SP-74-5

RNATIONAL INSTITUTE FOR IIASA APPLIED SYSTEMS ANALYSIS

SYMPOSIUM PROCEEDINGS

MULTILEVEL COMPUTER MODEL OF WORLD DEVELOPMENT SYSTEM

EXTRACT
from the
PROCEEDINGS OF THE SYMPOSIUM
HELD AT IIASA, LAXENBURG
April 29 – May 3, 1974

M. MESAROVIC & E. PESTEL, EDITORS

VOLUME V

SCHLOSS LAXENBURG
A-2361 AUSTRIA

TABLE OF CONTENTS

PART A CONSTRUCTION OF WORLD SYSTEM MODEL

A-1 MOTIVATION, OBJECTIVES, AND CONCEPTUAL FOUNDATION VOLUME I
A-2 METHODOLOGY FOR CONSTRUCTION AND STRUCTURE OF THE MULTILEVEL WORLD SYSTEM MODEL VOLUME I

PART B SPECIFICATION OF SUBMODELS AND LINKAGES

B-1 ECONOMICS VOLUME II
B-2 POPULATION VOLUME III
B-3 FOOD VOLUME III
B-4 ENERGY VOLUME IV
B-5 ENVIRONMENT VOLUME V

PART C COMPUTER IMPLEMENTATION AND SIMULATION OF NORMS AND DECISION PROCESSES

C-1 AN APPROACH TO MODELING OF HIGHER STRATA VOLUME VI
C-2 INTERACTIVE MODE AND COMPUTER IMPLEMENTATION VOLUME VI

PART D THEORETICAL SUPPORT

D-1 MATHEMATICAL FORMULATION VOLUME VI
D-2 STATISTICAL ANALYSIS VOLUME VI

VOLUME V

PART B SPECIFICATION OF SUBMODELS AND LINKAGES

B-5 ENVIRONMENT

Page

V.1.	GLOBAL ENERGY SUBMODEL R.P. Heyes, R.A. Jerdonek, A.B. Kuper	B 1083
V.2.	ENVIRONMENTAL IMPACT ASSESSMENT M. Gottwald, R. Pestel	B 1121
V.3.	SUBMODEL OF GLOBAL WATER CYCLE ON REGIONAL BASIS M.A. Cardenas, J.M. Huerta	B 1277

V.1. GLOBAL ENERGY SUBMODEL

R.P. Heyes, R.A. Jerdonek, A.B. Kuper

April 1974

Introduction

This global energy model is a beginning toward an interactive model in which the various impacts of human activity upon natural energy flows may be studied, and useful inferences may be drawn.

The model structure is designed to be of sufficient complexity to be useful eventually in energy planning and in understanding energy interactions. Each sector and interface of the model can be expanded as deemed necessary to include details of energy flow processes.

The model is "quasi-dynamic". That is, steady-state power flow and energy storage in the environment have been modelled. However a great many feedback paths which are responsible for stabilizing or destabilizing the system have not been included. The model presented is therefore only accurate very near its operating point, and is not useful in examining the effect of perturbations or stability.

The effects of man are two-sided. He can either affect the energy environment by changing the level of an energy integrator (e.g., thermal pollution), or he can disturb the stabilizing feedback mechanisms (e.g. changing the albedo). The model structure should be taken as the basis for additional investigation. When particular aspects of the earth's energy flows are to be examined, the pertinent feedbacks should be added before plausible results can be obtained. Inclusion of all such feedbacks in one model would be too great a task. The burden of proof for sufficient characterization of these feedbacks will be the Achille's heel of this, or any other model.

In Part I of this paper, the structure of the model is described. In Part II, parameters used in the model are discussed. Part III describes the computer program and the results of runs in which natural energy reservoirs were monitored versus predicted increased future human energy demand.

Part I - Structure

The structure of this global energy model is arranged in five modules: i) energy flow in the atmosphere (Fig. 1), ii) physical allocation of the energy (Fig. 2), iii) energy flow in the plant and animal kingdom (Fig. 3), iv) human power generation (Fig. 4), v) human power consumption (Fig. 5). The first two represent physical energy flows, the third the energetics of the biological sector, and the final two the cultural energy patterns.

The input-output structure of each module is as follows:

I. Atmospheric:

PS - power from sun

PSR - power reflected

PSL - power incident to land

PSW - power incident to water

PSA - power absorbed in atmosphere

II. Allocation:

PIR - reflected power

PSP - power to plants

PMH - hydro power

PSH - direct conversion of sun light to power

PPCD, PPR, PFD, PGD, PND, PHD, PHIND, PHAD - power that has been dissipated

III. Bioenergetic:

PPCD + PPR - power dissipated by plants and animals

PPH - plant power for human use

PAH - animal power for human use

IV. Human Generation:

PFH - fossil fuel power to human

PFD - fossil fuel power to dissipated

PGH - geothermal power to human

PGD - geothermal power to dissipated

PNH - nuclear power to human

PND - nuclear power to dissipated

V. Human Consumption:

PHD + PHIND + PHAD - total power dissipated by human consumption

For each module, internal structure will be described and explained, including the relevant parameters.

B 1o88

Note: the following notational convention is used

P___ is called a parameter, and its first letter is always P. It has units of power.

P___K is a transformation. It can be time-varying, nonlinear, etc., but it is static. The output parameter of transformation P___K is P___.

E___ is an integrator or accumulator of power, and therefore has units of energy.

Summing junction, i.e. PZ = PX + PY

I. Atmospheric:

Explanation of parameters or transformations

PS - is the solar constant. It is the total radiation from the sun incident on the upper atmosphere including all wave lengths. It has a variation of $\pm$ 3% due to the eccentricy of the earth's orbit. Since our time steps are annual, an average value can be taken. Other orbital variations such as the period of precession are ignored. Disruptions of the solar constant by the sunspot cycle are also ignored. They can affect the intensity and wave length distribution of the radiation by 1-2%.

The effect of clouds of water droplets is modeled by three transformations.

PSCRK - % of incident power reflected into space

PSCAK - % of incident power absorbed by the droplets

PSCIK - % of incident power passed to surface

The reflectivity of clouds are determined by their height, thickness, and whether composed of ice or water.

The effect of atmospheric scattering is modeled by two transformations:

PSSRK - % of incident power scattered into space

PSSIK - % of incident power scattered onto the earth's surface

Atmospheric scattering can be broken into two basic groups, Rayleigh and Mie

1) Scattering by air molecules (radius is small compared to wavelength of radiation) scatters primarily the high frequencies (blue).
2) Scattering by haze and dust particles (radius comparable to wavelength). This gives rise to more complicated relations of the angular distribution of scatter.

Radiation that is not scattered or incident on clouds is considered direct.

PSDIK - % of incident power directly incident to surface

PSDAK - % of incident power directly absorbed into atmosphere

Nearly all radiation over 2900 A is passed. Ozone in the stratosphere accounts for absorption of high frequencies.

PSILK - % of earth's surface that is land

All other surface is of course considered water. Partitioning of power to land and water is assumed to be adequately modeled by % of surface. This assumes, for example, the water and land have equal amounts of cloud cover.

Surface albedo is defined as $\frac{\text{reflected power}}{\text{incident power}}$ at the surface of the earth.

PSLRK - average land albedo

PSWRK - average water albedo

The albedo of water is a function of the sun's elevation and the diffusivity of the incident power.

II. Details of Allocation Module

The power incident to the land masses, PSL, is allocated as follows:

PSLEK - is the % of PSL used for evaporation

PSLPK - is the % of PSL incident on plants and therefore available for photosynthesis.

PSLH - is the amount of power generated by the use of solar cells or solar "farms"

The remaining power of PSL is PSLS and this goes to sensible heating of the land masses.

The power incident to water, PSW, is allocated in a similar manner.

PSWEK - % of PSW used for evaporation

PSWPK - % of PSW used for photosynthesis

PSWS - power available for heating of water.

There are three accumulators of energy in this module:

EI - This is the reservoir of internal energy of the earth. This includes the sensible heat of the air, land, and water. EI is related to the average global surface temperature of 14° C.

EL - This is the reservoir of latent heat of vaporization. It is assumed that the annual changes of the latent heat of fusion cancel, i.e., there is no net glaciation, and therefore it is not included in the model. No upper limit on the amount of energy stored in this accumulator is included in the model.

EM - This is the reservoir of mechanical energy. This includes winds and currents, and the potential and kinetic energy of water on land.

PIR - This is the power lost due to the earth acting as a radiator. Although a great quantity of long wave radiation is radiated from the surface, most it is absorbed by the CO_2 and H_2O and reradiated back down. Some of the power is radiated up and some is lost in the "window" between the CO_2 and H_2O absorption. Both of these losses contribute to PIR.

PIT - is the internal power contribution to the thermodynamical cycles and circulations. This is physically generated by areas of different surface temperature on the globe.

PLT - is the contribution to the thermodynamical cycles from latent heat. Latent heat of vaporization is a very important factor of atmospheric heat, giving up to 2/3 of its total.

PTC - the sum of the previous two powers, and represents the total power in driving the hydrological and thermo dynamical cycles and circulations.

PTI - is the power from PTC which re-enters the accumulator of internal energy. This return of power comes from precipitation and the convergence of flux of sensible heat.

PTM - the power from the thermodynamic cycles which drives the winds and currents.

PMI - the power released from winds and currents to internal energy due to the viscous dissipation of mechanical energy.

PMH - wind power for human use extracted from the mechanical energy reservoir. This also includes hydropower.

III. Bioenergetic Module

The consecutive losses in converting wide-spectrum incident sunlight to carbon compounds can be summarized as follows: i) a loss due to the limited useful wavelengths, 390-760 mu, ii) albedo loss, iii) loss of not falling on photosynthetic tissue, iv) loss of not falling on photosynthetic pigments, v) losses in the photosynthetic process in converting the absorbed sunlight to carbon compounds.

PPCK - accounts for the efficiency of the above described processes excluding the albedo loss, which was previously accounted for.

PPC - the gross primary production.

EP - energy content of total plant biomass.

PPR - power dissipated from the plant biomass including respiration - all energy losses in metabolism, primary heat, etc. - transpiration, and any other losses which are proportional to biomass.

PPAH - amount of power contained in plants fed to animals which is under man's control.

PPA - amount of power contained in plants eaten by herbivores in the natural setting.

PPD - amount of power contained in plants eaten by decomposers.

EA - energy content of the total animal biomass. This includes the top three trophic levels - herbivore, carnivore, top carnivore, and the plant decomposers.

PAD - power dissipated from the animal biomass, i.e. respiration.

PPH - plant power to human use, includes food and forestry.

PAH - animal power to human use.

IV. Human Generation

PF - Source of fossil fuel power

PG - source of geothermal power

PN - source of nuclear power

PFEK - extraction and generation efficiency for fossil fuels

PGEK - extraction and generation efficiency for geothermal

PNEK - extraction and generation efficiency for nuclear power

PFH, PGH, PNH - power for human use

PFD, PGD, PND - power dissipated.

V. Human Consumption

PH - total power available for human consumption

PHD - power dissipated in converting PH into consumer useful form. Would contain, for example, efficiency of converting oil into home heat. In this model PHD is returned to EI, while in actuality some fraction would go directly to EL.

EHIN - total energy stored in industry, transportation, consumer goods, etc. which was required to turn it into items useful to man.

PHIND - depreciation and consumption of the energy in EHIN. When the energy of EHIN is no longer useful to man it is dissipated to EI or it goes into an energy "sink", e.g., landfill. This later fact is not reflected in the model.

EHA - energy in food accumulated for human use.

PHAD - power in food consumed and therefore dissipated from EHA.

Now that the micro structure of the model has been examined, some overall comments and assumptions should be brought out. The two fundamental themes running through the model are the first and second law of thermodynamics. That is that energy at every point is conserved and that as energy passes through any conversion there is an efficiency loss. The general tendency of the process modelled is to convert the high frequency sun's radiation into long wave heat. This fact is however only accounted for indirectly in the model. Only the quantity of power or energy is traced through the system and not its "qualitative" aspects. These aspects show up in such places as the ability of plants to utilize certain wavelengths - or water's albedo being a function of diffusivity.

Additional assumptions were that tidal power was negligible, as was the conduction of heat in rocks from the center of the earth. The latter may not be locally negligible.

To regionalize this model from its present global form, one basically has to allow the import-export of power from the energy integrators, except for EP, and from the components of PH, and compute regional values for all the transformations.

A summary of possible extensions which would add more basic form to the model, not including possible feedbacks, are as follows:

a) break EI into the energy of the land, water, atmosphere

b) include the latent heat of fusion

c) split EA and EP into respective domestic and natural integrators

d) dissaggregate the human use module into at least industry, agriculture, transportation, residential and commercial use.

