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COMMITTEE OF THE WHOLE

THE AGENCY'S CONTRIBUTION TO SUSTAINABLE DEVELOPMENT

Note by the Director General

1. On 15 September 1988 the Board of Governors agreed to recommend to the General Conference that it adopt the draft resolution contained in Attachment 1; this draft resolution had been submitted to the Board by Sweden, supported by Denmark, Finland and Norway, and was co-sponsored by Canada in the course of the Board's discussion.
2. In addition, the Board decided that the Note by the Secretariat contained in Attachment 2 should be attached as background information for the General Conference.

THE AGENCY'S CONTRIBUTION TO SUSTAINABLE DEVELOPMENT

Draft resolution recommended by the Board of Governors

The General Conference,

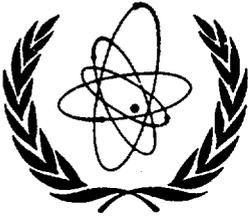
(a) Noting United Nations General Assembly resolution 42/187 of 11 December 1987, by which the General Assembly transmitted to all governments and to the governing bodies of the organs, organizations and programmes of the United Nations system the report of the World Commission on Environment and Development and invited them to take account of the analysis and recommendations contained in the report in determining their policies and programmes;

(b) Noting further United Nations General Assembly resolution 42/186 of 11 December 1987, by which the General Assembly transmitted to all governments and to the governing bodies of the organs and organizations of the United Nations system the Environmental Perspective to the Year 2000 and Beyond as a broad framework to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound and sustainable development;

(c) Noting the reference in paragraph 35 of the Agency's annual report for 1987 that "many of the Agency's activities in 1987 were such as to help in achieving environmentally sound development, and in the preparation of future programmes of the Agency the Environmental Perspective and the World Commission's analysis and recommendations will be taken into account"; and

(d) Considering operative paragraph 9 of United Nations General Assembly resolution 42/187, which calls upon the governing bodies of relevant multilateral development assistance and financial institutions to commit their institutions more fully to pursuing sustainable development in establishing their policies and programmes in accordance with the national development plans, priorities and objectives established by the recipient Governments themselves:

Requests, in line with operative paragraph 18 of United Nations General Assembly resolution 42/187 and paragraph 12 of United Nations General Assembly resolution 42/186, the Director General to submit to the Board of Governors in February 1989 information on the contribution of the Agency's programme activities towards achieving the objectives of environmentally sound and sustainable development as a basis for a report to be submitted to the forty-fourth session of the General Assembly.

**B**GC(XXXII)/COM.5/62
Attachment 2GOV/INF/552/Rev.1
8 September 1988

International Atomic Energy Agency

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REPORT OF THE WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT

and

THE ENVIRONMENTAL PERSPECTIVE TO THE YEAR 2000 AND BEYOND**Note by the Secretariat****1. INTRODUCTION****1.1 Background**

1. In paragraphs 45 and 46 of document GOV/INF/547, the Board's attention was drawn to United Nations General Assembly resolutions 42/187 and 42/186 (see Annexes 1 and 2) welcoming the report of the World Commission on Environment and Development and adopting the Environmental Perspective to the year 2000 and Beyond respectively.

2. In these resolutions the General Assembly, inter alia, called upon the governing bodies within the United Nations system "to review their policies, programmes, budgets and activities aimed at contributing to sustainable development", "to take account of the analysis and recommendations contained in the report of the World Commission in determining their policies and programmes" and "to report regularly to the General Assembly on the progress made in achieving the objectives of environmentally sound and sustainable development..."

3. The World Commission on Environment and Development was set up by the General Assembly in December 1983 as an independent body to propose long-term environmental strategies for achieving sustainable development. The Secretary General appointed Gro Harlem Brundtland as Chairman of the twenty-one member Commission (see Annex 3). The Commission held public hearings on five continents, commissioned studies and set up expert panels on various problems. It adopted its report unanimously and presented it to the General Assembly in 1987. The thrust of its message is directed to national governments and, among the international organizations, to the major development and financing agencies.

4. The Environmental Perspective, prepared by the Governing Council of UNEP in 1987 and adopted by the General Assembly as a broad framework "to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound development", reflects many of the concerns of the World Commission's report and sets goals and recommends actions for governments and for the international community.

5. Some major conclusions in the World Commission's report and in the Environmental Perspective are summarized in the following sub-sections of the Introduction to this paper. Section 2 contains some general comments on the two documents by the Agency's Secretariat, and Sections 3 through 7 give information on Agency programmes relevant to sustainable development, including point-by-point information on questions about nuclear energy raised by the World Commission.

1.2 The report of the World Commission on Environment and Development

General considerations

6. The central message of the World Commission's report is that economic growth needs to be revived and that, in the long run, there can be no sustainable development unless environmental concerns are taken into account. More should be done to integrate environmental concerns into the development activities of the United Nations system, and more emphasis should be placed on preventive rather than clean-up activities. "Sustainable development" is defined as development which "meets the needs of the present without compromising the ability of future generations to meet their own needs."

7. The report lists, in its Part II, the common challenges under the following headings:

- Population and Human Resources
- Food, Security: Sustaining the Potential
- Species and Ecosystems: Resources for Development
- Energy: Choices for Environment and Development
- Industry: Producing More with Less
- The urban challenge.

Energy

8. The World Commission's treatment of the energy question is, of course, of primary interest to the Agency. There are, however, many programmes of the Agency which address problems which fall under other common challenges presented by the WCED, e.g., the excessive use of fertilizers and pesticides in agriculture and water resource development.

9. Summarizing its treatment of energy the World Commission states: "A safe and sustainable energy pathway is crucial to sustainable development; we have not yet found it." The World Commission concludes that "It is clear that a low energy path is the best way towards a sustainable future. But given efficient and productive uses of primary energy, this does not mean a shortage of essential energy-services. Within the next 50 years, nations have the opportunity to produce the same levels of energy-services with as little as half the primary energy supply currently consumed..."

10. The World Commission points out that no form of energy -- not even new and renewable ones -- is without environmental consequences and risks. It highlights the risks of increased reliance on fossil fuels - due to the greenhouse effect, air pollution and acidification of the environment.

11. The World Commission sees some major unsolved issues in the use of nuclear energy and gives a catalogue of items on which international agreement must be reached. The report concludes that "The generation of nuclear power is only justifiable if there are solid solutions to the presently unsolved problems to which it gives rise".

1.3 The Environmental Perspective to the Year 2000 and Beyond

12. As regards energy, the Environmental Perspective gives the goal as "The provision of sufficient energy at reasonable cost, notably by increasing access to energy substantially in the developing countries, to meet current and expanding needs in ways that minimize environmental degradation and risks, conserve non-renewable sources of energy and realize the full potential of renewable sources of energy".

13. The recommended action as regards nuclear energy is as follows: "International co-operation should aim at the creation of a regime for the safe production and use of nuclear energy, as well as the safe handling of radioactive waste, taking into account, through appropriate mechanisms including prior consultations, the interests and concerns of countries that have decided not to produce nuclear energy, in particular concerns regarding the siting of nuclear plants close to their borders. This regime should extend globally to encompass observance of comparable standards and procedures on management of reactors and the sharing of information and technology for nuclear safety. The Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency should be complemented by bilateral and subregional agreements and should also lead to technical co-operation among countries on environmental management of nuclear energy."

2. GENERAL COMMENTS BY THE AGENCY'S SECRETARIAT

14. In the Secretariat's opinion, "to take account of the analysis and recommendations contained in the report of the World Commission...", as called for by the General Assembly (para. 2 above), does not mean accepting them uncritically as a basis for action.

15. It is the Secretariat's view that neither report in raising questions about nuclear power adequately takes into account measures taken in radiation protection and nuclear safety. ICRP's work on principles for radiation protection started in 1928. The Agency's safety standards, guidelines, recommendations, data and procedures have all been arrived at through considerable international collaboration, not only among experts from Member States, but also, depending upon the exact subject matter being considered, with organizations such as FAO, ICRP, ILO, IMO, OECD/NEA, UNEP, UNSCEAR, WHO and WMO. (These are dealt with in Sections 5, 6 and 7.)

16. The concept "low energy path" is not defined in the report and the World Commission appears not to have considered what is likely to occur in the near-intermediate future or the importance of the different contributions to the world energy supply mix. These subjects are discussed in Sections 4.1 and 4.2 below.

17. The World Commission's major issues concerning nuclear energy are treated in Section 4.3, and the catalogue of items on which international agreement must be reached is discussed in detail in Section 5.

18. In a number of non-nuclear problem areas considered in the World Commission's report, e.g., agriculture, industry and resource development, nuclear techniques are making a significant contribution to the study or mitigation of environmental problems and thereby to sustainable development. The Agency's activities in some of these areas may be less visible than those related to energy production, but they are nevertheless important.

19. The pertinent programmes relating to the application of isotopes and radiation are discussed below in Section 3.

3. NUCLEAR APPLICATIONS

20. Nuclear and isotopic techniques were used to study natural processes long before the Agency existed. From the late 1940s, radioactive as well as separated stable isotopes became readily available. The use of such isotopes and the development of analytical tools, including tracer methods, neutron activation analysis, X-ray fluorescence and atomic absorption spectrometry, have added to the techniques available for the study and detection of environmental pollutants such as pesticides and toxic metals. In addition, these tools have become standard methods for assessing water and mineral resources. The use of nuclear techniques to help solve pollution problems is well known and is an important contribution to the concept of sustainable development.

21. Table 1 gives examples of nuclear techniques used for different purposes.

22. Naturally, the most significant activities are in the Agency's programme areas related to food and agriculture. One major area of investigation within the programme area of "Soil fertility" concerns optimization of the use of nitrogenous fertilizers, which would also reduce run-offs. Another programme area of interest is "Agrochemicals and residues", in which the focus is both on the investigation of the fate of pesticide residues in food, feed, soil, water and biota, and on the development and improvement of pesticide forms which could reduce environmental contamination.

23. The Agency's studies and applications of the sterile insect technique (SIT) to control and eradicate the Mediterranean fruit fly and the tsetse fly within certain geographical areas have produced significant successes -- for instance, in Central America in the case of the fruit fly. As one of the biological methods of insect control, SIT will help to minimize the use of pesticides.

24. Nuclear analytical techniques are being proposed and used to determine toxic elements in food, solid wastes (such as coal ashes) and atmospheric aerosols. The Monaco Laboratory has a long-standing programme for the analysis of non-radioactive pollutants of the sea.

