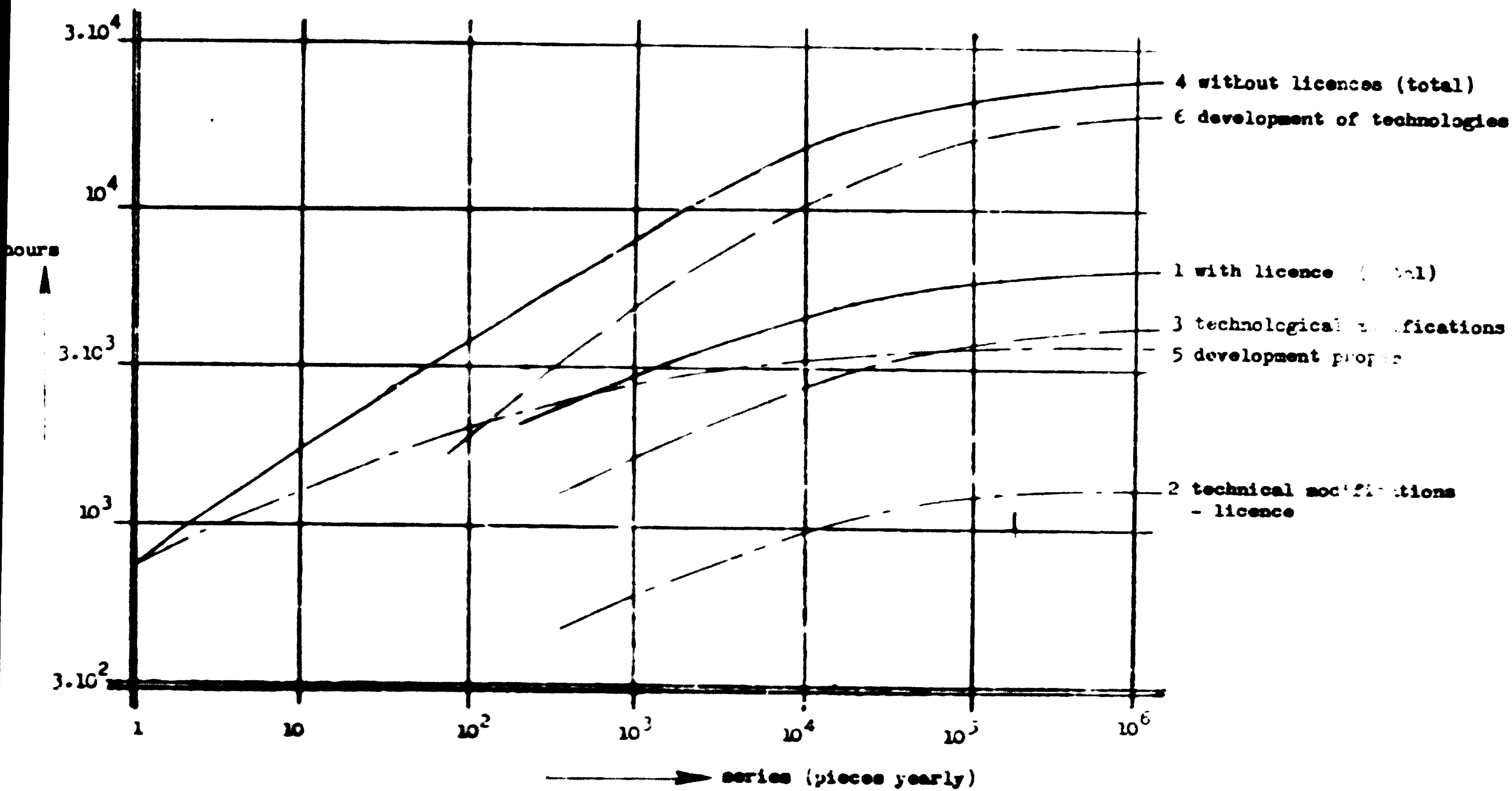
S_2 is the ratio of the number of economically attainable components to the total number of components needed (components base guarantee)

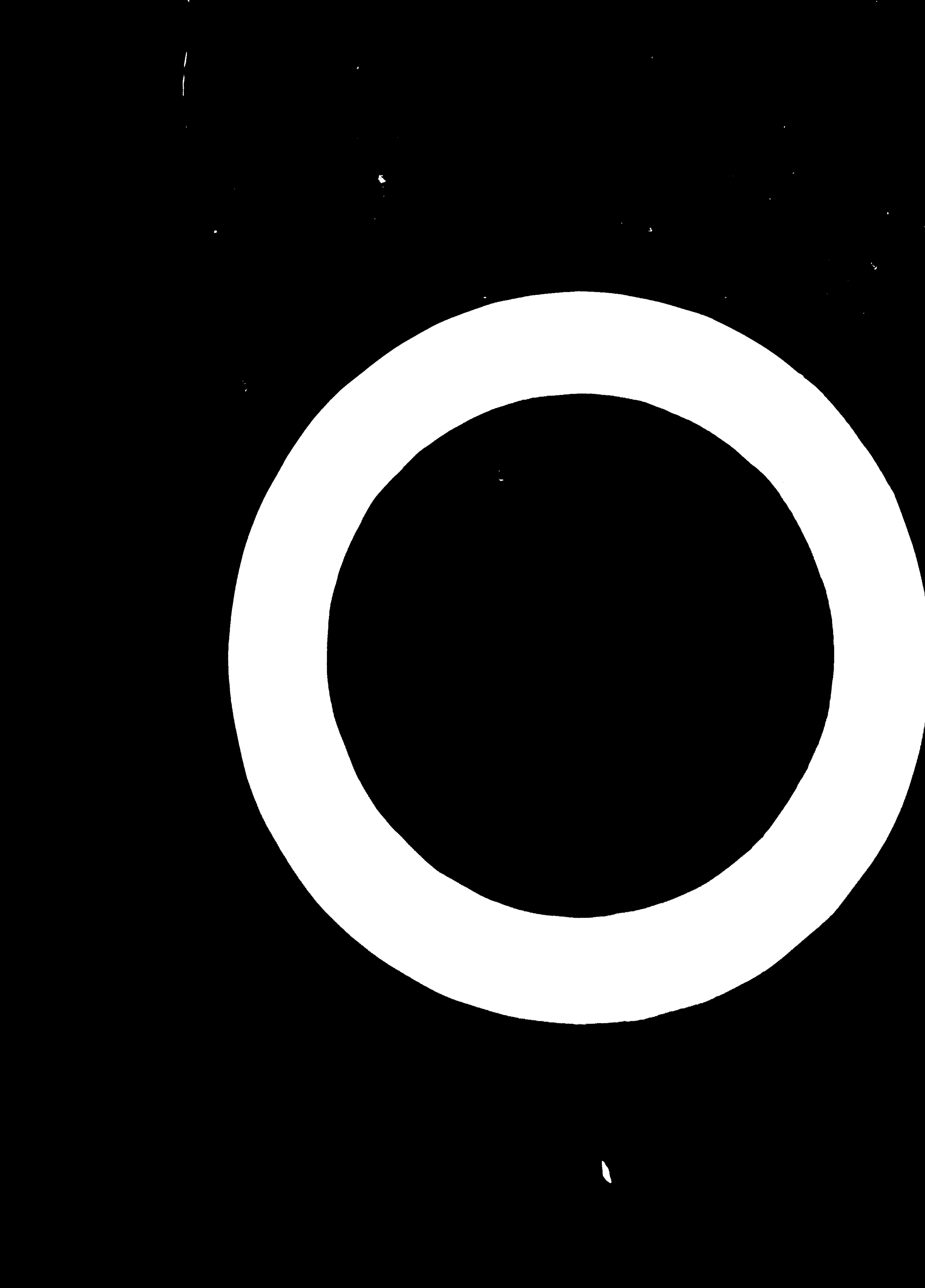
S_3 is the ratio of the number of qualified personnel in the area to the number employed by prominent producers (labour co-efficient)

S_4 is the ratio of the estimated value of technical equipment for the proposed production to the estimated value of a prominent producer's identical equipment (equipment factor)

Figure 1

Technical ... of final electronic ...





The results obtained by estimating S_1, S_2, S_3, and S_4 for several areas and by calculating the products S_T indicate the most suitable location for the manufacturing facilities.

A similar process may be used in determining suitable groups of products. Even when S_T _ 0.05 a sufficient long-term guarantee can still be secured for a given area. If $S_1 = 0$, indicating that there is no outlook for even minimal local production of special materials, no long-term guarantee is possible.

The Technical Base

This term is used to designate the research, development, design and technological capacities required in connection with the preliminary assessment of technologies and technical services for a new group of products.

The factors requiring consideration to establish a sound technical base are a) the complexity of the product, b) the level of production, c) the technologies used, d) the scope of co-operation with producers, e) the licences and technical assistance which will be requirdd.

The complexity of the product and the level of production influence the scale of the technical base, particularly in the electronics industry. A small series of articles requires a large staff for research and development, whereas a large series and mass production require more intensive technological research and development.

Fig. 1 shows the necessary technical capacities plotted against the estimated production series for a unit complexity of equipment. The example of a unit complexity of final product is part of an apparatus containing one vacuum tube or one transistor and including all associated mechanical and electrical components.

Curve 1, representing required technical capacity as a whole, has been drawn for the case of a licenced production that includes special technological devices. Unavoidable modifications of licence-design from the viewpoint of additional labour capacities are shown by Curve 3. This Curve represents the capacities required for technological modifications (different starting materials, protection of products against specific climatic conditions, air conditioning of working areas, etc.).

In the case of a new production which has been established without the purchase of licences the Curves 4,5, and 6 are added. Curve 4 represents over-all capacity of technical work, curve 5 represents the design and development of the product and curve 6 represents the technological work and the development of technological equipment.

An example would be a factory that previously had a licenced production of products using vacuum tubes. This factory now aims to establish a more complex final product, in this instance a 7 transistor single-range sound broadcasting receiver. It is assumed that the factory obtains the necessary licence and imports special equipment. A further assumption is that an output of 10^5 items per year is attained. This means that curves 1, 2 and 3 will be used. For 10^5 items the results indicated are 5,000 hours by curve 1 (total hours of technical work), 1,500 hours by curve 2 (partial development work) and 3,500 hours by curve 3 (modification of technologies added to the licence).

Since a 7 transistor receiver is involved these figures are then multiplied by 7. The resulting total needs are 35,000 hours on technical capacity, 10,000 hours on design modifications and 25,000 hours on technology modifications.

The law represented by fig.1 is valid for all new production processes to be introduced. It is always necessary, however, to arrange a convenient complexity unit. The limits of necessary capacity may be found from statistical data concerning typical cases of establishing new production processes.

A minimum time-lapse between the start of research and the establishment of the new manufacturing process should be aimed for because of considerations of design life. A maximum time lapse of 3 years may be allowed for the most complex articles.

These are certain limitations connected with licence production. Experience has shown that a complexity of the order of 100 active electronic circuits is the maximum feasible where licenced production is remote from the licencer. It is therefore better for a developing country to build up its technical capacity gradually. This can be done by starting on the basis of partial licences and then establishing its own qualified technical base for additional, more complex items.

[illegible]

Transmitters

Transmitters [illegible] frequency bands on which [illegible]

[illegible].

a) MF - Radio [illegible] Amplitude modulation

[illegible] frequency portion

b) [illegible] - [illegible]

[illegible]

[illegible] portable

radio [illegible].

c) VHF - V.H.F. [illegible] (Amplitude [illegible] modulation)

Television [illegible] broadcasting, tele-

communication [illegible] communication equipment -

fixed [illegible].

d) UHF - Ultra High [illegible]

Television [illegible] telecommunications - fixed frequency operation.

These types of equipment are technically [illegible] complex and it is probable that importation [illegible] developed countries will continue [illegible]. However, [illegible] production systems for a group of countries might well be economically [illegible].

Transmission Equipment

This [illegible] equipment for the transmission of information over open wire lines [illegible]. The choice of equipment will depend on the number of circuits [illegible] over [illegible]. It [illegible]

i) Channelling equipment for O/W lines, cables and radio systems

modems

oscillators

filters

line amplifiers

signalling and test panels

power supplies

ii) Exchanges (telephone)

Step - by - step

Rotary

Crossbars

Crossbars with electronics

Electronic

PABX

PBX

Manual exchanges

Power supplies

iii) Exchanges (telex)

Uniselector

Crossbar

Manual

Automatic error correction equipment

TRDXs

Tape-perforators

Tape-transmitters

Voice frequency telegraph carrier systems

Power supplies

iv) <u>Cables</u>

Power cables

Stranded wire cables

Hook-up wires

Multipair cables

Co-axial cables

v) <u>Aerials</u>

Solid copper wires

Stranded copper wires

Solid and flexible co-axial cables

Wave-guides - brass

Steel cables and guys

<u>Sound and television broadcast receivers</u>

The manufacture of these products necessarily involves the use of a great range and variety of intermediate products. The manufacture of these intermediates requires very careful consideration in view of the elevated level of economic production. Those which are suitable for local manufacture include most of the standard passive components, plus loudspeakers and perhaps batteries. (A convenient source of manganese dioxide would obviously be a major consideration where the manufacture of batteries is concerned).

Others, notably semi-conductors, vacuum tubes, ferrites, magnetic circuits for loudspeakers and deflection aggregates for picture-tubes, are more suitable for co-operative manufacture by groups of countries. It is worth remarking in this context that few manufacturers of radio and television receivers also manufacture the components used in their products. Most of these are fabricated by component specialist firms. Even the basic P.C.B.s are contracted out.

MATERIALS AND COMPONENTS

In the manufacture of telecommunication equipment certain special basic materials are essential. Their quality and variety determine the kind and level of technology employed, the degree of automation in production and the performance characteristics and reliability of the final product.

Although only small quantities of some materials are required the quality of these materials has to be very high. Semi-conductors provide an obvious example. Production is impossible without small quantities of very high purity materials.

Materials of magnetic, insulating and conducting types are also extremely sensitive to climatic conditions. The manufacture, transport and storage of components made with these materials pose serious problems, especially in tropical climates.

It is unlikely that any one country can obtain all these materials from its own resources. The problem of special materials can be solved, at least partially, by international co-operation and improved trade relations. An accurate assessment of a country's resources is therefore important in deciding the types of product to manufacture.

The following list contains some of the most important groups of materials used in the manufacture of telecommunications equipment:

Metallic materials

Copper and aluminium for conductors

High purity metals and alloys for semi-conductors (germanium, antimony, indium, tin, lead, aluminium, gallium and Au-Ga alloys)

Materials for contacts (Tungsten and Au-Ni alloys)

Materials and alloys for vacuum purposes (kovar, tantalum, molybdenum)

Magnetic materials and alloys (cobalt and Al-Ni alloys)

Gold, platinum, rh[illegible] or [illegible] material)

Stainless steel [illegible] (for [illegible] or [illegible])

Chemicals

Nitric acid, [illegible] acid, [illegible], [illegible], photo-sensitive lacquers – [illegible]

Ferrites, [illegible] sulph[illegible], for [illegible] and piezo-[illegible]

Ferric-chloride, [illegible] sulphate, [illegible], [illegible], lactic-acid, [illegible] materials, [illegible], etc., for print[illegible]

Luminescent materials, [illegible] materials, fluorescent materials, zinc ox[illegible]

Plastic and [illegible] materials

Dielectric (styroflex, polyethyleneterephthalate, polystyrene, P.T.F.E.)

Structural (S.R.B.P. glass-reinforced synthetic resins, unplasticized P.V.C., ABS)

Glass materials and semi-products

Glass materials for bulbs, UV glass, etc.

Beading glass

Quartz glass

Varnishes

Insulating (for conductors)

Impregnating (for windings and condensers)

Sealing Compounds

Cerasene, epoxies, polyesters, etc.

Technical and Rare Gases

Nitrogen, hydrogen, helium, krypton, xenon, etc.

Minerals and other materials

Talc, kaolin, quartz, magnesia, graphite, manganese dioxide

It will be realized that this list is by no means exhaustive.

