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United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.181/14
10 October 1974

Original: ENGLISH

Expert Group Meeting on Building and Facilities, Design and Lay-out for Industrial Research and Development Centres

Innsbruck, Austria, 23 - 27 September 1974

/research centre/s & /laboratory/s

FINAL REPORT */ (Meeting on building and facilities for R&D centres, 1974).

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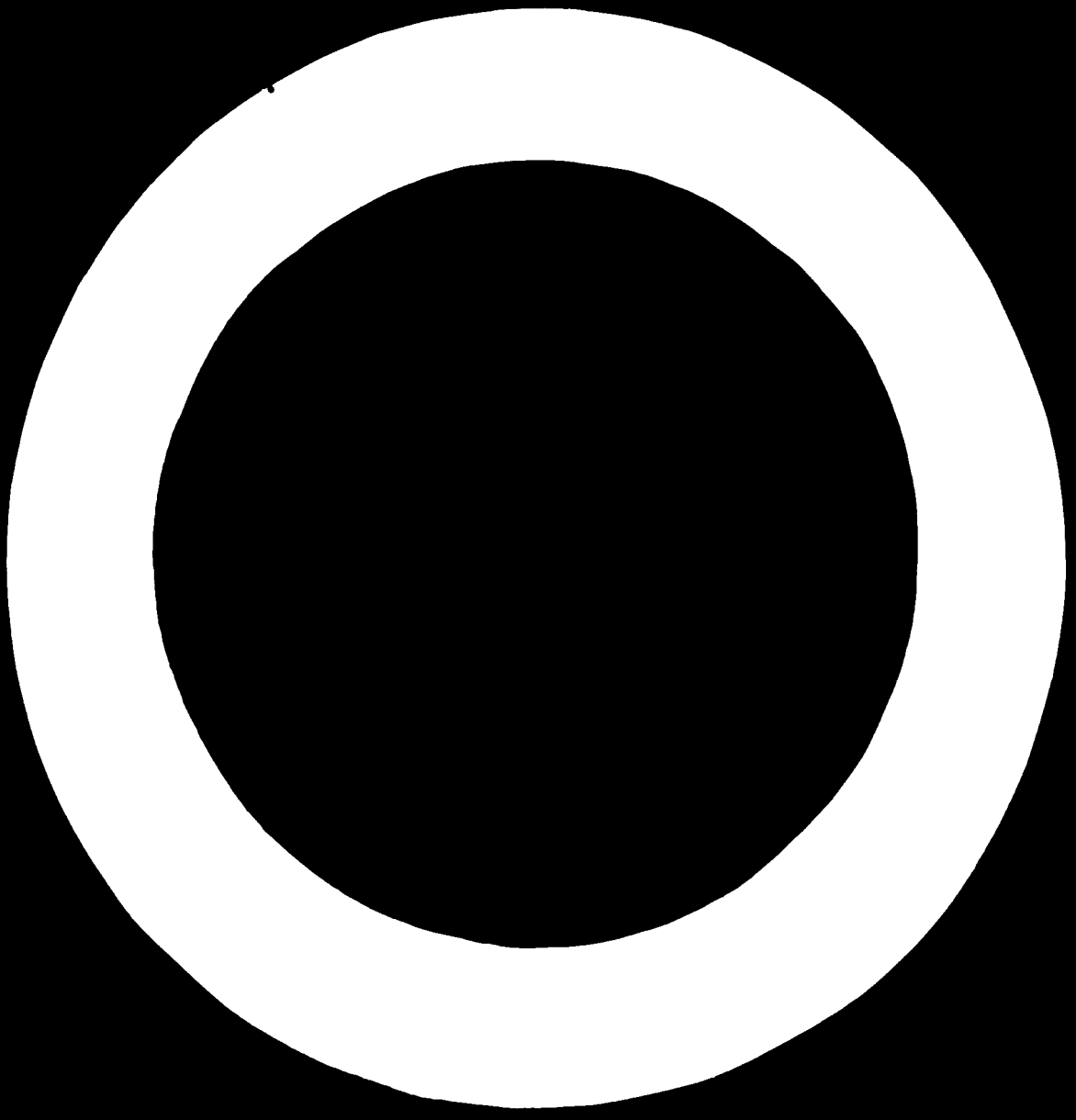

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LETTER OF TRANSMITTAL TO THE EXECUTIVE DIRECTOR OF UNIDO

The group of experts comprising architects, engineers and senior executives of R and D centres involved with planning, designing and constructing buildings and facilities for Industrial Research and Development Centres, which met in Innsbruck, Austria, from 23 - 27 September 1974, has the honour to submit its findings and recommendations for possible follow-up action. These recommendations emphasize the need to develop methodologies for bringing about the development of buildings and facilities which could easily be adapted to meet the continuously changing needs of Industrial Research and Development Centres in response to the changing requirements of the industrial community resulting from the increasing pace of technological development and changing social order.

On the basis of papers prepared in advance by nine of the experts, as well as other supporting material, and drawing upon the knowledge and experience of several organizations, we discussed in depth various aspects related to planning, construction and the equipping of research and development centres. These aspects broadly include site location; design and layout; construction and finishing; laboratory services including lighting, ventilation, air-conditioning, furnishings, provision and installation of R and D equipment, and economic factors. The deliberations clearly brought out the complexities of the problem and identified considerable areas of agreement and some areas of divergence. As a result, the group made a number of recommendations, the implementations of which will assist in the process and methodology for planning, designing and equipping industrial research and development centres in developing countries in particular, and other countries in general.

The importance of establishing clear and effective communications between the architect, various specialists and the responsible authorities of the research and development centres was stressed. A clear understanding of the objectives, management structure of the centre, the purpose of the buildings and facilities to be established, and the immediate and long-term goals of the proposed infra-structure were identified as important steps towards the establishment of these communications. In order to achieve effective communication, and thereby suitable facilities and buildings for research and development centres, the group recognized that one way would be to utilise intermediary expertise with a specialized consultant who would provide a compatible interface with research and services management personnel on the one side, and with architects and engineers on the other. Where such intermediary expertise is not available, the group felt that efforts should be made to develop it.

We wish to record our appreciation to the staff of the Industrial Institutions Section and Conference Services of UNIDO for their assistance during the meeting. We also wish to express our appreciation to the authorities of the Kongresshaus Innsbruck for putting their time and excellent facilities so freely at our disposal.