25. Water resource investigations and development are now unthinkable without techniques using radioactive and stable isotopes. The Agency has assisted Member States with technical co-operation projects in hydrology since its beginning. There are at present some 70 projects in 60 Member States.

Table 1: NUCLEAR APPLICATIONS -- EXAMPLES

Environmental Monitoring and Assessment

1. Food and Agriculture

- Studies of nitrogen fixation in crops and trees to optimize the use of nitrogenous fertilizers
(Co-ordinated research programmes, TC projects and training courses)
- Nuclear techniques for the improvement of fertilizer and water management practices
(Regional TC programme in Latin America)
- Monitoring pesticide residues in food and the environment and development of controlled release pesticides
(7 active co-ordinated research programmes, TC projects)

2. Nuclear Techniques in Pollution Studies

- Early work on isotope data in precipitation
- Analysis of non-radioactive pollutants with nuclear techniques
(Co-ordinated research programme)
- Nuclear techniques in flue gas monitoring and pollutant transport studies
(Co-ordinated research programmes, TC projects, information exchange)

Diminishing and Ameliorating Environmental Impact

1. Food and Agriculture

- Radiotracer studies to reduce or eliminate pesticide residues during food processing
(Co-ordinated research programme)
- Sterile Insect Technique (SIT)
(Co-ordinated research programmes, major TC projects, information exchange and laboratory services)

2. Physics and Chemistry

- Electron beam processing of combustion flue gases to remove SO₂ and NO_x
(Co-ordinated research programmes, information exchange and TC projects)

Resource Development

1. Hydrology

- Studies of origin and flow of water
(Some 70 TC projects in 60 Member States, regional TC projects, information exchange, laboratory services)

2. Minerals

- Nuclear techniques for mineral exploration and assessment
(Co-ordinated research programmes, information exchange and TC projects)

3. Food and Agriculture

- Plant breeding and genetics
Co-ordinated research programmes, information exchange and TC projects
- Animal production and health
Co-ordinated research programmes, TC projects

26. A technical report on "Isotope techniques in the hydrogeochemical assessment of potential sites for the disposal of high-level radioactive wastes" (1983) and a report on "Nuclear techniques in groundwater pollution research" (1980) are examples of the value of nuclear techniques in water pollution studies as well as in resource assessment determinations.

27. Recent work has indicated that electron accelerators can be used for cleaning flue gases from fossil-fuelled power plants, without the major chemical installations now needed for SO₂ and NO_x removal. The primary effort is aimed at investigating if promising results obtained at small plants can be extrapolated to plant sizes of the current power plant generation.

3.1 The Amazon Project

28. One of the major technical co-operation projects of the Agency relates to the Amazon region in Brazil. This project is an example of the integrated use of isotope techniques in a major environmental investigation. The project concerns the effects of changing land use on the ecology and climate of the Amazon region. Questions important to many countries with tropical rainforests are being addressed in this project. The project is also one which shows how different disciplines can be joined in one major investigation. Three major Brazilian research institutes are involved under the co-ordination of the National Nuclear Energy Commission, and from outside, groups from France, the Federal Republic of Germany and the USA are participating. Sweden is providing considerable funding.

29. The clearing of tropical rainforests raises two major issues: environmental and ecological effects, and the problems of sustainable agriculture on the cleared land. About half of the rainfall in the Amazon Basin (5.8 million square kilometres) comes from recycling from the forest. There is concern that removal of significant quantities of forest will reduce rainfall not only in the Amazon region, but also elsewhere. Tropical rainforest ecosystems have often developed on fragile soils, and large-scale interventions can have very far-reaching effects, also on river systems in the region. Isotope techniques are of key importance in studies of this ecosystem.

3.2 Non-nuclear energy resources

30. Nuclear techniques are used also in the development of non-nuclear energy resources. In 1975 and 1981, meetings were held by the Agency on the Application of Nuclear Techniques to Geothermal Studies. The papers were published in special issues of the journal "Geothermics" in 1977 and 1983. A co-ordinated research programme, started in 1984, is studying isotopic and geochemical techniques in geothermal exploration in Latin America. In addition, nuclear techniques are used in coal exploration and in the analysis of, e.g., heavy metal residues from coal burning.

4. ENERGY DEVELOPMENT

4.1 "The low energy path"

31. As the World Commission does not give any general directions for future energy supply except the desirability of a "low energy path" and a recommendation for more research into renewable energy forms, it would seem desirable to review the basis which it appears to have used in its discussion of the world's energy future.

32. The World Commission's energy scenario appears to be based on "An End-Use Oriented Global Energy Strategy" by J. Goldemberg, T.B. Johannson, A.K.N. Reddy and R.H. Williams published in 1985 (Annual Review of Energy 10:613-688), which presents a possible future scenario for 2020. This is at considerable variance with the conclusions of studies of energy demand and supply over the next 20-30 years made by the World Energy Conference (WEC), the International Energy Agency (IEA) of the Organisation for Economic Co-operation and Development (OECD), the Commission of the European Communities (CEC) and the International Institute of Applied Systems Analysis (IIASA) - see Table 2.

Table 2: FUTURE ENERGY DEMAND					
	1980	1990	2000	2010	2020
A. WORLD TOTAL PRIMARY ENERGY DEMAND (Mtoe)^{1,2}					
1. OECD/IEA (1982)	6900	8230-8750	10500-12100		
2. CEC (1986)	7270		10800		
3. IIASA (1985)	6800	8000	9900	11300	
4. WEC (1986) ²⁾	7700	9400	11100	13300	15500
5. Goldemberg <u>et al.</u>	7800				8400
B. DEVELOPING COUNTRIES, TOTAL PRIMARY ENERGY DEMAND (Mtoe)					
1. OECD/IEA (1982)	950	1410-1620	2320-2840		
2. CEC (1986)	1100		2270		
3. WEC (1986)	1950		3500		5500
4. Goldemberg <u>et al.</u>	2220				4400
C. WORLD ELECTRIC ENERGY DEMAND (TWh)					
1. IIASA (1985)	8100	11000	16200	17500	
2. Goldemberg <u>et al.</u>	8150				15600
 Sources:					
OECD/IEA:	World Energy Outlook (1982)				
CEC:	Energy 2000 (1986)				
IIASA:	International Energy Workshop 1985. A summary of projection responses from 70 organizations, governmental and non-governmental, national and international (1985)				
WEC:	Conservation Commission, position paper at WEC Conference in Cannes, 1986				
 Notes:					
1)	Mtoe = Million tons of oil equivalent. There are differences depending on whether and how so-called "non-commercial" energy sources in developing countries, mainly fuel wood and animal dung, have been included.				
2)	This is a "plausible" hypothesis out of three considered by the WEC Conservation and Studies Committee				

33. It is necessary to understand the background and purpose of the scenario drawn up by Goldemberg et al. The article states that "the purpose is to show that it is both technically and economically feasible to evolve an energy future compatible with the achievement of a sustainable world. Our scenario is not a forecast, but a normatively constructed energy future that we believe could evolve with appropriate public policies".

34. When considering future energy demand, it is reasonable to make "forecasts" covering the fairly short-term future (up to 2000-2010), but for the longer-term future one can speak only of "projections" - fraught with large uncertainties. The studies of the organizations mentioned above have yielded numerous forecasts up to 2000 and projections beyond that date. They are almost unanimous in forecasting an increase in total energy demand from about 7000 Mtoe in 1980 to 10,000-12,000 Mtoe in 2000; also, a further increase is forecast for the period 2000-2010 and projected for the period 2010-2020. It should be noted, moreover, that the figures relating to the studies made by these organizations reflect what they consider to be low-energy scenarios, with only a moderate increase in per capita energy use in the industrialized countries and considerable increases in energy conservation and in the efficiency of energy end-use assumed.

35. The forecasts/projections for electric energy indicate an even more pronounced increase in demand as likely than for primary energy. For example, although -- in general -- primary energy consumption has been increasing in OECD countries, since about 1973 it has not been increasing as fast as Gross Domestic Product (GDP), whereas electric energy consumption has been increasing at about the same rate as GDP - if not slightly faster (see Figure 1) -- and it is expected that these trends will continue. This also reflects the role of electricity in conservation of primary energy through its higher efficiency in end uses. In this connection, moreover, it is important to bear in mind that the present per capita consumption of electric energy varies greatly from one country to another (see Annex 4).

36. It should be further noted that the results of Goldemberg et al. depend heavily on a change to electricity as the end use form of energy. The scenario for 2020 involves an increase in electricity production by more than 90% over the level of 1980, which is smaller than the increase foreseen in, e.g., the projections of IIASA, but not entirely inconsistent with other projections for this particular sector. Also, Goldemberg et al. assume nuclear electricity production of more than 50% above the level of 1987, and electricity production from solar, wind power and cogeneration with biomass and fossil fuels which is slightly more than that from nuclear in 2020.

37. Judging from the forecasts presented in Table 2, it seems realistic to foresee a considerable increase in overall energy demand at least until 2010. However, one must then ask how the increased demand is going to be met in a sustainable manner given the increasing certainty about the existence of a greenhouse effect, which is described by the World Commission as making "heavy future reliance upon fossil fuels problematic".

38. The World Conference on the Changing Atmosphere, held in Toronto in June 1988, produced a statement which is highly pertinent in this context. The following are some quotations from that statement:

"The Earth's atmosphere is being changed at an unprecedented rate by pollutants resulting from human activities, inefficient and wasteful fossil fuel use and the effects of rapid population growth in many regions. These changes represent a major threat to international security and are already having harmful consequences over many parts of the globe."

"Far-reaching impacts will be caused by global warming and sea level rise, which are becoming increasingly evident as a result of continued growth in atmospheric concentrations of carbon dioxide and other greenhouse gases. Other major impacts are occurring from ozone layer depletion resulting in increased damage from ultraviolet radiation."

"An initial global goal should be to reduce CO₂ emissions by approximately 20 percent of 1988 levels by the year 2005. Clearly, the industrialized nations have a responsibility to lead the way, both through their national energy policies and their bilateral and multilateral assistance arrangements."

"Apart from efficiency measures, the desired reduction will require (i) switching to lower CO₂ emitting fuels; (ii) reviewing strategies for the implementation of renewable energy, especially advanced biomass conversion technologies; (iii) revisiting the nuclear power option, which lost credibility due to problems related to nuclear safety, radioactive wastes, and nuclear weapons proliferation. If these problems can be solved, through improved engineering designs and institutional arrangements, nuclear power could have a role to play in lowering CO₂ emissions."