[illegible]

[illegible]

This technology is concerned with the [illegible] and [illegible] transformers, [illegible], [illegible] coils, [illegible]

The [illegible] for [illegible] are as follows:

i) Horizontal or vertical [illegible] for transformer windings including the equipment necessary for [illegible] coils during winding.

ii) Tools for the preformation of coils for rotating machines.

iii) Wrapping machines for coils to be insulated with tape or strip material.

iv) Insulation [illegible] presses.

v) Semi-automatic winding machines for [illegible] coils.

In the production of television receivers, special attention must be given to the manufacture of deflection coils and output transformers for horizontal scanning. Adhesive-coated, [illegible]-insulated wire is used for the winding of deflection coils. [illegible] is carried out on special winding machines. The coils are then heat-treated to obtain the desired shape and rigidity. Finally they are assembled with ferrite cores, and, where climatic conditions necessitate, impregnated with silicon grease.

Output transformers for horizontal scanning have to be insulated against high operating voltages. Multiple winding machines are therefore used in their manufacture. Quality control during and after the manufacturing process is important.

The following equipment is required for the manufacture of these

i) Multiple automatic or semi-automatic machines

ii) Winding machines for deflection coils and transformers

iii) Machinery and tools for pre-forming and heat-treating of deflection-coils and transformers

iv) Checking devices for insulation.

Magnetic circuits

This is the basic component of a transformer. Starting materials consist of magnetically oriented low-loss steel fabricated in sheets or rolls. Core-formers are made on sequence stamping presses. Single operation concentric stamping tools are used in series and small series production runs.

The equipment required for the production of magnetic circuits for mains and output transformers includes:

i) Sequence presses
ii) Standard presses for pre-stamping
iii) Automatic presses for slotting
iv) Stamping devices
v) De-sharpening grinders
vi) Tightening presses
vii) Lacquer-coating machines
viii) Coiling and de-coiling equipment for magnetic steel delivered in rolls
ix) Circular scissors
x) Annealing ovens
xi) Waste treating equipment for steel sheets and stamping tools.

The magnetic circuits for loudspeakers pose special problems because of their delicacy. Permanent magnets for these circuits are made from oriented ferrites or from special high nickel or cobalt steel alloys. The manufacture of these components is usually quite different from that of other magnetic circuits.

Magnetic conducting components are produced by standard mechanical engineering methods, that is to say, stamping, heat pressing, and the turning of cylindrical parts. Conductivity is increased by the use of annealing ovens, usually conveyorized, and the annealed parts are then insulated with metal. Special attention needs to be given to the metal insulation of the air gap and adjoining parts.

Basic equipment consists of:

i) Presses for flat parts

ii) Heated stamping presses

iii) Automatic machine tools for cylindrical parts

iv) Magnetising and demagnetising devices

v) Turret or conveyor metal moulding equipment.

Insulants

This group comprises materials in sheet or roll form, including varnished cloth, slot insulations, and bushings with directed electrical fields. Processes comprise the preparation of bonding resins, lacquering, pressing and curing. Requirements for the manufacture of laminated insulating materials include air-conditioned storerooms for basic materials and finished products, liquid chemical tanks, cutting machines, lacquering machines and presses for laminated insulants.

Mica Materials

This group includes micanites, commutator micanite, micafolium, mica tape and mica plates. The traditional mica splittings are now being replaced by mica mat. Mica mat is made from mica pulp which contains a bonding medium (about 5% by weight). The manufacture of mica mat is similar to that of paper and uses the same techniques. Compared with mica splittings, mica mat has numerous advantages, including flexibility and homogeneity. In addition, the manufacturing process requires less space and makes more efficient use of available labour.

Major requirements for production include:

i) Mills for grinding mica pulp

ii) Simple paper milling machines for making mica mat

iii) Stamping semi-automats and tools for making pressed articles from mica powder.

Porcelains and other Ceramics

Starting materials are porcelain, steatite, ceramic dielectric materials, agrosets, electro-faience, and oxide ceramics. The manufacturing process requires high curing temperatures which confer both mechanical and electrical strength. The main steps in the manufacturing process are pressing, pulling and forming and casting. The basic equipment includes machines to prepare and homogenize the ceramic paste, forming machines and presses, spray machines for glazing and curing ovens.

Epoxies

These are used for instrument and [illegible] transformers, magnetic coils and commutators. Epoxy potting resins combine [illegible] mechanical and electrical strength [illegible] exceptionally high degree of immunity [illegible] climatic conditions. However, the equipment required for epoxy casting [illegible] is expensive. It would be economical only [illegible] the case of standardized components in a plant serving the needs of a group of countries.

Cables

The manufacture of cables comprises several operations. They include the insulation of the conducting core, the combining of the insulated conductors by twisting them together and the insulation of the complete system with materials designed to protect it against mechanical and chemical damage. These procedures are:

i) stranding

ii) pressing out

iii) insulation.

In the case of plastic-insulated cables, the same sequence of operations applies, i.e.

i) stranding

ii) extrusion pressing

iii) sheathing.

The linear nature of the operation requires additionally machinery for pulling, coiling and de-coiling.

The basic equipment consists of -

i) Paper cutting machines

ii) Cabling machines

iii) Stranders

iv) Insulating machines

v) Sheathing presses

vi) Extrusion presses (for plastic, lead and aluminium)

vii) Equipment for pulling, coiling and decoiling.

Semi-conductors

The basic starting material for the manufacture of semi-conductors is semi-crystalline silicon with controlled impurities of iridium, gallium, etc.

Homogenous silicon mono-crystals of high purity and 20 to 50 mm in diameter are made from semi-crystalline silicon by zone purification in H/F ovens. Special devices are used to cut the mono crystals into wafers with thicknesses from 0.1 to 1. mm according to future use. These wafers are then accurately machined to the required thickness on automatic grinding machinery. The diffusion and epitaxial junctions are made in gas filled, temperature controlled ovens and then encapsulated after they have been provided with contact areas, soldered leads, etc.

More complex components are made by planar-epitaxial methods. The system of leads, junctions, etc., is deposited by metallic condensation on a photo-lithographically produced pattern. Programme-controlled optical systems of high accuracy are required for this purpose.

The production area for the manufacture of solid state components needs a specially controlled environment with electro-static air filtration systems and constant humidity and temperature control. The major items of equipment required for the manufacture of semi-conductors are:

i) Zone purification equipment

ii) Plate-cutting equipment

iii) Plate grinding and polishing equipment

iv) Checking and measuring devices to ensure that the plate conforms to the electrical and mechanical parameters

v) Ovens for the diffusion processes

vi) Chambers for the epitaxial processes

vii) Checking equipment for intermediate controls

viii) Contact and soldering devices

ix) Encapsulation process

x) Machines for attaching leads and applying glass or ceramic bushings

xi) Die casting presses for cooling radiators

xii) Checking devices

xiii) Photographic miniaturizing equipment for structural parts

xiv) Programme controlled stepping equipment for the manufacture of micro structures by planar technology

xv) Air filtration and temperature control equipment for all working areas.

Vacuum Components

Tubes, etc

Glass is the traditional material for forming the envelope of these systems but ceramics are also beginning to be used. The metal parts are manufactured by traditional mechanical engineering processes requiring presses, etc. [illegible] from components by vacuum annealing. Systems are assembled by hand, semi-automatically or by the use of special fully automatic equipment.

Highly specialized processes are involved in the production of filaments, cathodes and screens for picture tubes. They include the deposition of emissive layers by spraying, the covering of filaments with ceramic layers by dipping and the sedimentation of luminophores on the screens of picture tubes. The sealing of tubes, degassing and vacuum pumping is carried out on multiple automatic machines which have a high rate of productivity.

Equipment required for the manufacture of vacuum components includes:

i) Machinery for making grids, filaments and cathodes

ii) Pumping and sealing automats with oil and diffusion pumps.

Great caution must be used in considering the production of certain advanced types of vacuum tubes. The advance of solid state techniques and the increased use of integrated circuits implies a rapid obsolescence for these types.

Printed circuit boards

Printed circuit boards are made from copper clad resin-bonded paper or copper clad resin-bonded glass fibre. The circuit pattern is printed on the laminate by the conventional silk screen printing process or by photo-mechanical techniques, depending on the total precision required. The pattern is protected by acid resistant ink or films and the excess copper is removed in a conveyorized etching machine. The circuit is then cleaned and dried and [illegible] flux is applied by roller tinning machines. The insertion of components (resistors, capacitors, diodes, etc.) is carried out either manually or automatically. Connexions are soldered manually or automatically on wave-soldering machines.

A main assembly conveyor is used to control the assembly of mechanical parts and structural components, and the insertion of PCBs and their connexions with one another.

Passive components

This group of products includes fixed capacitors and resistors for radio and television receivers, electrolytic capacitors, power capacitors, potentiometers (for power factor correction, interference suppression, amplifiers, transmitters, etc.), soft and hard magnetic ferrites, switches, push buttons, variable capacitors and special components.

These components are required for use in domestic production programmes and as spare parts for servicing imported equipment. A variety of technologies and starting materials are required and a high level of output of most of these components is needed for economic operation. Components which lend themselves to domestic manufacture are fixed and capacitors and resistors for receivers, electrolytics, soft magnetic ferrites, switches, variable capacitors. Some indication of the level of output required for economic operation is given by the following:

capacitors - 12×10^6 units per annum

resistors - 2×10^7 units per annum

- always provided that the number of types is small.

Where the demand for one type is in excess of 10^7 items per annum, it may be possible to consider manufacture in several countries simultaneously. The production of toll type and electrolytic capacitors must be located in a suitable climate.

Loudspeaker and electro-acoustical devices

Loudspeakers for receivers, power speakers for public address systems, transmitter insets and receiver capsules for telecommunications equipment, headphones, high fidelity speakers, and general purpose microphones are included in this category.

With the exception of power speakers and those intended for high fidelity applications, all these products are suitable for domestic manufacture. Loudspeakers for radio receivers in particular would appear to present the most economically feasible proposition where this is linked to domestic production of low-cost receivers.

Ideally, the manufacture of most of these products should be concentrated in one plant serving the requirements of a group of countries. The plant producing magnetic circuits for loudspeakers needs ideally to be located in a country whose material resources include nickel, cobalt aluminium and ferrite materials. The manufacture of paper-cones for loudspeakers is complex and requires high quality paper materials.

The materials used in the manufacture of these products are not especially sensitive except to climatic conditions and protective packaging is required only for those articles which are liable to be subjected to climatic extremes.

Competent production of magnets and of standard magnetic circuits in a country with an adequate material base should offer interesting export possibilities even to industrially advanced countries.

Licences should be purchased for the manufacture of resistors, ferrites, switches and variable capacitors in order to promote good product quality and operational reliability.

Licences and specialized production equipment are important for the production of high quality oriented magnets made from alloys and ferrites and also for the production of loudspeaker paper cones.

Sound and television broadcast receivers components

Some of the items used in these products are suitable for local manufacture. They include the standard passive components, loudspeakers, and batteries.

Some are more suitable for co-operative manufacture by groups of countries. These include semi-conductors, vacuum tubes, picture tubes, ferrites, magnetic circuits for loudspeakers, paper cones for loudspeakers and deflection aggregates for picture tubes.

The special materials used in the manufacture of these products, e.g. semi-conductors, vacuum tubes, picture tubes, magnetic circuits, necessitate a centralised production location. The manufacture of picture tubes, for example, is a very delicate operation because of the sensitivity of the components to be transported during the production process.

Determination of capacity and location for starting or expanding production

Most manufacturing processes have a definite minimum industrial scale. A level exists below which production becomes economically unsound. This minimum scale may also have a decisive effect on the degree of precision required in the demand projection. It has been estimated, for example, that in the manufacture of transmission channel modems a level of production of 2000 to 3000 units per year needs to be maintained. For switching equipment this level is of the order of 30,000 to 40,000 lines per year. With plastic capacitors 10 to 12 million per year is the minimum level for economic production. If, when contemplating the manufacture of these items, a minimum production of the level indicated cannot be envisaged, it will obviously be unwise to set up a factory and no price estimates will be necessary in making a preliminary estimation of demand.

The plan of analysis for a specific project should envisage three fundamental situations: (a) where the total demand is clearly less than the smallest production unit which may be installed (b) where the demand is the same as the capacity of the smallest production unit and (c) where the demand is clearly greater than the largest production unit which may be installed.

The size of the project is usually taken to mean its productive capacity during a normal operating period. This is expressed as a function of the number of working days and the number of production hours required to attain a specific level of output. The optimum size and the best location will be those which lead to the most favourable economic results. This may be quantified by such coefficients as net return; minimum unit cost; sales-cost ratio; total profits.

The most important factor in determining the size of a project is clearly the volume of demand. All industries have a characteristic curve of production costs as a function of size. Combining these cost curves with those of demand variation as a function of one or more of the factors previously mentioned will often reveal the possibility of catering for an output greater than that corresponding to current demand.

The geographical distribution of the market is also an important factor in determining the size and physical location of a project. National development policy will influence the decision to a considerable degree and the options(a) a single plant for the whole of the market (b) a central plant with satellite plants in other places (c) several plants of equivalent size spread over the area, will be selected according to the particular requirements of this policy.

The basic relations between size and location arise from the geographical distribution of the market and from the influence of location on costs. In some locations the sum of input costs to the plant and the output costs to the market will be small and a series of locations can be established where freight costs are equally low. These points may be considered as possible sites for installing plant and balanced with the remaining factors it should be possible to select the final location from among them. The solution will depend to some extent on the input/output weight ratio. As a general rule, developing countries have a special interest in locations where transport costs give a definite advantage to the domestic producer.

A comparison of the telecommunication, metallurgy, machine and mechanical equipment, transportation, electrical, precision engineering, metalware, chemical, paper, food and textile industries, reveals the fact that next to precision engineering, telecommunications is the most labour-intensive.

In addition it is probably the one which requires the minimum physical effort on the part of its direct labour force.

The method of analysing the locational force of labour involves a) an estimation of the effect of the various types of labour required on the total production cost of the industry in question, b) an examination of the availability of the various types of labour at the different locations, the labour rates at these locations, c) an estimation of the effect of these rates on total production costs to determine how they modify the equation.

ESTIMATION OF DEMAND

There are two stages in the study of the market: The collection of data and the establishment of empirical bases for their elaboration and analysis. The analysis and elaboration stage is required to answer the fundamental questions of this study: What will be the eventual market demand? At what price will the product be sold? What are the specific marketing problems of the product?

In the field of telecommunications equipment there are obviously certain items such as satellite communications equipment and submarine communications equipment, radio equipment for broadband radio-links, ancillary television equipment etc., which it would be quite uneconomic to produce locally because of the restricted character of national demand. There remain two sectors where local production may be considered to be economically feasible: i) voice frequency communications, ii) carrier frequency communications.

There are of course items which from the operational point of view should be included in one sector but which, from a technical point of view, are nevertheless classified under the other. Cases in point are single-channel radio-links to connect a remote subscriber directly to an exchange, subscriber carrier equipment to allow multi-subscriber operation over the same pair into one exchange, and voice-frequency connexions over multi-pair cable connecting a central exchange with satellite exchanges in the same area or town. However, for the purposes of evaluating the overall requirements of a country the basic operational division applies.

The market outlet for these types of equipment will be basically the national P.T.T. administration. But there are others such as the Armed Forces, the Police and Gendarmerie, and private enterprises such as oil and mining companies, which should not be overlooked since their their combined requirements can amount to a sizeable proportion of total P.T.T. needs.

The basis of a market survey for this type of equipment is essentially the requirement for telephone lines. Once this is established the demand for switching equipment is easily derived. The basic data are i) the actual number of subscribers, in urban and rural categories classified according to usage, i.e. domestic or business; ii) the relation of these figures to the total population in the different concentration points; iii) the investigation of any anomalies found in the growth curve plotted over the past ten years where possible; iv) the per capita income and, where applicable, divergences at the main concentration points; v) the growth rate of the per capita income plotted over the last 5 - 10 years; vi) the projected growth rate of the per capita income in the framework of the national development plan; vii) an assessment of factors which could disturb the normally extrapolated requirements; viii) the waiting lists for subscriber equipment at the concentration points and their development over a significant period of time. With these data the future development of telephone density of a country can be predicted by means of a logistic growth function whose determinant parameters can be calculated.

Furthermore, the general growth functions apply to all countries uniformly although they will not, of course, be synchronous.

