This is the second article in a series being written by other UN organizations who co-operate directly with the IAEA by means of various projects, either in the field or through joint research. A World Health Organization authority has written the following report on nuclear power and the WHO role in the public health sector. In WHO/IAEA joint endeavours in this area, it is the responsibility of both organizations to ensure that all necessary precautions have been taken in the interests of public health, of safety and of the environment. Public acceptance has an important role to play in the expansion of nuclear power programmes and the public health authorities' need to educate, guide, and reassure the public.

Nuclear Power and Public Health

The energy crisis presents mankind with a challenging situation. Some countries are increasing the commercial production of energy from nuclear sources because of the dwindling supplies and rising costs of fossil fuels. Nuclear plant systems are also increasing in efficiency and economy and they have the clear advantage over conventional plants that they avoid some aspects of pollution and degradation of the environment.

The nuclear power industry has always emphasized the health and safety aspects of the various stages of power production. Nevertheless, the question of public acceptance is becoming increasingly important in the expansion of nuclear power programmes. Objections may arise partly from the tendency to accept familiar hazards but to react violently to unfamiliar ones such as radiation, which is not obvious to the senses and may result in delayed adverse effects, sometimes manifested only in the descendants of the individuals subjected to the radiation. The public health authorities therefore have an important role in educating the public to overcome these fears. However, they also have the duty to reassure the public and convince it that proper care has been taken to protect man and his environment. This duty can be fulfilled by means of independent evaluation and control to ensure that safe nuclear facilities are built, care is taken with their siting, they are operated safely, and the effects of possible accidents are minimized.

The selection and development of a nuclear power facility should be carried out with a sound understanding of the factors involved. WHO has collaborated with the International Atomic Energy Agency (IAEA) in the preparation of a booklet[1] summarizing the available information on the subject. It deals with the role of atomic energy in meeting future power needs, radiation protection standards, the safe handling of radioactive materials, disturbances of the environment arising from plant construction and ancillary operations, and the public health implications.

The public health effects of nuclear power production can be conveniently divided into three categories: accidental injuries and deaths not related to radiation, radiation health effects, and environmental effects.

Accidental injuries and deaths

These hazards are caused by physical interaction between man and the energy system and are not related to radiation exposure. They occur mainly in fuel manufacture, power plant construction and maintenance, and, to a lesser extent, uranium mining and the transportation of materials. They are largely related to occupation and are associated with the fabrication, construction, mining, and transport operations involved. The general public may also be involved in accidents concerning vehicles carrying nuclear and non-nuclear materials to and from power plants.

Although the common occupational injuries account for a significant proportion of the expenditure on health in the nuclear power industry they have attracted relatively little interest. At the international level, they have been the concern mainly of ILO, with some collaboration from WHO and IAEA.

Radiation health effects

These include harmful effects that may be observed in the exposed individuals, either relatively soon or long after exposure, and genetic effects, which affect subsequent generations. They may result from exposure to radiation or to emitted pollutants during normal operations or as a result of accidents in the energy system. They may affect the employees as well as the general public.

In decreasing order of importance, the normal operations for producing nuclear electricity with the greatest potential for total radiation exposure of employees are power plant operation and maintenance, uranium mining, and the reprocessing of fuel. Uranium mining, however, is by far the most dangerous of these operations from the point of view of radiation exposure of individual employees.

Radiation exposure of the general public may result from local and global environmental contamination with radioactive pollution from nuclear power and reprocessing plants, from the transportation of fuel, and from reactor accidents.

WHO and IAEA have been active in supporting the International Commission on Radiological Protection (ICRP) and the International Commission on Radiation Units (ICRU) in the preparation of primary standards and basic radiation protection criteria. The ICRP propose radiation dose limits at which somatic damage has not been observed. It also recommends that all exposure to radiation should be considered potentially damaging to man and that exposure of the public to radiation as a result of industrial processes should be permitted only if it is justified in terms of the ratio of benefit to risk. The primary radiation standards have been accepted and used by WHO and IAEA as a basis for deriving standards, regulations, and codes of practice. They have also been accepted by various countries and international and regional organizations.