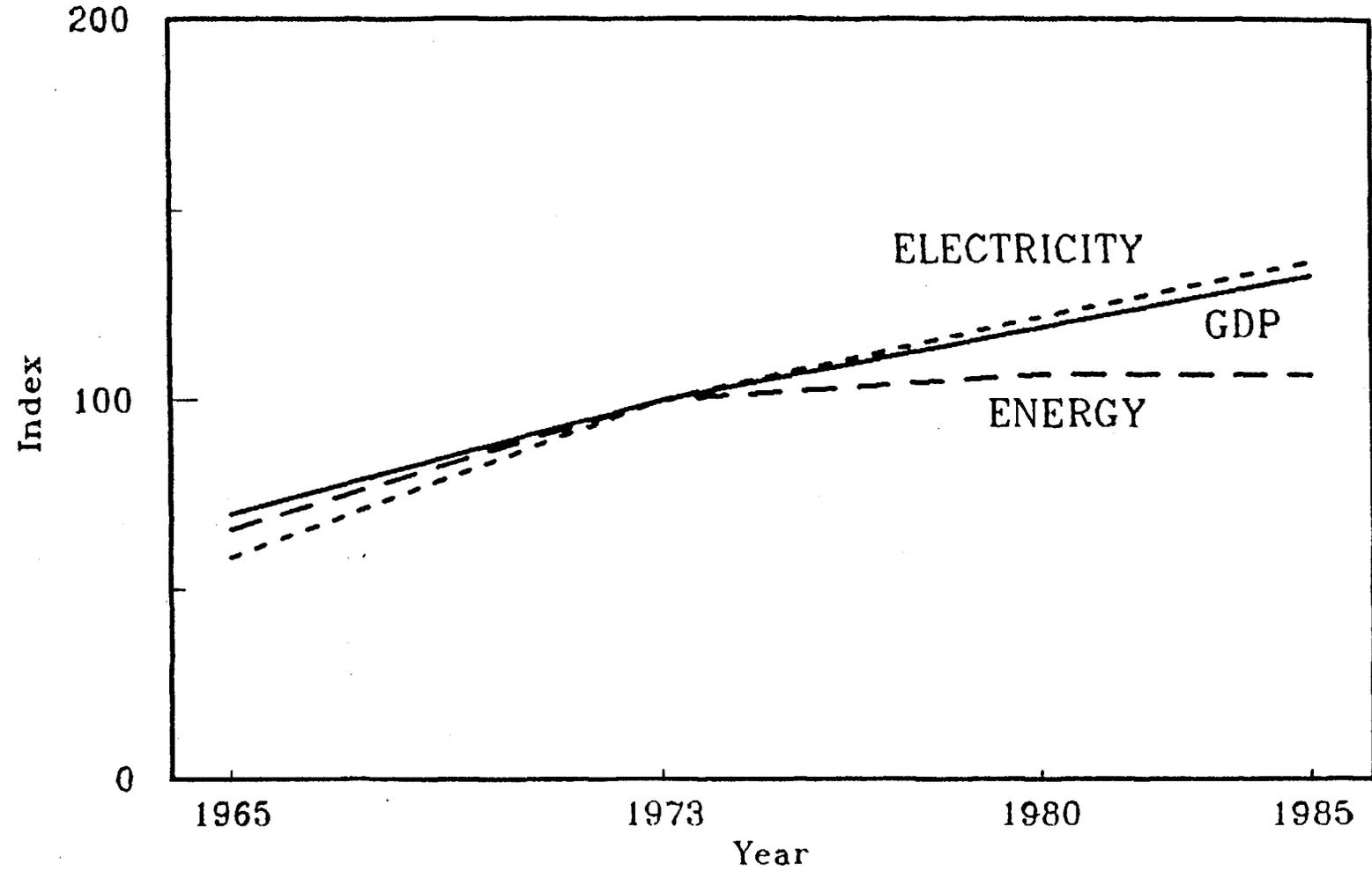
4.2 Energy supply mixes

39. In the Secretariat's opinion, the critical question regarding sustainable future energy supplies is that of the future mix of supply options. The World Commission estimates that renewable energy sources could -- in theory -- provide 7500-10,000 Mtoe annually (of the order of the world's present total energy consumption), but its estimate is not supported as a practical proposition by the organizations already mentioned. While all of these foresee an increased use of hydro power for electricity generation (to some 650 Mtoe annually by the year 2000), IEA and WEC consider that solar energy, geothermal energy and biomass can be expected to contribute only an additional 50-60 Mtoe to the "commercial" energy balance of 2000 - i.e. less than 1%. On the other hand, it is expected that coal use will have increased by 36%, from 2200 Mtoe in 1986 to 3000 Mtoe annually by 2000. In the OECD countries, the forecast is for the use of coal to increase by 45%, from 760 Mtoe in 1986 to 1100 Mtoe in 2000 (Energie, La Documentation Française, 1988).

40. The World Commission does not mention the environmental advantages of nuclear power under normal operating conditions, despite the fact that the use of nuclear power has led to reduction in SO₂ emissions. In France, for example, emissions of SO₂ decreased by 56% between 1980 and 1986, mainly owing to a marked increase in the use of nuclear power for electricity production, and data from Belgium and Finland also point to significant reductions in SO₂ emissions attributable to the increasing use of nuclear power. Also, France achieved a total decrease of NO_x emissions by 9% between 1980 and 1986, as the decrease in the emissions from the electric power generating sector more than offset the increase in the dominating transport sector. Nuclear power generation does not, of course, produce any emissions of CO₂.

Fig. 1

Trends in GDP, primary energy consumption, and
electricity consumption in OECD countries



Source: IAEA EEDB
World Development Report, 1986 and 1987 editions.
Note: each curve is normalized to 100 % in 1973.

4.3 WCED's main issues concerning nuclear energy

41. As mentioned in para. 11 above, the World Commission raises four issues concerning the development of nuclear power: (1) costs, (2) health and environmental risks, (3) nuclear accident risks, and (4) radioactive waste disposal. In addition, it points to a concern about the proliferation of nuclear weapons.

The proliferation concern

42. The World Commission concludes that "Among the dangers facing the environment, the possibility of nuclear war is undoubtedly the gravest". The dangers of proliferation associated with the use of nuclear energy are stressed in the report, where it is stated that "Co-operation is needed ... among suppliers and buyers of civilian nuclear facilities and materials and the International Atomic Energy Agency, in order to provide credible safeguards against the diversion of civilian reactor programmes to military purposes, especially in countries that do not open all their nuclear programmes to IAEA inspection", and that "We therefore recommend in the strongest terms the construction of an effective international régime covering all dimensions of the problem. Both nuclear weapons states and non-nuclear weapons states should undertake to accept safeguards in accordance with the statutes of the IAEA".

43. It is clear that, if more States were to have nuclear weapons, more States would be in a position to trigger environmentally disastrous warfare. It is a moot question, however, whether the development of nuclear power for electricity production increases the risk of horizontal proliferation. Conversely, the absence of nuclear power development is no guarantee against horizontal proliferation. The reality is that the transfer of peaceful nuclear technology has been used as a means of obtaining commitments to non-proliferation and verification thereof through safeguards. The maintenance of credible safeguards and their application when agreement has been reached on the submission of further installations to safeguards is one of the primary tasks of the Agency.

Nuclear energy costs and financing

44. The World Commission concludes that "Nations should look very closely at cost comparisons to obtain the best value when choosing an energy path."

45. The Nuclear Energy Agency (NEA) of OECD and the Agency continuously monitor the actual and projected costs of nuclear and fossil-fired power plant construction and operation, with and without environmental protection measures. The most recent study, published by NEA in 1986, concludes that nuclear power plants built in OECD countries with reasonable construction times (6-10 years) would be competitive with coal-fired plants everywhere except near coal mines in Western Canada and the central USA.

Health and environmental risks

46. While recognizing the value of the ICRP's recommendations and the Agency's Nuclear Safety Standards (NUSS), the World Commission points out that they are not binding on governments and that different permissible levels of radioactive contamination are set by individual governments, causing disruption in markets and confusion among populations.

47. Since the Chernobyl accident, the relevant international and intergovernmental organizations -- the Agency, WHO, FAO, the CEC and NEA -- have reviewed the adequacy of their guidance on intervention dose levels, have sup-

plemented that guidance with numerical derived intervention levels and have continued work on harmonizing basic radiation protection criteria for consideration by, e.g., the Codex Alimentarius Commission. The Agency's NUSS Codes have been updated and submitted to the Board of Governors for approval. (Sections 5, 6 and 7 give further information on this subject.)

Nuclear accident risks

48. Stating that "... although the risk of a radioactive release accident is small, it is by no means negligible ...", the World Commission makes a number of recommendations related to nuclear safety.

49. Virtually all of these recommendations are covered in the Agency's programmes on the "Safety of nuclear installations" and "Radiation protection". (See Sections 5 and 7.)

Radioactive waste disposal

50. The World Commission notes that "nuclear waste technology has reached an advanced stage of sophistication" but, nevertheless, holds that "the problem of nuclear waste disposal remains unsolved". This is an opinion which is not shared by knowledgeable scientists and engineers. (The subject is dealt with in Section 7.)

5. RECOMMENDATIONS OF THE WORLD COMMISSION RELATING SPECIFICALLY TO NUCLEAR ENERGY

51. In its conclusions on nuclear energy, the World Commission gives a list of items on which "international agreement must be reached". The text of each item and a brief description of the present situation is given in this Section. Two subject areas were viewed as requiring more detailed discussion, the environmental aspects of nuclear safety/radiation protection and radioactive waste disposal; they are covered in Sections 5 and 6 respectively.

5.1 "Full governmental ratification of the conventions on 'Early Notification of a Nuclear Accident' (including the development of an appropriate surveillance and monitoring system) and on 'Assistance in the Case of a Nuclear Accident or Radiological Emergency' as recently developed by IAEA"

52. Both conventions were adopted by consensus in 1986 and are both in force. To date (22 August 1988), 72 States have signed and 31 ratified the Convention on Early Notification, and 70 have signed and 26 ratified the Convention on Emergency Assistance. The subject of the development of an appropriate surveillance and monitoring system is discussed in subsection 4.7.