Where carrier frequency communication is concerned two basically different requirements have to be met: a) the transmission of inter-urban telephone traffic b) the transmission of broadcast programmes. For inter-urban telephone traffic the existing transmission network and its historical development will need to be known, plus i) the initial bandwidth, ii) the initial number of channels, iii) the increase in bandwidth, iv) the increase in the number of channels, v) the increase in telephone density at the linked points, vi) the limitation of the links in terms of hours of operation, vii) the utilization factor of the channels, viii) the average subscriber acquisition time over the links.

Where the transmission of broadcast programmes is concerned the data on which estimates for future requirements will be based are: i) the amount of radio and television programmes originating from existing studios, ii) the number of radio and television transmitters actually in operation and the areas covered by them, iii) the number of links between studios and transmitters.

The extrapolation will be deduced from the areas remaining to be covered by broadcast transmission and the importance allocated by government to this coverage.

Valuable information on this subject is contained in the report of the Third Plenary Assembly of the CCITT (Special Autonomous Working Party GAS 5) 1964 entitled "Economic Studies at the National Level in the Field of Telecommunication (1964-1968)".

Having determined the quantities of equipment required over a given period of time it will be necessary to decide which types of equipment are best suited to local manufacture and consultation with the ITU will be advisable to draw up specifications for the equipment in order to ensure its suitability to a proposed environment and its conformity with certain special requirements such as compatibility with existing systems, etc.

__Negotiations with government authorities on import, tax concessions, etc.__

Prior to the setting up of a new production facility in a developing country, agreement will have to be reached with the host government concerning the financial environment in which the firm will have to operate.

Factors such as tax exemption or concessions on investment, import concessions and restrictions, customs duties, concessions on the repatriation of capital, etc., will play a large part in influencing the decision of a manufacturer regarding the feasibility of such an enterprise. They will also influence decisively the pricing policy which will have to be established.

The new factory will also require patent licences from the parent company to manufacture the proposed equipment. The determination of this fee will depend on:

a) international practice,

b) licence fees already agreed with other manufacturers, and

c) the regulations in the country of investment.

Licence fees are normally given as a percentage of sales. They usually include a percentage to cover R and D costs in the parent factory and by this means the new factory is spared the cost of setting up its own R and D facility and at the same time ensures itself that its production will be kept in line with the latest technological advances.

The laws governing foreign investment in a country are always of a very general nature since they have to apply to the whole spectrum of industries and industrial requirements.

In the case of telecommunications enterprises, a rather unique situation applies. Firstly, they are dealing with technically highly sophisticated products. Secondly, the local market is likely to be very limited. And thirdly, they will operate at serious disadvantages with regard to export.

The general nature of the laws governing foreign investment will have to be adapted to meet these special circumstances, and concessions will need to be aimed at:

i) keeping the starting costs low

ii) protecting the current production and

iii) supporting future exports.

The first two are intimately linked with the adopted pricing policy. If a decreasing price policy is favoured, there is theoretically no need for any protection at all, provided the prices are high enough and no imported equipment is allowed in the market. But this is an unrealistic standpoint and a compromise solution will need to be reached so that prices from the beginning are as competitive as possible and at the same time secure an adequate return for investors.

Discussion will need to be made in which certain figures are assumed to be constant and other acting as interdependent variables.

The constants are:

i) the projected quantity of production

ii) f.o.b. cost of machinery and depreciation rates per step of manufacture

iii) f.o.b. cost of imported piece parts and components and cost of locally produced material

iv) labour, utilities (gas, power, water, etc)

v) licence fees

vi) required return on invested capital

The variables are:

i) Customs duties and taxes on imported plant and equipment

ii) Customs duties and taxes on imported parts and components

iii) Tariff on import protection from external competitors

iv) Price of finished product

v) Steps of manufacture

vi) Amortization period of start-up costs

vii) Deferment of profits and dividends.

A multi-equational mathematical model can be built up on this basis but it will be better to agree on certain reasonable compromises from the start in order to reduce the number of variables.

In practice, discussion centres around the following points:

1) <u>Initial Operational Period</u> (first five years)

   a) Exemption from customs duties and related taxes on the importation of plant and equipment for the factory. This will absorb a considerable amount of the start-up costs.

   b) Corporation tax exemption. (A reasonable time scale for this is ten years.)

2) <u>Current Operational Period</u>

   a) <u>Import barriers to external competition</u>. This will normally be in conformity with the Government's trade policy but its application must be very clearly defined. In particular, it needs to be stated which products and with which characteristics it applies to. On the one hand, a manufacturer cannot be expected to produce all types of telecommunications equipment within his range of manufacture. On the other hand, the importation of products fulfilling the same functions but with some variations which might put them outside the import restrictions cannot be allowed. A classical example of this would be radio-links with different frequencies. Obviously, a manufacturer who commits himself vis-à-vis the customer to supply him with the necessary equipment will not be able to manufacture all possible frequency ranges. It is therefore necessary to define the customs commodity as widely as possible, agreeing on the proposal and in conjunction with the manufacturer the exact specifications of the range of equipment required.

Special clauses can be included to the effect that complete sub-assemblies for local assembly work can be imported from the parent company at advantageous conditions when the requirement for different equipment for a one-off project arises.

b) Protection against local competition. This is a more difficult requirement to accomplish directly, but it is as necessary as the first, since normally the market will hardly be big enough for one manufacturer to operate competitively.

In giving this sort of protection, the Government accepts virtually the creation of a monopoly for one manufacturer. The manufacturer will therefore have to prove that he is not making unreasonable profit out of this situation and that he is able to meet the demands of his customer(s) in the agreed manner. Suitable legislative machinery will need to be devised to maintain regular verification of this.

c) Supply agreement. The purpose of a supply agreement is to guarantee the sales of manufactured equipment where the manufacturer is in the unique marketing position of having only one major customer and has no means of opening other markets in the country. Such an agreement, which should be subject to review every five years on average, will protect both customer and manufacturer. It will provide:

i) that the manufacturer will produce the types and quantities of equipment required by the administration in line with a jointly agreed manufacturing programme,

ii) that the customer will purchase all his requirements from the manufacturer and will not place any orders with outside manufacturers without prior consultation and agreement.

3) Support for future exports

Government help will be needed to create competitiveness by initiating exports to countries with which trade agreements exist. This may take the form of a supply agreement similar to that which exists between the manufacturer and his domestic customer. The quantities supplied to a new country even at lower prices ex-factory than on the home market will ensure a better spreading of overheads and reduce the impact of depreciation on the equipment unit. This in turn will be reflected back on the home market in the form of lower prices.

4. <u>General agreements</u>

The potential manufacturer will generally require certain financial assurances before investing in a new manufacturing operation. These take the form of general agreements which cover:

a) the repatriation of capital and profits after deduction of taxes, statutory reserves, etc.

b) the payment of licence fees and for technical information in the currency of the investor

c) the employment of expatriate personnel necessary in the context of the overall programme and the transfer of all or of an agreed part of their salaries to their own countries.

Requirements for skilled and semi-skilled labour

Overall requirements for the different grades of labour are arrived at from an analysis of the manufacturing process in question.

When production is based principally on human labour, individual work time is used as a basis for estimating output. A standard work time is established for each operation before determining the standard number of man/hours. The conversion of this final figure into individual persons on a company's payroll is then done in accordance with local regulations. The analysis of optimum usage man/machinery may then be done in the usual form, considering the priorities of low foreign capital expenditure, maximum employment of local labour and regulations regarding single/double shift working.

When the organizational structure and the number and qualification of labour on the shop floor have been accurately determined, the necessary job descriptions can be written up. Basically, they will be copies of those in use in the parent company with minor modifications determined by specific local conditions. Personnel are then selected and/or trained to match these job descriptions.

In the production of exchange and transmission equipment skilled personnel are required only in critical operations such as drilling, turning, milling and casting. Elsewhere semi-skilled personnel are suitable.

For normal assembly operations semi-skilled personnel are perfectly adequate and skilled personnel are required only in a supervisory capacity. Here, the ratio of semi-skilled personnel is largely a function of production; the greater the output the higher the ratio.

<u>Sources of finance and special problems of joint venture</u>

Manufacturers interested in establishing production facilities in a developing country will, generally speaking, look for financial partners from

a) private, semi-private or governmental enterprises in the country of origin of the manufacturer.

b) private, semi-private or governmental enterprises in the country where it is proposed to establish the new facility.

c) The P.T.T. administration (as different from the above) where the P.T.T. is to be the major customer.

The term "financial partners" in this context is used to designate only these entities which participate in the profiles of the company as shareholders. It does not include those who contribute to the financing of the operation in the form of fixed interest loans.

There are not many instances in which partners of the first category are involved. Governments normally invest in a developing country within the framework of bi-lateral technical co-operation agreements and in such an instance a national call for tender would have to be issued.

COST AREAS

Manufacturing costs may be classified under the following categories:

1. Production costs

This includes cost of materials, direct labour, indirect labour, depreciation and utilities.

2. Related costs

Rejects and other manufacturing variances, inventory adjustments, packing and shipping costs.

3. Overheads

Administration and general costs, marketing and sales promotion, finance costs, interest repayments, royalties, management fees, transfer of know-how, taxes, net income.

In addition to the running costs of the operation will be the start-up costs. This covers mainly:

a) the purchase of land

b) training of personnel (initial training)

c) the running-in of machinery

d) other manufacturing start-up costs

e) the marketing promotion costs

The amortization will be spread over a certain number of years. All these factors influence the eventual selling price of the equipment and although some are determined directly as a function of the general policy of the manufacturer and the regulations of the country of investment, others will have to be analysed in detail for every case.

In order to do this a certain amount of basic information has to be obtained from local sources. This will concern:

a) the site of the proposed factory

b) government preferences regarding location

c) the proposed incentive structure for the new enterprise

d) alternative locations and a comparison of availability of utilities, transport, labour resources, etc.

e) the cost of land

f) the cost of building on the selected site

g) the availability and cost of utilities (gas, water, power, drainage, telephone lines, etc.)

h) the cost of security

i) the cost of skilled, semi-skilled and unskilled male or female labour. This will include availability, transport to and from the factory site, regulations governing employment in country (canteen facilities, medical and first-aid facilities etc.), social charges on wages.

j) working hours, paid holidays, regulations regarding overtime, etc.

k) availability of middle and top management, salaries and social charges, educational ratings, experience in related industries.

l) depreciation regulations for buildings, machinery and

m) laws and regulations governing foreign investment (covering taxes, customs duties, repatriation of profits and capital, management fees, royalty transfer, etc.)

PRODUCTION COSTS

To determine production costs the production sequence of the equipment to be manufactured will have to be determined. They will be classified according to the different steps of manufacture as outlined in the section dealing with the organization of production. Each manufacturing step will then be the subject of a separate cost analysis to determine the most economic method of production.

This will be the most effective compromise between:

a) low foreign currency investment

b) low foreign currency recurrent expenditure

c) maximum utilization of local resources

MATERIALS (raw materials, sub-assemblies and components)

The material required for each of the manufacturing steps can be procured in order of preference:

i) through local purchase from related industries already established in the country

ii) through the firm's own local production

iii) by importation

Purchase from established local industries

Even though this procedure is preferable it should be carefully examined in terms of quality for the applications envisaged and in terms of price in relation to open market procurement. It is advisable to have this assessment made in the presence of a representative of the Ministry of Industry or the government department which is concerned with these problems.

Supply from firm's own local production

In the absence of a local supplier this is envisaged as the next possibility. A rough cross-check of the investment in machinery required against the utilization factor of this machinery as compared to the activity in the parent company will determine whether this strategy is worth pursuing or whether it is better to pass straight over to importation. The basis of comparison will be the landed cost of the imported article (with its high content of foreign currency expenditure) and imported raw material, (with its high expenditure on manufacture).

If the utilization factors are of the right order of magnitude and the projected growth of production can bring it near to a reasonably economic figure the following possibilities can be evaluated:

a) The importation of the material until local production becomes viable.

b) The investigation of the possibilities of supplying related industries in the country and adopting local manufacture from the start of the operation.

The latter possibility should again be explored with a representative of the appropriate government authority in order to ensure that the requirements of the market will be met from this envisaged source. It will also be necessary to draw up a separate agreement for manufacture with the government.

Obviously as soon as the possibility of local manufacture of sub-assemblies is envisaged this production will become the subject of a complete manufacturing planning exercise in itself. It will comprise the steps outlined above for production costs and related costs, as far as this is applicable.

The total cost of material will then be the sum of:

i) the cost of raw material and sub-assemblies bought locally

ii) production and related costs of sub-assemblies of own local manufacture

iii) landed cost of imports. (The charges for landing the material should be carefully evaluated and determined in terms of taxes, customs duties, customs clearance costs and transport to factory site.)

MACHINERY and TOOLS

Once the availability of materials has been determined the necessary machinery and tools required for the manufacture of the equipment are well defined. It can be assumed that all machinery and tools will have to be imported. They will normally be purchased through the parent company where all necessary adaptions and modifications can be made to standard type machinery.

For the importation of machinery the government normally provides special conditions such as exemption from duties and taxes.

The depreciation of machinery as part of the manufacturing costs will be determined by the experience of the parent company and by existing local regulations.

It should be kept in mind that the purchase of machinery and tools is a recurrent item of foreign capital expenditure and provision for obtaining transferable currency should be made when the manufacturing plan is agreed with the government.

TRAINING COSTS

These may be considered in two parts; the pre-operational preparatory training of supervisory personnel and of operatives, and the purely operational on-going training designed to improve capacities and skills and which is aimed at increasing productivity and efficiency. Both costs will figure in the total cost of labour as part of the manufacturing plan.

UTILITIES and RELATED PRODUCTION COSTS

Utilities will be included in the manufacturing plan in the usual form and at the costs derived from the basic information as outlined above. The continuity of utility supply and the impact of interruption on the manufacturing process will have to be determined in detail.

The utilities required will, therefore, be categorized in respect of their availability as follows:

a) utilities produced in the factory, i.e. compressed air, water, etc.

b) utilities stored in the factory, i.e. bottled gas, oil, etc.

c) utilities under continuous supply, i.e. electricity, telephone, etc.

a) <u>Utilities produced in the factory:</u> The design of the factory will ensure that sufficient space is allocated for the production and storage of these utilities and the machinery will be included in the overall heading to take care of the necessary depreciation.

A critical requirement can be water which may not be available through piped supply. The costs for surveying the territory, finding the optimal location of a well and transporting the water via a storage tank can be negotiated with the appropriate government department concerned with industrial location and industrial development policy and agreement can be reached regarding the financing and partial repayment.

b) <u>Utilities stored in the factory:</u> The only point to consider here is continuous availability. This will lead to an investigation of alternative sources of supply in case of emergencies and, where necessary, the provision of adequate bulk storage space on the factory floor plus an adjustment for higher container costs.

c) <u>Utilities under continuous supply:</u> The reliability of this supply will determine the solution to be applied. This may lead to the provision of floating batteries with alternators for certain processes, overall generating sets or a combination of both with the necessary switchgear, stabilizing units and the like.

The related production costs will be determined primarily by the manufacturer's own experience in the parent plant as well as by Company policy regulations. These will then have to be adapted to the local environment and to special customer requirements. The manufacturing variances, for example, will be a function of the ability and skills of the labour as well as of the efficiency of training and may have to be included with a higher value at the start of operations, decreasing to the standard practice level over an estimated length of time.

Packing and shipping costs will depend largely on the location of the customer, the means of transport, the handling during transport and any special provisions dictated by local climate and other influences. This might necessitate special kinds of packing and the establishment of special packing procedures.

Administration and general costs

The following functions are an integral part of the whole organization to co-ordinate control and manage as well as to perform certain additional activities:

a) Additional functions for production

production engineering and production control

industrial engineering

quality control

purchasing and shop accounting

b) Additional functions of the operation

marketing and sales

finance

labour relations

c) Ancillary functions

communications (mail, telephone, transport)

safety and social (security, first aid, canteen facilities, etc.)

d) Management

Pre-operational expenses and start-up costs

These will be chiefly the costs of initial know-how transfer and of the required technical assistance in the form of full documentation, drawings and designs, manufacturing flow-charts, the presence of specialized technicians from the parent factory for supervising the installation of machinery, the running in of this machinery, trial production runs, adaptive engineering, etc.