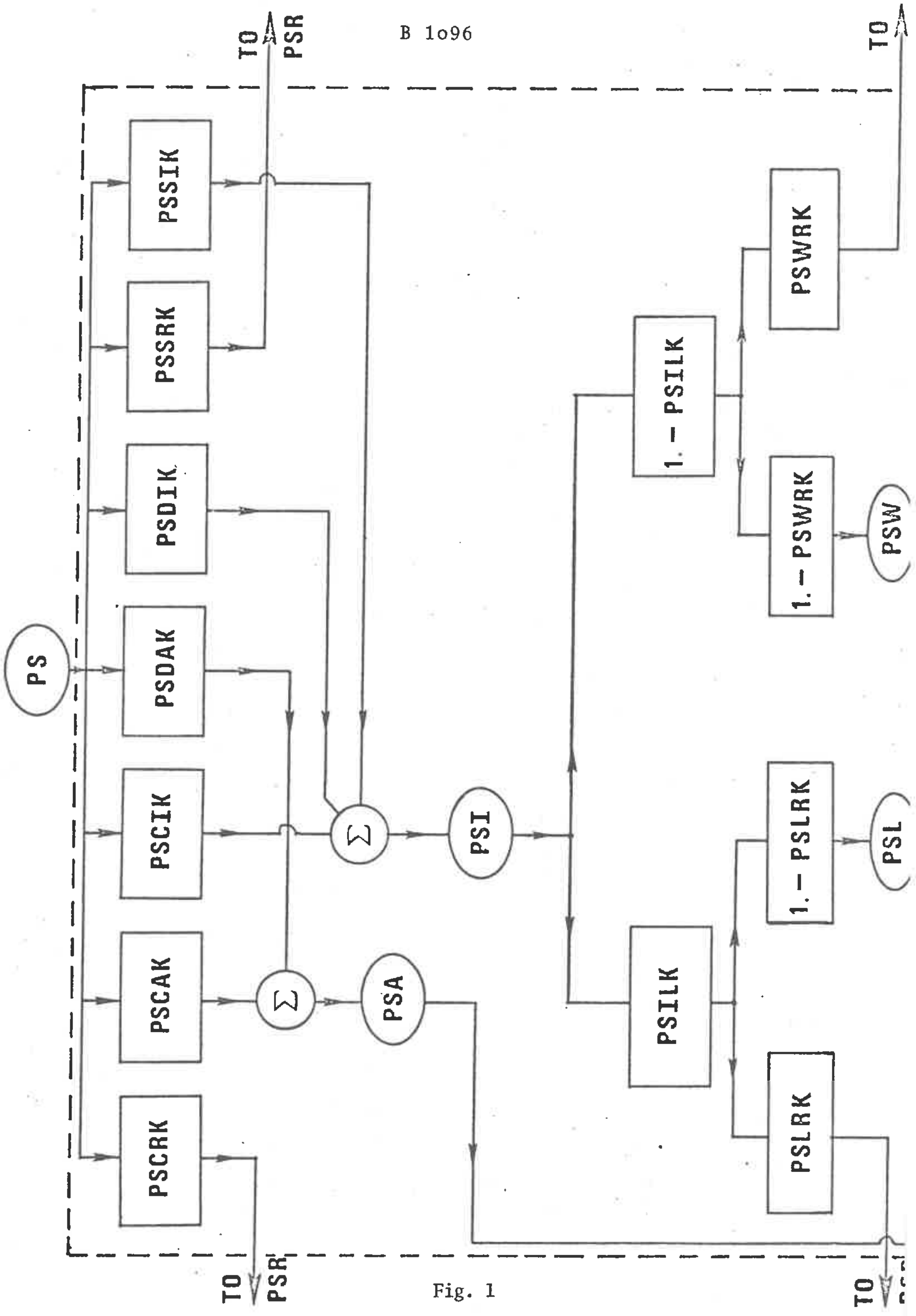

PS
PSCRK
PSCAK
PSCIK
PSDAK
PSDIK
PSSRK
PSSIK
TO PSR
TO PSR
Σ
Σ
PSA
PSI
PSILK
1. – PSILK
PSLRK
1. – PSLRK
1. – PSWRK
PSWRK
PSL
PSW
TO
TO

Fig. 1

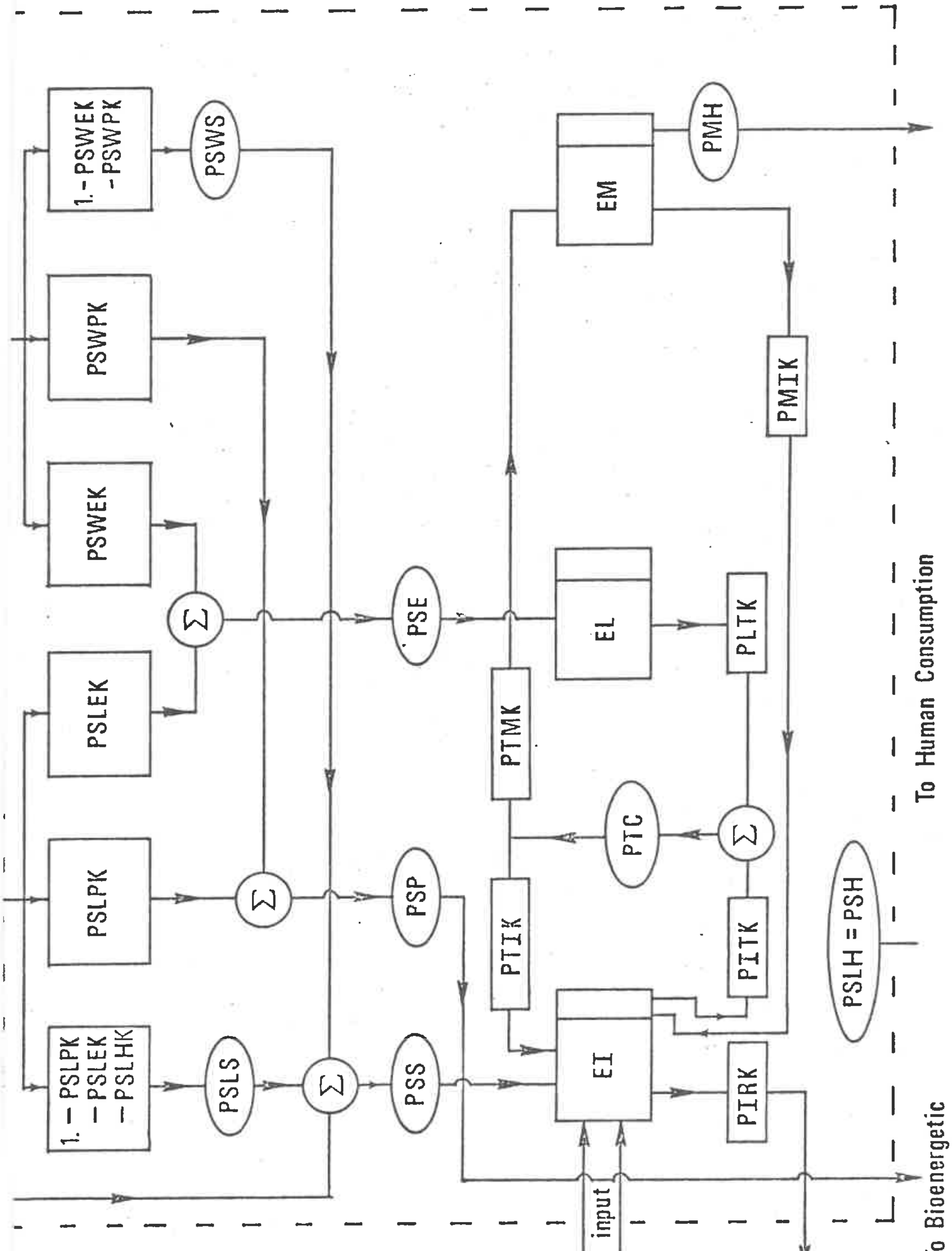

1.-PSWEK
-PSWPK
PSWS
PSWPK
PSWEK
PSLEK
PSLPK
1. – PSLPK
– PSLEK
– PSLHK
PSLS
Σ
PSE
PSP
PSS
EM
PMH
EL
EI
PMIK
PLTK
PTMK
PTC
PTIK
PITK
PIRK
PSLH = PSH
input
To Human Consumption
To Bioenergetic

Fig. 2

B 1o98

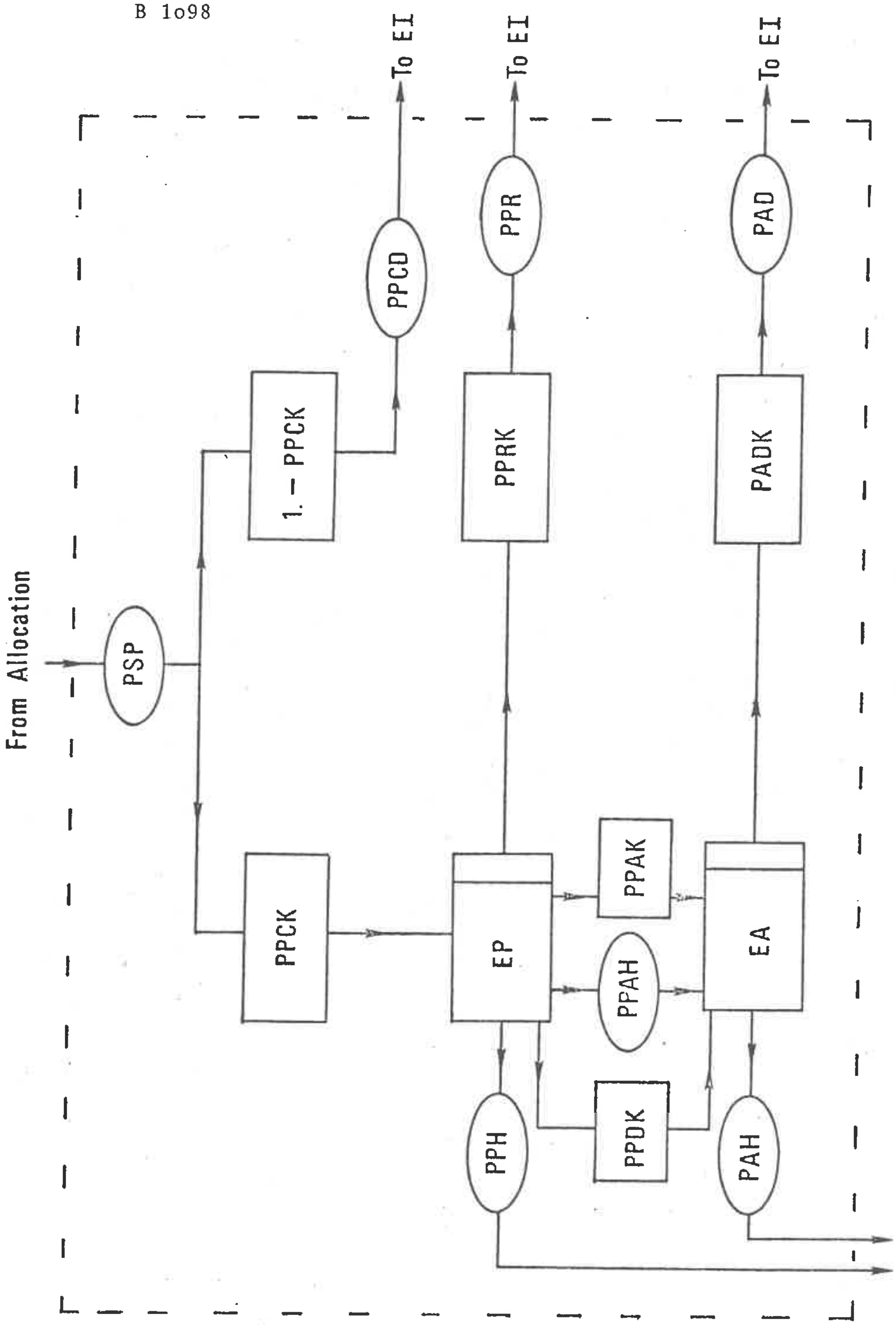
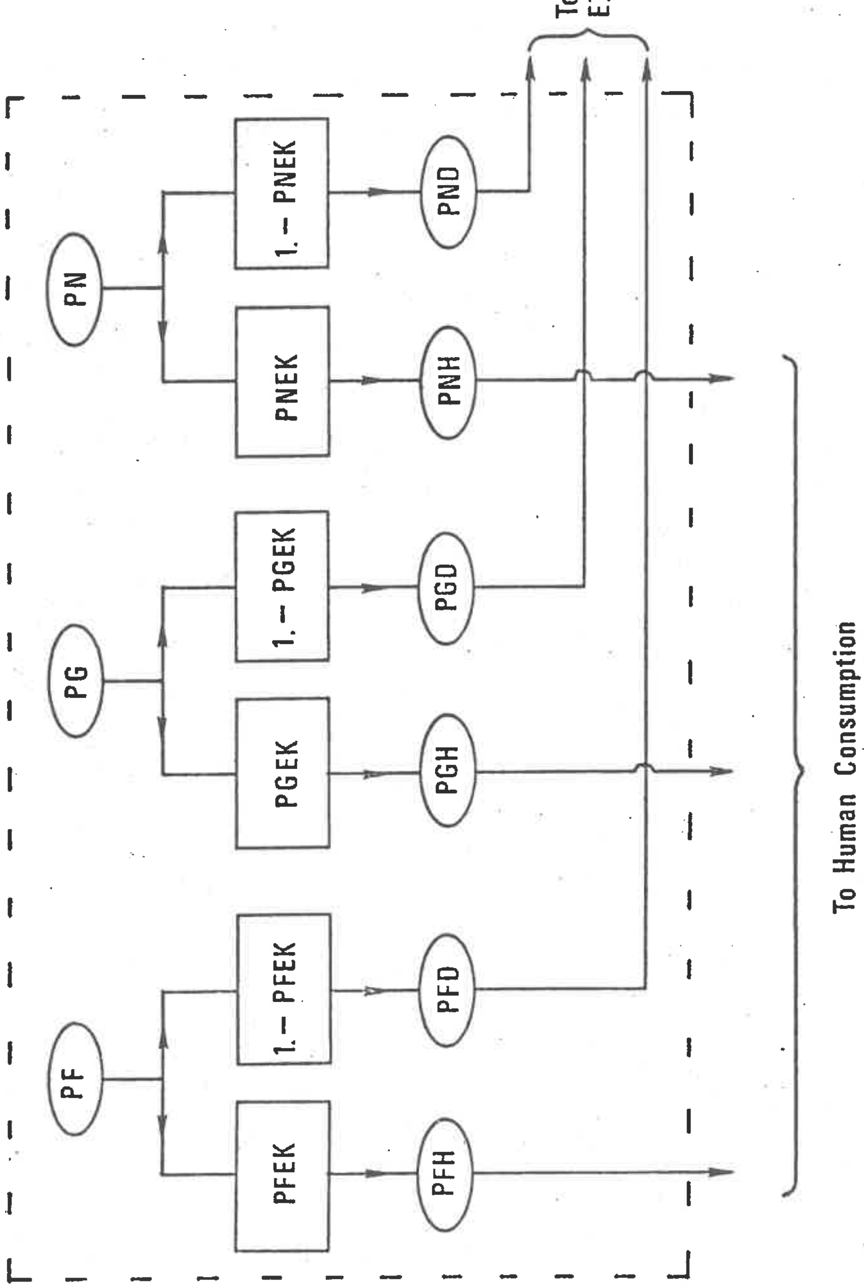