5.2 "Emergency response training for accident containment and for decontamination and long-term clean-up of affected sites, personnel and ecosystems"

Emergency response training

53. The establishment of appropriate and adequate emergency planning and preparedness programmes in support of nuclear facilities depends heavily on the availability of people trained to do the job. Technical guidance alone will not suffice. Interregional training courses on "planning, preparedness and response for radiological emergencies" were held in 1982, 1984 and 1987.

54. Since an actual emergency is a rare event, the most realistic way of testing, maintaining and improving the effectiveness of emergency response capabilities is through drills and emergency exercises. In 1981, the Director General wrote to all Member States offering to send special assistance missions to help in the development and improvement of emergency plans by reviewing existing plans and evaluating emergency exercises. Since that date the Agency has responded to some 15 requests for such missions.

Decontamination after large-scale accidents

55. A new area was added to the radioactive waste management programme after the Chernobyl accident to address questions of decontamination after large-scale accidents. It is intended to issue during the 1989/1990 period two technical reports on the safe transport, disposal and stabilization of very large volumes of contaminated material from the clean-up of large areas after a nuclear accident and on the rehabilitation, decommissioning and disposal alternatives for a nuclear reactor after a serious accident, based on the experience from Chernobyl.

5.3 "The transboundary movement of all radioactive materials, including fuels, spent fuels, and other wastes by land, sea, or air"

56. In 1959, the Agency began to develop safety regulations for the transport of all radioactive materials, covering all modes of transport. In developing these regulations, the Agency worked in close co-operation with other international bodies such as the Central Commission for the Navigation of the Rhine, the Central Office of International Railways, the European Atomic Energy Community, the International Maritime Organization, the International Air Transport Association, the International Civil Aviation Organization, the International Labour Organisation, the International Standards Organization, the Universal Postal Union, and the World Health Organization. The first edition of the Agency's recommended Regulations for the Safe Transport of Radioactive Materials (Safety Series No. 6) was published in 1961; revised editions were issued in 1964, 1967, 1973 and 1985. One of the current areas of review is the examination of the requirements for packaging plutonium shipments by air, in order to determine whether they are sufficiently stringent.

57. The IAEA's recommendations have been adopted by the United Nations, have been adopted by or are the basis for the national regulations of essentially all Member States of the Agency, and have been incorporated into regulatory documents issued by a number of international organizations. The safety record in the shipment of radioactive materials over a period of more than 35 years is exemplary. More than 10 million packages of radioactive materials are transported each year with minimal risk. This good safety record has not, however, given rise to complacency. The Agency's regulations have been further improved. Better packages have been developed and Safety Series No. 6 will continue to be updated and revised to reflect these improvements.

58. It is recognized that even the best regulations are of little value unless their provisions are complied with. For this reason, the Agency also provides advisory material on the proper application of the Transport Regulations, and has encouraged the development of effective programmes of quality assurance for packaging and assurance of compliance with regulatory requirements. In addition, the Agency has prepared recommendations on the development of emergency services and emergency response plans to minimize the consequences of accidents and is helping Member States and international organizations to make provision for such events.

59. Physical protection to prevent the theft or sabotage of materials to be transported is also important. Responsibility for the physical protection of dangerous goods is a matter of national sovereignty, but international co-operation and consensus in this field are vital. In 1972, the Agency published "Recommendations for the Physical Protection of Nuclear Material", which were revised in 1975 and 1977. Between the years 1977 and 1979, 58 countries and the European Atomic Energy Community negotiated, under the aegis of the Agency, a Convention on the Physical Protection of Nuclear Material, establishing standard measures of physical protection during international transport. The contracting parties are required to provide for punishment for a number of defined criminal offences and to co-operate in preventive measures and information exchange on such acts as theft, sabotage and extortion involving nuclear material. The Convention entered into force in 1987 and now has 47 signatories and 23 parties.

5.4 "A code of practice on liability and compensation"

60. There are at present two international conventions on civil liability for nuclear damage, the Paris and Vienna Conventions. The Agency's Board of Governors has endorsed the establishment of a link between the two conventions and approved a recommendation that a Joint Protocol be proposed for adoption at an international conference held this year in conjunction with the thirty-second General Conference. Once in force, the Joint Protocol will extend the benefits of the Paris Convention to the States party to the Vienna Convention and vice versa, and eliminate problems arising from simultaneous application of both Conventions. It is hoped that this would encourage a broader adherence to the civil liability conventions. The IAEA is also continuing its studies on the question of State liability for transboundary damage to the environment in the event of a nuclear accident.

5.5 "Standards for operator training and international licensing"

61. In 1979, as part of the Nuclear Safety Standards programme (NUSS) the Agency issued a safety guide on "Staffing of nuclear power plants and the recruitment, training and authorization of operating personnel" (see Table 3 for a listing of all NUSS documents). There is also a programme to review requirements of and criteria for qualification standards for nuclear power plant operating personnel and to appraise related training programmes. A guidebook on qualification of nuclear power plant operations personnel was published in 1984 and is scheduled for updating in 1989. There is no international licensing of reactor operators; the examination of the qualifications of such personnel is the responsibility of national authorities. The Agency has, however, through its technical co-operation programme, helped to establish national training centres for plant operating personnel.

5.6 "Codes of practice for reactor operation, including minimum safety standards"

62. Under the NUSS programme, the Agency has issued a comprehensive set of 5 codes of practice and 55 safety guides, the last of them published in 1986. The codes cover the areas of governmental organization, siting, design, operations and quality assurance (see Table 3). The code on "Safety in nuclear power plant operation including commissioning and decommissioning" was published in 1978. The term "minimum safety standards" often causes confusion as it can be taken to mean a lowest common denominator. Many States have already promulgated or may desire to set standards more stringent than the NUSS standards, which reflect an international consensus. However, the NUSS

standards should not be viewed as a lowest common denominator, but rather as constituting a baseline which may be built upon depending on local circumstances. Even standing alone they provide an adequate level of safety conforming with radiation protection principles. Several countries have also adopted them in part or as a whole as national regulatory standards.

Governmental organization	Siting	Design	Operation	Quality assurance
Training, qualification Licence applications Application review Inspection, enforcement Emergency preparedness License content, format Regulations and guides	Earthquakes Seismic analysis Atmospheric dispersion Population distribution Man induced events Hydrological dispersion Hydrogeology Foundations Site survey River floods Coastal floods Extreme meteorology Tropical cyclones	Safety functions Fire protection Protection systems Internal missiles Man induced events Ultimate heat sink Emergency power Control systems Radiation protection Fuel handling Safety principles Containment Reactor coolant Core design	Training, qualification In-service inspection Limits and conditions Commissioning Radiation protection Emergency preparedness Maintenance Surveillance Management Fuel handling Plant wastes	Programme Records system Procurement Construction Operation Design Organization Manufacture Auditing Fuel assemblies

63. The Agency has traditionally provided advice and assistance to Member States through expert missions. In 1982 the OSART (Operational Safety Review Teams) programme was set up to make in-depth three-week long reviews of operational safety practices at nuclear power plants. Although the programme was initially planned for developing countries, its value soon became apparent also to industrialized countries. OSART teams had up to August 1988 reviewed operations at 21 plants in 15 Member States. For the remainder of 1988 and 1989 11 missions are confirmed with an additional five likely.

5.7 "The reporting of routine and accidental discharges from nuclear installations"

64. Discharges of both a routine and an accidental nature are reported to national authorities. Bilateral and multilateral arrangements also exist for the reporting of certain releases. The reporting of discharges to international organizations is done retrospectively and selectively for assessment purposes. These kinds of assessments are done on a recurring basis by UNSCEAR. The licensing of routine discharges is done by national authorities as is surveillance for compliance with discharge limits.

65. The reporting of accidental discharges having potential transboundary consequences, on the other hand, falls under the Convention on Early Notification of a Nuclear Accident. A communications system designed to rapidly notify responsible national authorities about such accidents is being established by the Agency pursuant to its responsibilities under that convention. Demonstrations, including the use of the Global Telecommunication System of the World Meteorological Organization, which has been supporting the Agency's

work under the Convention, have been conducted. The system should be fully operational by the end of 1988. However, it should be noted that the primary responsibility for notification and emergency planning and preparedness remains with national authorities.

66. Reporting mechanisms for marine discharges of regional importance have been developed for the Baltic, through the Helsinki Commission, and the North-east Atlantic, through the Paris Commission. Upon request, the Agency does provide technical advice on marine radioactivity to regional conventions and to Regional Seas programmes sponsored by UNEP, but it has no role in their operations (see subsection 7.3 for a discussion of the London Dumping Convention). For airborne releases of radionuclides no similar conventions exist.

5.8 "Effective, internationally harmonized minimum radiological protection standards"

67. Radiological protection is a field where there have long existed effective, internationally accepted standards. The ICRP, which began its work in 1928, considers and publishes the basic principles upon which radiation protection should be based. The implementation of the ICRP principles was left to national authorities. In 1962, the Agency published the first edition of the Basic Safety Standards for Radiation Protection (Safety Series No. 9), based on ICRP principles. When the second edition was published in 1967, the Board of Governors recommended that all Member States should conform their own regulations to the Standards. The third edition was published in 1982 and was jointly sponsored by the World Health Organization, the International Labour Organisation, the Nuclear Energy Agency of OECD, and the IAEA.

68. The above-mentioned standards apply to controlled sources of radiation and therefore are not applicable to accident situations, where the only way in which exposures may be limited, if needed, is by some sort of intervention. The concept of "intervention levels" came into being after the fire at the Windscale reactor in 1957. A summary of the intervention levels of dose and derived levels of specific nuclides in air and foodstuffs and on pasture in different countries is given in Safety Series No. 55, "Planning for off-site response to radiation accidents in nuclear facilities", published in 1981. Guidance on setting intervention levels was provided by the Agency in 1985 as Safety Series No. 72, and on derived intervention levels in 1986 as Safety Series No. 81. Much of the confusion after the Chernobyl accident arose from the widely varying response actions, particularly the levels at which protective measures were initiated. This prompted the governing bodies of a number of international and intergovernmental organizations to request that the existing guidance be reviewed with the purpose of seeking better harmonization. Since that time, the relevant organizations, particularly the IAEA, WHO, FAO, OECD/NEA and the CEC, have been working in close co-operation. A revised version of Safety Series No. 72 is expected to be published in 1989. Since the guidance given in Safety Series No. 81 will need to reflect these changes also, it too will be revised and broadened.