Yours sincerely,

H.C. Visvesvaraya
Chairman

INTRODUCTION

Background

Industrial research and development centres established in developing countries aim at providing various services to the Government, local and foreign enterprises and other industrial development agencies. The services include applied research and testing and analysis of raw materials and industrial by products to identify their industrial uses; testing and analysis of industrial products for quality control and quality certification purposes; techno-economic feasibility studies for the establishment of new industries or the expansion of existing ones; assistance to industry in trouble-shooting, standardization and quality control, selection of industrial processes, equipment and appropriate technology, market research, cost accounting, plant lay-out, product and productivity improvement, and diversification of production; advice to the Government on technological matters; and assistance related to national standardization and quality control programmes.

The industrial research and development centres therefore form a core of multi-disciplinary technologists whose main aim is to accelerate the industrial growth of the country. Depending upon the level of development of the country and of the centre the number of professional staff for centres in most developing countries varies from 10 to 30. These technologists, must respond to the complex needs of the community with the very limited resources at their disposal.

Several governments in developing countries have recognized the need to establish such industrial research and development centres in their countries and are attaching great importance to them. With a few exceptions, their financing is the responsibility of the Government who is usually the main client of the centre's services. At the initial stages of the centre's development most of the funds allocated for the centres are utilized in setting up its buildings and facilities. Due to the limited expertise available in most developing countries, some of these buildings and facilities have been conceived and planned either unfunctionally and/or for prestige purposes. A need has been identified to assist these countries in the economic utilization of these funds to set up buildings and facilities which could easily be adapted to meet the changing needs of their centres in response to the requirements of the industrial and business community.

I. ORGANIZATION OF THE MEETING

1. In recognition of the above, UNIDO, in co-operation with the Kongresshaus, Innsbruck, organized an Expert Group Meeting on "Building and Facilities, Design and Lay-out for Industrial Research and Development Centres" in Innsbruck, Austria, from 23 - 27 September 1974.

On the basis of papers prepared in advance by nine of the experts, as well as other supporting material, and drawing upon the knowledge and experience of several organizations various aspects related to planning, construction and the equipping of research and development centres were discussed in depth. These aspects broadly included site location, design and lay-out; construction and finishes; laboratory services including heating, water and gas supplies of various types, lighting, ventilation,

air conditioning, furniture and furnishing; cost and economic factors.

The deliberations clearly brought out the complexities involved and identified considerably the areas of agreement and some areas of divergence. As a result, the group made a number of recommendations the implementations of which would assist in the process and the methodology for planning, designing and equipping industrial research and development centres in developing countries in particular, and other countries in general.

Participants

2.- The group of nine experts who were selected in their individual capacities and on the basis of their experiences, comprised architects and senior executives of R and D centres involved with planning, designing and constructing buildings and facilities for Industrial Research and Development Centres. One of the experts who had prepared a paper was not able to attend the meeting. Sixteen other participants involved with various aspects of the subject, either in industrial research or consulting firms and international organizations - in both industrialized and developing countries - also attended the meeting. The list of participants is attached as Annex I.

Opening of the Meeting

3.- Mr. S.N. Adam of the Industrial Institutions Section of UNIDO and Director of the meeting, welcomed the participants on behalf of UNIDO. In his introductory remarks he gave some background information on the meeting and underlined the importance which UNIDO was attaching to the meeting. He expressed the hope that the deliberations of the meeting would produce results and concrete recommendations which would form the basis for an envisaged publication which could assist the developing countries in the processes and methodologies for planning, designing, constructing and equipping industrial research and development centres.

Election of Officers

4.- The following were elected officers of the meeting:

Chairman:	Mr. H.C. Visvesvaraya, Director Cement Research Institute of India
Vice-Chairman:	Mr. J. Nekarda, Director of International Affairs, Czechoslovak Institute for Regional Planning
Rapporteur:	Mr. P. Silver, Partner and Director for Facilities, Research and Development, Cruzen and Partners

Agenda and Schedule

5.- The Agenda and Schedule adopted for the meeting are reflected in Annex II. Where it was found convenient, papers on closely related subjects were presented consecutively and discussed simultaneously.

Discussion Papers

6 - A total of eight technical papers and four addenda were presented at the meeting. Two of these papers covered all aspects of the subject. One paper was presented each on Site Location and Design; Lay-out; Construction and Decoration; and Equipping of Laboratories. One paper and three addenda were presented on Facilities, Heating and Air-conditioning, Ventilation and Lighting. Another paper and one addendum were also presented on Furniture and Finishings. A list of documents reproduced in connection with the meeting, is attached as Annex III.

Organization of Work

7 - Discussions on each specific aspect of the subject were introduced by the presentation of a short paper and/or case study prepared on that topic by an expert. As these papers were made available to all participants in advance, presentation did not involve reading the paper, but was made by introductory remarks given by the author, pinpointing the highlights of the paper. This was followed by extensive discussions on the topic. At the end of each day's discussions the rapporteur with the assistance of the UNIDO secretarial staff summarized the discussions on that day's topics.

8. On the morning of the fourth day of the meeting, the participants were divided into four separate discussion groups in order to draft specific recommendations covering:-

- General considerations and site location;
- Design, Lay-out and construction;
- Technical Services and Environmental Control;
- Furniture, Furnishing and R and D Equipment.

In the afternoon of the same day the draft recommendations of each group were reviewed by the entire meeting. The rapporteur and the UNIDO secretariat later made the necessary co-ordination among the recommendations and incorporated them into the draft final report of the meeting, which was discussed the next day.

Closing of the Meeting

9.- At the closing session the draft final report of the meeting and its recommendations were reviewed and adopted. UNIDO was authorised to carry out the necessary editorial modifications and to reproduce and circulate the final report.

The Chairman thanked the participants for their active co-operation the rapporteur for his dedicated efforts, the director of the meeting for his guidance, and the UNIDO service staff for their assistance.

Mr. S. Ndam, Director of the meeting, thanked the Chairman for his efficient handling of the meeting and the participants for their positive contributions to the deliberations of the meeting. He also thanked the authorities of the Kongresshaus, Innsbruck, for putting their time and excellent facilities so freely at the disposal of the meeting.

II. SUMMARY OF DISCUSSIONS

A. GENERAL CONSIDERATION AND SITE LOCATION

General Considerations

10. The process of planning buildings and facilities for Research and Development Centres involves the interaction of architects, research managers and their staff, special consultants, technologists and economists. Such a process should emphasize the need to develop a clear dialogue between the architect and the client so as to develop a solution which meets the real needs of the centre. The success of such a dialogue depends upon the quality of the programming information used by the architect, which must be in a language that both the architect and the centre's management can understand. An intermediary, the laboratory planning consultant's providing of a detailed programme suitable for the architect to design the facility is important.