From Allocation
PSP
1. — PPCK
PPCD
To EI
PPRK
PPR
To EI
PADK
PAD
To EI
PPCK
EP
PPAK
PPAH
EA
PPH
PPDK
PAH

Fig. 3

B 1o99



To EI
PN
1.- PNEK
PNEK
PND
PNH
PG
1.- PGEK
PGEK
PGD
PGH
PF
1.- PFEK
PFEK
PFD
PFH
To Human Consumption

Fig. 4

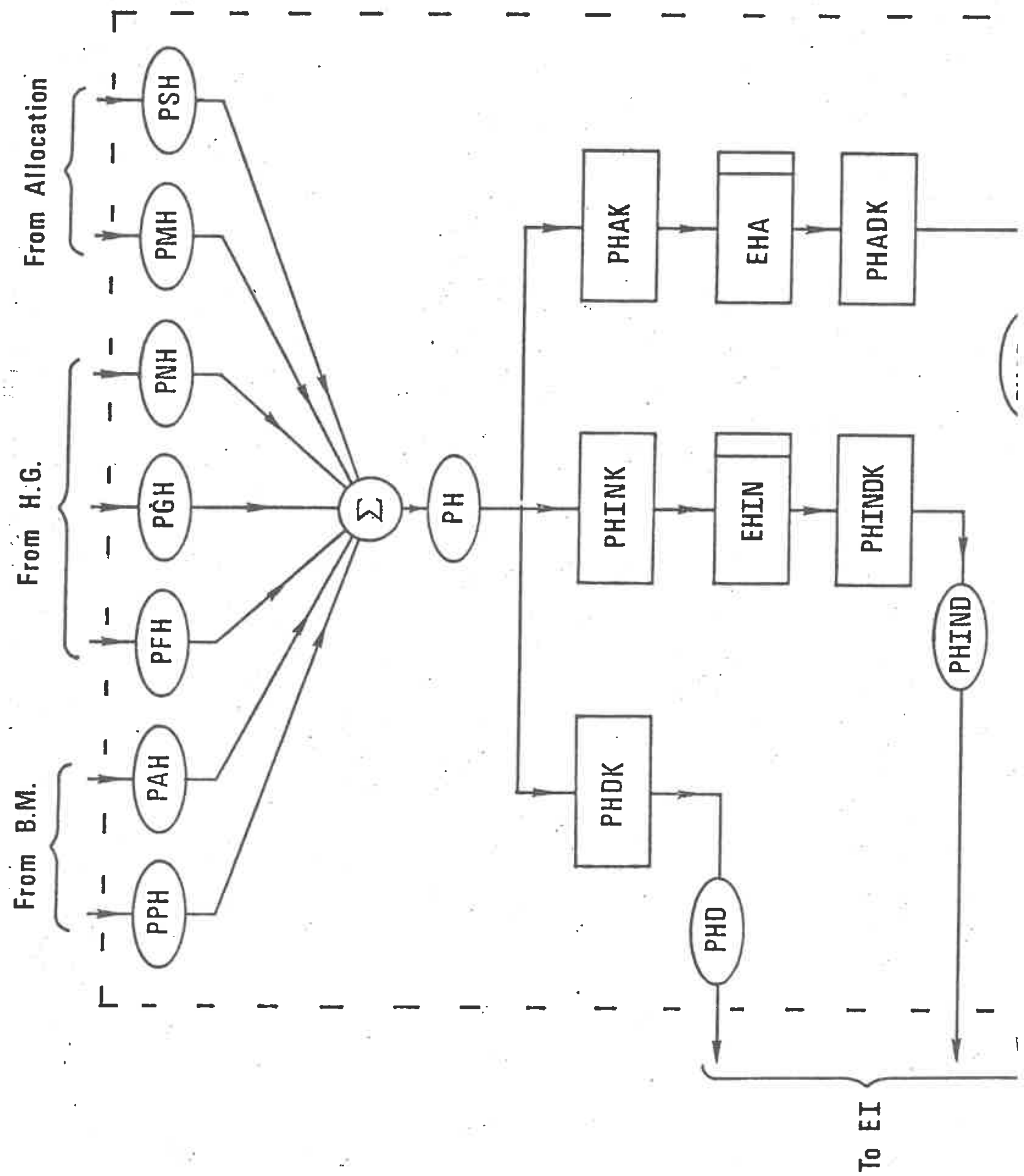

From Allocation
From H.G.
From B.M.
PSH
PMH
PNH
PGH
PFH
PAH
PPH
Σ
PH
PHAK
EHA
PHADK
PHINK
EHIN
PHINDK
PHIND
PHDK
PHD
To EI

Fig. 5

Part II - Parameter Evaluation

Evaluation of parameters has been done by analysis of relevant literature. In some cases, information on magnitudes and relationships could be used directly. In other cases, assumptions were necessary in order to utilize available data.

Discussion of the data and assumptions follows. The work is intended to serve the purposes of an aggregated steady-state global model which may be separated into regions by area. Methods should be considered as indication of how parameters could be developed by continued study of each sector.

Atmospheric

Total average solar power outside the Earth and Earth-Sun distance is [1] 350 w/m^2. Division of this power is taken as that given by Flohn [2] i.e. 25% reflected, 1% absorbed and 14% transmitted by clouds; direct radiation 16% absorbed and 26% transmitted; scattered radiation 7% scattered upward and 11% scattered downward.

Thus 17% solar power is absorbed in the atmosphere, 32% reflected and scattered upward and 51% is incident on the surface of the Earth. Total area of the Earth is $5.1x10^{14}m^2$ of which continental area is 29%, or $1.49x10^{14}m^2$, ocean area is 71%, or $e.61x10^{14}m^2$. [3]

The albedo of land and water is taken to be the same, 10%. This reflectivity of surfaces is reported to range from 3% for some waters to 90% for remote area snow. [4] Values could be estimated more accurately for regions using FAO land use data [5] to weight land area fractions.

Energy flows and storage in atmosphere are those shown in Fig. 6[1].

Organic

Total global net primary production has recently been reviewed in a Symposium.[6] The value given is $100x10^9$ tons dry organic tissue/year from the continents and $55x10^9$ tons/year from the seas for a total of $155x10^9$ tons/year. (In 1970 Woodwell[7] cites $164x10^9$ tons/year.) This production is for about the year 1950 and is attributed 66% to terrestrial, 34% to marine and 0.8% to freshwater.[8] (Freshwater ecosystems are given as covering approximately 0.5% of the Earth's surface.)

Energy content of plants is 4.25 kcal/dry gram world average.[9] Thus energy equivalent of $155x10^9$ tons is $6.87x10^{17}$kcal or 179 mw/m^2 = primary production. Using total annual solar energy of $510.x10^{18}$kcal, one obtains average conversion efficiency of solar full spectrum at Earth surface to plant tissue of 0.13% (0.07% seas, 0.3% land).

Respiration is taken to expend 50% of gross production.[3] (In a mature forest the figure is 80%[7], whereas figures of 20-40% are cited[10] for other ecosystems.)

For the organic integrators in this sector, World biomass estimated for year 1950 is $1.84x10^{12}$ tons dry.[8] (This is 18. KWH/m^2. Most of this biomass is terrestrial ($1835x10^9$ tons). It is assumed that this is total dry matter of living organisms. Animal biomass is taken as 10% plant biomass.[11] Thus plant integrator is 16.4 KWH/m^2, animal 1.6 KWH/m^2.

Man harvests[3] from land about $1.3x10^9$ tons/year and $1.7x10^7$ tons/year from water (88% from seas). Thus harvest is 0.85% of primary production, which gives harvest of $1.5mW/m^2$. This is taken as divided $1.4\ mW/m^2$ in plant, $0.14\ mW/m^2$ in animal harvest.

Feed to livestock is taken to have an energy content 10 times the energy value of animal output to man.[10] Fraction of primary production grazed by feral herbivores is assumed to be 15%. (In a "late successional" system 3%,[7] and in a freshwater aquatic system 34%[10] is cited.) This gives $26\ mW/m^2$ plant power consumed by feral herbivores. Remaining primary production is available to decomposers.

Cultural

Data is selected for year 1970. The starting point is 1970 world energy consumption (E) of $7x10^9$ tons coal equivalent[12] or 100 wH/m^2- year. It is assumed that this energy was 90% fossil and 10% hydro. (In U.S. it was 96% fossil, 4% hydro[13]. In less developed countries, hydro is a larger share. Hydro contribution in detail is available[14]). Thus fossil power to Man is $10mW/m^2$, hydro is $1mW/m^2$ and geothermal, renewable organic, wind and currents, and direct solar power are neglible in 1970. Nuclear in 1970 was 0.3%[15] of total energy supply in U.S. and is assumed neglible world-wide in 1970. Geothermal is not expected to contribute[16] as much as 0.9% in year 2000, wind as much as 0.3%, tidal as much as 9.% to world power. Nuclear is expected to contribute over 30%. Solar power has large potential.

We assume that extraction and transport of fossil fuels consumes 10% of the mined energy. (In the case of nuclear the 10% would go mainly for enrichment before use.) Thus 10 mW/m^2 becomes 11 mW/m^2 at the source. Total power to human including organic power is then 11 + 1.5 = 12.5 mW/m^2. This checks with the estimate that Man's energy consumption is about 7% of primary production[3] or 7% of 179 mW/m^2 or 12.5 mW/m^2. It is assumed that cultural processes are 40% efficient in use of energy. (Based on consumption in roughly equal parts: estimated industry efficiency 40%, transportation 20%, heating and cooling 60%, electrical generation 30%).[15]

Industrial tangible capital integrator is obtained by assigning an energy value to total world capital in 1970 of 6,250 billion 1963 dollars.[17] Odum suggests[18] a conversion of 10,000 kcal/$ in 1971. Assuming a rate of inflation of 5%/year in energy purchasing power, 1963 dollars could purchase 14,500 kcal, or 16.8 KWH. The total energy stored in tangibles would then be 200 WH/m^2.

The World ratio of energy to food production to that to all industrial and etc. activity is assumed to be 10:90. This is based on the following rough estimation. World ratio of harvest to total human energy consumption is 0.85%/7%[3] as already noted, or 12%. Most of this harvest is coming from intensive terrestrial agriculture which has a low fuel (food)-to-food energy amplification factor. (As a guide, a high amplification factor is 6, cited[19] for fish caught by atoll inhabitants. This natural harvesting involves no cultivation and minimal transport and processing.) Thus we estimate amplification factor of 2 for intensive agriculture, or the energy expended directly is 50% of yield. In addition, non-direct energy consumption for equipment and fertilizer further reduces amplification factor. In U.S. 1963 agriculture, indirect energy expenditure was estimated to equal direct[20].