69. The Chernobyl accident, through its transboundary impact, pointed out the general unpreparedness to cope with international trade in contaminated food products. Considerable inter-secretariat work, with the Agency as consultant to FAO and WHO, was required to enable recommendations to be submitted to the Codex Alimentarius Committee in July 1988 on recommended levels of radionuclides in foods moving in international trade. These recommendations are to be circulated to countries for comment through the Codex contact

points so that a revised version may be reviewed and accepted by the Committee in 1989.

5.9 "Agreed site selection criteria as well as consultation and notification prior to the siting of all major civil nuclear-related installations"

70. Symposia on the siting of nuclear facilities were held in 1963, 1967 and 1974. The proceedings were published by the Agency. Technical reports on aseismic design and testing of nuclear facilities and earthquake guidelines for reactor siting have been prepared (1968, 1972). An early Safety Series report (No. 29) on the application of meteorology to safety at nuclear plants dealt also with site selection. Siting of radioactive waste disposal facilities is covered in Section 6 on waste management. In 1978 a code of practice, "Safety in Nuclear Power Plant Siting", was published under the Agency's NUSS programme, along with a number of supplementary safety documents (see Table 3).

71. There are valid concerns regarding consultations on and prior notification of plans to site a nuclear facility. This is a concern of individual States located in proximity to a proposed site, and bilateral and multi-lateral arrangements would be the mechanism for consultations.

5.10 "Standards for waste repositories"

72. These are covered in Section 7.

5.11 "Standards for the decontamination and dismantling of time-expired nuclear reactors"

73. It should be noted that practical experience exists from the decommissioning and dismantling of a number of smaller nuclear power stations. The Agency published, in 1980, Safety Series No. 52, entitled "Factors relevant to the decommissioning of land-based nuclear reactor plants". Technical reports on aspects of decommissioning nuclear facilities were published in 1983, 1985 and 1986. Current work involves the development of technical and regulatory guidance and reviews of the status of selected technologies and management systems. In addition, in 1987 the Agency held its first international symposium on safety aspects of the ageing and maintenance of nuclear power stations. With an increasing number of nuclear power stations facing problems of degradation of plant and equipment as a result of age-related processes, questions of the safe operation of older plants and plant life extension as an alternative to decommissioning are of growing importance worldwide.

5.12 "Problems posed by the development of nuclear powered shipping"

74. In 1960, the Agency and the International Maritime Organization (IMO) jointly held a symposium on nuclear ship propulsion. In 1968, the Agency published, on behalf of itself and IMO, a Safety Series report on "Safety considerations in the use of ports and approaches by nuclear merchant ships" (Safety Series No. 27). A Code of Safety for Nuclear Powered Merchant Ships was updated in 1981 by IMO. Civil nuclear powered shipping has so far proven to be less promising than expected. There are at present no operating nuclear merchant ships; therefore, no effort on the part of the Agency in this area is currently warranted. There are existing nuclear powered military vessels and ice breakers. These ships are covered under the Convention

on Early Notification and, in fact, the Agency was advised in 1986 of the sinking of a damaged Soviet nuclear submarine, even though no releases of radioactive material occurred.

6. RADIATION PROTECTION WITH EMPHASIS ON ENVIRONMENTAL MATTERS

75. In the context of WCED's definition of "sustainable development", it should be noted that one objective of radiation protection is to protect not only present but also future generations from harmful effects of ionizing radiation. The ICRP dose limitation system can be applied to all radiation exposures of individuals and of populations at whatever time and place the exposure is received. That is to say that the dose received through the release of radionuclides is taken into account, whether it is received by a known individual at the time and near the place of release, or by some future individual, say 1000 years in the future and halfway around the world. The consideration of future as well as present exposures enters into decisions on regulation of such activities as releases from nuclear power plants and management of waste disposal facilities. Other industries could well emulate such an approach.

76. The Agency's programmes on the monitoring and assessment of environmental radioactivity involve radiation protection, waste management, agrochemicals and the Agency's laboratories at Seibersdorf and Monaco. To set the stage for a discussion of the Agency's work in matters of environmental radioactivity, it is useful to review the symposia and conferences held over the years. Table 4 lists the subjects of some meetings, often co-sponsored by other interested organizations.

Table 4: SYMPOSIA ON RADIONUCLIDES AND THE ENVIRONMENT

Assessment of radioactive contamination in man (WHO, 1964, 1971, 1984)
Assessment of airborne radioactivity (1967)
Physical behaviour of radioactive contaminants in the atmosphere (WMO, 1973)
Environmental contamination by radioactive materials (FAO/WHO, 1969)
Rapid methods for measuring radioactivity in the environment (FRG, 1971)
Transuranium nuclides in the environment (USERDA, 1975)
Behaviour of tritium in the environment (NEA, 1978)
Environmental migration of long-lived radionuclides (CEC/NEA, 1981)
Radioactive contamination of the marine environment (1972)
Impacts of nuclear releases into the aquatic environment (1975)
Techniques for identifying transuranic speciation in aquatic environments (CEC, 1980)
Impacts of radionuclide releases into the marine environment (NEA, 1980)
Environmental behaviour of radionuclides released in the nuclear industry (NEA/WHO, 1973)
Environmental surveillance around nuclear installations (1973)
Environmental effects of cooling systems at nuclear power plants (UNECE, 1974)
Combined effects of radioactive, chemical and thermal releases to the environment (NEA, 1975)

6.1 Environmental monitoring and impact assessment

77. A number of safety standards, guides, recommendations, procedures and data and relevant technical reports published over the years give a clear idea of the direction the Agency has gone in the area of environmental monitoring and impact assessment. Only documents published since 1970 are referred to in the following selective discussions.

Environmental standards and criteria

78. Although some releases to the environment from routine operations are unavoidable, there are standards and criteria for setting limits to such releases. In 1978, the Agency published guidance for use by national authorities on concepts and principles for planned environmental releases of radioactive material. This was completely revised in 1986 with the publication of Safety Series No. 77 "Principles for limiting releases of radioactive effluents into the environment". In essence this document provides a procedure for limiting the dose to the most exposed population (the "critical group") from a particular source. The limit, called a "source or release upper bound", will be considerably lower than the primary dose limit for the general public recommended by ICRP and the Agency in the Basic Safety Standards. This is so because the primary dose limit applies to exposure of the individual from all sources, not just the one being considered. In 1988, the Agency published "The application of the principles for limiting releases of radioactive effluents in the case of mining and milling of radioactive ores." The question of limiting releases of effluents is receiving continuing attention and a new safety guide is planned for 1990/1991. A technical document establishing source upper bounds for specific practices will be issued in 1990.

79. Releases of transboundary significance are covered by the document "Assigning a value to transboundary radiation exposure", published in 1985 as Safety Series No. 67. The document sets forth the principle that "policies and criteria for protecting populations outside national borders from releases of radioactive substances should be at least as stringent as those for protecting the population of the country in which releases occur."

80. Since an individual member of the public may also be exposed to sources of radiation resulting from widespread regional or global releases, upper bounds (i.e. fractions of the primary limit) are also needed for sources with regional or global impact. A Safety Series document on the "Establishment of upper bounds to doses to individuals from global and regional sources" is in publication. The global and regional upper bounds differ from the source upper bound in that they apply to the sum of doses from many sources, not to the dose from one particular source, and they must be implemented through international agreements, rather than by national authorities alone.

81. Work is also continuing to establish internationally agreed principles for the exemption of sources of trivial levels of radiation from regulatory control. Assuming that international consensus is achieved in 1988, the project should be completed in 1991.

Environmental monitoring

82. "Environmental monitoring" is a term used in two different senses. The first is monitoring for surveillance and compliance with authorized procedures and the second is monitoring for research, to collect information relevant to assessment of behaviour and pathways of radionuclides in the environ-

ment. Both are important in Agency programmes. Three Safety Series documents have been prepared on the subject: "Objectives and design of environmental monitoring programmes for radioactive contaminants" (1975), "Monitoring of airborne and liquid radioactive releases from nuclear facilities to the environment" (1978) and "Radiation monitoring in the mining and milling of radioactive ores" (1988). These are complemented by a number of technical reports (see Table 5).

Table 5: TECHNICAL REPORTS ON ENVIRONMENTAL MONITORING
Reference methods for marine radioactivity studies (1970 and 1975)
Radiotracer experiment design in marine biological systems
Partition coefficients and concentration factors in the marine environment
Thermal discharges at nuclear power stations
Particle size analysis in airborne contamination assessment
Tritium in some typical ecosystems
Measurement of radionuclides in food and the environment

83. Work for the near future includes the preparation of a new safety guide. In co-operation with FAO, WHO, WMO and UNEP, an international symposium will be held in 1989 on environmental contamination following a major accident.

Environmental assessment

84. In the area of environmental impact assessment, there are two Safety Series publications: "Generic models and parameters for assessing the environmental transfer of radionuclides from routine releases" (1982) and "Environmental assessment methodologies for sea dumping of radioactive wastes" (1984). Work is proceeding on methods for assessing individual and collective doses in connection with the guidelines for limiting releases to the environment, and a document on the subject will be published in 1989. A co-ordinated research programme on validation of models for the transfer of radionuclides in the terrestrial, urban, and aquatic environments initiated in 1987 will be completed in 1992. Technical reports dealing with assessment and effects are listed in Table 6.

Table 6: TECHNICAL REPORTS ON ENVIRONMENTAL ASSESSMENT AND EFFECTS
Effects on aquatic organisms and ecosystems
Methodology for assessing impacts on aquatic ecosystems
Oceanographic models for deep sea disposal of wastes
Assessing the impact of deep sea disposal on living marine resources
Assessment methods for regionally and globally dispersed radionuclides
Environmental effects of cooling systems

Radionuclide measurements in environmental samples

85. The Chernobyl accident pointed out the need for national laboratories to be able to handle large numbers of samples of food and other environmental samples in a short period of time. In addition, information on reference methods for measurement of radionuclides needed to be updated in light of the

simpler and more reliable methods introduced since the FAO/WHO/IAEA publication in 1966 on methods of radiochemical analysis. To respond to these needs, the Agency introduced a programme on "Fallout Radioactivity Monitoring in Environment and Food" (MEF). A document with a comprehensive list of reference methods for key radionuclides and a section on the instrumentation and space requirements of a proper radioactivity measurement laboratory has just been prepared and will be published as a technical report entitled "Measurement of radionuclides in food and the environment". This document will soon be complemented by one dealing with rapid methods of analysis for emergency situations.