11. In order to develop an appropriate building solution it is necessary to conduct a study of the total economic and social growth pattern of the country. Such a solution should take into account the availability of indigenous materials and the social and political objectives of the project. The concept of the project should recognise the importance of local factors since no one plan can suit all the varied conditions that exist in different countries. In planning the centre, provision should be made for growth potential and social welfare activities if the environment is to contribute to the intellectual climate required for research and development work.

Location

12. Because of the concentration of economic, social, intellectual and other activities and national decision making organs at the capital or principal business city, these cities provide, in most developing countries, the most suitable location for research and development centres. While the general site location often is more of a political and economic decision, the location of the specific plot should be based on the results of technical investigations.

In general, the specific site location is often a function of the nation's particular situation and no one formula for selection will cover all aspects for all countries. A guideline could however outline the technical factors involved and provide appropriate data for use in the political process and some framework for decision making. Whichever site is chosen, it should provide for growth and have adequate supporting utilities and a hygenically undefective environment.

13. The selection of a plot should, therefore, take among other factors the following into consideration, as far as possible:

- the plot should be sufficiently big not only for the convenience of the construction and for the operation of the proposed centre, but also for meeting its needs on possible future expansion, not only physically but also in its scope; as time passes the scope of R and D centres could also change - multidisciplinary centres may give special emphasis to only a few of their areas, a single discipline could grow much faster than other or new disciplines may emerge;

- the plot should have good technical qualities - especially with sufficient bearing capacity, acceptable ground water level and acceptable surface character;

- the plot should enable a free dispositional solution for the centre and a suitable orientation of individual parts with respect to cardinal points and orientations of the whole complex;

- the Centre should form an expressive compositional element in the selected location;

- the plot should provide good transportation facilities to individual functional components of the city and industrial establishments;

- the plot should enable the centre to use existing technical infrastructure water, supply sewerage heating system, gas, electricity etc.

- the plot should have a hygenically satisfactory environment. The building of the centre should also contribute to the improvement of the environmental conditions of the place where it will be located.

B. DESIGN, LAY-OUT, CONSTRUCTION AND FINISHES

Design and Lay-out

14. In the design and lay-out of the buildings and facilities for a Research and Development Centre, the emphasis should be placed on the need for adaptability. The centre should be adaptable only to the extent that is necessary to meet the reasonable anticipated change. The estimation of the frequency of change is a sensitive value judgement based upon experience combining objective and subjective criteria.

15. Many design solutions are available, but none meets the requirements of all situations. The design of an institute involves the trade off of functional, aesthetic and economic factors, and the architects options are set within the context of these limits which affect each other and require a specific balancing in each situation.

16. Basic concepts of affecting design and lay-out must emphasise the role of the management structure. The building designs should not restrict management options since the trend towards group or team work has led to an institutional type of Research and Development establishment requiring a design quite different from a design conceived for traditional departmental research centres. In order to accomodate anticipated changes, sufficient adaptability in the building design must be provided so that it has a dynamic capacity for change and expansion without disturbing the centre's operation. This contributes to the optimization of the centre's utilisation and to bringing better returns on investments.

17. The centre's laboratory spaces should be modularised, that is, they should be built of elements of an appropriate size such that the elements could be grouped to form spaces of varying sizes so as to meet any set of given required functions. This enables the laboratory to expand or contract from a given use without modification of the building systems. The modular plan should indicate the planning methodology by which a number of laboratory spaces could be grouped together to form one uninterrupted serviceable space.

Experience has shown that the configuration of a bench laboratory should be maintained within a fairly constricted proportion, that is, the proportion should be such that the laboratory is a unit of modules between 3.0 m (10 feet), and 3.6 m (12 feet) wide, with varying depths.

18. In all cases, laboratories should be conceived of as having essentially two ways of exiting which are remote from each other and are set up in such a way that the expansion from one laboratory to another does not negate this exiting (egress) potential.

Construction and Finishes

19. The construction technology of a Research and Development Centre should be the result of available construction systems. However, laboratories with equipment sensitivity requirements should be constructed of materials which do not develop the inherent short-comings that are characteristic of some buildings systems.

20. The materials must account for the need for control of vibration, noise level, as well as fire limitation, smoke, dangerous chemicals and fumes. Soft and difficult to clean materials with sensitive, less durable finishes are not appropriate for research facilities. Materials which are capable of being repaired, replaced and/or relocated without significant effect upon the operation of the building are far more suitable.

Within the laboratory itself floors, walls and ceilings should be maintained as natural, relatively simple unadorned materials, leaving the interior to be finished by the user.

21. Every effort should be made to utilize local materials and skills to meet the building's requirements so that changes could be achieved without necessitating the utilisation of services and equipment requiring considerable outside skills and operation for replacement, installation, repair and maintenance. Various considerations for the design, lay-out, construction and finishing of buildings and facilities for R and D centres are outlined in Annex IV.

C. TECHNICAL SERVICES AND ENVIRONMENTAL CONTROL

Technical Services

22. The design of technical services for Research and Development Centres must take into account the nature of current and anticipated activities of the centres. These activities usually would indicate the type and degree of services required. These services include electrical, plumbing and drainage systems for utilities such as gases, steam, compressed air, various types of water and vacuum.

23. In the design of technical services emphasis should be placed on installations which can be carried out without special techniques and utilising as much available local skills and materials and minimizing technical labour.

Environmental Control

24. Environmental design emphasises the influence of local climatic conditions on the building design. A definition of the laboratory environmental requirements should precede all design efforts. From that, an analysis should be conducted to determine the availability of local technology

and how it could meet these requirements/only when natural local technology is not capable of meeting that end, should mechanical or industrial techniques be considered respectively.

25. Several important factors minimise the need for and the use of non-local technology in the design of laboratory air conditioning systems. Appropriate attention should be given to the control of temperature and humidity, with emphasis on air intake and exhaust An effort should be made to minimize the utilisation of energy through proper building insulation and ventilation and through the use of natural air conditioning methods, when appropriate, in lieu of mechanical systems.

Special Considerations

26. As a brief guide, the following special considerations for the different mechanical services are presented. These are further elaborated in Annex V.

i) Air-Conditioning

- Outside conditions
- Inside conditions
- Environmental control
- Building, design and function as well as mechanical design
- Local building technology

ii Water and Gas Supplies and Waste Drainage

Additional to the items under para i) above, the following have to be considered:

- Type of available water and gas supplies and type of ground, where the building is located
- Rooms that need the same type of gas waste drainage and/or treated water should be grouped together where feasible
- The systems have to be installed with flexibility so that alterations can be made easily

iii Electrical Supply

In addition to i) and ii) above, it should be considered whether tropicalized equipment is necessary.