Agro integrator is taken to be 10% of annual harvest, or 15 WH/m^2. This is based on approximately 5% seed stocks required[21] plus food stockpiles. Another approach, suggested by Clapham, is to use "Minimum Prudent Reserve" figures of U.S. and World agricultural bureaus.

Parameters are listed in Table I.

TABLE 1

Parameters

PS			350. w/m^2
PSCDK	25.% PS		
PSCAK	1% PS		
PSCIK	14.% PS		
PSDAK	16.% PS		
PSDIK	26.% PS		
PSSDK	7.% PS		
PSSIK	11.% PS		
PSA	17.% PS		
PSI	51.% PS		
PSILK	29.% PSI		
PSIWK	71.% PSI		
PSLDK	10.% PSIL		
PSWDK	10.% PSIW		
PSLR			1. mW/m^2
PPC			360. mW/m^2
PECD			180. mW/m^2
IECH		16. KWH/m^2 (1.8 w-yr./m^2)	
IAN		1.6 KWH/m^2 (0.18 w-yr./m^2)	
PECH			1.4 mW/m^2
PAH			0.14 mW/m^2
PCF			1.4 mW/m^2
PEC			26. mW/m^2
PAN			150. mW/m^2
PAND			18. mW/m^2
PFF			11. mW/m^2
PFFDK	10.% PFF		
PH			
PHDK	60.% PH		12.5 mW/m^2
PHTHK	36.% PH		
PHCMK	4.% PH		
IEHT		200. WH/m^2 (23.mW-yr./m^2)	
IEHCH		15. WH/m^2 (1.7mW-yr./m^2)	

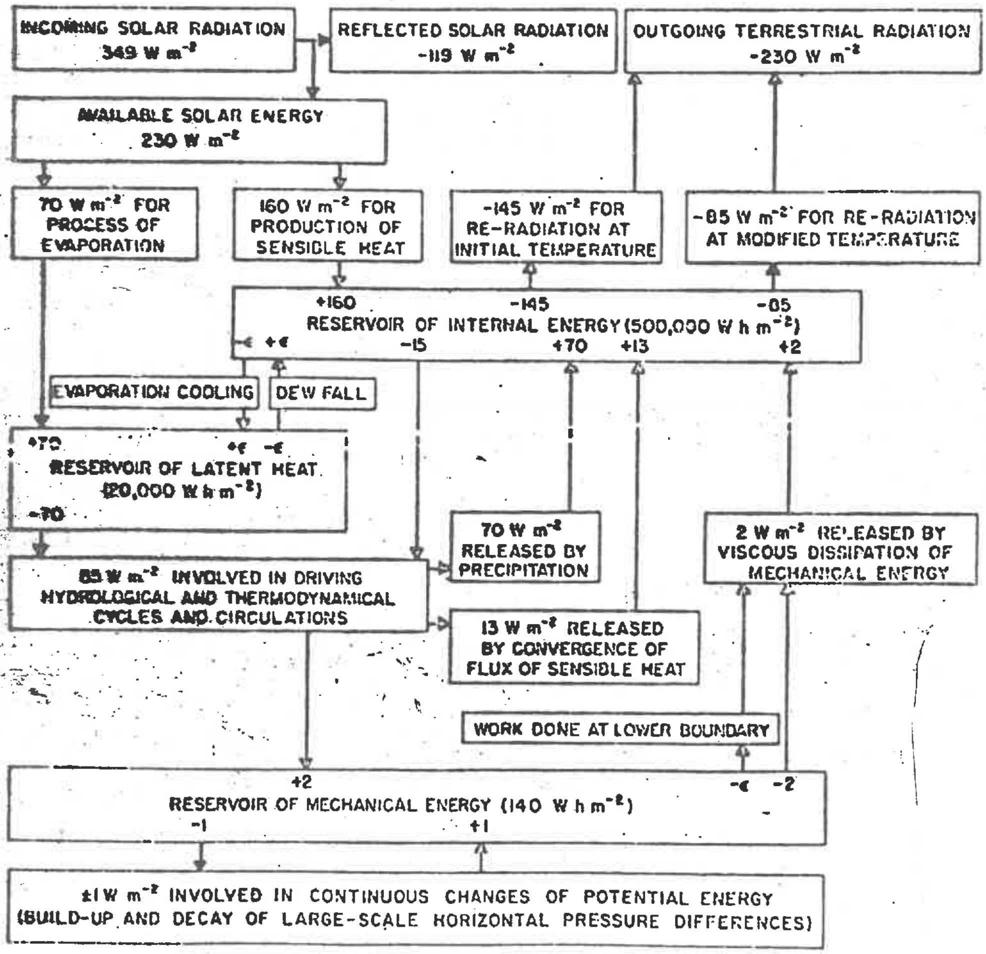


Fig. 6. The global mean energy cycles of the atmosphere. A solar constant of 1395 W m^{-2} and a global albedo value of 0.34 are assumed. The average total incoming radiation to the globe is ¼ of the solar constant. ε denotes an average rate of less than 0.5 W m^{-2}. The estimated reliability of the solar constant is 3%; of the derived energy rates, this totals approximately 10% (Lettau, 1954a).

Fig. 6

PART III - Computer Program

A FORTRAN program was written to implement the global energy model on a computer. The program was used to verify the consistency of the steady-state energy flows and integrator initial conditions, and to calculate the relative impact and effect of man's future energy demand on the global energy flows.

In the first step, values for the model parameters which had been obtained from the literature were entered into the program. Steady-state runs were made and parameters adjusted until a set of energy flows and integrator initial conditions were obtained which were consistent with the literature and yielded a stable model. The model parameters obtained are given in Table II.

In the second step, predicted future human energy demand to Year 2080 [17] was entered into the model as a time-varying parameter; with the assumption that human energy deman would be satisfied by a mixture of 54% from fossil fuels, 30% from nuclear power, 10% from direct solar power, 5% from the earth's mechanical reservoir (e.g. wind or hydro power), and 1% from geothermal power. Human use of plant and animal energy was assumed constant. (This source is expected to increase but at a lower rate than the other energy sources.) The impact on the environment resulting from the future human energy demand was determined by comparing the resulting human energy flows with the corresponding natural energy flows, or determining the effects of the human energy flows on the natural energy reservoirs under the assumptions of the model.

Significant results include an increase in internal energy in 110 years from 55.8 to 56.0 watt-yr./m^2 which corresponds to a proportional rise in the Earth's average temperature from 287^o to 288.2^{o}k (14^o C. to 15.2^{o}C), and human heat dissipation into the environment equal to 1.6% of the natural global energy flow into weather cycles. Also, the energy extracted from the Earth's mechanical reservoir in 110 years will equal 3.2% of the energy put into this reservoir by the weather cycles, with a resulting decline of 3.0% in the energy stored in the mechanical reservoir.

Included here are model output graphs for the next 110 years of the assumed human energy demand (Fig.7); ratios of human energy dissipation to natural energy dissipation (Fig. 8) and to energy flow into weather cycles (Fig. 9); and graphs of internal (i.e. heat) energy reservoir (Fig. 10) and the Earth's mechanical energy reservoir (Fig. 11).

Although the model does not include any of the natural feedbacks (e.g. cloud cover, carbon dioxide concentration, glaciation) which may have stabilizing or destabilizing effects on global energy flows; these computer outputs show that man's use of energy will result in significant contributions to these flows with possible adverse effects on the Earth's climate or weather patterns in 110 years.

A listing of the program is included here in Appendix 1.

B 111o

PARAMETERS

TABLE II

Power in watts/m^2

Energy in watt - years/m^2

PS	PPH	PAH	PPAH			
349.000	0.0014000	1.400E-04	0.0014000			
EL	EM	EI	EP	EA	EHIN	EHA
1.92999	0.0134995	55.7998	1.79999	0.198994	0.0228992	0.0017200
PSCRK	PSCAK	PSCIK	PSDAK	PSDIK	PSSRK	PSSIK
0.249996	0.0099998	0.139996	0.159996	0.259995	0.0699978	0.109997
PSILK	PSWRK	PSWEK	PSWPK	PSLRK	PSLEK	PSLPK
0.289993	0.0799980	0.359993	0.0011000	0.0799980	0.359993	0.0047998
PLTK	PITK	PTIK	PTMK	PMIK	PIRK	
30.4995	0.259995	0.976974	0.0229993	125.000	4.00000	
PPRK	PPAK	PPDK	PADK			
0.0999985	0.0139997	0.0839977	0.889984			
PFEK	PGEK	PNEK	SUBDT			
0.899994	0.899994	0.899994	0.0099998			
PHDK	PHINK	PHAK	PHINDK	PHDAK		
0.599991	0.359993	0.0399990	0.199997	0.289993		
PHFK	PHGK	PHNK	PHSK	PHMK		
0.539978	0.0099998	0.299995	0.0999985	0.0499992		