The major radiation exposure in underground uranium mining results from airborne radon and the products of its decay that are found in the atmosphere of the mines. It has been demonstrated that excessive exposure to radiation in uranium mining leads to cancer. It

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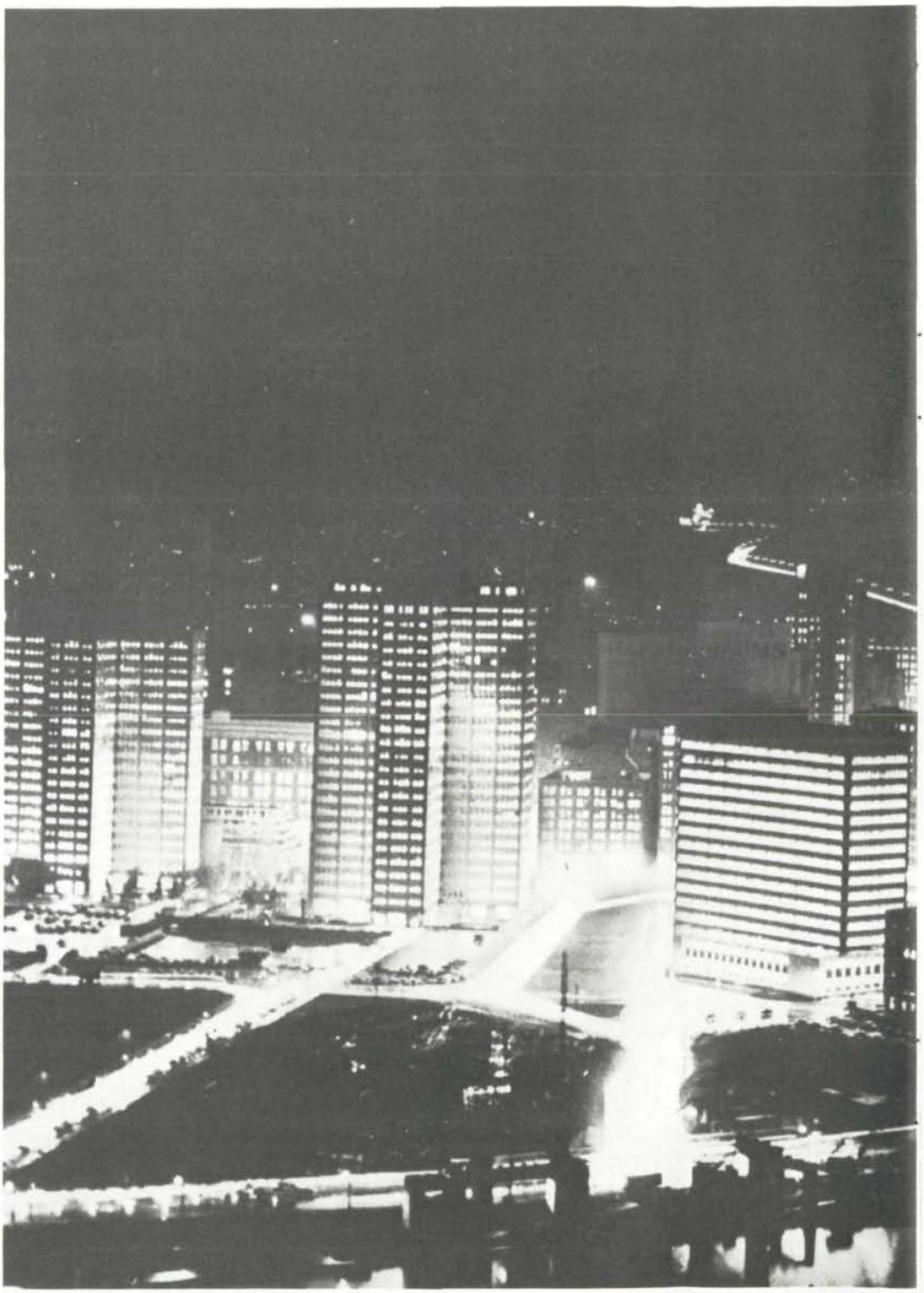