D. FURNITURE, FURNISHINGS AND R AND D EQUIPMENT

Furniture and Furnishings

27. Many systems for the design of furniture for R and D centres exist. These systems include standards related to size and material which, however, are not applicable in every situation. Factors affecting laboratory furniture design include:

a) the design basis on which the system is developed;
b) the need for adaptability;
c) the design for pre-fabrication;

d) the maintenance of static equilibrium under various equipment loads;
e) the finishing of the construction, and
f) the extent and intended use of the furniture.

28. There are several approaches to laboratory furniture design. One of these is a system of cabinet supporting tops which tends to restrict flexibility. The second and more flexible system consists of structural frames supporting tops with independent moveable cabinets. Furniture design must be sensitive to anthropometric differences affecting the proportion of the furniture. The principal effect appears to be on the height of the furniture. In addition, it may be necessary to modify some aspects of established furniture and equipment standards to meet the limitations of local industry.

29. The planning of the furniture and equipment arrangement should involve the architect since the design is a result of an interaction between all the aspects of the building design and construction. A planning expert could act as an interface between the R and D management and the local architect in designing a laboratory furniture which utilizes local skills and could be integrated into the project's design requirements. Since many developing countries deal with small multi-purposes and multi discipline operations they require considerably less sophisticated facilities, Nevertheless, the design of laboratory furniture should allow for adaptability in accordance with the changing work of the laboratory, which may require additions and/or alterations to the furniture.

30. Table tops should be given considerable attention. The choice of suitable table top material is important. These materials include wood, ceramics, stainless steel, glass, cement abestos, stone and plastics. The choice of table top material should be based on the use and resistance to damage from chemical, toxity, and impact.

R and D Equipment

31. The appropriate choice of equipment requires expert advice. If this is not available locally then outside expertise should be solicited. A good source of information could facilitate the process for the equipment selection. Because of problems peculiar to developing countries, equipment lists (catalogues) aimed for the use of Research and Development Centres in developing countries should contain more details related to alternative choices and recommended spare parts.

32. Instruments should be well maintained. The supply of equipment should include spare parts, installation, initial operation and training of local Research and Development staff in its proper maintenance.

33. The establishment of servicing organizations on a national or multinational level should be considered. Such organizations could, among other functions, help in training technicians in the instrument repair and maintenance.

34. There is a need for a service workshop in Research and Development Centres. Such a workshop should be manned by at least an electronics technician trained in diagnosis, and at least a fine mechanics technician. These technicians should be trained to diagnose problems in instrument failures.

III. RECOMMENDATIONS

A. GENERAL CONSIDERATIONS AND SITE LOCATION FOR R AND D CENTRES

General Considerations

35. Since the planning and designing of industrial R and D centres is a complex activity involving simultaneously many specialized activities and determination of optimum solutions in the face of conflicting parameters it is recommended that this entire process be conceived as a multi-disciplinary process, and right from the beginning everyone concerned should be made to get actively involved.

36. The team should consist of the R and D management and its relevant research staff, the design architect, the furnisher, the equipment supplier, and specialists in various services. In order to ensure proper and smooth communications amongst the divergent interests and to ensure a comprehensive linkage, the introduction of a new component in the form of expertise in the programming of buildings and facilities for R and D centres is recommended. Since such expertise is not easy to find, UNIDO should consider having programmes for the development of such expertise in developing countries as part of its programme for the promotion and stimulation of industrial R and D in developing countries.

The design team selected should be well versed and experienced in the design of industrial R and D centres. When all the required experienced personnel for the team are not locally available, it is advisable that the locally available experts are augmented and assisted by outside experts.

37. UNIDO could help in identifying such experts who could work on the design teams, including R and D managers, architects, engineers, experts in technical services, furnishers and equipment suppliers.

38. Since many developing countries are or would be establishing multi-disciplinary industrial R and D centres for both multi and specialised purposes, the expert group recognizes a need for these countries to be assisted by providing them with suitable guidelines in the establishment of buildings and facilities for their centres. These guidelines are visualized to be in the form of booklets containing basic model recommendations, basic lists of equipment, personnel requirements, model building plans, and exemplary test standards and methods. The expert group recommends that UNIDO take the necessary steps, on an urgent basis, towards the preparation of such guidelines for wide distribution in developing countries. The expert group also recognizes that such guidelines would be of immense value as a starting point, to officials involved with the development of new R and D centres in such developing countries. More detailed exercise in the direction of establishing such new R and D facilities would then come later.

Site Location

39. Whilst the group recognises that the location of an industrial R and D centre - especially in developing countries - is often determined by political and social considerations, it is recommended that those in charge

of establishing such centres should endeavour to select sites which satisfactorily meet the technical requirements while simultaneously fulfilling the political and social objectives.

40. It is further recommended that resources needed to establish and run R and D centres, environmental conditions for their satisfactory functioning and proximity to industries who are users of the R and D results should form the basis for the main technical considerations. The resources needed would include the scientific and technical skill, materials for construction, communication systems, information and documentation facilities specialized facilities, opportunities for intellectual interactions such as through university research workers or personnel of other R and D organizations.

41. The group identified certain preconditions essential for the successful location of R and D centres, the important ones of which include:

- clear specification of the function of the centre in the frame of the country's R and D netwok and industrial development;
- securing desirable relations with relevant organizations;
- detailed operational and organizational scheme of the centre expressing the most suitable mutual internal relations within the working organs of the centre; and
- specification of desirable geographic and technical conditions of the plot.

In the process of locating the centre it is advisable to use the method of comparison of locational variants by systematically evaluating the pros and cons of alternative sites from the point of view of the points including those covered above.

B. PLANNING, LAY-OUT, DESIGN, CONSTRUCTION AND FINISHING

42. In the design, lay-out and selection of construction methods and materials for Industrial R and D Centres it is recommended to first clearly define the project through a careful preparation of the statements of overall requirements and systems criteria. A detailed design of the project can then proceed on a rational basis with the assistance of the design team

43. In the planning and lay out of R and D centres the following major points, in addition to the normal considerations, should be taken into account:

- the management pattern of the centre should influence the lay-out and design rather than the building having to dictate the pattern later on;
- the planning should be such as to provide for adaptability without disproportionately high expenditure;
- the lay-out should provide for planned and unplanned expansion in the most convenient and economical manner;
- every possible endeavour should be made to multipurpose what is established in order to maximise returns from the large investments which might be involved;
- a clear distinction should be made between laboratory bench scale investigations, investigations with larger unit operations, and pilot plant investigations. In the location of each of these activities, an

important consideration should be the convenience and practicability of securing the required inputs and disposing of the outputs at reasonable cost

44. It is recommended to commence the planning process with a general statement of overall requirements. This statement should be prepared using the headings and in the order given in Annex IVA. These broadly relate to functional organization, basic equipment, and space determination and relationships Although in the preparation of the statement related to functional organization, each organization will have its own specific requirements, the typical functions of R and D centres which may be considered are listed in Annex IV B.