B 1111

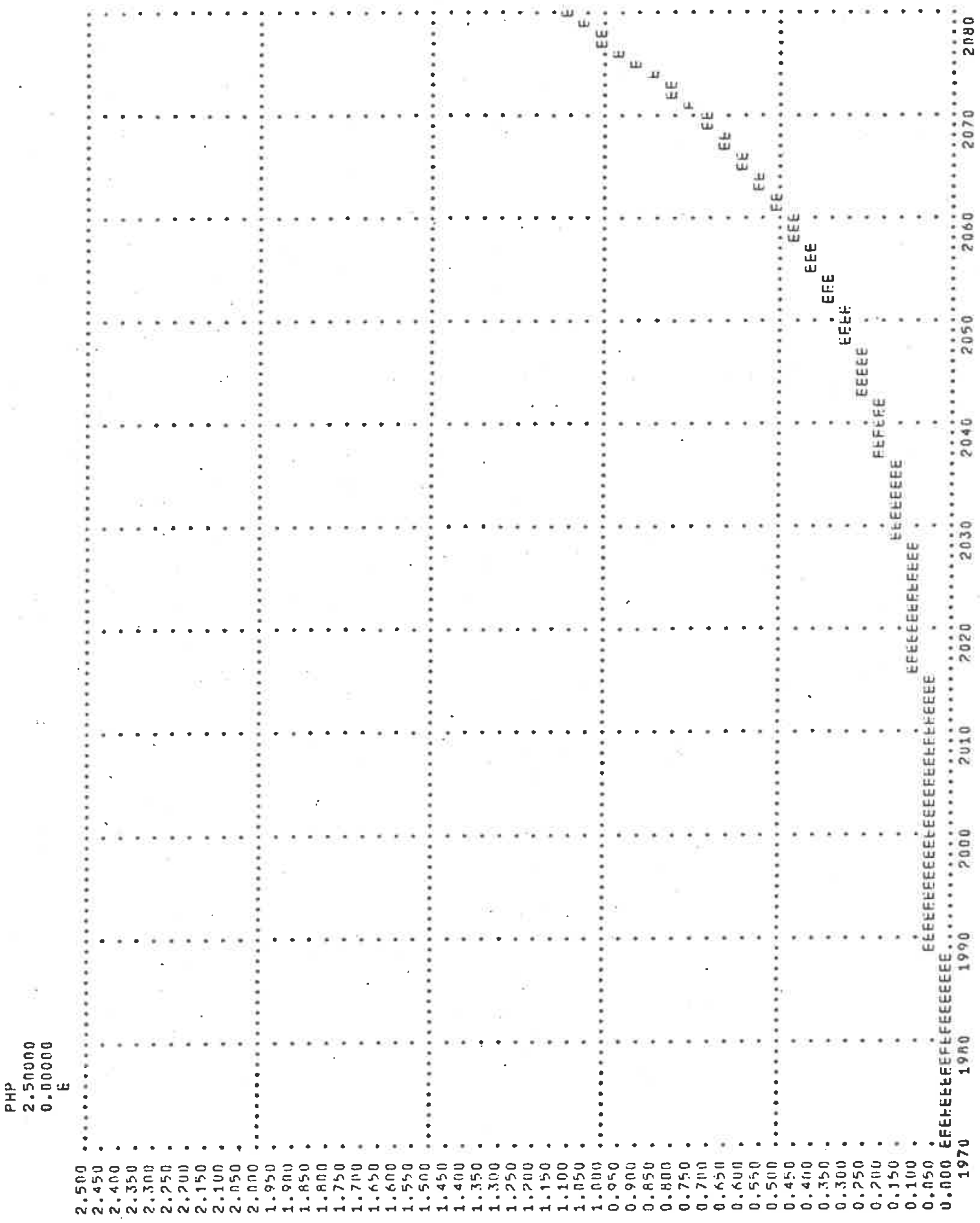

PHP
2.50000
0.00000
E
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080

Fig. 7

B 1112

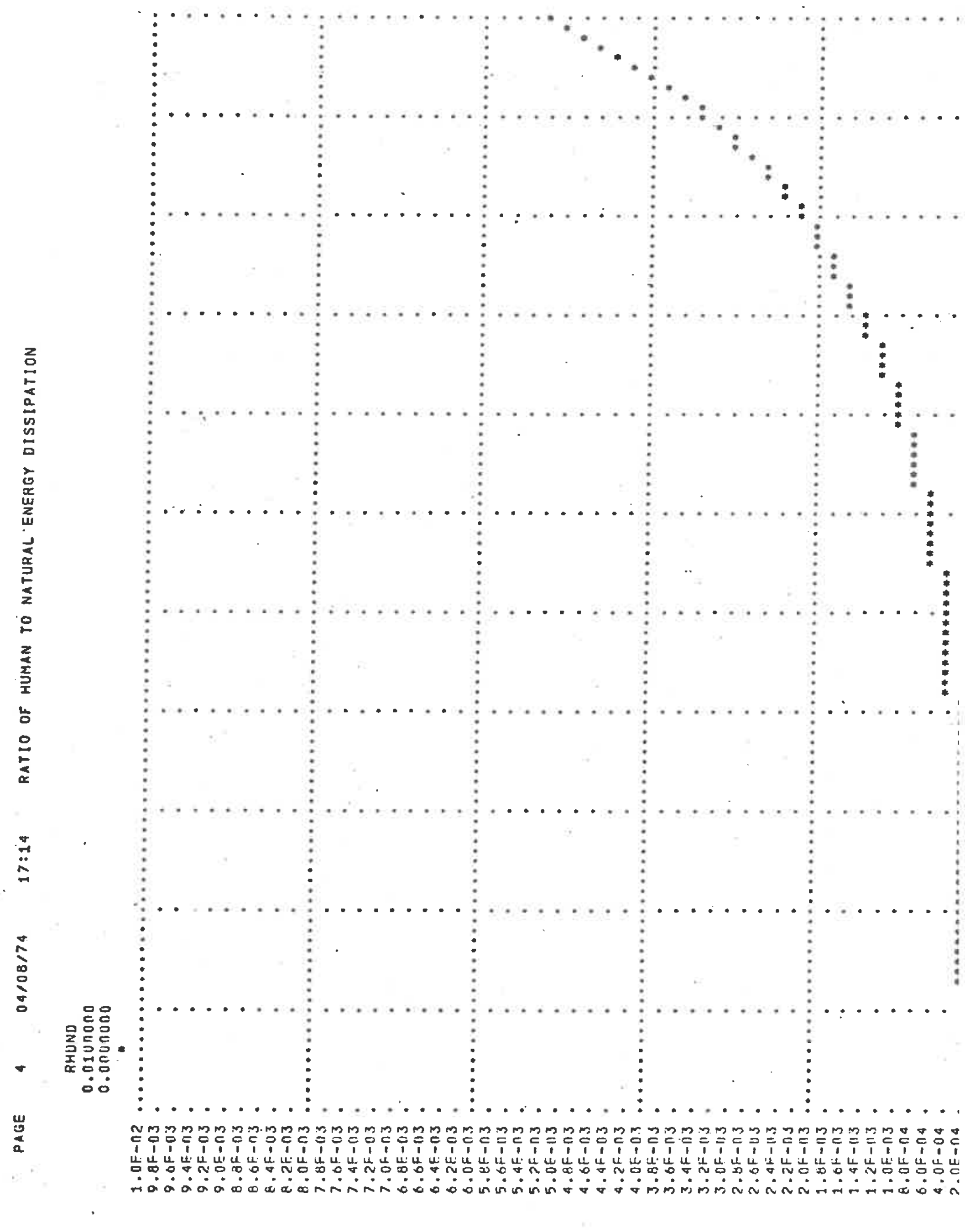

PAGE 4 04/08/74 17:14 RATIO OF HUMAN TO NATURAL ENERGY DISSIPATION
RHUND
0.0100000
0.0000000
1.0E-02
9.8E-03
9.6E-03
9.4E-03
9.2E-03
9.0E-03
8.8E-03
8.6E-03
8.4E-03
8.2E-03
8.0E-03
7.8E-03
7.6E-03
7.4E-03
7.2E-03
7.0E-03
6.8E-03
6.6E-03
6.4E-03
6.2E-03
6.0E-03
5.8E-03
5.6E-03
5.4E-03
5.2E-03
5.0E-03
4.8E-03
4.6E-03
4.4E-03
4.2E-03
4.0E-03
3.8E-03
3.6E-03
3.4E-03
3.2E-03
3.0E-03
2.8E-03
2.6E-03
2.4E-03
2.2E-03
2.0E-03
1.8E-03
1.6E-03
1.4E-03
1.2E-03
1.0E-03
8.0E-04
6.0E-04
4.0E-04
2.0E-04

Fig. 8

B 1113

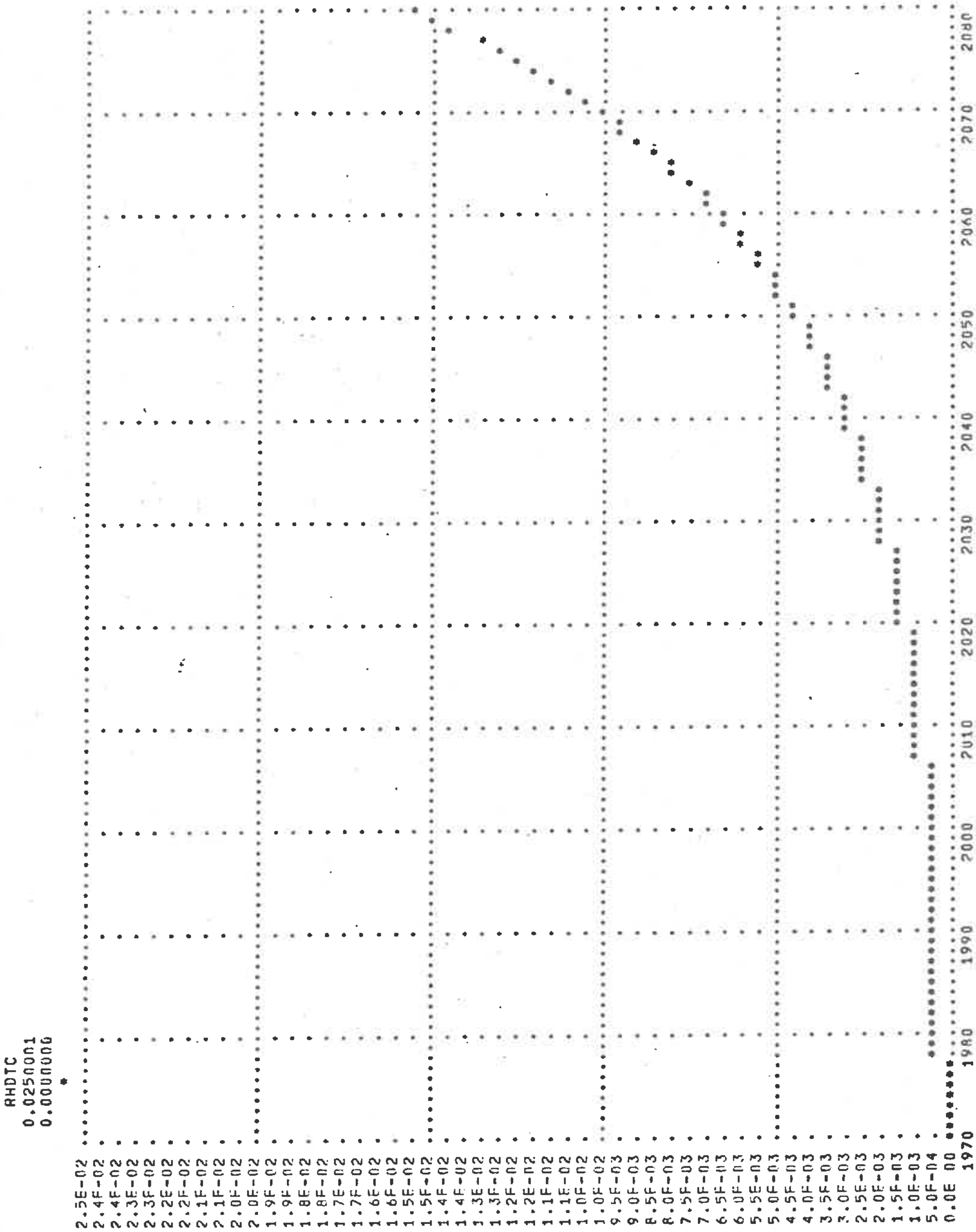

RHDTC
0.0250001
0.0000000
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080