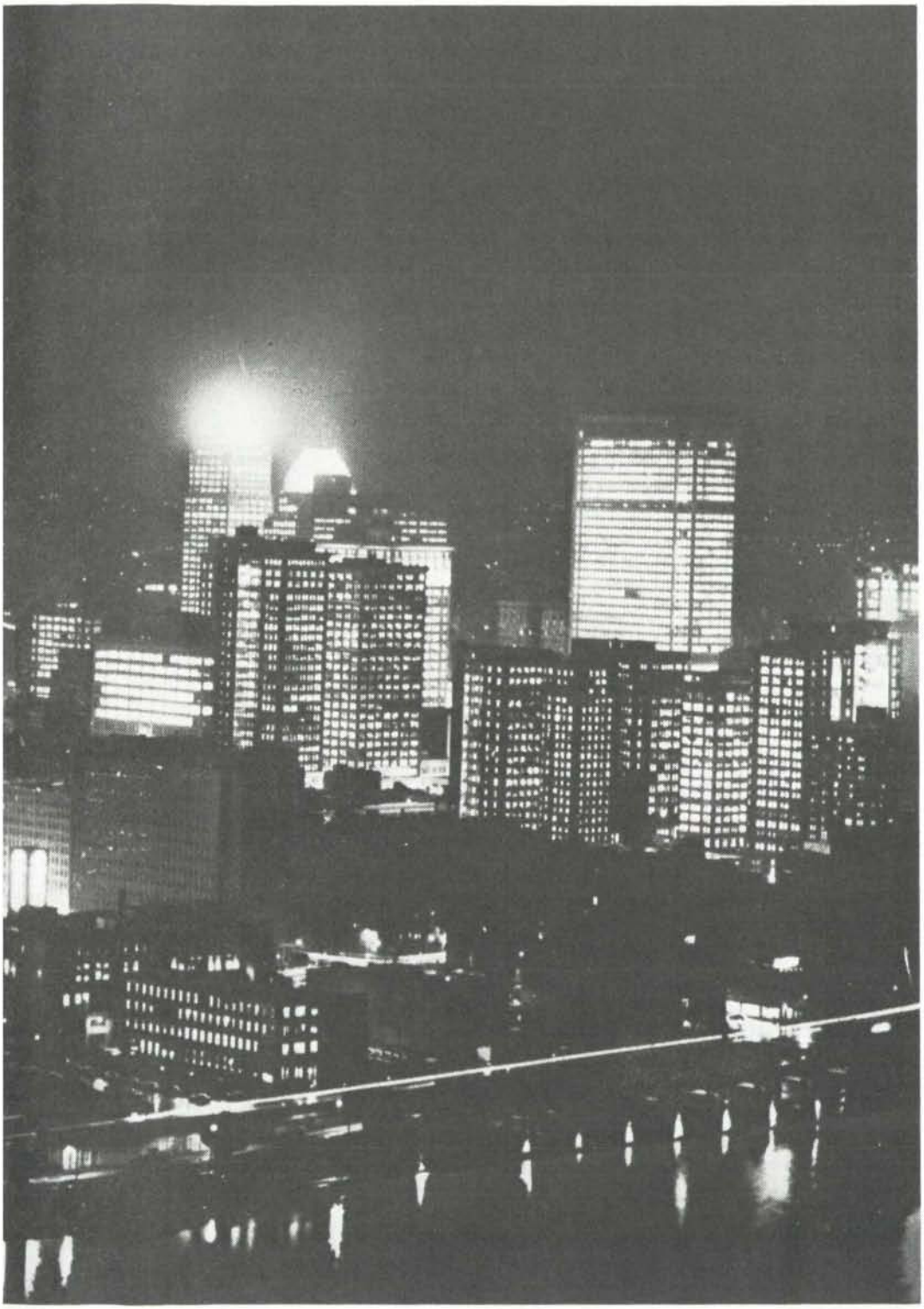
Man has been exposed to ionizing radiation since the beginning of time, but in recent years the amount of radiation has risen so much that it is now the object of international concern. This is a night view ▶ of downtown Pittsburg, Pennsylvania, USA, a district lit by atomic energy — Photo: USIS