45. When the statement of overall requirements has been completed it is advisable to prepare a statement of systems criteria in accordance with the points outlined in Annex IV-C.These points cover structural, architectural, mechanical, electrical, safety, fire protection, communications and site infrastructural aspects.

C. TECHNICAL SERVICES AND ENVIRONMENTAL CONTROL

46. It is recommended that mechanical services be engineered to give the appropriate environmental conditions and service supplies (water, gas, electricity, heating, ventilation and air conditioning) to all areas, whether they be laboratories, pilot plants, offices or libraries. It is essential to consider the total environment, both open and closed. It is further recommended that such areas be designed as 'flexible units of space', which are adequately serviced and provide for maximum adaptability for the future and consistent with the economy of initial cost. A rigid initial design which precludes any future option for adaptation without considerable expense should be avoided.

47. Because of the impact of mechanical services on the basic design of the buildings it is important to recognize the need to allocate sufficient space in points such as riser ducts and ceiling voids. These should be firmly established at an early stage of the building design Since plant rooms (mechanical service rooms) could amount to as much as 10% or more of the total floor area they should also be taken into consideration at the initial stage of the building design.

48. It is recommended to select systems which provide the required environmental conditions, at minimum energy consumption, especially in view of the high energy costs and general world shortage of indigenous fuels. Design of a full air-conditioned space for example, in situations where natural ventilation would suffice, could be totally inappropriate.

49. Before embarking on more sophisticated systems, it is recommended to consider simple air movement or evaporation cooling systems, which could provide adequate solutions at lower costs of installation, maintenance, space and energy consumption.

In general, it is recommended to give due consideration to requirements for:

Communications - external and internal

Safety - Fire, personnel, communications, etc.

Lighting - Natural and artificial (colour and intensity)

- Pipework - Should be appropriately coded according to service;
- Installation and Maintenance - Labour costs should be balanced against material costs together with the degree of sophistication
- Roofs and Basements - May also be considered for housing mechanical plants, etc.

D. FURNITURE, FURNISHING AND R AND D EQUIPMENT

Furniture and Furnishing

50. It is recommended that the planning of furniture and furnishings of industrial research and development centres involve all relevant parties since the design is a result of an interaction between all the aspects of laboratory design and construction. It is advisable to retain the services of a planning expert to act as an interface between the Research and Development management and the architect in developing a laboratory furniture design which utilizes local skills and could be integrated into the project's and design requirements. It is recommended to accord considerable attention to the selection of suitable materials.

51. In the design of laboratory furniture it is recommended to take into account the anthropometric differences affecting the proportion of the furniture. The principle effect appears to be on the height of the furniture. It might therefore be necessary to modify some aspects of established furniture and equipment standards to meet the limitations of local industry.

R and D Equipment

52. It is recommended that a check list be used for the selection of laboratory instruments. Elements to be included in such a check list are outlined in Annex VI. It is further recommended that a detailed check list be prepared by UNIDO for wide circulation in developing countries.

53. In the actual selection of the R and D equipment it is advisable to solicit the assistance of a consultant who is familiar with the technical details of the equipment. It is also highly desirable that such a consultant possess a thorough knowledge of the conditions in the country for which the equipment is intended.

54. In the case where the acquisition of a large number of varied equipment is involved, consideration should be given to contracting a single supplier with access to many manufacturers and in a position to provide a service programme. Efforts should be made to combine responsibilities for purchasing and procurement in one national organization. This would help to avoid the purchase of unnecessary improper and unjustified R and D equipment.

55. It is recommended to establish national or international service organizations capable of supplying service facilities over a wide area, thereby reducing duplication of service facilities and skills. The procurement of instruments should provide for adequate training of staff installation and initial operation and sufficient spare parts.

56. It is recommended that R and D centres establish suitable service workshops which would provide the capacity to diagnose R and D equipment

problems. The minimum staff requirements for such a workshop would be an electronics technician and a fine mechanics technician.

E. CONCLUDING RECOMMENDATION

57. The expert group recognizes that it is outside the scope of the terms of reference of this meeting to deal with the issues relating to promotion, development and organization of Industrial Research and Development in developing countries, which are in fact already receiving the close attention of UNIDO. But the group also firmly believes that any effort spent on creating buildings and facilities could be fully fruitful only when the objectives and the functional purpose of the research and development centre are clearly defined. In order to achieve this, the expert group re-emphasizes the need for, and recommends that UNIDO should assist developing countries in establishing the short-term and long-term goals of new and/or existing industrial R and D centres, their objectives, scope, programmes and suitable organizational patterns.

ANNEX I

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ANNEX II

AGENDA AND SCHEDULE

Monday 23 September 1974

Morning:

09.00 Registration and administrative matters

10.00 Opening session

Organization of the meeting

a) election of officers

b) adoption of the agenda and schedule

c) organization of work

11.00 Presentation and discussion of General Background Papers

Afternoon:

14.00 Continuation of presentation and discussion of General Background Paper

Tuesday 24 September 1974

Morning:

09.00 Presentation and discussion of Additional Background Paper and Case Study on " Selection of Location and Design "

Presentation and discussion of Additional Background Paper and Case Study on " Lay-Out "

Afternoon:

14.00 Presentation and discussion of Additional Background Paper and Case Study on " Construction and Decoration "

Presentation and discussion of Additional Background Paper and Case Study on " Facilities, Heating, Air-conditioning, Ventilation and Lighting "

Wednesday 25 September 1974

Morning:

09.00 Presentation and discussion of Additional Background Paper and Case Study on " Furniture and Finishings "

Presentation and discussion on Additional Background Paper and Case Study on " Equipping "

Afternoon:

14.00 General Discussions

Thursday 26 September 1974

Morning:

09.00 Drafting of Recommendations of the meeting in Working Groups

Afternoon:

15.00 Review of Draft Recommendations

Friday 27 September 1974

Morning:

10.00 Closing Session

a) Finalisation and Approval of Draft Recommendations and Report of the meeting

b) Adjournment

ANNEX III

LIST OF DOCUMENTS

Aide Memoire	ID/WG.181/1
Provisional Agenda	ID/WG/181/2
Provisional Annotated Agenda	ID/WG/181/3
Provisional Schedule	ID/WG.181/4
Laboratory Furniture and Fittings by Mr. P. Geyer	ID/WG.181/5
Equipping of Laboratory by Mr. H. Roesler-Schmidt	ID/WG.181/5/Add.1
Industrial Research and Development Centres 1 - Selection of Institute's Location and 2 - Considerations for Buildings Design by Mr. J. Nekarda	ID/WG.181/6
Heating, Air-conditioning and Ventilation; Facilities; and Lighting by Mr. S. Barthelmess and Mr. D. Dittert	ID/WG.181/7
Heating, Air-conditioning and Ventilation; Facilities; and Lighting Fume Cupboards and Exhaust System by Mr. P. Geyer	ID/WG.181/7/Add.1
Heating, Air-conditioning and Ventilation; Facilities; and Lighting Some remarks relating to power supply in laboratories by Mr. P. Geyer	ID/WG.181/7/Add.2
Heating, Air-conditioning and Ventilation; Facilities and Lighting Environmental Controls and Related Considerations for Calibration and Testing Laboratories by Mr. E. L. Donegan	ID/WG.181/7/Add.3

Planning and Design of the National Metrology Centre in Brasil by Mr. F. Becker and Mr. L.E. Indio da Costa	ID/WG.181/8
Criteria for Planning and Development of Industrial Research and Development Centres by Mr. P. Silver	ID/WG.181/9
Considerations in Planning and Lay-Out of Centres for Industrial Research and Development by Mr. M. C. Visvesvaraya	ID/WG.181/10
Provisional List of Participants	ID/WG.181/11
A. Technical Considerations for Construction B. Decoration by Mr. J. E. Breese	ID/WG.181/12
Equipping of Laboratories in Developing Countries and Criteria for Equipment Maintenance and Procurement by Mr. H. Maier	ID/WG.181/13
Final Report	ID/WG.181/14

ANNEX IV

FACTORS TO BE CONSIDERED WHEN SETTING UP A RESEARCH AND DEVELOPMENT CENTRE

A. OVERALL REQUIREMENTS FOR RESEARCH AND DEVELOPMENT CENTRES

The Functional Organization:

A definition of the various functions that will comprise the facility. A suggested starting point is an organization chart followed by succinct descriptions of the functions.

The Personnel complement by organisation relating to some typical functions:

A statement of the personnel to comprise the functions within specific time frames.
A suggested starting point is the Functional Organisation Chart.

The Basic Equipment Statement:

A statement of the basic equipment to be used in each of the functional areas comprising the organization of the Centre. The concentration at this point should be on that equipment that might effect the buildings design, e.g. size, weight, temperature and humidity requirements, sensitivity to vibration, vibration inducing, general environmental considerations including safety.

Space Determination:

Define the types of spaces that will be required to meet the functional, personnel and equipment needs. Express the needs of these spaces as modular increments as far as possible; bearing in mind that a building(s) should be developed around anticipated need for the function and equipment.

Space Relationship:

Establish the preferred relationship of the functional elements with due regard to communal uses, e.g. food service, library, stores, shops, etc. and to utility demands, safety, cross - contamination and influences (isolation), etc.

B. TYPICAL FUNCTIONS IN REFERENCE TO ORGANIZATION

Non-Laboratory Functions:

(a) general administration
(b) conference rooms and auditorium
(c) first aid and medical office
(d) literary and industrial information centre
(e) training and productivity centre
(f) techno-economics
(g) operations research
(h) marketing
(i) computer terminal or facilities
(j) others

Staff Welfare Functions:

(a) catering services
(b) hotel facilities
(c) recreational facilities
(d) living or residential areas (when needed)
(e) transportation and packing
(f) others

Laboratory Functions:

(a) standards and quality control
(b) general testing
(c) metallurgical testing
(d) construction and building materials laboratories
(e) food science laboratory
(f) mechanical design
(g) electronics instrumentation
(h) large unit operations
(i) pilot plants
(j) others

Supporting Services Functions:

(a) building maintenance
(b) work shops-carpentry, sheet metal, machine
(c) shipping - receiving dock
(d) stores
(e) storage
(f) others

C. SYSTEMS CRITERIA

Structural and Architectural:

Basic criteria must be established for the design of the structural system with regard to floor loadings, geographical influences, e.g. seismic and special foundation problems, wind loading, etc. and vibration isolation problems to be considered.

The architecture should be as required for the functions with regard to geographical influences, technical capabilities, indigenous materials, minimal maintenance, expansion, etc. Generally material for the buildings should be selected on the basis of ready availability, durability, and low maintenance factors. While lowest initial cost will be important the cost over the expected life of the building may in some cases be a more useful criteria for selection.

Mechanical:

Basic criteria must be established for the design of the mechanical systems, e.g. heating, ventilation and air conditioning, piping and plumbing. This should include statements of the temperature and humidity conditions to be maintained in the various functional areas with particular attention to the scientific apparatus requirements, and climatic influences as they may affect the architecture and consequently the mechanical systems. Statements as to the project services required such as water, special treated waters, gases, vacuum, waste, etc.

Attention is called to the special requirements of some apparatus for services, both in type and quantities. The elements comprising these systems must be integrated with the architecture in a manner to minimize interference with the functions (primarily in sound and vibration).

Systems should be employed that may be easily maintained by local craftsmen with some spare parts inventory provided as a part of the construction.

Electrical:

Basic criteria for the electrical systems must be established that will enable the engineers to design the systems. This must include profound lighting levels (with due respect to the architecture) for the functional elements; general power loading and special power loading for apparatus; emergency power usage; landscape lighting; the building systems, e.g. mechanical and elevators; special isolation and grounding for apparatus; and isolation from RF interference of apparatus and equipment.

Total energy systems, combining the mechanical and electrical system requirements, should be evaluated particularly in regions where local sources of energy are marginal.

Safety and Fire Protection:

Criteria must be established for the provision of safety and fire protection systems that are commensurate with the local conditions. Particularly remote sites might suggest the provision of the centres own ambulance service or a small dispensary for handling of emergency situations.

Fire protection systems must be related to the various hazards to be encountered in the functional areas. All sites should be provided with fire protection, loops (containing hydrants) with fire hoses provided as may be required due to local fire fighting capabilities. All sites should be provided with at least two ingress-egress points for emergency purposes.
Fire detection and alarm systems with control monitoring should be considered.
Appropriate signs and colour codings should be employed to designate specific hazard and safety conditions. Protection and secure procedures must be developed for non-fire related accidents, e.g. biological, radiation, gas releases, etc.