Some of the marketing start-up costs may have to be considered as well even though for the typical customers of communications equipment these could be quite low.

Finally, there will be the costs of the piece parts, raw material and components ordered for the production as well as the work in process before the first sales are made.

Minor items such as office furniture will not be analyzed in detail.

Design considerations

Radio design at the present state of the art is essentially a compromise between existing designs and certain special requirements. In this case, the special requirements are low-cost and operational reliability. Whether developing countries will wish to invest in design personnel is a matter of development policy: the alternatives are to use contract personnel or to commission a basic design which would be available to all countries which might wish to adopt it. In this manner tendering for components would be done on a group basis with all the advantages which this entails from the cost angle. At the same time, individual countries would be at liberty to manufacture some components where other factors indicate the economic feasibility of such an undertaking.

So far as design personnel are concerned, Fig. 2 gives the approximate break-even points. Just as the cost of equipment must be carefully considered as a function of annual production, so also must the utilisation of design personnel. It is very easy to over-staff the design section. This can be a source of embarrassment if the need arises to reduce the number of personnel because of slackening production.

Judicial use of contract personnel can give flexibility without liability. The disadvantages of a large amount of contract work are that:

i) Continuity of design is difficult to maintain

ii) Direct design costs will be higher

iii) There will be little or no training of permanent personnel.

Medium and low frequency circu

than FM and shortwave circuits and

for the user. Transistors and asso

available for the medium and low fr

tolerances in the components are f

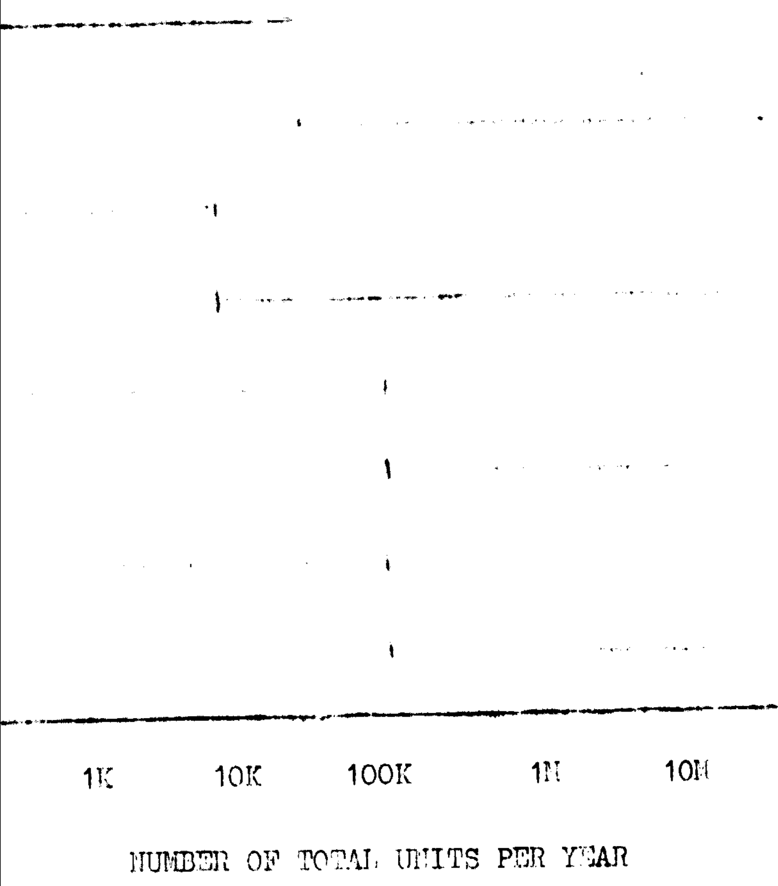
Fig. 2

<u>Design and Manufacturing Personnel</u>

Manufacturing Managerial Personnel	Contract Personnel
	Employ Personnel
Industrial Design	Contract Design
	Employ Personnel
Mechanical Design	Contract Design
	Employ Personnel
Electronic Design	Contract Design
	Employ Personnel

cuits require much less design talent
these designs are simpler to operate
sociate components are more readily
frequency bands and permissible
far less critical.

l Consideration vs. Annual Quantities



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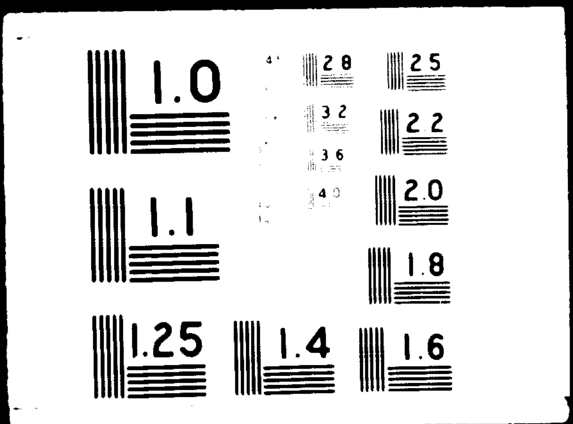


RADIO AND TELEVISION RECEIVERS

Low Cost Concept

Low cost is a relative concept and will be closely related to per capita income in the country where the receivers are produced.

It is essential that a low-cost design does not imply unreliability. The term is used to indicate that maximum value should be obtained from the cost of the system. Over-designing must therefore be avoided. The main factors which determine the cost of the product are:

i) Design - including circuit design and external appearance
ii) Quantity - and size of each production lot
iii) Buying-in prices of materials and components
iv) Cost of labour
v) Skill of labour
vi) Manufacturing facilities
vii) Quality control
viii) After-sales service or guarantee.

The most important consideration with regard to design is to provide sufficient latitude in the specifications. If this is not done, manufacturing procedures may require a critical alignment involving extra work and extra components. Low-cost receivers are not always dependent on simple circuit design. The success of the design will depend on matching the circuit with components that are satisfactory in performance, cost, reliability and availability.

RADIO RECEIVERS

The specifications given in Annex I cover three types of receivers:

Type A - low sensitivity [illegible] receiver

Type B - combined [illegible] receiver

Type C - a medium sensitivity [illegible] - [illegible] receiver

Each type of receiver is adapted to a particular broadcast transmission system. The area to be covered, the type of terrain and the kind of interference problems likely to be encountered in the area will determine the transmission system. Frequencies from [illegible] kHz to 1600 kHz are classed as the MF band. Broadcast transmissions in this band are amplitude modulated and the coverage is mostly ground wave for reliable reception. With good atmospheric conditions propagation up to 1600 kilometres is common with 50 KW of transmitter power but about 300 kilometres is average for day time reception. Medium frequency reception is highly susceptible to electrical interference, both atmospheric and man generated.

Frequencies from 5 MHz to 30 MHz are classed as the HF band. Transmissions are typically amplitude modulated and are most useful where long distance communication is required. The sky-wave component is the one which gives the range but it is very susceptible to ionospheric propagation conditions. Antenna beaming is usually employed to improve reception but receiver design becomes more critical as the frequency increases and this influences the cost.

Transmissions in the 88MHz to 108 MHz band are frequency modulated. Amplitude limiters can be employed in the receiver circuitry and greatly [illegible] [illegible]

Power requirements

[illegible] power supply [illegible] "A" [illegible] current [illegible] Class "B" audio output circuit [illegible] that it requires [illegible]

The considerations [illegible] to the production of transmission [illegible] apply to the production of radio receivers.

The mechanical functions of a radio receiver are

i) To protect the components from the environment

ii) To enhance the appearance of the receiver

iii) To provide the necessary controls tuning, tonality, audio level on - off

iv) To integrate electrically and mechanically all the components of the receiver

v) To provide a visual tuning indication

iv) To protect the user from dangerous voltages in mainspowered receivers

vii) To provide the receiver with a suitable pack for transporting

Cabinet Material

The choice is basically between woods and plastics. Wood has numerous disadvantages. It is not a suitable material for use on a large production basis, cabinets require a fairly high level of skill on the part of cabinet makers, strict dimensional tolerances are harder to achieve and to maintain with wooden structures and unless properly sealed some woods are capable of absorbing enough moisture to make them electrically conductive. Dangerous potentials need therefore to be carefully isolated from wood cabinets

Nowadays, plastic materials and in particular polystyrene are used extensively in the manufacture of receiver cabinets throughout the world. Its advantages are ease of fabrication, uniformity of product, low material cost, dimension stability, excellent insulation properties and very low moisture absorption.

Against this must be ranged the large initial investment required for injection-moulding equipment and the sophisticated engineering required in the design and production of the moulds. Costs are in the region of £50,000 for a 24 oz shot injection moulding machine, the size required for a table model radio receiver cabinet, and the moulds for this size of cabinet can cost up to £75,000. On the other hand raw plastic costs are low, typically around 10 20 per pound, and an output of one per minute approximately can be achieved with this equipment.

Printed Circuit Boards

Fig. 3 also reveals another major consideration in the production of domestic radio receivers: the use of a printed circuit board versus the hand wire chassis. However, the benefits conferred by the use of the PCB in quantity production make this a dilemma which is more apparent than real. Nevertheless, a substantial initial investment is involved in the design and production of P.C.Bs. This investment would have to cover accurate industrial camera equipment, silk screen printing facilities, etch lines, roller tinning lines, a large drilling capacity and/or pierce-and-blank press facilities, facilities for the analysis and control of chemical processing and a large inspection department.

Normally, P.C.Bs for domestic radio and television applications are etched from 1 oz per sq. ft. copper foil supported on a SRBP substrate. However, where conditions of high humidity prevail epoxy glass would be indicated but with a consequent increase in unit cost.

With SRBP pierce-and-blank operations present few problems although an appropriate grade would need to be specified. If epoxy glass is used hand or stylus drilling will be required for certain hole sizes and this in turn raises production and material problems. Solid carbide drills are required for this operation and problems of resin-smear can be critical in certain applications.

Complete circuit boards can be purchased from vendors but where pierce-and-blank operations are involved tool costs must be paid for by the purchaser. With a circuit involving 200 to 250 perforations the cost of one pierce-and-blank tool would be in the region of £750.

Hand wired Chassis

The use of a hand wired chassis involves very little tooling and other initial investment. The only major component is a metal stamping with a few mounting holes A hand wired chassis obviously requires much more direct labour than a PCB since each connection must be hand crimped around a mounting terminal. Soldered terminals in turn must be connected to the main metal chassis

Hand wiring is subject to operator variations which are difficult to control especially when using unskilled labour. Product uniformity suffers as a consequence and quality control and inspection are difficult.

New producers with limited resources would be well advised to purchase PCB requirements from an established vendor whether or not automatic soldering techniques are going to be used

Low Cost Television Receivers

The same general considerations apply to the manufacture of television receivers as for radio receivers with the proviso that here one is dealing with a technically much more complex product. However, experience has shown that low production assembly of monochrome television receivers does not require experience or skilled labour for the actual assembly operations. Production-line assembly techniques can be satisfactorily mastered with as little as two weeks training. This, of course, presupposes that assembly operations are broken down to the point where each operator performs a limited number of operations. It is important to note that countless hours have been wasted training operators in theoretical and technical details which have no utility.

No two markets would be expected to display the same requirements or identical manufacturing conditions. An ideal market development programme would permit a logical transition from importation of complete receivers to the ultimate goal of supplying most components from local industry.

The following sequence might be taken as a scheme for this programme:

1. Complete receivers - ready for immediate operation
2. Receiver less cabinet - a completely tubed, tested and aligned chassis, plus front panel, hardware and picture tube, requiring only installation in a locally produced cabinet
3. Semi-kits - basically a kit but with PCB(s) completely assembled and tested. Depending on individual circuit design the PCB(s) may contain up to 90 per cent of the receiver circuitry

4. **Kits** - [illegible] all components necessary to assemble receivers [illegible] at this stage [illegible].

5. **Partial [illegible]** - [illegible] produced [illegible] the imported [illegible].

6. **Components** - [illegible] permits the [illegible] multiple [illegible] to the point [illegible] a kit. The [illegible] will [illegible].

Figure [illegible] production volume of 1,000 radio [illegible] the total area required [illegible] sq. ft.) for an output of [illegible] per month [illegible] this down to [illegible] sq. metres [illegible].

Fig. 4.

APPROXIMATE [illegible]

[illegible] ASSEMBLY

1000 Sets Per Month	Square Metres	Square Feet
Materials Warehousing	[illegible]	4000
Production	[illegible]	4500
Finished Goods Warehousing	[illegible]	4000
Services and Miscellaneous	110	1200
TOTAL	[illegible]	[illegible]

Production Techniques

Step-by-step production technique is subject to many possible variations, depending on the actual design of the receiver and upon the desired rate of production. Generally a wide bench layout is employed and both sides are used. The configuration of the layout is adapted to suit the requirements of the available production area.

A proven technique for the small volume manufacturer is to purchase several complete sample receivers of the type to be produced from kit form. At least one is retained as a control sample; at least one is used for alignment training and technician training in fault finding. At least one sample is completely stripped down, step by step, with each step being written down and photographed. The positions of components and wires are sketched and each part is given an identification on the list of materials and on the receiver technical data sheet. This process is carried to the point where all parts are removed and the original receiver is reduced to the status of a kit of parts. This sequence when reversed then becomes the assembly schedule. Additionally advantages are [illegible] from [illegible] with the receiver layout and construction, with the [illegible] assembly sequence, and with the identification of parts on the list of materials.

ASSEMBLY

The assembly process can be divided into three groups

i) sub-assemblies

ii) chassis assembly

iii) final assembly

The Sub-assemblies comprise the following:

a) The [illegible] Mounting Assembly ([illegible] unit)

b) The Printed Circuit Board

c) The High Voltage Cage

d) The Control Sub-assemblies

<u>Chassis Assembly</u> includes:

a) Chassis riveting

b) PCB eyeletting

c) Component mounting

d) PCB mounting

e) Chassis wiring

f) Inspection

g) Test and alignment

It should again be noted that technician skills are not required in the test and alignment process as a basic routine is established such as:

1) Resistance test for power supply short circuits

2) Application of power and measurement of power supply voltages

3) Disconnection of power and connection of oscilloscope and deflection yoke, a speaker, and the alignment equipment specified by receiver manufacturer.

4) Re-application of power, checks on operation of video and deflection circuits and noise from speaker.

5) Alignment of Tuner/IF link, Picture IF, overall response, Sound IF.

Two weeks is usually sufficient to train inexperienced and unskilled operators to handle this work efficiently. With the completion of the test and alignment the chassis is ready for installation. It is at this stage in the process that operational defects first occur. For this reason the repair section is usually located adjacent to the test and alignment position.

<u>Final Assembly</u> comprises:

1) The installation of the mask and the picture tube, the speaker, the complete chassis with timer mounting assembly, auxilliary controls and antenna terminals, trim items and control knobs, and the picture tube neck components such as the deflection yoke.

2) Final set-up and adjustment of all receiver functions.

3) Final inspection.

4) Operational test.

MANUFACTURE

Decisions on whether to make components or to buy them.

When initiating the manufacture of radio receivers and other telecommunication equipment the overall developmental strategy of the industry must receive extremely careful consideration. Long term commercial viability will depend on this strategy and on how it is implemented. A situation of technological stagnation can quickly be reached by selecting the wrong priorities.

Obviously vertical integration is profitable only where a large production base justifies the investment. But component manufacturing is a highly competitive business and a decision to enter this field should weigh carefully the cost of setting-up of production facilities against the loss of competitive bidding.

Developing countries possessing comparatively unsophisticated machinery and tools may be able to produce from the start such items as AF and IF transformers, RF coils, film capacitors and simple switches. With delicate materials such as ferrites it would be impractical to introduce local production until a substantial manufacturing base has been attained.

Fig. 5 presents in graphic form some of the typical vertical integration decisions; the points where domestic production of certain items becomes economically feasible. These points, it is important to note, are based on American production techniques and figures. With labour intensive techniques of manufacture the cut off level would be considerably lower. It must also be noted that the abscissa is in units of identical models per annum.