86. The Agency's Analytical Quality Control Services (AQCS) programme has been in operation since 1959. Reference materials are prepared and distributed to various laboratories in Member States not only for the assessment of low levels of radioactivity, but also for the determination of minor and trace elements and the analysis of certain organic compounds. Recently bulk environmental and foodstuff samples containing elevated levels of radioactivity have been collected in order to prepare materials for intercalibration studies. The first of these, a milk powder, is available for distribution.

87. The Isotope Hydrology Unit has been collecting, analyzing and publishing information on environmental isotopes in precipitation since the Agency's foundation. The samples are collected by meteorological services in 70 countries and territories. A series of publications entitled "Environmental Isotope Data No. 1 - No. 8: World Survey of Isotope Concentration in Precipitation" gives meteorological data, tritium compositions, and deuterium and oxygen-18 isotopic concentrations from 1953 to 1983.

88. With regard to monitoring for non-radioactive pollutants, the Agency has been assisting WMO in the Background Air Pollution Monitoring Network. The Agency was requested to provide laboratory services in cases where no or insufficient national facilities were available.

6.2 Risk management, comparative assessment and decision aiding techniques

89. The health risks and environmental effects of different energy technologies have been aspects of the public debate concerning energy systems. Developing a common basis to compare risks and effects has not been an easy task and is far from complete. Much effort has gone into the development of models for transport through atmospheric, aquatic and terrestrial pathways and the incorporation of pollutants into food chains. However, relationships between the amounts of material present in air, water and foodstuffs; the amounts incorporated into the human body; the relationship between chronic and acute exposures; and the effect of such exposures are at best poorly known for most pollutants. The understanding of the effects of radioactivity is generally good, but comparative studies involving radioactive and non-radioactive pollutants entail very large uncertainties. In addition, some environmental effects do not involve man, but rather some aspect of the environment, such as climatic changes (carbon dioxide increases) or ecosystem disruption (dying forests or barren lakes from acid rain), that are not directly related to health.

90. However, in recent years there has been a shift in emphasis from comparison of risks to the management of risks. The Agency has joined with UNEP, UNIDO and WHO in a joint project on assessing and managing health and environmental risks from energy and other complex industrial systems. The

project has four main objectives: to develop a guide for risk management and hazard control procedures; to establish and operate an information system on health and environmental effects; to train personnel in risk management and hazard control; and to promote a risk management hazard control approach to energy and other complex technology planning and use. There is much interest in this project. In 1987, an inter-agency project document was signed by the Agency, WHO and UNEP foreseeing the development of a procedure guide by 1991.

7. RADIOACTIVE WASTE MANAGEMENT

91. A characteristic of radioactive waste in comparison with wastes from other activities (industrial, agricultural, etc.) is that it arises in small quantities and that the associated hazard decreases with time. To illustrate the point: a coal fired power plant sets free -- apart from huge quantities of CO₂, SO₂ and NO_x -- a larger amount of toxic heavy metals than the total amount of spent fuel arising from a nuclear power plant producing the same amount of electric energy.

92. The main objective for management and disposal of radioactive waste is control, containment and isolation from the biosphere. The scientific and technical community continues to confirm that no additional breakthrough in technology is needed for safe disposal of any radioactive waste, including high-level waste such as spent fuel.

93. In the early 1960s a number of Safety Series documents were prepared on disposal into the sea, in ground and rivers, lakes and estuaries and on the management of wastes at nuclear power plants and from radioisotope users. In addition, the treatment of low- and intermediate-level radioactive wastes was considered in a number of early technical reports. In the 1970s, however, the increased concern about environmental issues led many countries to place greater emphasis on the management of radioactive wastes, and the Agency responded with increasing emphasis on waste management issues. Over the years waste management subjects have been the topics of a number of conferences and symposia held at frequent intervals starting in 1959. In Table 7 is a listing of the topics covered.

Table 7: RADIOACTIVE WASTE MANAGEMENT SYMPOSIA/CONFERENCES Co-operating agencies and year are given in brackets
Waste disposal (1959)
Treatment of low- and intermediate-level wastes (ENEA, 1965)
Disposal into seas, oceans and surface waters (1966)
Disposal into the ground (ENEA, 1967)
Treatment of airborne wastes (USAEC/Harvard University, 1968)
Management of low- and intermediate-level wastes (NEA, 1970)
Management of nuclear fuel cycle wastes (NEA, 1976)
Underground disposal (NEA, 1979)
Management of gaseous wastes (NEA, 1980)
Management of alpha-contaminated wastes (CEC, 1981)
Management of uranium mining and milling wastes (NEA, 1982)
Radioactive waste management (USDOE, 1983)
Conditioning of wastes for storage and disposal (CEC/NEA, 1983)
Siting, design and construction of underground repositories (1986)
Management of low- and intermediate-level wastes (CEC, 1988)

7.1 Standards and criteria for low-level waste disposal sites

94. In 1977, work began on the development of an integrated approach to the preparation of standards and criteria for the disposal of radioactive wastes into geological formations. The resulting Safety Series reports for low- and intermediate-level wastes are listed in Table 8. The guidebook on shallow ground disposal has a companion technical report on "Site investigations for repositories for solid radioactive wastes in shallow ground", which covers the earth science and other studies required for the selection and confirmation of an underground repository site.

Table 8: LOW- AND INTERMEDIATE-LEVEL WASTE SAFETY SERIES
Safety assessment for underground disposal
Safety analysis methodologies
Disposal in rock cavities
Site investigations, design, construction, operation, shutdown and surveillance (in rock cavities and shallow ground)
Criteria for underground disposal
Acceptance criteria
Performance assessment
Guidance on underground disposal
Disposal in shallow ground -- a guidebook

95. At the present time, the coverage of this area is considered up-to-date and emphasis is being placed on providing practical assistance to Member States. In support of this assistance a technical document is being prepared for publication in 1990 with guidelines for safety assessment procedures. In addition, attention is being focused on the problems of wastes with chemical as well as radiological hazards (so-called "mixed wastes"). A number of reports are under preparation in this area. In 1989 the Agency, in co-operation with OECD/NEA, is planning a symposium on safety assessments of radioactive waste repositories.

7.2 High-level waste disposal

96. A publication on "Safety principles and standards for the underground disposal of high-level radioactive waste" is expected to be approved and published in 1989. It should assist in the implementation of a number of high-level waste repository projects being planned in several countries. Other recent publications on high-level waste in the Agency's Safety Series or Technical Reports Series are listed in Table 9.

Table 9: HIGH-LEVEL RADIOACTIVE WASTE PUBLICATIONS
SAFETY SERIES
Safety principles and standards (in preparation)
Safety analyses for deep repositories
Regulatory procedures
TECHNICAL REPORTS SERIES
Solidification techniques
Handling and storage of conditioned wastes
Durability of solidified forms
Solidified waste characteristics
Site selection factors
Site investigations for deep repositories
Near-field effects
Site investigation techniques

7.3 Marine waste disposal

97. Radioactive waste has been disposed of into the marine environment since the 1940s. This practice was, in fact, continued until a moratorium took effect in 1985. Since there was concern about the transboundary implications of such disposals in the late 1950s, specifically at the United Nations Conference on the Law of the Sea in 1958, the Agency commissioned a scientific panel to examine the problem and recommend measures to ensure that such activities would not result in unacceptable hazards to man. This resulted in Safety Series No. 5, "Radioactive waste disposal into the sea", published in 1961. That document was in continuous demand until its replacement in 1981, by Safety Series No. 61. The entry into force in 1975 of the Convention on the Prevention of Marine Pollution by the Dumping of Wastes and other Matter (London Dumping Convention, 1972) gave the Agency specific responsibilities for the definition of high-level radioactive wastes unsuitable for dumping at sea, and for making recommendations to national authorities in matters concerning the issuance of special permits for ocean dumping of radioactive wastes not falling within this definition. The Agency prepared the first "Definitions and Recommendations" in 1975, and revised them 1978 and 1986 in the light of technical advances. Considerable technical documentation on this subject exists, and the subject is kept under continuous review. For example, a document completed by the Agency in 1987 for publication in 1988, on the potential impacts on marine organisms of dumping under conditions near the limits set as unacceptable, has indicated that the current "Definitions and Recommendations" would have to be revised taking such impacts into account. However, in light of the current moratorium on dumping, there is no urgency to initiate such a revision.

7.4 Current issues and future directions

98. The needs for the management of radioactive wastes in developing countries vary with the level of use of radioactive materials, the existence of a uranium mining industry or the existence of power or research reactors. In order to meet the needs of developing countries for advice on practical approaches to the integrated development of radioactive waste management systems, the Agency initiated a Waste Management Advisory Programme (WAMAP) in 1987. Assistance is given in the establishment of regulations, the development of a regulatory framework for licensing and inspection, the analysis of problems and the selection of solutions, and the design, construction and operation of waste management facilities

99. The Agency has also been exploring mechanisms for providing international peer review assessment services in the area of radioactive waste management. The concept of a Waste Management Assessment and Technical Review Programme (WATRAP) has recently been proposed to help Member States in the evaluation of the technical, operational, and performance features of planned or existing waste management systems. This programme is directed towards those States which have well established waste management programmes. Developed Member States requesting these services would be expected to cover the cost of the review. The programme is expected to begin early in 1989.

100. Regulations or conventions on the export of toxic wastes are being developed by both OECD and UNEP. Radioactive wastes are expressly excluded in this work. There is at present no international regulation or convention covering the export of radioactive wastes. The subject will be discussed at the thirty-second regular session of the General Conference in 1988.