Fig. 9

B 1114

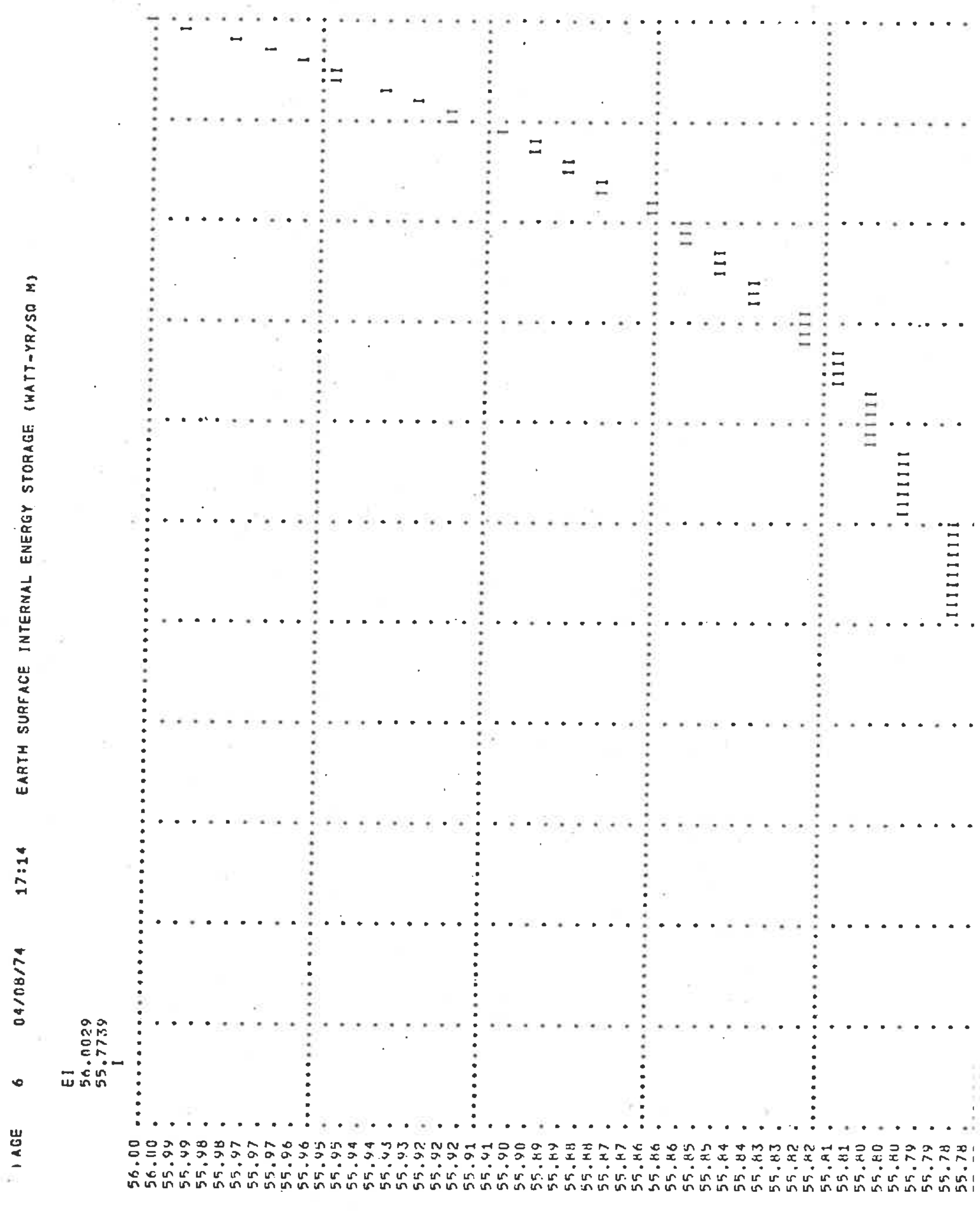

AGE 6 04/08/74 17:14 EARTH SURFACE INTERNAL ENERGY STORAGE (WATT-YR/SQ M)
EI
56.0029
55.7739

Fig. 10

B 1115

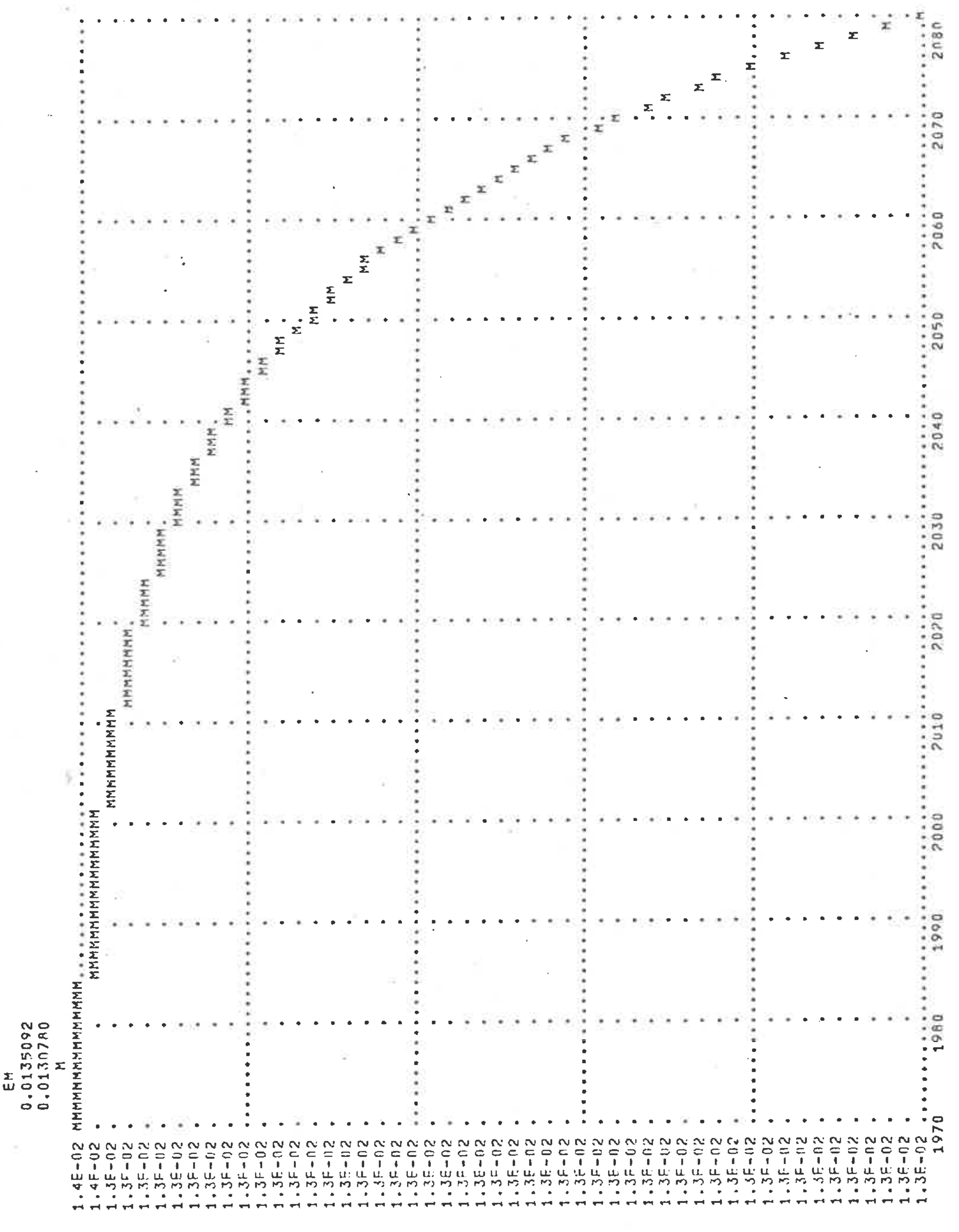

EM
0.0135092
0.0130780
M
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
1.4E-02
1.3E-02

Fig. 11

References

1. "Handbook of Geogpysics and Space Environments," ed. S. L. Valley (AFCRL, 1965) p. 3-3
2. "Climate & Weather," H. Flohn, (M-H, 1959)
3. R. H. Whittaker & G. E. Likens, Human Ecology 1, 4 (Sept. 1973) p.357
4. "Inadvertent Climate Modification" (SMIC) (MIT 1971) p. 81
5. FAO Yearbook 1970
6. Symposium on Primary Production of the Biosphere, Human Ecology 1, 4 (Sept. 1973)
7. G. M. Woodwell, Sci. Am. 233 (Sept. 1970) p. 64.
8. H. Lieth, Ref. 6, p. 303
9. G. E. Likens, Ref. 6
10. D. M. Gates, Sci. Am. (Sept. 1971) p. 43
11. Private comm. J.C. Koonce
12. C. Mazzolini, priv. comm.
13. Data for Assessment of Energy Technologies, Assoc. Univs. Inc. (April 1972)
14. World Energy Supplies 1968-1971, UN Statist. Paper, Ser. J/16(UN, New York, 1973)
15. C. M. Summers, Sci. Am. (Sept. 1971) p. 96.
16. P. N. Ross, Westinghouse Power Systems Planning
17. B. Hughes, private comm.
18. "Environment, Power and Society", H.T. Odum (Wiley, 1971), p. 46
19. Ref. 18, p. 47
20. R. A. Herendeen "An Energy I/O Matrix for the U.S. 1963", Center for Advanced Computation Doc. 69, Univ. of Ill. (Urbana, 1973) p. 20.
21. P. Clapham, private comm.

```
132125 REMOVE,33,PERMAN
132127 COMPIL,33,PERMAN
          COMMON NDT                                                    733      2
          DO 1 IT=1,NDT                                                 733      3
          CALL COMONI(IT)                                               733      7
          IF(IT-1) 2,2,3                                                733     10
        2 CONTINUE                                                      733     18
C            INITIALIZE STATE VARIABLES                                 733     20
          GO TO 4                                                       733     21
        3 CONTINUE                                                      733     23
C            RESET STATE VARIABLES                                      733     25
          EL=ELOLD                                                      733     26
          EM=EMOLD                                                      733     29
          EI=EIOLD                                                      733     32
          EP=EPOLD                                                      733     35
          EA=EAOLD                                                      733     38
          EHA=EHAOLD                                                    733     41
          EHIN=EHIOLD                                                   733     44
        4 CONTINUE                                                      733     47
          PHP=.0017*PHP                                                 733     49
C            ATMOSPHERE POWER FLOW                                      733     53
          PSCR=PSCRK*PS                                                 733     54
          PSCA=PSCAK*PS                                                 733     58
          PSCI=PSCIK*PS                                                 733     62
          PSDA=PSDAK*PS                                                 733     66
          PSDI=PSDIK*PS                                                 733     70
          PSSR=PSSRK*PS                                                 733     74
          PSSI=PSSIK*PS                                                 733     78
          PSA=PSCA+PSDA                                                 733     82
          PSI=PSCI+PSDI+PSSI                                            733     86
          PSIL=PSILK*PSI                                                733     91
          PSIW=(1-PSILK)*PSI                                            733     95
C            HYDROSPHERE POWER FLOW                                     733    101
          PSWR=PSWRK*PSIW                                               733    102
          PSW=(1-PSWRK)*PSIW                                            733    106
          PSWE=PSWEK*PSW                                                733    112
          PSWP=PSWPK*PSW                                                733    116
          PSWS=(1-PSWEK-PSWPK)*PSW                                      733    120
C            GEOSPHERE POWER FLOW                                       733    127
          PSLR=PSLRK*PSIL                                               733    128
          PSL=(1-PSLRK)*PSIL                                            733    132
          PSLE=PSLEK*PSL                                                733    138
          PSLP=PSLPK*PSL                                                733    142
          PSH=PHSK*PHP                                                  733    146
          PSLH=PSH                                                      733    150
          PSLS=(1-PSLEK-PSLPK)*PSL-PSLH                                 733    153
C            PHYSICAL POWER I-O CALCULATIONS                            733    161
          PSR=PSCR+PSSR+PSWR+PSLR                                       733    162
          PSP=PSLP+PSWP                                                 733    168
          PSE=PSLE+PSWE                                                 733    172
          PSS=PSLS+PSWS+PSA                                             733    176
C            PHYSICAL ENERGY STORAGE                                    733    181
          NSUB=1./SUBDT+.1                                              733    182
          DO 10 ISUB=1,NSUB                                             733    191
```

```
          PLT=PLTK*EL                                              733    195
          PIT=PITK*EI                                              733    199
          PTC=PLT+PIT                                              733    203
          PTI=PTIK*PTC                                             733    207
          PTM=PIMK*PTC                                             733    211
          PMI=PMIK*EM                                              733    215
          PIR=PIRK*EI                                              733    219
          PMH=PHMK*PHP                                             733    223
          EL=EL+(PSE-PLT)*SUBDT                                    733    227
          EI=EI+(PSS-PIR-PIT+PTI+PMI)*SUBDT                        733    233
          EM=EM+(PTM-PMI-PMH)*SUBDT                                733    242
C            BIOLOGICAL ENERGY FLOW AND STORAGE                    733    249
          PPC=PSP                                                  733    250
C         (PHOTOSYNTHESIS CONV. EFF. INCLUDED IN PSLPK,PSWPK)      733    253
          PPD=PPDK*EP                                              733    254
          PPA=PPAK*EP                                              733    258
          PPR=PPRK*EP                                              733    262
          PAD=PADK*EA                                              733    266
          EP=EP+(PPC-PPR-PPA-PPD-PPH-PPAH)*SUBDT                   733    270
          EA=EA+(PPAH+PPA+PPD-PAD-PAH)*SUBDT                       733    280
          EI=EI+(PAD+PPR)*SUBDT                                    733    289
C            CULTURAL ENERGY FLOW AND STORAGE                      733    295
          PFH=PHFK*PHP                                             733    296
          PF=PFH/PFEK                                              733    300
          PFD=(1-PFEK)*PF                                          733    304
          PGH=PHGK*PHP                                             733    310
          PG=PGH/PGEK                                              733    314
          PGD=(1-PGEK)*PG                                          733    318
          PNH=PHNK*PHP                                             733    324
          PN=PNH/PNEK                                              733    328
          PND=(1-PNEK)*PN                                          733    332
          PH=PPH+PAH+PHP                                           733    338
C            CULTURAL ENERGY CONSUMPTION                           733    343
          PHA=PHAK*PH                                              733    344
          PHIN=PHINK*PH                                            733    348
          PHD=PHDK*PH                                              733    352
          PHIND=PHINDK*EHIN                                        733    356
          PHAD=PHADK*EHA                                           733    360
          EHIN=EHIN+(PHIN-PHIND)*SUBDT                             733    364
          EHA=EHA+(PHA-PHAD)*SUBDT                                 733    370
          EI=EI+(PHD+PHIND+PHAD+PFD+PGD+PND)*SUBDT                 733    376
          IF(SENSE SWITCH 0) 8,10                                  733    386
 8        IF(IT-6) 9,10,10                                         733    391
 9        PRINT 11,IT,ISUB,EL,EM,EI,EP,EA,EHIN,EHA                 733    399
10        CONTINUE                                                 733    422
          ELOLD=EL                                                 733    430
          EMOLD=EM                                                 733    433
          EIOLD=EI                                                 733    436
          EPOLD=EP                                                 733    439
          EAOLD=EA                                                 733    442
          EHAOLD=EHA                                               733    445
          EHIOLD=EHIN                                              733    445
```

B 1118

```
        RHDND=PHDTOT/PNDTOT                                              733    467
        RHDTC=PHDIOT/PTC                                                 733    471
        RHDTM=PHDTOT/PTM                                                 733    475
11 .    FURMAT(2I10,3F10.4,4F10.6)                                       733    479
 1      CALL COMONO(IT)                                                  733    485
        TURN PROGRAM 27 ON, 0                                            733    496
        STOP                                                             733    500
        COMMON PS,PSCR,PSCA,PSCI,PSDA,PSDI,PSSR,PSSI,PSA,PSI,PSIL,       733    503
       CPSIW,PSLR,PSL,PSW,PSWR,PSWE,PSWP,PSWS,PSLE,PSLP,PSLS,PSLH,PSR,   733    504
       CPSP,PSH,PSF,PSS,PMI          ,PIR,EL,EI,EM,PMH,PSCRK,PSCAK,PSCIK,733    505
       +    PSDAK,PSDIK,PSSRK,PSSIK,PSILK,PSLRK,PSWRK,PSLPK,PSLEK        733    506
        COMMON PLT,PIT,PTC,PTI,PTM                                       733    507
        COMMON SUBDT,PSWEK,PSWPK,PMIK,PIRK,PLTK,PITK,PTMK,PTIK           733    508
        COMMON PPC,PPD,PPA,PAD,PPDK,PPAK,PADK,EP,EA,PPR,PPRK,PHA,        733    509
       +    PHAD,PHADK,PHP,PHFK,PHGK,PHNK,EHA,PHSK,PHAK,PHINK,PHMK       733    510
        COMMON PF,PFH,PFD,PG,PGH,PGD,PN,PNH,PND,PH,PFEK,PGFK,PNEK,       733    511
       +    PPAH,PPH,PAH,EHIN,PHIND,PHINDK,PHIN,PHDK,PHD                 733    512
        COMMON PHDTOT,PNDTOT,RHDND,RHDTC,RHDTM                           733    513
        END                                                              733    514

*                                                                        133    649

*PROGRAM END.    0 FORTRAN ERRORS                                        133    650
*00000000  *00000000        END                                          133    651

                 0 ASSEMBLY ERRORS

            001124 PROGRAM OCTAL SIZE

            000652 EQL TABLE OCTAL SIZE

132314 FIN
```