Fig. 5

Basic Design Considerations vs. Annual Production Quantities

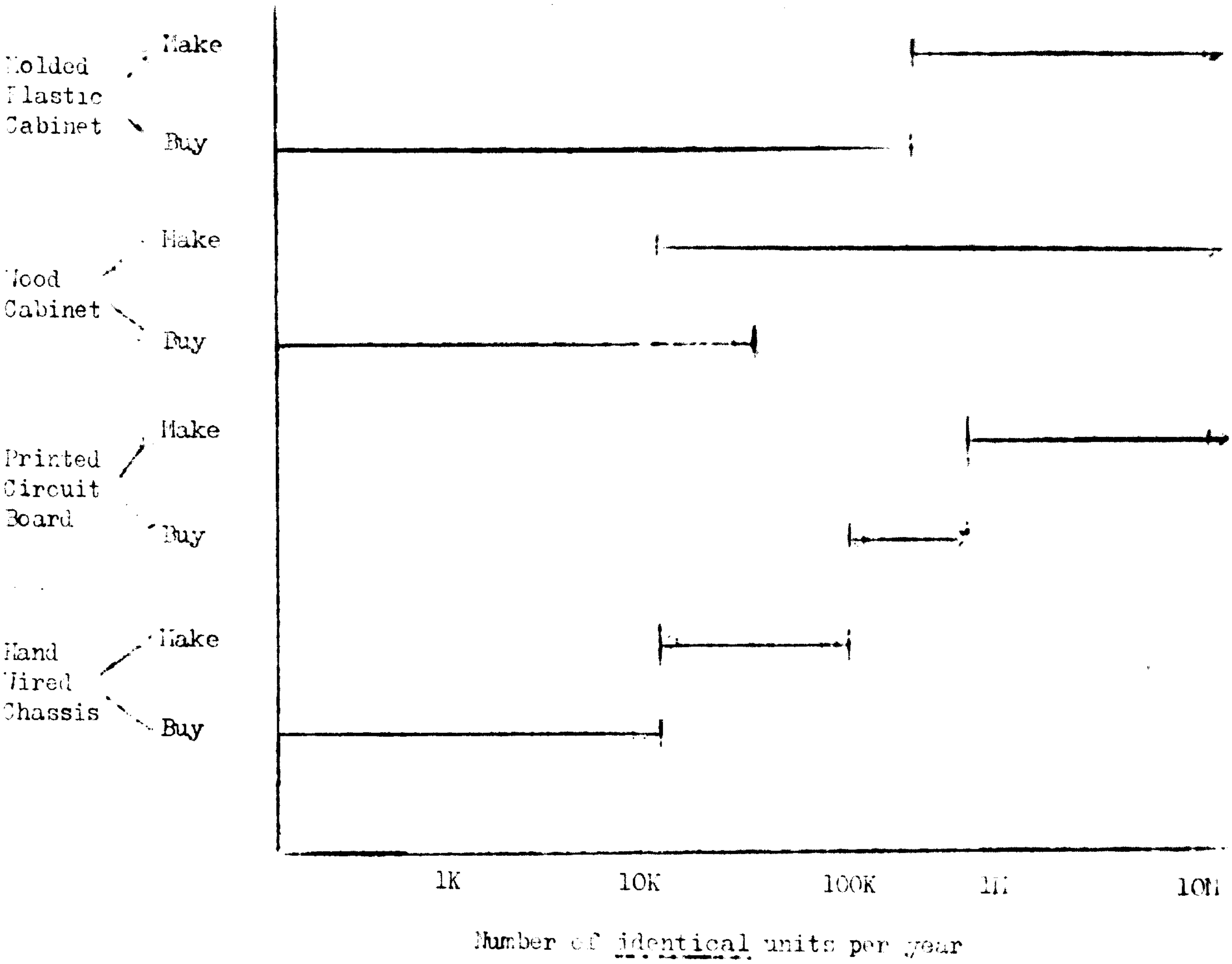
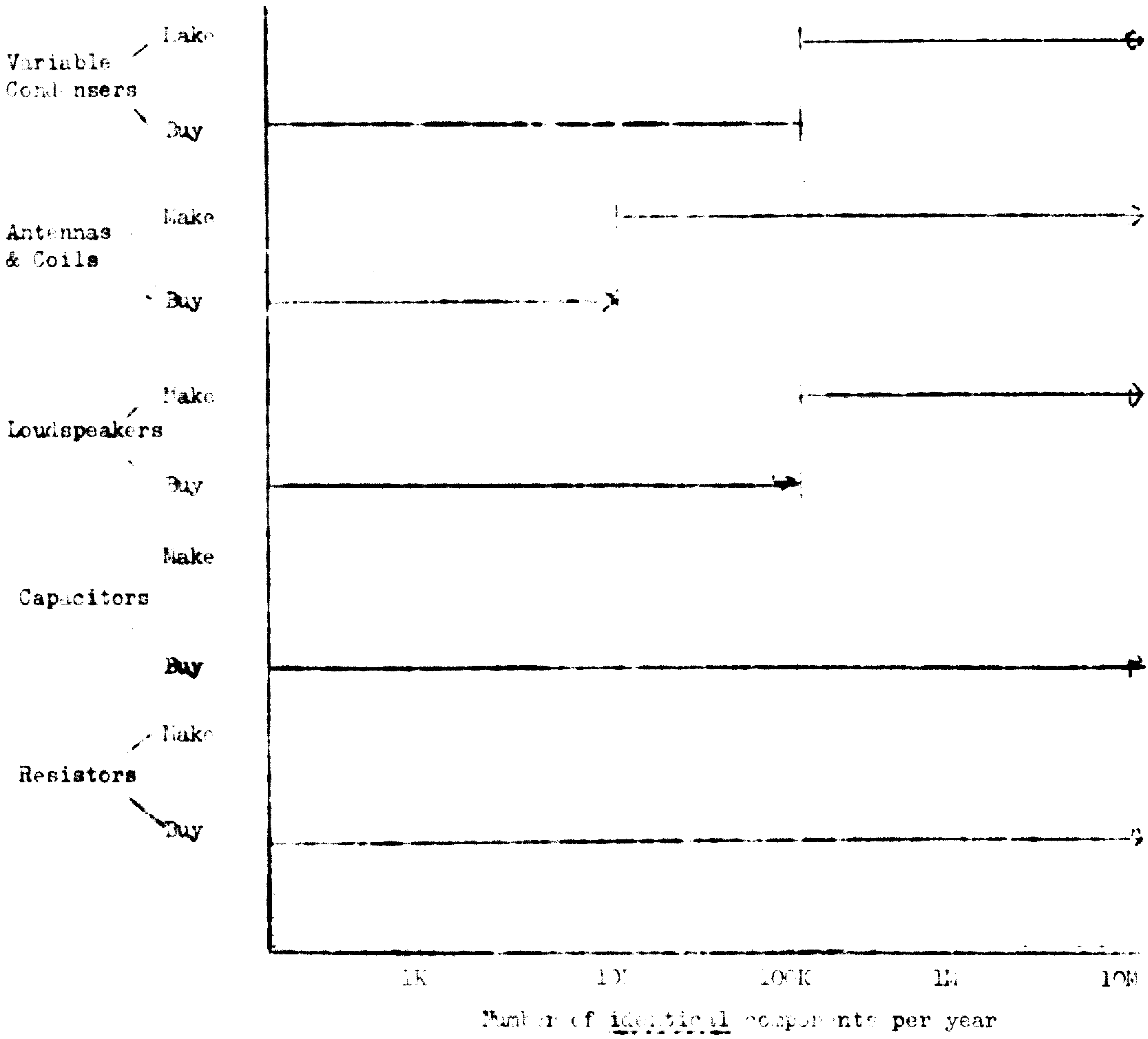


Fig. 6 depicts some of the vertical integration decisions that need to be made as a function of identical components per annum. The same reservations as ere made with Fig. 5 apply together with the structure that many good plans have gone astray because the proliferation of component variations as the design concepts evolved was not foreseen in the original planning. Very strict design disciplines are necessary to make extensive vertical integration economically feasible. A radio

Fig. 6

Vertical Integration Considerations vs Annual Production Quantities



manufacturer who decides to embark on the production of loud-speakers, for example, places himself in direct competition with component vendors that have a volume base of millions of units per annum.

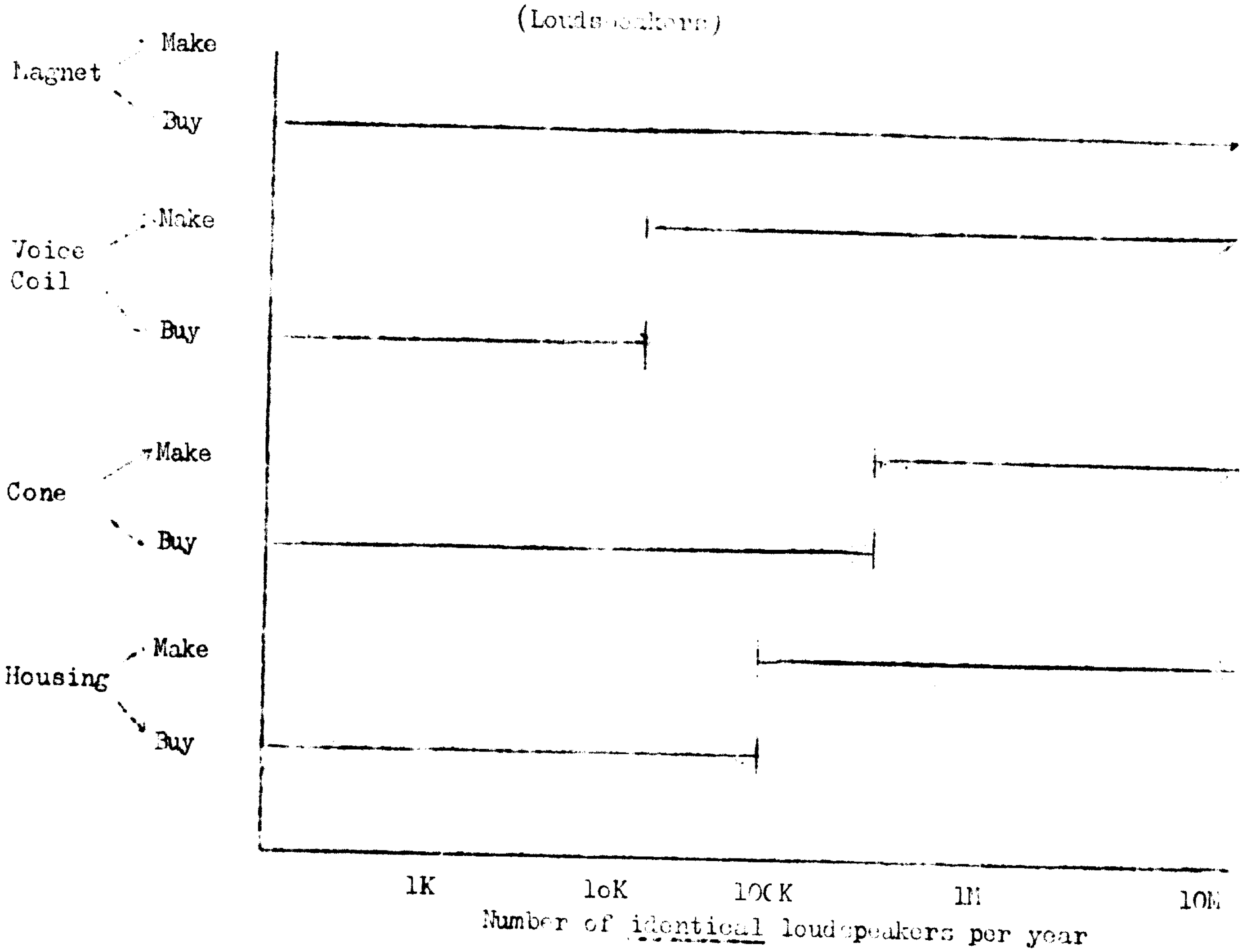
Fig. 7 shows that there are further decisions to be made even after the decision to manufacture a component. In this example the component parts of a loudspeaker are examined to determine which parts should be made and which should be purchased.

It will be evident that, as an extension of this, these items can be subject to further analysis until the raw material base is reached. Equally obviously each decision must be made in the light of the particular geographic location of the manufacturer. It may well be that indigenous raw materials or a favourable labour situation will make it possible for him to manufacture some of the components competitively.

Fig. 7

Design Consideration for Partial Vertical Integration

(Loudspeakers)



Problems of material handling and production facilities

[illegible] depend [illegible] kind of factory layout employed [illegible] metres will also be sufficient [illegible] radio receivers per month where flow operation [illegible] conveyor [illegible]

[illegible] with work-benches arranged along each [illegible] advantages [illegible] rationalization of production [illegible] uniformity and efficient control.

A typical flow operation system displays the following characteristics:

a) Work time on each process is evenly distributed.

b) Lay-out of each process is evenly [illegible] according to the order of assembly [illegible] delayed in transit [illegible] moved in reverse sequence [illegible] process by [illegible] one stage.

c) Work transportation is performed by powered conveyors minimizing transportation problems and labour employed.

The specifications of a dual belt system are given below:

Length of belt conveyor		30 metres
Effective total length		60 metres
Belt width		30 centimetres
Belt height above floor		75 centimetres
Belt speed (m/minute)	adjustable from	0.5 to 2.0
Work benches (48)	length 90 cm x	width 70 cm

Wiring and piping should be considered from the point of view of easy adaptability to changing processes.

Basically, the operating procedure is as follows. The work passes along the line through a series of assembly stages. Since it is necessary that no errors occur in the assembly work the products are gated through a series of check points set up along the line. Here it is tested and checked for acceptance and then allowed to advance along the line. Repaired work is injected into the line at the check point where incorrect assembly was discovered.

Process Analysis

Process analysis is carried out to divide each process into the most effective average unit of time. Assuming that each process is to be divided into 60 second pitch times, the net work is determined by a formula of standard time $N = 60' \times (1 - 0.20) = 48'$ where N is the net work time and 0.20 the standard allowance rate, which takes into account factors such as fatigue which will modify the standard work time.

A radio receiver undergoes approximately the following processes:

i)	mounting	20
ii)	wiring	5
iii)	aligning	4
iv)	cabinet assembly	8
v)	encasing	5
vi)	final testing	4
vii)	packaging	5

The figures on the right indicate the number of sub-divisions in each process. The number of man hours required is determined by multiplying the pitch time ([illegible]0 secs.) by the number of process. The result 0.65 is used as a basis for the output calculation.

Basically, process analysis determines the most efficient operating procedures and the most appropriate methods of using jigs and tools. The results of process analysis are used to determine the lay-out of the flow operation system, the content of each operation in the chain, the number of operators required and the work time involved.

Process Control

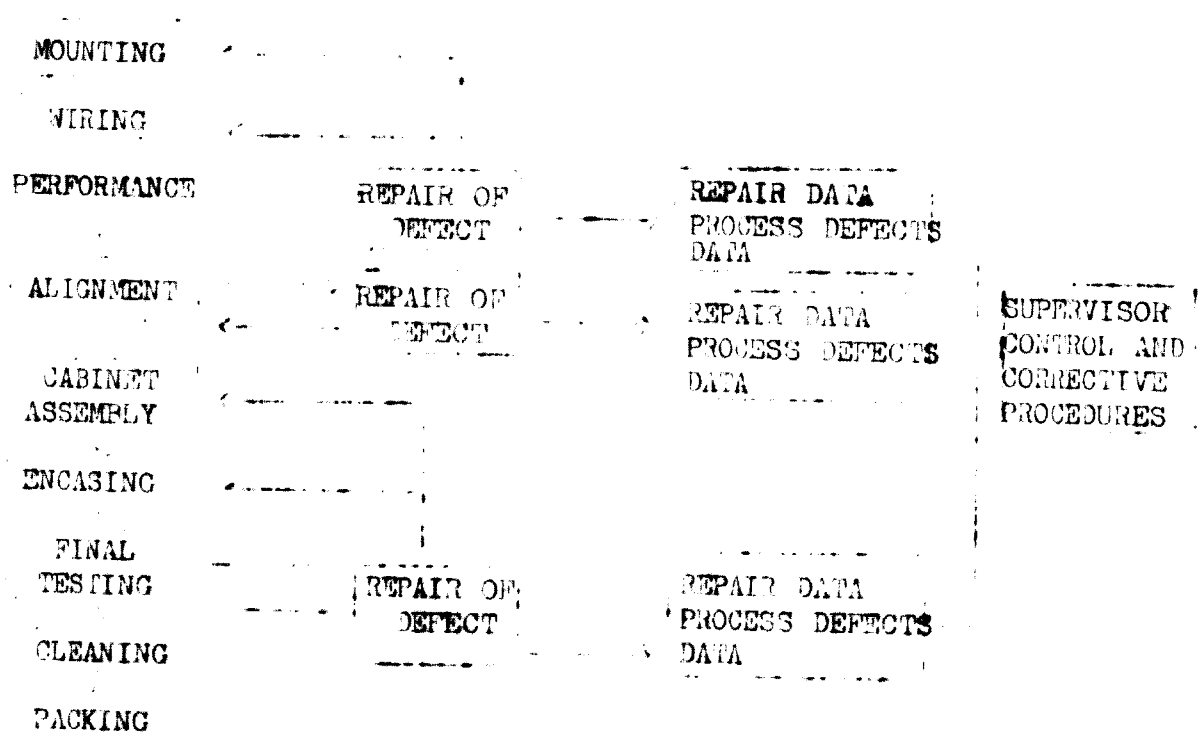
Process control is the system which ensures the application of the results of process analysis. It implies physical control of the operation of each process. This task is usually performed by the chief supervisor who is responsible for correct work and for the institution of effective counter-measures against defective assembly work.