has been estimated that during the past twenty years – including the period up to 1967 when occupational safety standards were either lacking or not strictly applied – some hundred out of several thousands of uranium miners have died of lung cancer in the USA and several hundreds more of those excessively exposed may die of the disease. However, the radon daughter product concentrations in mines have dropped steadily in recent years owing to improvements in ventilation. A joint IAEA/ILO/WHO symposium on radiological safety aspects of the mining and milling of nuclear materials was held in Vienna in 1963. It was followed by the publication of an ILO/IAEA code of practice on radiation protection in the mining and milling of radioactive ores. The three organizations are planning a similar symposium in 1974 to review the latest developments.

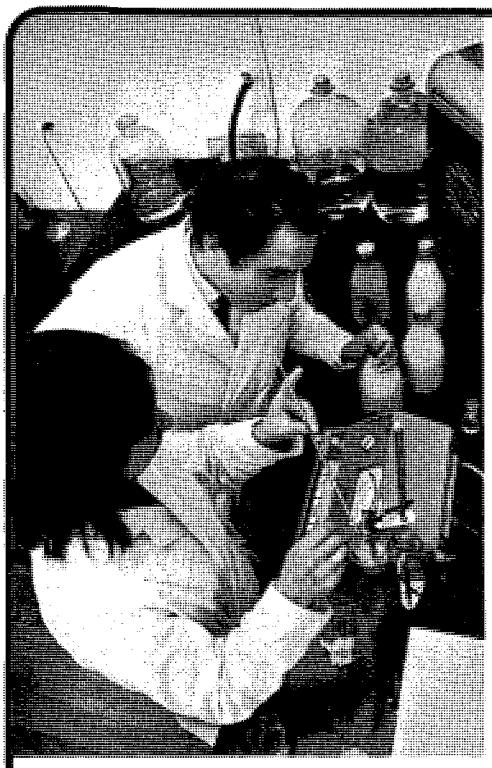
The main public health concern in the operation of nuclear systems is the exposure of employees of nuclear facilities to radiation, the disposal of radioactive wastes, reactor safety, and the transport of radioactive materials. The exposure to radiation of populations near nuclear facilities is not a major cause of concern.

Radiation exposure of employees of nuclear plants is usually monitored by personal monitors such as film badges, thermoluminescent dosimeters (TLD), and glass dosimeters. It has been kept at a fraction of the dose limits recommended by ICRP. Some radiation exposure also occurs primarily among contract employees, particularly during shutdowns for refuelling. WHO and IAEA have concentrated on developing comparable dosimetric methodologies and assisting in calibration, so as to facilitate the collection of information on the subject.

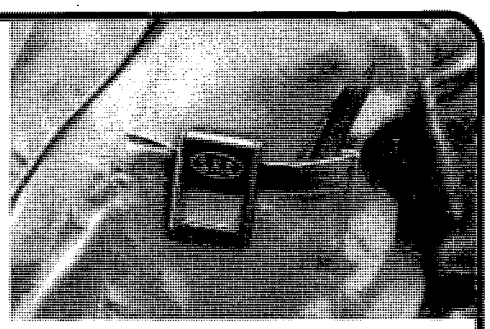
The management of radioactive wastes involves releases of low-level radioactivity and the storage of long-lived high-level radioactive wastes. WHO has collaborated with IAEA in preparing guidelines on the disposal of low-level radioactive wastes in rivers, lakes, and estuaries, and has also collaborated with IAEA and the Organisation for Economic Co-operation and Development (OECD) in reviewing and assessing the relevant health, technical, and public relations implications of the existence of long-lived high-level radioactive wastes that could be potentially dangerous for hundreds of thousands of years if not properly managed. An extensive amount of work on the management of high-level and alpha-bearing wastes has been carried out by various countries and by IAEA. Cooperation among countries as regards the health and safety aspects of such wastes, including the location and sharing of disposal sites, has been promoted by WHO and IAEA. WHO has also collaborated with IAEA in preparing guidelines for the selection of burial facilities for low-level radioactive wastes and for their surveillance.

Increases in environmental levels from nuclear power have been small. However, the problem of a possible future build-up has to be considered, particularly in the light of the 100-fold increase in nuclear power production expected in the near future and the fact that a technology for eliminating some of the long-lived gaseous effluents has still to be developed. Data on such discharges, particularly from reprocessing plants, have been scant and should be collected and coordinated on a worldwide basis. WHO and IAEA have therefore collaborated in the collection of information on environmental radioactivity and on methods for recording environmental releases of worldwide significance.

WHO has also designated an International Reference Centre at Le Vesinét, France, and several collaborating institutions. They are engaged in a programme aimed at ensuring the proper recording, collection, and processing of data on radionuclides in the environment.

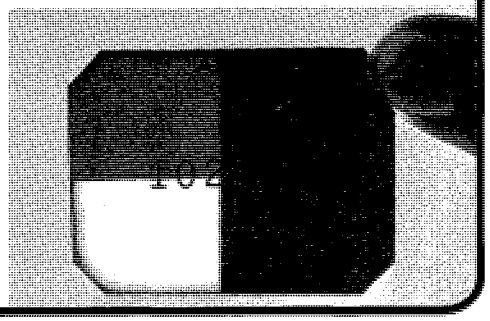


In a laboratory for industrial hygiene in Chile a chemist does radiochemical analysis of milk for strontium 90 — Photo: WHO, P. Larsen



Details of a film exposed to radiation: half the film has no filter in front, one quarter has an aluminium filter, and the other quarter a lead filter, so that different types of radiation can be recorded on the same film.