Communications:

The requirements for communications within and without the infrastructure should be established. Normal telephone and inter-communication or paging requirements between the various sections of the laboratories should be specified as well as any special provisions for present or future requirements for computer terminals, closed circuit TV, telex, etc.

Site Infrastructure:

Site development should account for all requirements of the laboratory buildings. Roads, sidewalks, parking areas, water services, storm drains, lighting etc. all should be adequate for the functional activities of the institute. The site infrastructure should be so oriented to facilitate appropriate disposal of solid, liquid and gaseous wastes. The various elements should be positioned to take full advantage of prevailing winds to minimise interference with other elements and the surrounding area.
The centre should enhance the environment of the region

ANNEX V

PHYSICAL FACILITIES FOR RESEARCH AND DEVELOPMENT CENTRES

A. HEATING, VENTILATION AND AIR-CONDITIONING (HVAC) SYSTEMS

1. REQUIREMENTS:

1.1. Outside conditions

(What outside conditions prevail in the area, where the building is to be built ?)

- maximum, minimum and average outside temperatures and relative humidity in previous years;
- radiant sun capacity and the movement of sun during the year;
- special local wheather conditions, such as sand storms, smoke, huricane, etc

1.2. Inside conditions

What requirements do the instruments have in regard to:-

- air temperature (level and accuracy);
- relative humidity (level and accuracy);
- air movement;
- air purity;
- maximum and minimum sound levels;
- cleanliness;
- pressure;
- electrical fields;
- vibrations.

2. [redacted]:

Calculation should be made in conjunction with the architect, concerning:-

- the orientation should be determined bearing in mind the radiant sun capacity;
- the necessity for windows should be established;
- the building should be positioned so that it has the least radiant sun capacity into the window;
- the type of shading should be decided;
- what material should be used for walls and roofs, considering the heatloss and storage capacity of the materials;
- what are the functions of each unit or room and what conditions are required;
- does the HVAC system have to run 24 hrs per day or only when the room is occupied;
- rooms which need a high sophisticated AC system should be grouped together and should not have a direct connection to rooms where equipment which is producing heat, dust or smoke is installed.

The outcome of para 2 should be a draft building design and a room-book, which describes the necessary conditions for each room.

3. EVALUATION AND SELECTION:

Together with the architectual design, the selection of the relevant HVAC system has to be made under the following headings:

- calculation of installation running costs for different units and total HVAC systems,
- consideration should be given to the availability of know how for installation and maintenance components and materials in the specific country;
- consideration of the planned and unplanned expansion of the Research and Development Institute

4. DESIGN OF THE HVAC SYSTEM:

At the design stage the following items have to be considered:

- the air inlet has to be so positioned that exhausted air is not being drawn in;
- the air inlet should be positioned so that it is not affected by dust, sun, smoke, etc.;
- reliability of the HVAC systems is essential in the rooms where the equipment needs a specific condition (data processing etc);
- consideration should be given to the zoning of the building to give adequate control;
- energy recovery systems may be considered at the points where a high rate of outside air has to be brought in;
- spare parts and filters may be standardised to avoid the need for large storage space for HVAC parts;
- it should be remembered, that some replacement parts have a long delivery time in developing countries, because of the availability of spare parts and engineers;
- any machines that create vibration should not be placed near to the laboratories and should be installed on separate floors, not directly connected to the ther parts of the building;
- in the laboratory area the duct work should be designed to allow the possibility of installing other equipment later;
- the duct work should be designed to incorporate necessary fire safety devices, taking into account the uses and occupancies of different areas;
- all services should be installed for easy access and have sufficient provision for later additional services.

B. WATER SUPPLY AND DRAINAGE

1. REQUIREMENTS:

1.1. Outside conditions

- is a piped water supply available ?
- what is the chemical structure of the available water ?
- what is the temperature of the water ?
- is the water supply guaranteed or has there to be an independant system (bore hole, water storage, etc.) ?
- is the building located in a wet area requiring surface water drainage ?
- care should be taken not to pollute the local water supply by discharging waste into the ground;
- can the soil/effluent system be accommodated into an existing mains system or has a special effluent treatment plant to be provided ?
- type and quantity of storage.

1.2. Inside conditions

The maximum amount of water is needed:

- toilets
- kitchens
- laboratories
- pilot plant
- office

If there is no exact requirement from the client, recommendations can be used.
Does the waste system have to be divided into separate systems, e.g. effluent - rainwater.
What are the requirements for the water in the different places ?

- temperature
- pressure
- softness
- chemical structure

As a guideline any type of water, hot and cold can be used in:

- toilets
- offices
- fire systems
- side rooms

Water with a chemical structure which does not include microbes should be used in:-

- food preparation areas

Soft water should be used in all places where you have to serve technical instruments or machines in:

- laboratories
- pilot plants, etc.

Water of appropriate temperature should be used in:-

- emergency showers

Chilled water may be required for:-

- special applications

2. BUILDING DESIGN.

The major questions for the water supply systems in buildings are:-
where in the building are pipe systems to be installed ?

in the floor
in the wall or at the wall
at the ceiling

Accessibility is important.

3. LOCATION OF SERVICES:

For cost reasons it may be best to group together the areas which need:-

hot water (if it is not possible you have to calculate whether a decentralised water heating system is cheaper than a centralised one);
soft water and/or chemically treated water (a chemically treated water system is highly expensive);
chilled water (the necessary insulation is expensive);

If possible rooms requiring specific drainage should be grouped together to ensure economy of the drainage system.

4. EVALUATION - SELECTION - DESIGN:

The basic data in 1 and 2 has to be evaluated and discussed with the architect in order to achieve maximum economy in design. The following points should be considered:-

availability of necessary spare parts;
the pressurising system has to be so designed to ensure a supply at all times;
the pumped supply for emergency showers, fire fighting, etc. should be connected to an emergency electrical supply if available;
the piped systems should be reasonably over-sized to give additional future expansion;
the type of waste system, treatment, etc., will depend upon size, location contours, etc.

It may be necessary to calculate the cost and requirements for different systems permitted
In laboratories, pilot plants etc consideration should be given to provide regular tee-off points to give flexibility for the future.

G. GAS SUPPLY

1. REQUIREMENTS:

1.1. Outside

Is a mains supply available or does a propane supply have to be installed?

1.2. Inside

In laboratories generally a supply will be required for kitchens etc. gas or electrical equipment should be evaluated.