Personnel distribution is planned from the production flow chart and is carried out by the production supervisor who allocates to each operator the task most suited to his aptitudes and abilities.

It is one of the characteristics of flow operation that work is halted if one process is suspended. Hence there is the absolute necessity of securing standby personnel to take the place of any absentee among the workers allocated to the processes. The amount of standby personnel is a function of the overall rate of absenteeism.

Analysis of the flow chart will determine the layout of the flow system. In particular, the location of alignment, repair and inspection stations needs to be carefully studied. When this is settled there must be a verification that all items and components for each station are correct, an examination to ascertain whether jigs are necessary for some operations and the preparation of all test instruments at the appropriate sites. Instruction sheets are then prepared for each operator and check loops inserted into the system. Fig. 10 presents the resultant configuration in diagrammatic form.

Typical flow charts for the production of radio receivers Types A, B, and C are appended in Annexure 3, together with a table identifying and giving brief specifications of the test instruments employed.



Organizing Production

Once the areas of equipment and quantities have been defined, the questions of manufacture and of production organization will have to be considered.

The term "manufacture" is often used as opposed to "assembly" to differentiate it from the simple piecing together of what might be called a kit of parts.

However, a genuine assembly of bought-in parts may well be considered as a first useful step towards local manufacture. It is convenient in this context to abandon the use of the term "assembly" and to define production in terms of "degrees of manufacture". To do this the full manufacturing process of the equipment under consideration is divided into its major segments and the number of these segments performed locally will be used as an index of the degree of manufacture.

With most types of transmission equipment the basic steps of production are:

1) rack testing
2) rack assembly
3) subrack testing
4) subrack assembly
5) cabling
6) printed circuit testing
7) printed circuit assembly
8) incoming inspection, electrical and mechanical
9) printed circuit board manufacture
10) framework manufacture
11) coil assembly and test
12) coil winding
13) metal piece parts
14) plating
15) plastic moulding parts
16) jacks and plugs
18) component manufacture

These basic steps can be grouped as follows:

Step		Manufacturing degree
1	----- 5	1 (pure assembly)
1	---- 8	2
1	---- 12	3
1	---- 15	4
1	----- 17	5

18 may be considered as a separate industry.

These groupings will differ according to the type of equipment manufactured and according to the philosophy of the manufacturer who may further subdivide each of the basic operations, but the principle remains.

Obviously the ultimate aim of an enterprise -and of the administration concerned- will be to produce locally as much of the equipment as possible, with the highest degree of manufacture that id economically feasible. But many of the manufacturing steps of basically different equipment are similar and can be performed by the same operators using the same equipment even though the tools may differ. This leads automatically to the acceptance of a sequential plan of manufacture in which the producer starts with manufacturing degree 1 of the most promising type of equipment as defined by his market research, and gradually augments the degree of manufacture. Other products may be added as soon as the volume of demand indicates the feasibility of economic production.

Experience has shown that where switching equipment is concerned an output of 30-40.000 lines per year is the lower limit for economic production. This can be catered for in one workshop. Where an output of 100,000 to 200,000 is contemplated some of the sub-assembly work, relays and machines will require a separate facility.

The table in fig.2. illustrates the average production time per 1000 lines.

Items	Rotary hours	Crossbar with electronic control hours	Crossbar with electro-mechanical control hours	
Component production			Type I	Type II
pressing	1200	1000	[illegible]	800
milling	400	200	[illegible]	100
automatic tools	1000	600	1600	1000
turret lathe work	700	200	400	200
drilling	700	300	700	400
tool making	400	100	400	200
fitting	1400	2300	2600	1400
casting	100	-	100	-
plastics	800	1500	2500	1500
mechanical work	500	10000	1000	700
Assembly				
switches		4000	3700	2300
relays	4700	4200	5400	3300
other devices	3800	600	12000	7800
cabling	1100	2800	7100	4500
final assembly	11000	100	[illegible]	7000
Control				
electrical tests	20	16000	500	300
Total	27820	43900	[illegible]	31500

Table 3. gives the average material requirements per 1000 lines

	kg	kg	kg	kg
Soft magnetic iron	[illegible]	1120	[illegible]	1300
iron materials	[illegible]	[illegible]	[illegible]	6000
non-ferrous	[illegible]	770	[illegible]	1365
precious metals	1813	6465	16091	30000
wire for coils	407	508	810	850
cable wire	302	1867	1333	270
switch cables	-	3000 metres	15560 metres	5000 metres
plastics	403	217	180	160
laminated board	159	159	270	110
transistors	-	7364(number)	360(number)	-
diodes	-	23496(number)	10000(number)	1000 (number)

Workshop area

Table 4. gives the average number of M^2 per worker in exchange production.

Shop	M^2
pressing	8
milling	6
automatic tools	8
machine	6
drill	6
repair	4
tool making	10
precision tools	6
fitting and cabling	7
finishing	11
electrical tests	11
plastics	10

Electro-plating requires approximately 70,000 M^2 where production of exchange equipment of 100,000 lines is contemplated and double this area would be required for painting. Obviously, the area allocated to these processes will be determined by the number of shifts employed. With three shift operation 600 M^2 respectively would be sufficient.

DISTRIBUTION and SERVICING

In the case of transmission equipment the question of distribution hardly arises. The PTT administration is likely to be the main if not the only customer. Installation is carried out under the supervision of the manufacturer, who is required to demonstrate that the equipment functions according to specification. Routine servicing is assured by the technical staff of the PTT and normally plays no part in the manufacturing agreement. However, in the case of private installations a service agreement may be drawn up between the manufacturer and the customer and routine maintenance and servicing will then be assured by the factory's technical personnel.

It is with radio and television broadcast receivers that distribution and servicing are likely to present problems. Normally these receivers are sold with an express or implied guarantee of reliability. This guarantee is important since it forms an essential component of product consumer appeal and no one is likely to buy a receiver nowadays without this guarantee. Generally, the term of guarantee should not be less than one year and it is the instrument by which the manufacturer assumes responsibility for repairing product defects without charge to the customer except where these defects have been caused by careless handling.

The reliability of broadcast receivers depends upon the technique of quality control, the level of manufacturing skill and the performance of the components used. Design technique may also be responsible for reliability under certain circumstances.

It is advisable to keep a close check on the defects of receivers sold to customers and to ensure that these data are passed on to the design and manufacturing sections in order that appropriate countermeasures may be instituted.

Costs of repairing defective products during the term of guarantee must be included in the product cost. The amount of repair expenses may be estimated statistically from the market results data and from the factory quality control data. In general terms, a factor of about one percent of product factory cost may be taken into account as expense incurred for guarantee of radio receivers. With television receivers this factor is considerably higher.

Most product defects occurring during the guarantee period are minor ones, easily dealt with by ordinary service technicians. Major defects are usually due to bad design and/or manufacturing techniques.

If skilled service technicians are not available in the dealer and distributor network the manufacturer will have to institute a repair group to carry out centralized repair work. This group will, in the case of radio receivers, have to be independent of the design section and production line. In the case of television receivers it is advantageous in the very early stage to expose the technical personnel to field failure problems and this can run parallel with the in-plant training of service technicians. From this point it will be appropriate to consider each category of receiver separately since distribution, installation and servicing do not present the same problems for each.

Radio Broadcast receivers

The distribution network for radio receivers in developing countries covers a very wide system of outlets. These may range from dealers actually specializing in electronic equipment down to general department stores and ordinary traders. Installation presents no problems: it is simply a matter of connection to an appropriate supply or the fitting of batteries.

Regarding after-sales service, replacement parts for all receiver models must always be kept in stock at the repair station. Replacement parts totalling about one percent of the marketed products generally proves adequate. Repair stations should be provided with test instruments such as volt-metres, ohm metres, audio oscillators, RF test oscillators and C.R. oscillascope equipment.

Television broadcast receivers

Due to the nature of television broadcast transmissions with its limited coverage (normally line-of-sight from the transmitting antenna) the market is rather compact. It will be confined initially at least, to one or a few densely populated areas of which the capital will be the most important.

Customer satisfaction is related directly to the quality of picture received and this is directly related to the quality of signal delivered to the antenna terminals of the receiver. In many installations a very simple antenna within the receiver cabinet will perform effectively but others, especially in fringe reception areas, may require complex outdoor antenna installations. Most receivers have a 300 ohm balanced antenna input. For optimum results antenna lead-ins must match this impedance.

Although factory servicing is recommended initially as the market grows the point will be reached where the outside service load will interfere with normal plant production routine. The service function complete with a stock of replacement parts and tubes, and the necessary test equipment will then have to be relocated outside of the plant. As the service load grows additional servicing branches will have to be added or independent service dealers trained to assume some of the servicing responsibility.

It is advisable to cater for servicing needs at the time of initial kit and/or component purchase in order to obtain the advantages of bulk prices. Sufficient extra parts and components should also be ordered to cover production line losses and in-plant component failures.

It should be stressed that the satisfactory development of the television broadcast receiver market will depend to a large extent on the adequacy of ater-sales servicing facilities.

TRAINING

The success of any manufacturing enterprise depends, among other things, on an adequate material base and on the competence of its employees. The relatively high labour content required in the manufacture of telecommunications equipment makes personnel skill a peculiarly critical area. Management must therefore direct its attention to this area if the enterprise is to be successful. Skills are developed by training and the importance of this activity cannot be overemphasized.

So far as the manufacture of transmission and switiching equipment is concerned training will inevitably be concentrated on producing competent engineers and plant operatives. Strong training programmes need to be developed in these two areas.

Engineer Training

Companies engaged in the manufacture of telephone equipment in the developing countries are faced with two major problems with regard to engineering talent. First, they are obliged to develop level of competence sufficient to meet the engineering challenges of the present. Second, they are involved in a constantly and rapidly developing technology and they have to make certain that their engineers' knowledge and competence are continuously updated to meet the demands of future development. The engineering force needs capability not only on the design and manufacturing side but also on the design, installation, operation and maintenance of the communication network.

The problems of providing for this kind of expertise are accentuated by the fact that no institution of higher education provides a curriculm specifically designed to meet the needs of the telephone industry.

Manufacturers in industrialized countries are faced with similar problems but they have the advantage of many years of experience in this field and can provide adequate in-service training for their young engineers. They also have the advantage of being able to draw on a substantial academically well-prepared labour pool.

The developing countries, on the other hand, have a shortage of academically well-prepared engineers and the opportunities for advanced professional training are limited. However, some of these difficulties can be resolved by

a) drawing on the technical skill available in the training centres of industrially developed countries,

b) sending engineers on training courses and making provision for them to train other engineers on their return,

c) drawing on expatriate instructors to conduct short term training programmes in specific areas.

Supervisor Training

The training of supervisory personnel needs to be adpated to the specific requirements of the individuals selected. Basically, the training should cover three inter-related areas

a) General supervision (industrial psychology, management techniques, organization and control, work planning, record keeping, and the relationship of the supervisor to production and profits.)

b) <u>Job function training</u> (the detailed knowledge of the manufacturing process under the supervisor's control, the planned sub-division of individual functions, job descriptions of the individual functions, performance standards, machinery and tools, maintenance engineering, information and training of supervised personnel.)

c) <u>Environmental Training</u> (general information on the job and it's relation to the overall activity of the factory detailed knowledge of the preceding and the subsequent manufacturing processes, relationship of the factory to the parent company, relationship of the factory to the national environment and its contribution to the economic development of the country as a whole.

Experience has shown that the overall training requirements can be most conveniently divided into a preliminary course designed to enable the supervision to execute his function, and on-going training to develop his additional skills and abilities.

<u>Operator Training</u>

Historically, much of the training of production line operators has been done in the form of on-job training in the production line itself. This is usually carried out under the supervision of the supervisor or of a senior operator. In some circumstances this is the only feasible method of operator training but it leaves much to be desired in terms of training efficiency.

The training itself should be based on a careful study of the job the operator is required to perform. Job function analysis is used to determine precisely the knowledge and the skills required, extraneous matter should be rigorously excluded, and the training should aim at teaching the required skills in a way which will enable the operator to perform at peak efficiency.

At the same time the operator should receive a full orientation course which will relate him and the job he is doing to the company as a whole and to the final product. The orientation course should also familiarize him with the working hours and the pay schedules of the company and with the health and welfare benefits. Information about the plant lay-out and organization, the relationship of the plant to the national economy and the operator's part as a member of the firm may also be included.

ANNEX I

PERFORMANCE SPECIFICATIONS FOR LOW-COST SOUND-BROADCASTING RECEIVERS

These specifications apply to the following types of receivers:

Type A: a low sensitivity AM receiver,

Type B: a combined AM/VHF receiver,

Type C: a medium sensitivity VHF-FM receiver

1. General

1.1 Each of the three types of receiver should be available for either mains or battery operation. For battery operation, all three types of receiver should be fully transistorized to ensure economy of power consumption. For mains operation, either valves or transistors may be used, consideration of cost being the guiding factor.

1.2 For battery-operated receivers, the minimum performance specifications listed in this Recommendation should be achieved for the nominal battery voltage less 30% as specified in the relevant I.E.C. publication.

1.3 The methods of measurement employed should be those recommended in the relevant I.E.C. publications for amplitude-modulation receivers and frequency-modulation receivers. (See Recommendation 237).

1.4 The receivers should be simple, robust and well protected against dust. Those intended for use in regions of high temperature and humidity should be treated so that they can be used under the climatic conditions laid down by the Administration concerned. The appropriate tests required by the Administration procuring such receivers should comply with the relevant I.E.C. publications.

1.5 If national regulations prescribe methods of measurement or tests differing from the standard I.E.C. methods, Administration will, where necessary, draw attention to this.

2. <u>Specification for Type [illegible] receivers</u>

2.1 Frequency coverage: 5[illegible] - [illegible]5 kHz

2.2 Sensitivity for 50 mW output 30% modulation at 400 Hz: 5 mV/m (with a built-in antenna with facilities for using an external antenna).

2.3	Signal/noise ratio for input as under § 2.2	20 dB (mains-operated tube receivers) 26 dB (transistor receivers)
2.4	Power output, for less than 10% distortion	not less than 0.1 W
2.5	Overall selectivity	
	at - 6 dB points	passband not less than ± 3 kHz
	at - 20 dB points	passband not greater than ± 10 kHz
2.6	Image, intermediate frequency and spurious response ratio	not less than 30 dB
2.7	Overall fidelity including acoustic response of loudspeaker	250-3150 Hz, within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100-4000 Hz within 12 dB limits (in a graphical presentation 400 Hz should be taken as the reference 0 dB level)

3. <u>Specification for Type B receiver</u> (the two types differing only in frequency range).