B 1119

B 112o

V.2. ENVIRONMENTAL IMPACT ASSESSMENT

M. Gottwald, R. Pestel

April 1974

B 1122

E N V I R O N M E N T A L   I M P A C T   A S S E S S M E N T

Part 1: Environmental Impact of the Energy System - A Dynamic Energy Emission Register for The Multilevel World Model

M. Gottwald, R. Pestel

April 1974

TABLE OF CONTENTS

		Page
Ch. 1 -	INTRODUCTION: THE ENVIRONMENT PROBLEM AND ITS RELATION TO SOCIETAL DEVELOPMENT	B 1124
1.1 -	General Environmental Considerations for Policy	B 1124
1.2 -	A Specific Scenario for Environmental Impact from Energy Use	B 1145
1.3 -	Underlying Assumptions	B 1157
Ch. 2 -	MODEL STRUCTURE OF THE ENERGY EMISSION REGISTER	B 1159
2.1 -	The Planned Energy Emission Model	B 1159
2.2 -	Status Quo of the Emission Register	B 1163
2.3 -	Variables and Definitions	B 1171
2.4 -	Block Diagrams and Equations of ER	B 1175
2.5 -	Listing	B 1191
Ch. 3 -	SCENARIO SPECIFICATION	B 1218
3.1 -	Classification of Scenarios	B 1218
3.2 -	Selection and Specification of Inputs	B 1220
Ch. 4 -	COMPUTER RUNS	B 1222
4.1 -	Description of the Underlying Energy Scenarios	B 1222
4.2 -	Comments	B 1223
4.3 -	Runs	B 1224
Ch. 5 -	DISCUSSION OF APPROACH: LIMITATIONS OF PRESENT ER AND NEXT IMPROVEMENTS	B 1266
	BIBLIOGRAPHY	B 1270

1. INTRODUCTION: THE ENVIRONMENT PROBLEM AND ITS RELATION TO SOCIETAL DEVELOPMENT

1.1 General Environmental Considerations for Policy

The objectives of the Working Group "Environmental Impact Assessment" (EIA) in the Multilevel World Model Project are threefold:

- to analyse environment issues and the environmental consequences of Man's activities
- to develop submodels for the World Model such that environmental considerations can be included in trade-off policy analyses
- to find and test specific policy recommendations for improving the environment.

Fig. 1.1 will serve to recall the view of Man's situation taken in the Multilevel World Model approach. We will not repeat the description and interpretation of this hierarchical system, as this has been done by M. Mesarovic and E. Pestel early in this Symposium (see also [60 , 68]).

A statement on what we mean by "environment" is in order, though. For our purposes it seems useful to distinguish between three types of environment:

(i) Natural Environment (Geophysical + Ecological + Technological Levels), of which Man is not considered a part but which he influences through technology;

(ii) Sociopolitical Environment (Economic + Institutional + Sociopolitical Levels), describing how individuals, groups, nations etc. are embedded in their larger social environments;

and (iii) Human biological and psychological Environment (the top two Levels), which stand for the "milieu interieur" of Man.

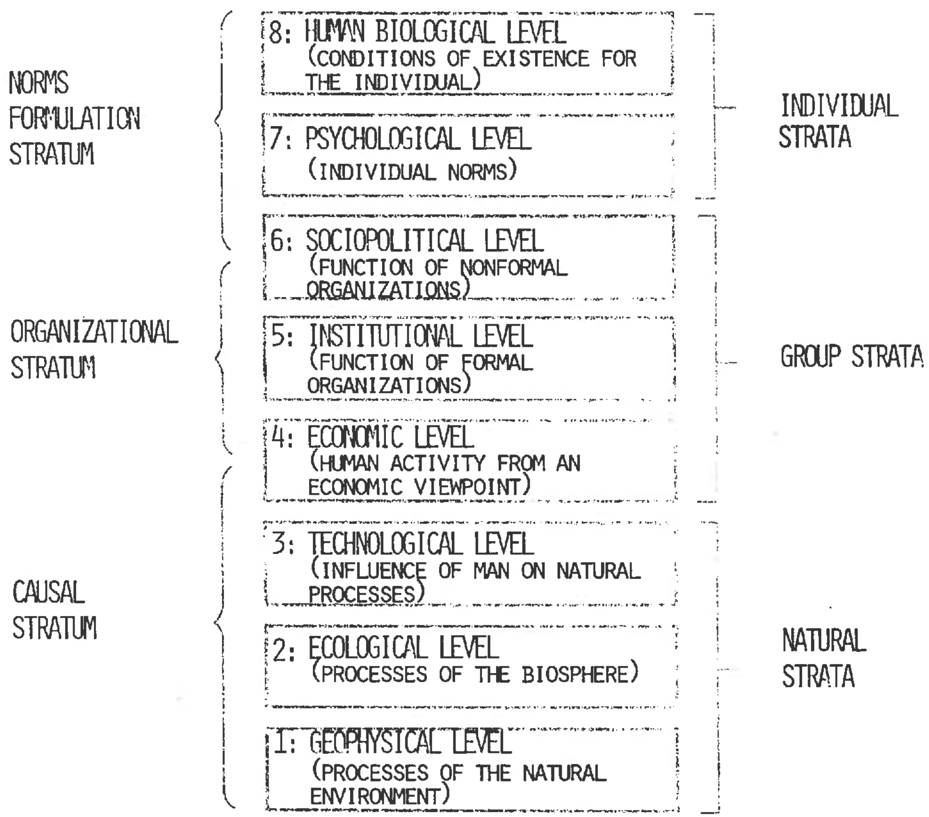


FIG. 1.1 AN INTEGRATIVE, STRUCTURED VIEW OF MAN'S ENVIRONMENTAL SYSTEM

Unless otherwise stated, EIA refers to Man's impact on natural environment (i). Of course, changes in the natural environment feed back to environments (ii) and (iii) and produce changes there.

These three larger subsystems are rapidly becoming more and more intensely interdependent, as illustrated in Fig. 1.2a. Any of the scenarios on population, food, energy and resources, or economics discussed at the Symposium constitute drastic examples of this growing interdependence, although none of them have yet explicitly reflected the issue of environmental impact in their model structures.

In preparation of this next very necessary step toward our objectives, we first have to find a conceptual foundation adapted to the overall approach taken in the Project. In addition to working definitions for "natural" environment and its subsystems (see also [79] and [25]), we also must identify the types of interaction between the Natural Levels and the Technological Level before we can speak of specific environmental impacts. Fig. 1.2b gives a first indication of the basic subsystems involved:

The Technological Level deals with those production processes which are of interest in a given scenario, i.e., it deals with specific technological alternatives. This distinguishes the Technological Level from the Economic Level which takes into account the entire economy of a region. However, each specific technology must be represented as completely as possible so that its entire spectrum of emissions and wastes and their corresponding quantities may be totally assessed. This is necessary for a meaningful comparison of technological alternatives w.r.t. their effects on environment.

The basic technological processes are shown in Fig. 1.2c. Man's material activities can be completely described by these 4 processes.