A film-holder clip; the films are sent out and returned on a 14-day basis — Photo: WHO, P. Larsen



The recent proliferation of nuclear reactors has justified a new approach to environmental contamination by radionuclides. A symposium organized jointly in 1973 by IAEA, the Nuclear Energy Agency, and WHO on the environmental behaviour of radionuclides released in the nuclear industry stressed the need to develop models for assessing radiation doses on a regional basis rather than on the basis of individual nuclear installations. A concept of "environmental capacity" limits has been developed with a view to determining the annual input of radioactivity that results in a regional population receiving radiation doses equal to the recommended annual dose limits. It is expected, however, that releases of radioactivity into the environment will be kept to the lowest level achievable and well below the limiting capacity.

IAEA, in collaboration with WHO, has also promoted regional cooperation in order to define, evaluate, and ultimately solve the problems associated with radioactive pollutants.

Thus, the IAEA/WHO European study group on radiological protection in 1973 reviewed the radiological and environmental problems arising from the activities of the nuclear industry. Regional cooperation among the Danube countries has been initiated.

The transport of radioactive materials has been increasing rapidly. Special attention is being given to the shipment of highly radioactive sources, such as spent fuel from reactors, which is expected to rise to tens of thousands of shipments annually by the year 2000.

WHO has collaborated with IAEA in a recent comprehensive review of the IAEA regulations for the safe transport of radioactive materials; this review has taken account of ten years of operational experience and has introduced some simplification of the administrative requirements for application of these regulations. Consideration has also been given to developing the principle of waste management at the point of waste production, e.g., combined fuel reprocessing and waste management, to eliminate the need to transport some high-level radioactive wastes.

The record of the nuclear industry as regards accidents has been good, accidents having been generally of a minor nature with no involvement or limited involvement of the general public. However, the probability of a catastrophic accident in a large power reactor or a reprocessing plant cannot be regarded as impossible. There is a need for the continuing review of new experience and information to evaluate and minimize potential hazards arising from accidents and malfunctioning of nuclear plants, particularly of the newer types. WHO and IAEA have collaborated in reviewing and assessing information on potential accidents and the means of preventing them or mitigating their effects through the proper siting, design, construction and operation of plants as well as planning and organizing emergency measures to cope with accidents. A publication[2] prepared by WHO in collaboration with IAEA and FAO deals with the public health aspects of radiation accidents and reviews the effects of nuclear power on the environment. WHO also collaborated with IAEA in a symposium on the handling of radiation accidents[3] and with IAEA, FAO, and ILO in a manual on planning for the handling of such accidents.[4]

Environmental effects

Environmental effects are caused by physical and chemical interaction between emitted pollutants, including thermal pollution, and the environment. A major effect of nuclear power production is waste heat. Present-day nuclear power plants, like their fossil fuel counterparts, have a thermal efficiency of about 30%, which means that less than one-third of the developed energy is converted into useful work. The remaining two-thirds are wasted as irrecoverable heat, largely through the condenser cooling waters. WHO collaborated with IAEA in a panel meeting to review present knowledge and prepare a publication[5] on the management, environmental effects, and beneficial uses of waste heat from nuclear power stations. The potential detrimental effects on the environment include influencing the reproduction, growth, and survival rates of aquatic organisms that have a relatively low tolerance to temperature variations, rendering water less suitable for certain purposes, affecting the atmosphere and causing, say, ground-level fog and icing, and accelerating the deterioration processes of structures caused by chemical pollutants. Some beneficial effects may also be produced by the waste heat, particularly in cold climates, and it may be utilized for heating and aquaculture.

References:

1 International Atomic Energy Agency (1972), "Nuclear power and the environment," Vienna.
2 World Health Organization (1965), "Protection of the public in the event of radiation accidents," Geneva.
3 International Atomic Energy Agency (1969), "Handling of radiation accidents," Vienna.
4 International Atomic Energy Agency (1969), "Planning for the handling of radiation accidents," Vienna (Safety Series Publication No. 32).
5 International Atomic Energy Agency (1974), "Thermal discharges at nuclear power stations. Their management and environmental impacts," Vienna.