8. TRAINING

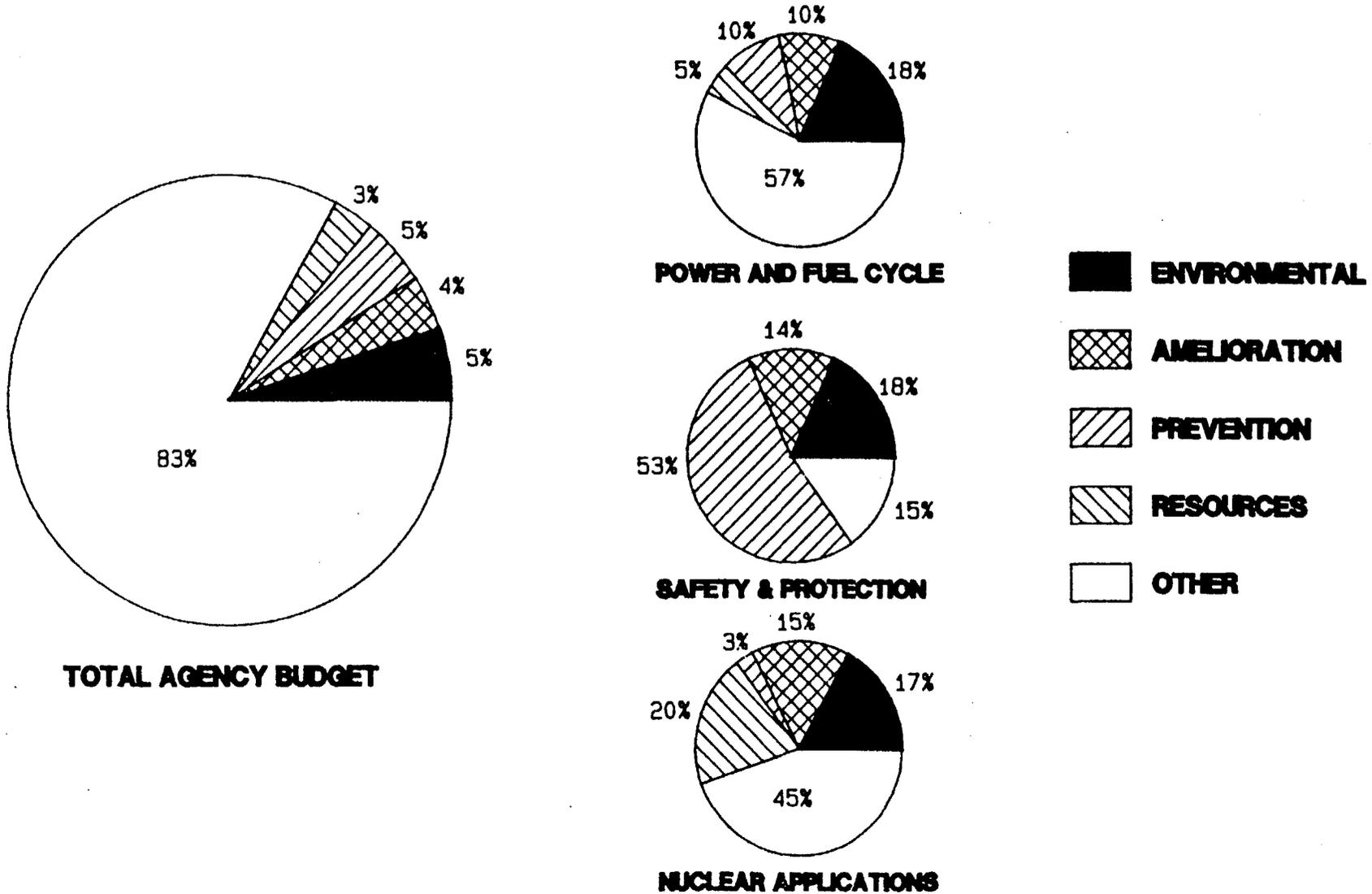
101. Training courses and fellowships are an important aspect of the Agency's technical assistance programmes. The Agency's Laboratory at Seibersdorf has trained many scientists in analytical techniques for both radioisotope measurements and the use of nuclear techniques for the determination of non-radioactive pollutants. Training in the use of isotope and nuclear techniques for assessment of pesticide residues, studies of soil/water problems and entomology has provided expertise to thousands of scientists from developing countries over the years. The Laboratory at Monaco has trained marine scientists and analytical chemists in analysis techniques related to marine pollution by radionuclides, and by hydrocarbons and heavy metals.

102. The role of the International Centre for Theoretical Physics (ICTP) in Trieste is also important in training. Theoretical physics may seem far removed from the practical study of environmental problems, but the role physics plays in understanding atmospheric and aquatic transport is fundamental. Physical transport mechanisms are the basis for all models. ICTP has had courses on solar energy, ecological modelling (continuing over many years), and atmospheric and ocean sciences, all of which are of direct relevance to scientists in developing countries working in areas related to the environment and resource development.

9. SIGNIFICANCE WITHIN THE AGENCY'S BUDGET

103. In total, the environment-related activities, as defined in Section 2, account for about 17% of the Agency's regular budget. Within the substantive programme areas, the percentage is much higher, ranging from 85% in Nuclear Safety and Radiation Protection to 43% in Nuclear Power and the Fuel Cycle (Fig. 2).

FIGURE 2:
**AGENCY REGULAR BUDGET 1989/1990
BY THEMATIC COMPONENTS**





General Assembly

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RESOLUTION ADOPTED BY THE GENERAL ASSEMBLY

[on the report of the Second Committee (A/42/821/Add.5)]

42/187. Report of the World Commission on Environment and Development

The General Assembly,

Concerned about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development,

Believing that sustainable development, which implies meeting the needs of the present without compromising the ability of future generations to meet their own needs, should become a central guiding principle of the United Nations, Governments and private institutions, organizations and enterprises,

Recognizing, in view of the global character of major environmental problems, the common interest of all countries to pursue policies aimed at sustainable and environmentally sound development,

Convinced of the importance of a reorientation of national and international policies towards sustainable development patterns,

Recalling that, in its resolution 38/161 of 19 December 1983 on the process of preparation of the Environmental Perspective to the Year 2000 and Beyond to be prepared by the Governing Council of the United Nations Environment Programme, it welcomed the establishment of a special commission, which later assumed the name World Commission on Environment and Development, to make available a report on environment and the global problématique to the year 2000 and beyond, including proposed strategies for sustainable development,

Recognizing the valuable role played in the preparation of the report of the World Commission by the Intergovernmental Inter-sessional Preparatory Committee of the Governing Council of the United Nations Environment Programme, as envisaged by the General Assembly in its resolution 38/161,

Recalling that in resolution 38/161 it decided that, on matters within the purview of the United Nations Environment Programme, the report of the Commission should in the first instance be considered by the Governing Council of the Programme, for transmission to the General Assembly together with the comments of the Council and for use as basic material in the preparation, for adoption by the Assembly, of the Environmental Perspective, and that on those matters which were under consideration or review by the Assembly itself, it would consider the relevant aspects of the report of the Commission,

Taking note of Governing Council decision 14/14 of 19 June 1987 1/ transmitting the report of the Commission to the General Assembly,

Noting that the Environmental Perspective to the Year 2000 and Beyond 2/ has taken account of the main recommendations in the Commission's report,

Recognizing the instrumental role of the Commission in revitalizing and reorienting discussions and deliberations on environment and development and in enhancing the understanding of the causes of present environmental and development problems, as well as in demonstrating the ways in which they transcend institutional frontiers and in opening new perspectives on the interrelationship between environment and development as a guide to the future,

Emphasizing the need for a new approach to economic growth, as an essential prerequisite for eradication of poverty and for enhancing the resource base on which present and future generations depend,

1. Welcomes the report of the World Commission on Environment and Development entitled "Our Common Future"; 3/

2. Notes with appreciation the important contribution made by the Commission to raising the consciousness of decision-makers in Governments, intergovernmental and non-governmental international organizations, industry and other fields of economic activity, as well as of the general public, in regard to the imperative need for making the transition towards sustainable development, and calls upon all concerned to make full use in this regard of the report of the Commission;

1/ See Official Records of the General Assembly, Forty-second Session, Supplement No. 25 (A/42/25 and Corr.1), annex I.

2/ Ibid., annex II.

3/ A/42/427, annex.

3. Agrees with the Commission that while seeking to remedy existing environmental problems, it is imperative to influence the sources of those problems in human activity, and economic activity in particular, and thus to provide for sustainable development;

4. Agrees further that an equitable sharing of the environmental costs and benefits of economic development between and within countries and between present and future generations is a key to achieving sustainable development;

5. Concurs with the Commission that the critical objectives for environment and development policies which follow from the need for sustainable development must include preserving peace, reviving growth and changing its quality, remedying the problems of poverty and satisfying human needs, addressing the problems of population growth and of conserving and enhancing the resource base, reorienting technology and managing risk, and merging environment and economics in decision-making;

6. Decides to transmit the report of the Commission to all Governments and to the governing bodies of the organs, organizations and programmes of the United Nations system, and invites them to take account of the analysis and recommendations contained in the report of the Commission in determining their policies and programmes;

7. Calls upon all Governments to ask their central and sectoral economic agencies to ensure that their policies, programmes and budgets encourage sustainable development and to strengthen the role of their environmental and natural resource agencies in advising and assisting central and sectoral agencies in that task;

8. Calls upon the governing bodies of the organs, organizations and programmes of the United Nations system to review their policies, programmes, budgets and activities aimed at contributing to sustainable development;

9. Calls upon the governing bodies of other relevant multilateral development assistance and financial institutions to commit their institutions more fully to pursuing sustainable development in establishing their policies and programmes in accordance with the national development plans, priorities and objectives established by the recipient Governments themselves;

10. Requests the Secretary-General, through the appropriate existing mechanisms, including the Administrative Committee on Co-ordination, to review and co-ordinate on a regular basis the efforts of all the organs, organizations and bodies of the United Nations system to pursue sustainable development, and to report thereon to the General Assembly through the Governing Council of the United Nations Environment Programme and the Economic and Social Council;

11. Stresses the essential role of the United Nations Environment Programme, within its mandate, in catalyzing the sustainable development efforts of the United Nations system, while fully taking into account the co-ordinating responsibilities of the Economic and Social Council, and agrees with the Commission that that role

/...

should be strengthened and that the resources of the Environment Fund should be substantially enlarged, with greater participation;

12. Considers that the Governing Council of the United Nations Environment Programme, within its mandate and with participation, when appropriate, at the ministerial level, should examine on a periodic basis the long-term strategies for realizing sustainable development, and should include the results of its examinations in its reports to be submitted to the General Assembly through the Economic and Social Council;

13. Agrees that the catalytic and co-ordinating role of the United Nations Environment Programme in the United Nations system should be reinforced in its future work on environmental and natural resource issues;

14. Reaffirms the need for additional financial resources from donor countries and organizations to assist developing countries in identifying, analysing, monitoring, preventing and managing environmental problems in accordance with their national development plans, priorities and objectives;