For other gases it is recommended that local safety regulations and requirements are considered.
The cost of piping for instance, may be considered against any hazard.

2. EVALUATION, SELECTION AND DESIGN:

The following points should be considered:-

- should the gas supply be centralized or localized ?
- if a central propane installation is proposed, adequate tanks should be provided to give continuity of supply.
- all pipework should have flexibility and provision for future additions and should be adequately protected by safety valves, etc.

D. ELECTRICAL POWER SUPPLY

1. REQUIREMENTS:

1.1. Outside

Is a mains supply readily available or has an overland supply to be brought to site.

Is there a need for a new transformer station and voltage stabilization, etc. ?

Is there power of different voltages available from city supply ?

1.2. Inside

In laboratories, pilot plants etc., thought should be given to provide flexibility and future additions.
If no information is available from the client regarding loads and connections then the appropriate recommendations or regulations for electrical services may be used

2. BUILDING DESIGN:

Consideration should be given to the types of supply required in each building type and the way the services are to be accommodated.
Cabling costs should be evaluated in relation to costs of modifications in the building plan
Both varying voltage supplies may be required in laboratories, pilot plants, workshops, etc.
Single voltage supply only may be required in offices, libraries, stores, etc

3. EVALUATION, SELECTION AND DESIGN.

The following points should be considered:

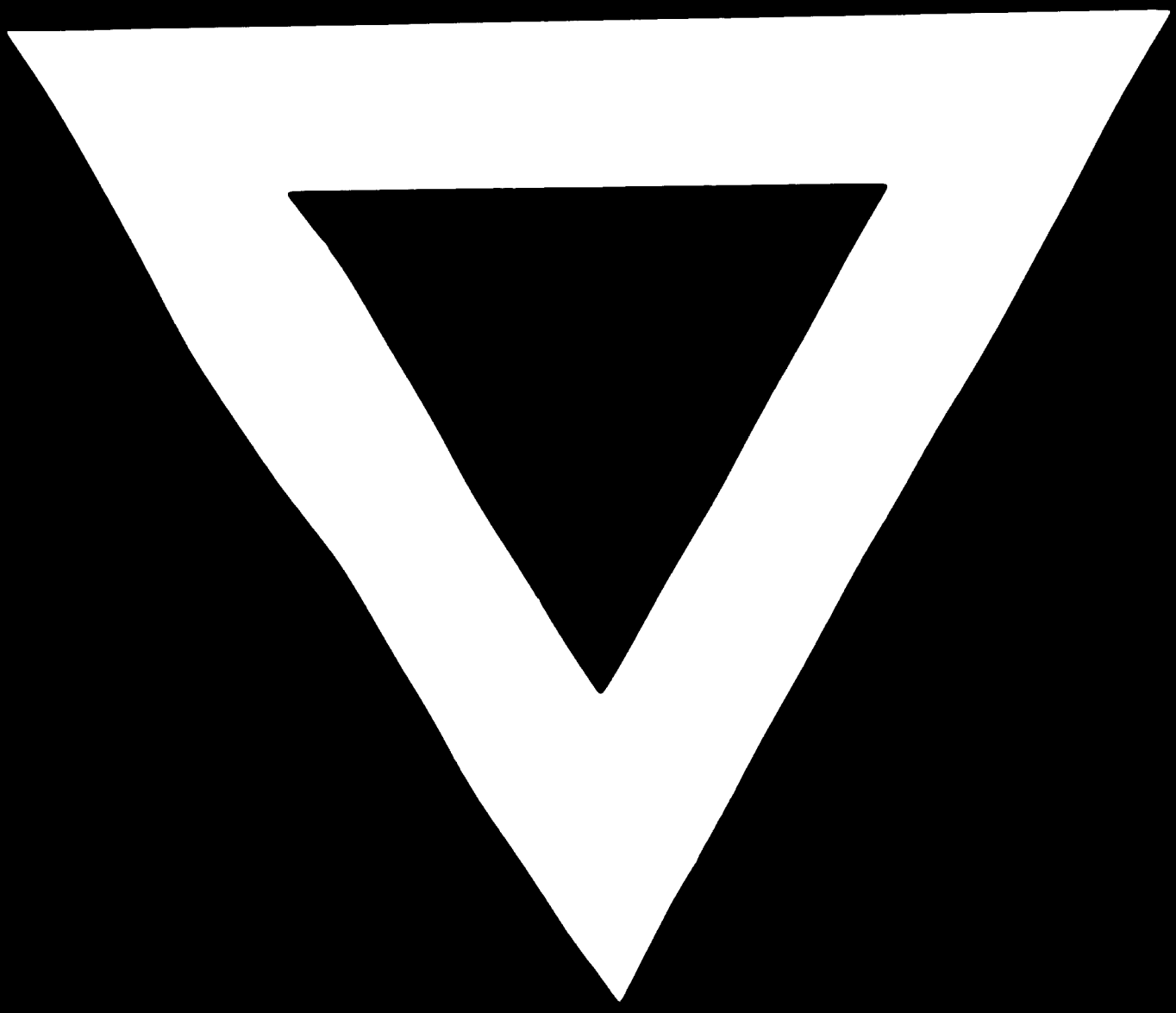
- rooms with a high fire risk should be separately considered;
- the system should be designed to prevent earth leakage;
- consideration should be given to the use of tropical equipment if needed,
- emergency generating of power may be required for the minimum capacity and may include the following:

  - fire fighting pumps
  - emergency lighting
  - smoke ventilation system
  - specialised areas

ANNEX VI

POSSIBLE CHECK LIST FOR THE SELECTION OF LABORATORY INSTRUMENTS

- functions of the instrument
- ranges and choice of units
- precision
- priority of basic or advanced apparatus
- space needs
- environmental requirements
- facilities needed (e.g. pressure gauge of water and gas, stability of voltage, etc.)
- sources of training
- service sources
- service life of equipments
- philosophy of spare inventory
- level of operator training
- criteria for selecting suppliers
- economic considerations
- desirability of standardization (e.g. plugs, sockets, currents, frequencies, design and tolerances of volumetric apparatus, thermometers, etc.)
- sources of further information (standards, catalogues, periodicals, books, bibliographies, automated reference systems, etc.)
- safety considerations
- get advice and assistance of local suppliers of materials, apparatus, furnishings and services
- find experts including specialists, who have a thorough knowledge of the conditions within the country in:-
  - procurement and commercial questions
  - legislative regulations
  - transportation, administration, intermediate storage of deliveries
  - service and repairs
  - training



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