3.1	Frequency coverage	B1 0.[illegible]-1.6[illegible] 2.[illegible]-16 MHz B2 0.525-1.60[illegible], [illegible]-[illegible].7[illegible] MHz The receiver shall be provided with adequate mechanical and/or electrical means for easy tuning.
3.2	Sensitivity for 50 mW output 30% modulation at 400 Hz	not worse than 1[illegible]0 µV
3.3	Signal-to-noise ratio, for input as under 3.2	20 dB (mains-operated tube receivers) 26 dB (transistor receivers)
3.4	Power output, for less than 10% distortion	not less than 0.1
3.5	Overall selectivity	
	at - 6 dB points	passband not less than ± 3kHz
	at - 20 dB points	passband not greater than ± 10kHz
	at - 40 dB points	passband not greater than ± [illegible]0kHz
3.6	Image, intermediate frequency and spurious response ratio	MF - not less than [illegible]0 dB
	Intermediate frequency and spurious response ratio	HF - not less than 12 dB
	Image response ratio	HF - not less than [illegible] dB
3.7	Overall fidelity including accoustic response of loud-speaker	250-3150 Hz within 18 dB limits

Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be: 100-4000 Hz within 12 dB limits (in a graphical presentation 400 Hz should be taken as the reference 0 dB level)

3.8	A.g.c. performance: change in output when the input is reduced by 30 dB from 0.1 V	not greater than 10 dB
3.9	Frequency stability	must be such that the receiver does not require frequent retuning

4. <u>Specification for Type [illegible] receivers</u>

4.1	Frequency coverage	87.5-108 MHz
4.2	Signal-to-noise ratio	30 dB
4.3	Sensitivity (noise limited)	- 75 dB rel. 1 mV (at a signal-to-noise ratio of 30 dB and 50 mW output power)
4.4	Intermediate frequency	10.7 MHz
4.5	Amplitude-modulation suppression ratio	20 dB
4.6	Power output	not less than 0.1 W
4.7	Overall selectivity	- 30 dB at ± 300 kHz
4.8	Overall fidelity including acoustic response of loudspeaker	200-5000 Hz within 18 dB limits
	Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100-5000 Hz within 6 dB limits (in a graphical presentation 400 Hz should be taken as the reference 0 dB level)
4.9	Radiation	The local oscillator radiation should be less than the limits specified by C.I.S.P.R. However, where national regulations exist, the radiation should be less than the limits specified therein.

4.10	Distortion	The distortion should be less than 5% for a frequency deviation varying between 15 kHz and 75 kHz with a modulation frequency of 400 Hz and an output power of 50 mW
4.11	Frequency stability	Must be such that the receiver does not require frequent retuning

Recommendation 416

1. General

1.1 The receivers should be simple, robust and well protected against dust. They should also be strong enough to withstand transport and handling by unskilled persons.

1.2 The pre-set tuning controls should be available only to authorized persons. The controls should be robust and include a channel selection switch, a fine tuning control to facilitate accurate tuning and compensate for any frequency drift during operation, and a volume control.

1.3 Each of the two types of receiver considered in §§ 2 and 3 should be available for either mains or battery operation. For battery operation the receivers should be fully transistorized to ensure economy of power consumption. For mains operation, either valves or transistors may be used, consideration of cost being the guiding factor.

1.4 For battery-operated receivers, the minimum performance specifications listed in this Recommendation should be achieved for the nominal battery voltage less 30% as specified in the relevant I.E.C. publication.

1.5 The methods of measurement employed should be those recommended in the relevant I.E.C. publications for amplitude-modulation and frequency-modulation receivers (see Recommendation [illegible]7).

1.6 The receivers, which are intended for use in regions of high temperature and humidity, should be tropicalized so that they can be used under the climatic conditions laid down by the Administration concerned. The appropriate tests required by the Administration procuring such receivers should comply with the relevant I.E.C. publications.

1.7 If national regulations prescribe measuring methods or tests different from the standard I.E.C. methods, the Administration will, where necessary, draw attention to this.

2. <u>Specification for H.F. communication receivers</u>

(two types, differing only in frequency range)

2.1 Frequency coverage (MHz) (a) 0.525-1.605; 2.3-21.75;
(b) 0.525-1.605; 2.3-9.775;

Receiver tuning may be fully bandspread on the broadcast bands appropriate to the requirements of any Administration or the receiver should be capable of being coarse pre-tuned to any spot frequency in

- the medium frequency band and
- each of the high-frequency bands;

with the provision that a limited number of spot frequencies (e.g. three) selected from the high-frequency bands, are made available for ready selection at any time, by the operator.

2.2 Sensitivity for 50mW output 30% modulation at 400 Hz	not worse than 150 uV
2.3 Signal/noise ratio for input as under §2.2	26 dB

2.4 Power output for less than 10% distortion	not less than 900 mW (at nominal mains or battery voltage) and not less than 400 mW (at the nominal battery voltage less 30%)
2.5 Overall selectivity	
at - 6 dB points	passband not less than ± 3 kHz
at - 20 dB points	passband not greater than ± 10 kHz
at - 40 dB points	passband not greater than ± 20 kHz
2.6 Image, intermediate frequency and spurious response ratio	MF - not less than 30 dB
Intermediate frequency and spurious response ratio	HF - not less than 12 dB
Image response ratio	not less than 10 dB (HF up to 10 MHz)
2.7 Overall fidelity including acoustic response of loudspeaker	250-3150 Hz within 18 dB limits
Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100-4000 Hz within 12 dB limits (in a graphical presentation 400 Hz should be taken as the reference 0 dB level)
2.8 A.g.c. performance: change in output when the input is reduced by 30 dB from 0.1 V	not greater than 10 dB
2.9 Frequency stability	must be such that the receiver does not require frequent retuning

3. <u>Specification for VHF community receiver</u>

3.1 Frequency coverage	87,5 - 108 MHz (provision must be made for one or more channels to be pre-selected).
3.2 Signal-to-noise ratio	30 dB

3.3 Sensitivity (noise limited)	- 85 dB rel. 1 mW (at a signal-to-noise ratio of 30 dB and 50 mW output power)
3.4 Intermediate frequency	10.7 MHz
3.5 Amplitude-modulation suppression ratio	24 dB
3.6 Power output	Not less than 900 mW (at nominal mains or battery voltage) and not less than 400 mW (at the nominal battery voltage less 30%)
3.7 Overall selectivity	- 30 dB at ± 300 kHz
3.8 Overall fidelity including acoustic response of loudspeaker	200-5000 Hz within 18 dB limits
Alternatively, it may be more convenient for some manufacturers to consider only the electrical characteristics which should be:	100-5000 Hz within 6 dB limits (in a graphical presentation 400 Hz should be taken as the reference 0 dB level)
3.9 Radiation	The local oscillator radiation should be less than the limits specified by C.I.S.P.R. However, where national regulations exist, the radiation should be less than the limits specified therein.
3.10 Distortion	The distortion should be less than 5% for a frequency deviation varying between ± 15 kHz and ± 75 kHz with a modulation frequency of 400 Hz and an output power of 50 mW.
3.11 Frequency stability	Must be such that the receiver does not require frequent retuning.

ANNEX II

SPECIFICATIONS FOR LOW-COST TELEVISION RECEIVERS

1. General

1.1 These specifications apply to two types of low-cost monochrome television receivers giving a satisfactory performance :

Type A - Receivers intended to give acceptable performance at the lowest possible cost.

Type B - Receivers intended to give good performance at a reasonable cost.

It is expected that receivers of Type A will normally be used for home viewing, whereas those of Type B will often be used for community viewing.

1.2 Where feasible, the use of mains-operated receivers is recommended. In general, battery-operated receivers are at present either of lower performance, or of higher cost.

1.3 In planning the use of these receivers, administrations should take account of their differing performances, the range of signal strength expected, and the possibilities for special antennae, pre-amplifiers, and low-loss feeders.

1.4 Administrations should further take account of the effect of the size of the screen and the cabinet on cost. The recommended values given are considered appropriate for the expected use of the receivers.

1.5 The receivers should be simple, robust, and well protected against the environment. Those intended for use in areas of high temperature, high humidity or dust should be [illegible] so that they [illegible] by the Administration. Appropriate tests, [illegible] I.E.C. Publications, should [illegible] radio [illegible].

1.[illegible] The [illegible] tests to be employed should be those [illegible] of I.E.C. Publications [illegible] (1[illegible]), 10[illegible] (19[illegible]), 10[illegible] ([illegible]) [illegible] 10[illegible] ([illegible]). National regulations [illegible] from these standards should [illegible].

1.7 The administration [illegible] should specify the television standard to be employed [illegible] mains voltage and frequency, if the receivers are to be mains-operated. Particular emphasis should be given to any difference [illegible] frequency and the field frequency of the television [illegible] to [illegible] national [illegible] or [illegible] disturbances.

1.[illegible] For battery-operated receivers, satisfactory performance should be secured with the battery voltage [illegible] below the nominal value.

1.[illegible] The receivers should comply with the [illegible] recommendations of I.E.C. Publication [illegible].

1.10 The following controls, at least, should be available to the user: power switch, tuning, contrast, brightness, volume.

2. <u>General specifications</u>

		Type A	Type B
2.1	Recommended size (diagonal) for the screen	[illegible] cm ([illegible]"–[illegible]")	48 cm (19") or larger

		Type A	Type B
2.2	Frequency bands	VHF or VHF and UHF	VHF or VHF and UHF
2.3	Power-supply tolerances (for mains-operation only)		
	– normal operation for voltage changes of (%)	± 10	± 10
	– freedom from damage for surges of .... ms duration and changes of (%)	± 30	± 30

3. Input characteristics

3.1	Input impedance at the antenna terminals (Ω)	75 or 300	75 and 300
3.2	Maximum noise figure for the receiver (dB)		
	– VHF	10	6
	– UHF	16	10
3.3	Noise-limited sensitivity at a signal-to-noise ratio of 30 dB and standard output (I.E.C. 107-3.3 (dBm))		
	– VHF	-50	-60
	– UHF	-40	-55
3.4	Tuning As described in I.E.C. 107-1.4.8.2 or as specified		
3.5	Characteristic of the automatic gain control (-20 to -50 dBm) (I.E.C. 107-3.6/2.7) (dB)	-	6

4. Output characteristics

4.1	Minimum audio-frequency range (I.E.C. 107-12.3) (Hz)	150-5000	150-5000
4.2	Minimum audio-frequency output at 10% distortion (I.E.C. 107-13.2.5) (W)	0.5	2.0 (mains operated only)

		Type A	Type B
4.3	Minimum picture resolution (I.E.C. 107-2.[illegible]) (lines)		
	- 6 MHz channel systems	225	290
	- 7 or 8 MHz channel systems	270	320
4.4	Minimum brightness at white-level for a black level of [illegible] nit (I.E.C. 107-[illegible] 4.1) (nits)		
	- 50 field systems	70	-
	- 60 field systems	70	150
4.5	Minimum [illegible] ratio (I.E.C. 107-[illegible])	30/70	30/70
4.6	Maximum mains ripple for a difference of 1 Hz between the mains frequency and the frame frequency (%)	-	0.4
4.7	Maximum relative non-linearity of scan over a complete field (I.E.C. 107-2.3.2) (%)	-	4
4.8	Maximum distortion of the picture outline (I.E.C. 107-2.3.3) (%)	-	3
5.	Interference		
5.1	Minimum rejection of the upper adjacent picture carrier (I.E.C. 107-4.2) (dB)	26	-
5.2	Minimum rejection of the lower adjacent sound carrier (I.E.C. 107-4.2) (dB)	30	-
5.3	Minimum image rejection (I.E.C. 107-4.5) (dB)		
	- VHF	40	50
	- UHF	20	30
5.4	Minimum intermediate-frequency rejection (I.E.C. 107-[illegible]4) (dB)	30	30

			Type A	Type B
5.5	Minimum video-sound crosstalk (I.E.C. 107-4.8.1)	(dB)	30	30
5.6	Radiation (I.E.C. 106A)		(According to Recommendation No. 24/2 of the CISPR)	
6.	Stability			
6.1	Maximum drift between 2 min and 60 min after the picture appears (I.E.C. 107-6.1.3)	(kHz)		
	– VHF		± 250	± 250
	– UHF		± 500	± 500
6.2	Maximum drift due to a change of + 10% in the supply voltage (I.E.C. 107-6.1.6)	(kHz)	± 100	± 100
6.3	Minimum range of lock-in (I.E.C. 107-6.2.3)	(%)	± 1	± 1
6.4	Minimum range of hold (I.E.C. 107-6.2.3)	(%)	± 2	± 2
7.	Reliability			
	Minimum mean time between failures requiring servicing, averaged over a production run	(hours)	1000	2000

BIBLIOGRAPHY

C.C.I.R. Doc. XI/5[illegible] (Italy), 1966-1969.