15. Reaffirms the need for developed countries and appropriate organs and organizations of the United Nations system to strengthen technical co-operation with the developing countries to enable them to develop and enhance their capacity for identifying, analysing, monitoring, preventing and managing environmental problems in accordance with their national development plans, priorities and objectives;

16. Invites Governments, in co-operation with the regional commissions and the United Nations Environment Programme and, as appropriate, intergovernmental organizations, to support and engage in follow-up activities, such as conferences, at the national, regional, and global levels;

17. Calls upon Governments to involve non-governmental organizations, industry and the scientific community more fully in national and international activities to support efforts towards sustainable development;

18. Invites the governing bodies of the organs, organizations and programmes of the United Nations system to report, as appropriate, through the Economic and Social Council, to the General Assembly, not later than at its forty-fourth session, on progress made in their organizations towards sustainable development, and to make such reports available to the Governing Council of the United Nations Environment Programme at its next regular session;

19. Also invites the Governing Council of the United Nations Environment Programme to provide comments on matters concerning progress on sustainable development that fall within its mandate, on the above-mentioned reports and on other developments, for submission to the Economic and Social Council at its second regular session of 1989 and to the General Assembly at its forty-fourth session;

20. Requests the Secretary-General to submit to the General Assembly at its forty-third session, through the Economic and Social Council, a progress report on

the implementation of the present resolution and to the Assembly at its forty-fourth session a consolidated report on the same subject;

21. Decides to include in the provisional agenda of its forty-third session a sub-item entitled "A long-term strategy for sustainable and environmentally sound development" under the agenda item entitled "Development and international economic co-operation".

96th plenary meeting
11 December 1987



General Assembly

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GENERAL

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30 March 1988

Forty-second session
Agenda item 82 (g)

RESOLUTION ADOPTED BY THE GENERAL ASSEMBLY

[on the report of the Second Committee (A/42/821/Add.5)]

42/186. Environmental Perspective to the Year 2000 and Beyond

The General Assembly,

Recalling its resolution 38/161 of 19 December 1983 on the process of preparation of the Environmental Perspective to the Year 2000 and Beyond, in which it, *inter alia*, welcomed the desire of the Governing Council of the United Nations Environment Programme to develop the Environmental Perspective and transmit it to the General Assembly for adoption, benefiting in carrying out that function from its consideration of the relevant proposals made by a special commission, which adopted the name World Commission on Environment and Development,

Welcoming the Environmental Perspective to the Year 2000 and Beyond, 1/ prepared by the Intergovernmental Inter-sessional Preparatory Committee on the Environmental Perspective to the Year 2000 and Beyond of the United Nations Environment Programme, referred to in General Assembly resolution 38/161, considered further by the Governing Council of the United Nations Environment Programme at its fourteenth session and adopted in its decision 14/13 of 19 June 1987, 2/ as a basis for the further elaboration of its programme and operations, while acknowledging that different views exist on some aspects,

1/ Official Records of the General Assembly, Forty-second Session, Supplement No. 25 (A/42/25 and Corr.1), annex II.

2/ Ibid., annex I.

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Appreciating that concepts, ideas and recommendations contained in the report of the World Commission on Environment and Development]/ have been incorporated into the Environmental Perspective,

1. Expresses its appreciation for the efforts of the Governing Council of the United Nations Environment Programme and its Intergovernmental Inter-sessional Preparatory Committee on the Environmental Perspective to the Year 2000 and Beyond in the preparation of the Environmental Perspective to the Year 2000 and Beyond;

2. Adopts the Environmental Perspective to the Year 2000 and Beyond, contained in the annex to the present resolution, as a broad framework to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound development, and specifically as a guide to the preparation of further system-wide medium-term environment programmes and the medium-term programmes of the organizations and bodies of the United Nations system, in the light of Governing Council decision 14/13;

3. Notes that the perceptions generally shared by Governments of the nature of environmental problems, and their interrelations with other international problems, and of the efforts to deal with them include the following:

(a) An international atmosphere of peace, security and co-operation, free from the presence and the threat of wars of all types, especially nuclear war, in which intellectual and natural resources are not wasted on armaments by any nation, would greatly enhance environmentally sound development;

(b) The imbalance of present world economic conditions makes it extremely difficult to bring about sustained improvement in the world's environmental situation; accelerated and balanced world development and lasting improvements in the global environment require improved world economic conditions, especially for the developing countries;

(c) Since mass poverty is often at the root of environmental degradation, its elimination and ensuring equitable access of people to environmental resources are essential for sustained environmental improvements;

(d) The environment puts constraints on as well as provides opportunities for economic growth and social well-being; environmental degradation, in its various forms, has assumed such proportions as can cause irreversible changes in ecosystems, which threaten to undermine human well-being; environmental constraints, however, are generally relative to the state of technology and socio-economic conditions, which can and should be improved and managed to achieve sustained world economic growth;

]/ A/42/427, annex.

(e) Environmental issues are closely intertwined with development policies and practices; consequently, environmental goals and actions need to be defined in relation to development objectives and policies;

(f) Although it is important to tackle immediate environmental problems, anticipatory and preventive policies are the most effective and economical in achieving environmentally sound development;

(g) The environmental impacts of actions in one sector are often felt in other sectors; thus internalization of environmental considerations in sectoral policies and programmes and their co-ordination are essential for the achievement of sustainable development;

(h) Since conflicts of interest among population groups, or among countries, are often inherent in the nature of environmental problems, the participation of the concerned parties is essential in determining effective environmental management practices;

(i) Environmental degradation can be controlled and reversed only by ensuring that the parties causing the damage will be accountable for their actions, and that they will participate, on the basis of full access to available knowledge, in improving environmental conditions;

(j) Renewable resources, as part of complex and interlinked ecosystems, can have sustainable yields only if used while taking into account system-wide effects of exploitation;

(k) The safeguarding of species is a moral obligation of humankind and should improve and sustain human well-being;

(l) Building awareness at various levels of environmental conditions and management, through the provision of information, education and training, is essential for environmental protection and improvement;

(m) Strategies to deal with environmental challenges have to be flexible and should allow for adjustments to emerging problems and evolving environmental management technology;

(n) International environmental disputes which are growing in number and variety, need to be resolved by peaceful means;

4. Welcomes as the overall aspirational goal for the world community the achievement of sustainable development on the basis of prudent management of available global resources and environmental capacities and the rehabilitation of the environment previously subjected to degradation and misuse, and the aspirational goals to the year 2000 and beyond as set out in the Environmental Perspective, namely:

(a) The achievement over time of such a balance between population and environmental capacities as would make possible sustainable development, keeping in

view the links between population levels, consumption patterns, poverty and the natural resource base;

(b) The achievement of food security without resource depletion or environmental degradation and restoration of the resource base where environmental damage has been occurring;

(c) The provision of sufficient energy at reasonable cost, notably by increasing access to energy substantially in the developing countries, to meet current and expanding needs in ways which minimize environmental degradation and risks, conserve non-renewable sources of energy and realize the full potential of renewable sources of energy;

(d) The sustained improvements in levels of living in all countries, especially the developing countries, through industrial development that prevents or minimizes environmental damage and risks;

(e) The provision of improved shelter with access to essential amenities in a clean and secure setting conducive to health and to the prevention of environment-related diseases, which would, at the same time, alleviate serious environmental degradation;

(f) The establishment of an equitable system of international economic relations aimed at achieving continuing economic advancement for all States based on principles recognized by the international community, in order to stimulate and sustain environmentally sound development, especially in developing countries;

5. Agrees that the recommendations for action contained in the Environmental Perspective should be implemented, as appropriate, through national and international action by Governments, intergovernmental and non-governmental organizations and scientific bodies;

6. Requests the Governing Council to keep under review the extent to which the long-term environmental actions recommended in the Environmental Perspective have been implemented and to identify any new environmental concerns that may arise;

7. Calls special attention to section IV of the Environmental Perspective, which spells out instruments of environmental action, to be used as support in addressing, as appropriate, problems dealt with in previous sections of the Environmental Perspective;

8. Stresses the essential role of the United Nations Environment Programme within the United Nations system in catalyzing environmentally sound and sustainable development, and agrees with the Governing Council that this role should be strengthened and that the resources of the Environment Fund should be substantially increased with greater participation;

9. Endorses the priorities and functions for the United Nations Environment Programme set out in paragraph 117 of the Environmental Perspective;

10. Decides to transmit the text of the Environmental Perspective to all Governments and to the governing bodies of the organs and organizations of the United Nations system as a broad framework to guide national action and international co-operation on policies and programmes aimed at achieving environmentally sound and sustainable development;

11. Calls upon the governing bodies of the organs and organizations of the United Nations system to consider the Environmental Perspective and take it into account in the development of their own medium-term plans and programmes as relevant to their own mandates;

12. Requests the governing bodies of relevant United Nations organizations to report regularly to the General Assembly on the progress made in achieving the objectives of environmentally sound and sustainable development in line with paragraph 114 of the Environmental Perspective;

13. Invites the Governing Council to report to the General Assembly at its forty-fourth session on the implementation of the present resolution and the relevant provisions of the Environmental Perspective.

96th plenary meeting
11 December 1987

Members of WCED

Gro Harlem Brundtland (Norway) -- Chairman
Mansour Khalid (Sudan) -- Vice Chairman
Susanna Agnelli (Italy)
Saleh A. Al-Athel (Saudi Arabia)
Bernard Chidzero (Zimbabwe)
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Janez Stanovnik (Yugoslavia)
Maurice Strong (Canada).

ELECTRIC ENERGY CONSUMPTION PER CAPITA
IN SOME COUNTRIES FOR 1985

	<u>kWh per person and year</u>
Norway	24 600
Sweden	16 000
USA	10 523
France	5 940
USSR	5 540
Japan	5 320
Italy	2 980
<u>Industrialized countries average</u>	7 000
Argentina	1 480
Brazil	1 420
Mexico	1 074
Egypt	491
Thailand	440
China	372
Morocco	291
Ghana	201
India	232
Indonesia	167
Bangladesh	46
<u>Developing countries average</u>	500

NUCLEAR POWER PRODUCTION IN 1987 WAS 1650 TWh.

Total wastes generated:

Low and medium level waste -- 100,000 m³ (before treatment)

Spent fuel -- 6000 tons, if and when reprocessed becomes
1800 m³ high-level waste as glass
(volume of a two family duplex house)