NUCLEAR ELECTRONIC INSTRUMENTS FOR TROPICAL COUNTRIES

The performance of electronic instruments is often affected by climatic conditions prevailing in tropical regions. This constitutes a special problem in atomic energy operations, including the widespread applications of radioisotopes, in which electronic instruments play a vital role. On the one hand, these sensitive devices are at present manufactured only in a limited number of countries, mostly with temperate climates, and on the other hand, many of the developing countries which need these instruments are situated in tropical regions. Unless the instruments are specially designed and constructed so as to be able to withstand tropical climates, failures in performance may seriously hamper the progress of work over a large area of an atomic energy programme.

This is a matter of special interest to the International Atomic Energy Agency, because the supply of nuclear equipment is an important part of the Agency's programme of technical assistance. Most of the countries which need the Agency's assistance are in tropical areas, while the few countries which can supply nuclear electronic instruments belong mostly to temperate regions. The Agency, therefore, is particularly anxious to ensure that the instruments supplied by it for use in tropical countries conform to certain specifications designed to meet the requirements of tropical climates.

The first task is to decide what these specifications should be. In December 1961, the Agency convened a meeting of consultants from eleven countries to examine the problem and make recommendations as to the technical specifications of nuclear electronic instruments for use in tropical countries. Largely based on these recommendations, a document has now been prepared for providing general guidance to the Agency when purchasing equipment for supply to tropical countries. Some of the main specifications set forth in this document, as well as the considerations underlying them, are briefly summarized in this article.

Climatic and Operational Conditions

The Agency document points out that of the two main climatic conditions in tropical regions, namely damp heat and dry heat, the former is generally the more severe - so far as effects on the behaviour and performance of electronic instruments are concerned. In dry heat regions also, difficult problems are created by rapid and large variations in temperature and excessive dust. An appendix to the document contains a list of tropical countries, with an indication of the prevailing climatic condition (damp or dry heat) in each case.

High temperature and humidity are encountered in areas such as Malaya, Burma, Thailand, the East Indies, the coastal regions of India, Guiana, Equatorial Africa, Madagascar (Malagasy Republic), the West Indies south of the 15th parallel, etc. The climatic conditions are particularly severe during the monsoon or the rainy season, which may be as long as six months, and in areas where the rainfall is constantly heavy. The situation is further aggravated by the fact that it is the hot summer season.

In the coastal regions of some countries the air temperature during the hot season may rise to 40°C during the day, with very large daily variations in temperature. The minimum temperature recorded at night during the less warm season is about + 20°C under shelter. Consequently, the relative humidity is constantly very high and frequently approaches saturation, particularly in forest regions. Mould growth is general and many parasites thrive in such climatic conditions.

High temperature and low humidity conditions prevail in regions such as North Africa, Sahara, Arabia, Iran, Turkey, non-coastal regions of India, etc. Air temperature may rise during the day to + 60°C and fall to - 20°C at night. The normal daily variations are of the order of 40°C. Relative humidity is generally very low and may be as little as 5 per cent. Dust and sand are a special problem in these regions and must be taken into consideration in the design and choice of equipment. Sunlight has also deleterious effects on some materials, such as rubber and certain plastics.

Apart from general climatic conditions, operating or immediate environmental conditions must also be taken into account in the design and construction of instruments for use in tropical countries. For example, fluctuations in mains voltage is extremely large in some regions. While it is impracticable to provide for very large fluctuations in all designs, it is suggested that all equipment intended for tropical countries should be able to withstand at least + 10 per cent variations from nominal mains input voltage during normal operation, and occasionally withstand drops of - 20 per cent without damage.

The immediate environment of operation is also important because the severity conditions vary de-

pending on whether the instruments are operated in the open or inside a laboratory and, in the latter case, whether or not the laboratory is air-conditioned. The severity conditions to be encountered in tropical regions are therefore specified in three categories, namely, outside operation, inside operation in non-conditioned laboratories and inside operation in air-conditioned laboratories or specially controlled areas. An appendix to the document gives a list of nuclear electronic instruments and indicates the maximum severity conditions applicable in different cases.

Main Specifications

The document contains detailed specifications as to the choice of materials and electronic components for use in equipment intended for tropical countries.

Regarding materials, the general requirement is that all materials must be of "premium" quality best suited for their respective purposes under the environmental conditions outlined in the document. Among the more specific requirements are that adhesives should be impervious to moisture and mould growth, insulating materials should be such as do not retain water and moisture, and that lubricants should be such that their viscosity is not abnormally affected under the conditions of use in tropical countries. All metals must be able to withstand the environmental conditions in tropical countries, especially in respect of corrosion. To prevent corrosion due to electrolytic action between dissimilar metals in the presence of moisture, each metal should preferably be so selected that the contact potential difference between them does not exceed 0.5 volt. Where this is not possible, the contact surfaces are to be electroplated or so finished as to keep the potential difference below this limit, or adjacent surfaces should be insulated.

A considerable part of the report is devoted to specifications regarding electronic components. There is a set of minimum requirements which the components must satisfy so as to withstand the effects of heat, moisture, mould growth, salt mist, vibrations, etc. This is followed by detailed specifications in respect of different types of components. For example, it is stated that, wherever possible, long-life electronic tubes should be used and special attention should be given to the effects of radiant heating. When transistors are used, particular attention should be given to ensuring that the maximum operating temperature of these components is not exceeded; it is pointed out that the equipment in which they are used is required to operate in an air temperature of at least + 40°C and yet maintain the performance claimed for it in normal temperate climatic conditions.

Among other specifications given in the document are those relating to construction and design, marking, testing and packing. It is stated that all equipment ordered by the Agency for supply to a tropical country is required to withstand, without loss of performance or reliability, mechanical shocks and/or vibrations, as well as rough use in transport and transit handling. As regards testing, it is stated that all equipment purchased by the Agency must be in operation for at least 100 hours under normal laboratory or factory conditions before being presented for certain acceptance tests to be carried out in the presence of a representative or agent designated by the Agency. In certain cases, special tests may be necessary to check the reliability of an instrument or any of its components under accelerated damp heat conditions.

An attempt has been made to base all the recommendations contained in the document on agreed international procedures, i.e. on procedures recommended and published by the International Electrotechnical Commission.