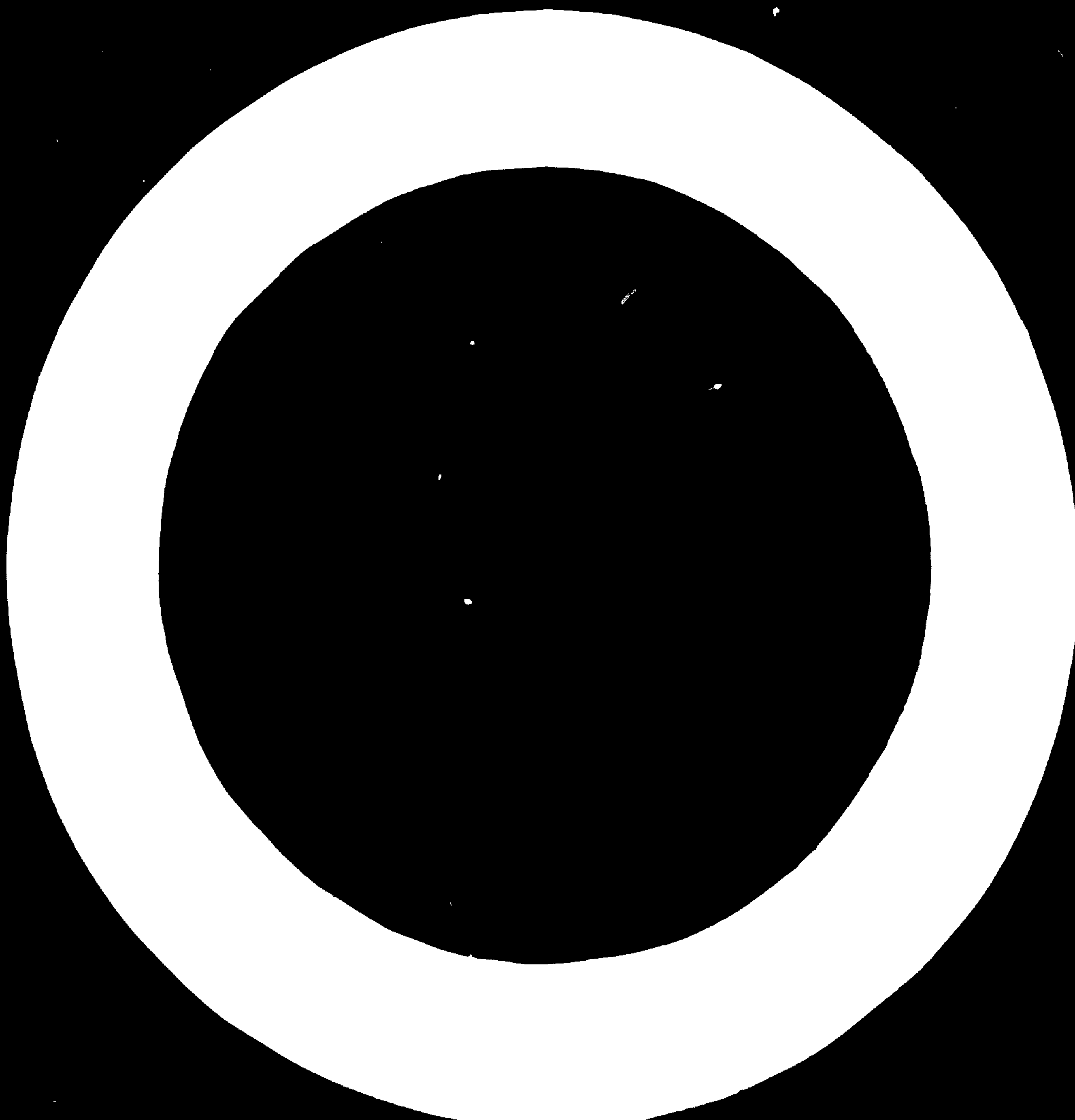


FIG. —1— FLOW CHART FOR PRODUCTION OF RADIO TYPE A INCL'NG LAYOUT AND ARR'NT OF INSTRUMENTS

PITCH TIME : 60 SEC. STEP NUMBER : 43

PRODUCTION : 480 SET / DAY, WORKING HR 8/DAY

SYMBOL . AS TO WORK BENCH SYMBOL

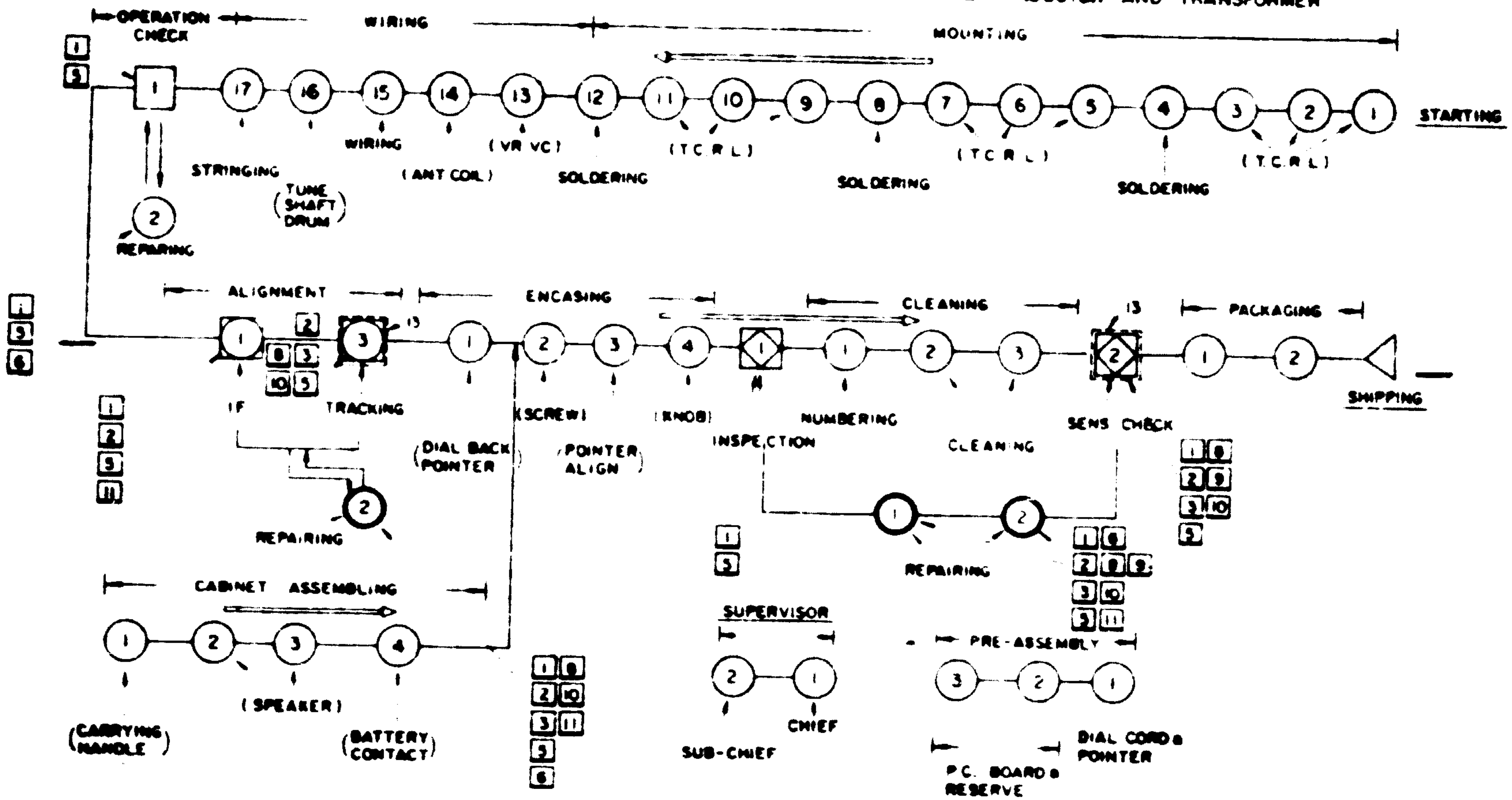
1 2 --- TEST INSTRUMENT
NUMERALS INDICATE ITEM NO (SEE TABLE I)

[ ] ---- SHIELD ROOM

(T,C,R,L) --- ITEM OF MOUNTING

T --- TRANSISTOR
C --- CAPACITOR
R --- RESISTOR
L --- INDUCTOR AND TRANSFORMER

VC --- TUNING GANG
VR --- VOLUME CONTROL



NOTE : IN THE CASE OF ELECTRICALLY NOISY ROOM SHIELD ROOMS MAY BE REQUIRED FOR THE PROCEDURE OF TRACKING ALIGNMENT & SESITIVITY CHECKING.

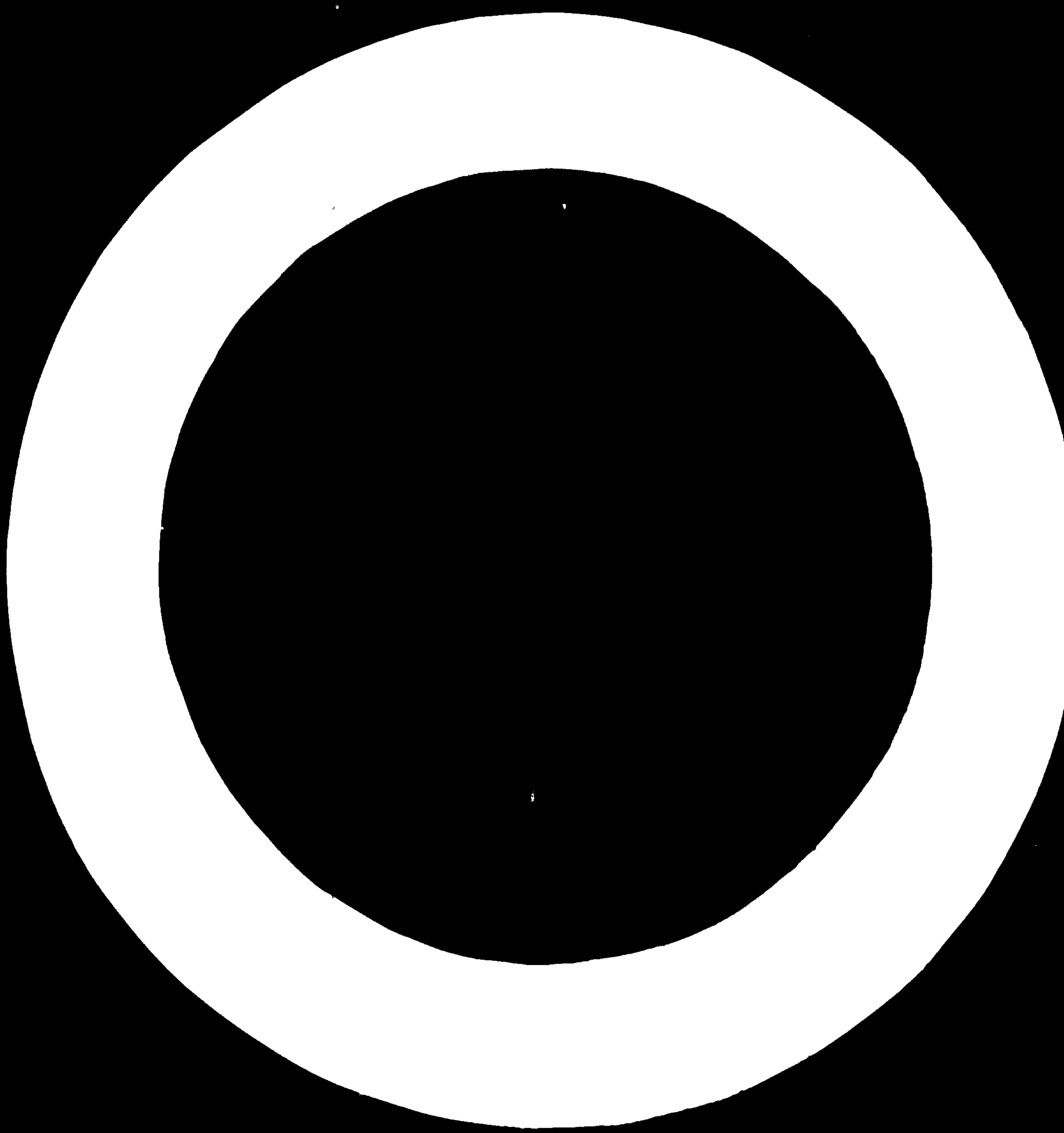
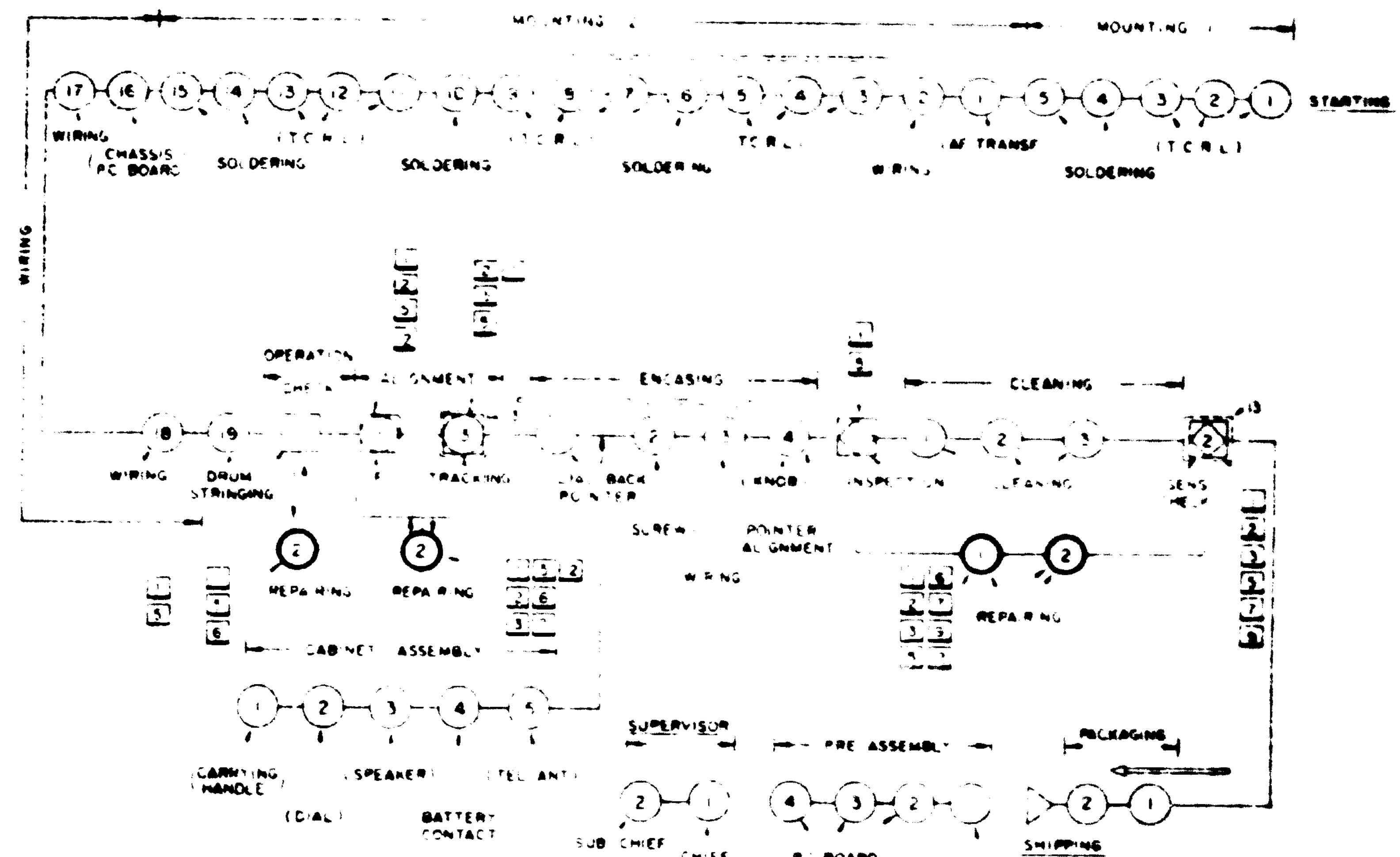


FIG. 3 FLOW CHART FOR PRODUCTION OF RADIO TYPE C INC NG LAYOUT AND ARR NT OF INSTRUMENTS
PITCH TIME 60 SEC STEF NUMBER 4A
PRODUCTION 480 SET / DAY, WORKING HR 8 / DAY

SYMBOL
AS TO WORK BENCH SYMBOL
[1] [2] --- TEST INSTRUMENT
NUMERALS INDICATE ITEM NO. SEE TABLE
[ ] ---- SHIELD ROOM

(T C R L) --- ITEM OF MOUNTING
T TRANSISTOR VC TUNING GANG
C CAPACITOR
R RESISTOR
L INDUCTOR AND TRANSFORMER



NOTE IN THE CASE OF ELECTRICALLY NOISY ROOM SHIELD ROOMS MAY BE REQUIRED FOR THE PROCEDURE OF TRACKING ALIGNMENT & SESITIVITY CHECKING

[illegible]

[illegible]	[illegible]	[illegible]
1	[illegible] (Pulse Generator)	[illegible] Pulse width: [illegible] sec.
2	Oscilloscope	Sensitivity: V — 1mV/cm; H — 1 mV/cm; Ext. — P-P [illegible] mV/cm
3	V.T.V.M.	[illegible] : [illegible] Sensitivity: [illegible] at input imp. of 5[illegible] ohm
4	[illegible] V.T.V.M.	Freq. range: [illegible] Voltage range: 1mV - 10V Input impedance : Less than 5P[illegible].
5	Stabilized DC power Supply	Output : [illegible] - 25V, ± 2 [illegible] - 2A

6	Ohmmeter & Voltohmist	[illegible] range	: [illegible] 1[illegible]
		V range	: up to 1[illegible] V [illegible]
		A range	: up [illegible] 1[illegible]
7	[illegible] Signal Generator	Freq. range	: [illegible] 11.[illegible]
			[illegible] 131
		Output	: [illegible].3[illegible] - [illegible].1V
			Z = 75Ω or 50Ω
		Modulation	: [illegible] - 10 kHz Dev.
			[illegible]
		Mod. freq.	: 40 Hz - 1[illegible]Hz
8	AM signal Generator	Freq. range	: 100kHz - 3[illegible]Hz
		Output	: 1uV - 1[illegible]
			flat within ± 1dB
		Modulation	: 0 - 100[illegible]
		Mod. freq.	: 400Hz, 1[illegible]Hz
		Including Test loop	
9	Distortion Meter	Freq. range	: 20Hz - 20[illegible]kHz
		Distortion range	: 0.1 - 3[illegible]
		Level	: [illegible].3mV - 10V
10	Test Loop	Freq. range	: 4[illegible] - 30MHz
		Loop diam	: 250mm
		Cable length	: 1,2 m

11	455kHz Sweep Generator	[illegible]	: 4[illegible] – 5[illegible]kHz
		Sweep	: [illegible] ± 5[illegible]kHz
		Marker	: 445, [illegible]5, 455, 4[illegible] and 4[illegible]
		Sweep rate	: 1[illegible] lines/sec.
		Output control	: [illegible] – [illegible].1V
12	10.7MHz Sweep Generator	[illegible]	[illegible].5 – 11.[illegible]
		Sweep	: [illegible] ± 5[illegible]kHz
		Marker freq.	: 10.55, 1[illegible].625, 1[illegible].7, 1[illegible].775, and 1[illegible].[illegible]
		Repetition rate	: 1[illegible] lines/sec.
		Output control	: 1[illegible] – [illegible].1V
13	Shield Room No. 1	Frequency	: 4[illegible]kHz – 2[illegible]MHz
		Attenuation	: [illegible]
		Dimensions	: 1[illegible] D x 1[illegible] x 1[illegible] (cm)
14	Shield Room No. 2	Frequency	: 4[illegible]kHz – [illegible]MHz
		Attenuation	: 1[illegible]
		Dimensions	: 1[illegible] D x 3[illegible]0 W x 27[illegible] (cm)

9. 8. 72