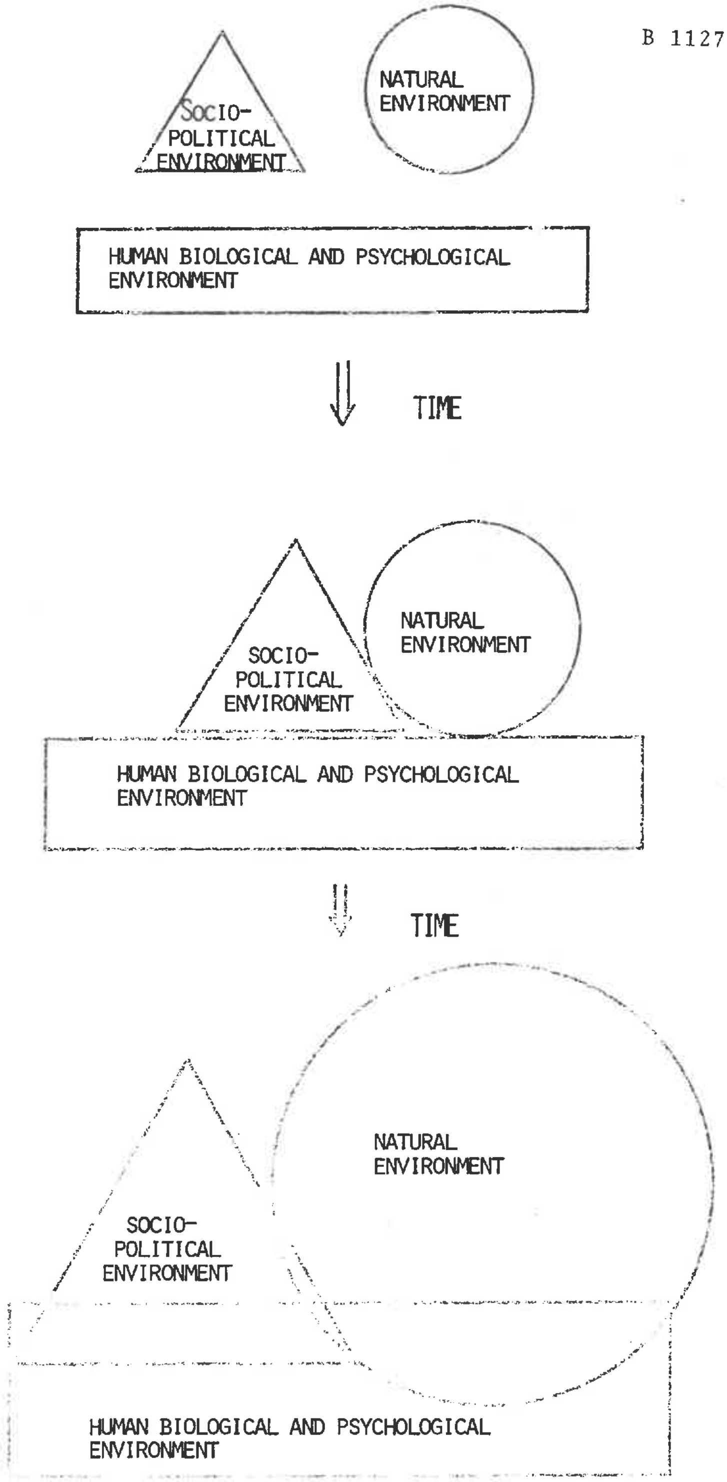


FIG. 1.2A GROWING INTERDEPENDENCE BETWEEN NATURAL, SOCIOPOLITICAL, AND HUMAN BIOLOGICAL AND PSYCHOLOGICAL ENVIRONMENT

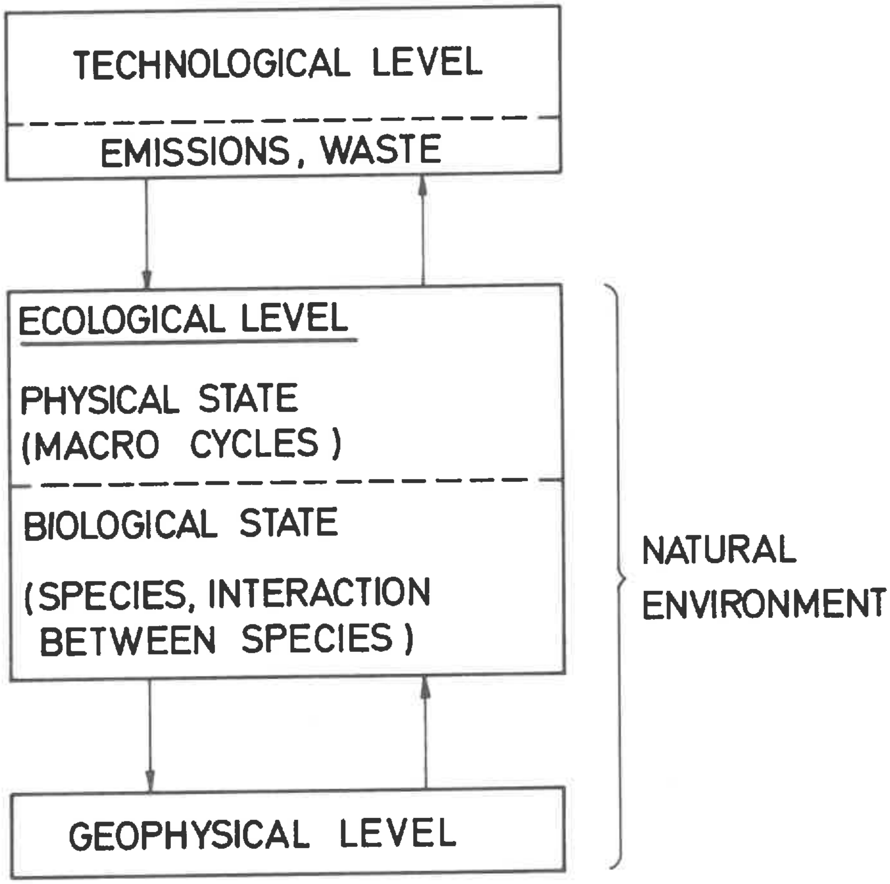


Fig. 1.2b BASIC SUBSYSTEMS OF NATURAL ENVIRONMENT

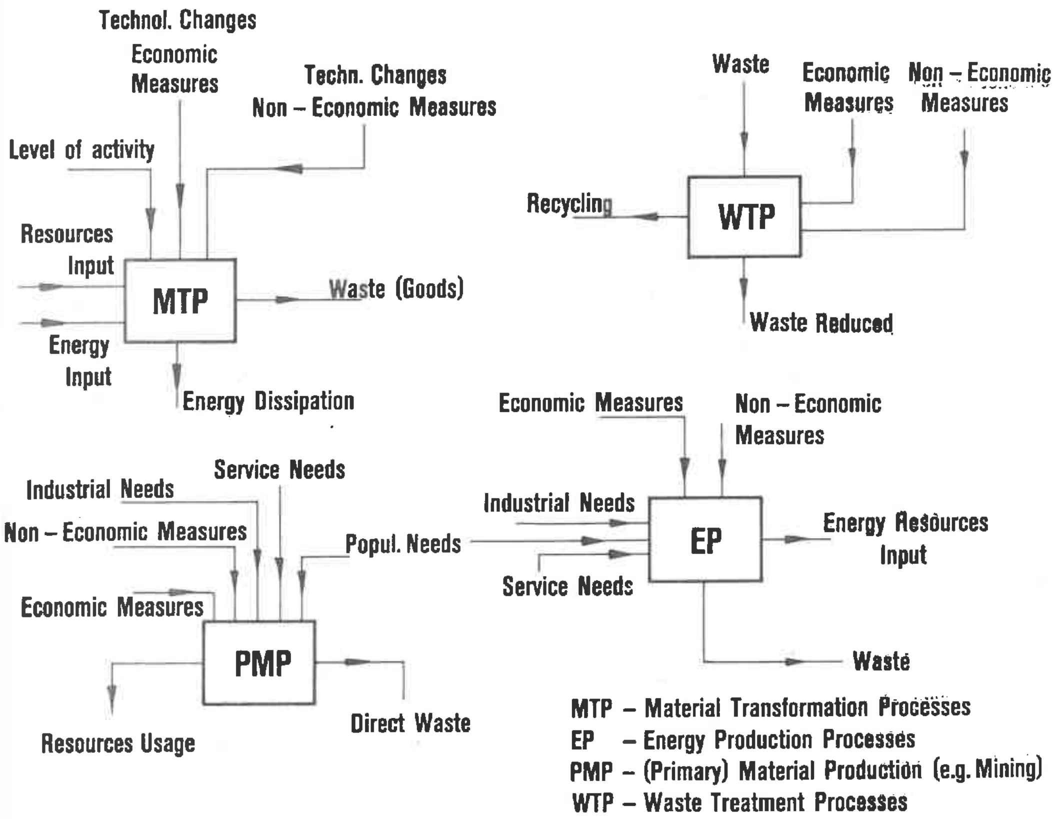


Fig. 1.2.c BASIC TECHNOLOGICAL PROCESSES

Fig. 1.2b might seem to suggest that EIA is a subtask of TA (Technology Assessment), concentrating only on the environmental consequences of technological change and neglecting the economic, sociopolitical, and cultural-normative effects. Furthermore, the scheme might seem to contain a bias toward a "passive" view of an environment affected by Man's economic and technological activities instead of being actively shaped for the betterment of Man's situation.

Unfortunately this criticism is justified for most TA and EIA activities to date. In our approach we avoid this bias by using TA and EIA as analysis tools in a more comprehensive policy search process guided by the norms and goals of society [68] . Fig. 1.2c indicates that this can be done, e.g., by introducing also non-economic policy variables affecting the technological processes.

Back to Fig. 1.2b: the emissions and waste - and also the natural resources and the energy used in the technological processes - affect the Ecological and the Geophysical Level. The view taken here suggests that the disturbances do not directly affect the biosphere but indirectly by changing the physical state of the abiotic environment. Because of the size of the World Regions considered and because of the long-term problems addressed in the Project the first submodels of the physical state of the ecosystem developed so far had to be macro models of material and energy flow [12,24,50,52,73].Present Project strategy is to develop as complete a set of these macro cycle models as necessary for an adequate representation of physical state in the context of the long-term global problematique.

A much more complex problem is the analysis of biological state. E.g., the analysis of species development requires a far higher degree of spatial and temporal resolution than physical state while at the same time, e.g., processes of ecological succession take something like 10^5 years to develop. It is a truism to add that ecological theory is yet far away from successfully tackling such dilemmas, that theory and empirical knowledge have only begun to converge, and that only recently the more classical approaches ("niche", predator-prey, biomass flow, climax equilibrium after succession etc.) are being expanded and synthesized into more powerful systemic approaches. For a concise overview of the evolution of ecological theory see [79] .

Finally, on the Geophysical Level processes of resource extraction, climatological and meteorological processes etc. are modeled, as far as they are relevant to a scenario under investigation [12, 53] .

So far the approach adopted here is not in principle at odds with "classical" ecology oriented along botanical and zoological lines, although problems of scale would seem to prohibit the mosaic-like decomposition necessary to arrive at the sufficiently self-regulatory ecosystems which classical ecology is interested in. The main difference, however, lies in the assumption here that Man must often be seen as an integral part of the ecosystem and not merely an external disturbing factor. Fig. 1.6 illustrates the emphasis we put on the management and control of ecosystems and on inclusion of environmental aspects in comprehensive planning. An account of where the EIA Working Group stands w.r.t. ecosystem theory is given in [15] .

After having described the basic material processes through which Man interacts with the environment we are faced with the task of defining some operational measure of Man's impact on nature. Fig. 1.3 serves to illustrate the problems that arise:

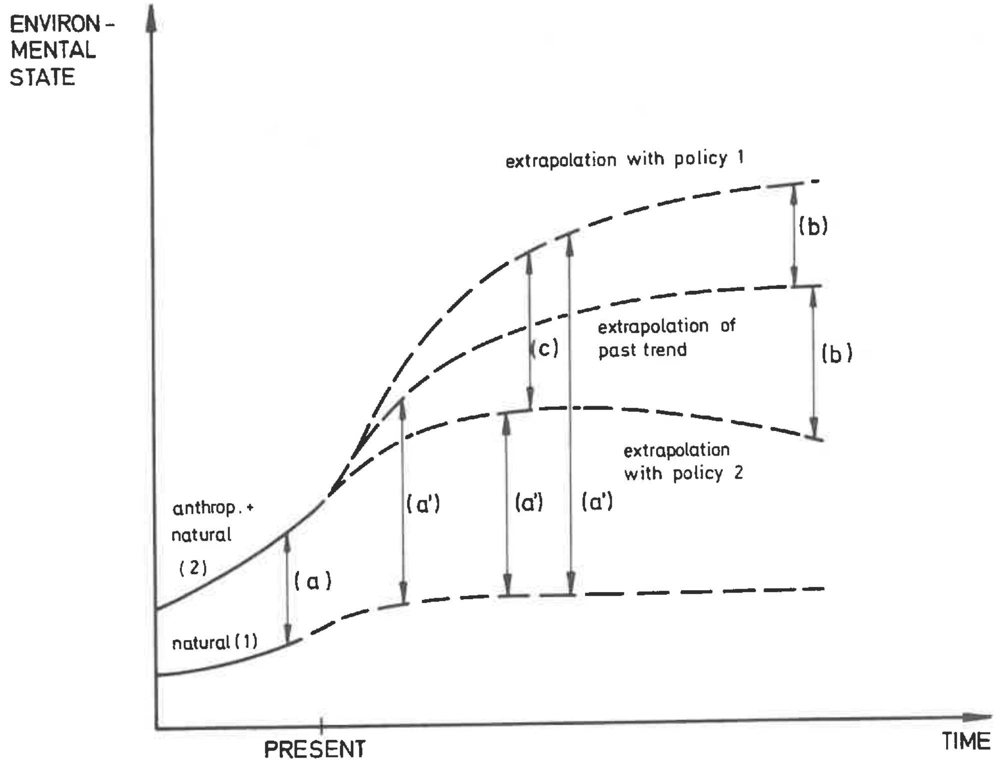


Fig. 1.3 THE ENVIRONMENTAL IMPACT CONCEPT

(a) ANTHROPOGENIC vs. NATURAL

(a') ANTHROPOGENIC vs. NATURAL extrapolated into the future

(b) PAST TREND vs. POLICY-INDUCED CHANGE

(c) DIFFERENCE BETWEEN ALTERNATIVE POLICIES

(i) We must be clear about what we want to observe. In the simplest case one can express a set of observables as state variables (e.g. CO_2 concentration in air, number of cows in Germany, or the intensity of natural radioactivity). More frequently, however, relevant characteristics of a system are more complex and have to be expressed as indicators (e.g., "quality of life" as a function of individual mobility, material standard of living, life expectation, etc). Usually such indicators are given in quantitative terms as some combination of state variables which are assumed to be indicative of the characteristics (e.g., mobility = f(cars/capita), material standard of living = f(GNP/capita, etc.).

We believe that no combination of state variables or indicators is powerful enough to tell us where a system is going if the essential structural relationships behind them are not seen. Therefore we prefer to derive indicators by complexity reduction from dynamic models (see also Fig. 1.6).

Therefore, in Fig. 1.3 "environmental state" means either a state variable or an indicator derived from an environment model. Thus "environmental state" can be either a parametric or a structural measure.

(ii) Terms of reference are needed as a basis for comparison. Here it is useful to distinguish three cases:

curve (1) - The "natural" state (unperturbed by Man) is known or can be inferred with sufficient precision.
Example: Natural levels of radioactivity.

curve (2) - Environmental state as unperturbed by Man cannot be determined or is of no interest, but the combination of Man and Nature can be.
Example: The number of cows in Germany.

The third case, which is the most relevant one for long-term planning or forecasting, is an in-between of the first two: for the past, the present, and the near future the "natural" state can be determined, but not for the more distant future, because the structural relationships of Man's interaction with Nature are not well enough understood.

Example: CO_2 concentration in the atmosphere. We know how it has increased from pre-industrial times until now, but we do not know how the burning of fossile fuels, the intensification of agriculture, the pollution of the oceans etc. might affect total biomass and the global CO_2-cycle.

(iii) Environmental impact is then the difference between the reference situation and that of some alternative development. Here several cases seem important for analysis:

(a) For "ex post" analyses the difference between curves (1) and (2) measures the impact of Man on Nature. Not indicated in Fig. 1.3 is the possibility of comparing different past developments in similar systems that were impacted upon in different ways, e.g., similar soils that were used with different agricultural technology ("case study" approach).

(a') If curves (1) and (2) can be extrapolated with some confidence over the time span of interest, then their difference can be used as a reliable measure of impact. This is then also true for the analysis of policy alternatives as indicated in the diagram.

(b) The difference between trend extrapolation ("standard run") and the development under some policy is an important measure of impact that can be used even if the "natural" state cannot be inferred.

(c) The direct difference between the outcomes of two policies is perhaps the most useful measure of impact for two reasons: Like definition (b) it does not require knowledge about unperturbed Nature and, secondly, it provides necessary information for a comparative cost-risk-benefit analysis of the two policies.

This brief discussion of the environmental impact concept, however incomplete, illustrates one important point:

Environmental Impact Assessment (EIA) is not an autonomous planning tool. Its full significance unfolds only when used as an input for policy assessment and evaluation. In the following we explain how EIA can be used for this purpose.

Fig. 1.4a illustrates the functional steps and their general sequence in an integrative planning process:

Values, expectations etc., here simply called norms, determine the broader goals set by policy makers. Example:The desire to create for our children and grandchildren a better environment and sufficient resources will make us search for new options in energy policy based, e.g., on solar and geothermal energy as well as on more conservative energy consumption patterns.

Within the policies the planner will consider several strategies that show some promise. Example: An energy policy based on cooperation between oil exporting countries and an oil-based industrialized nation might be attainable by a strategy of heavy investments by the industrial nation for development of large-scale solar energy in the oil exporting nations.

The strategies in turn must be assessed and evaluated as to their feasibility. Here an EIA will help to discover what the environmental consequences of such strategies might be. Of course, all along there are feedbacks to the higher steps, and the search process is strongly iterative, providing for the generation of new alternatives as well as for a discarding of unpromising alternatives.

Example: The comparison of two different investment strategies for

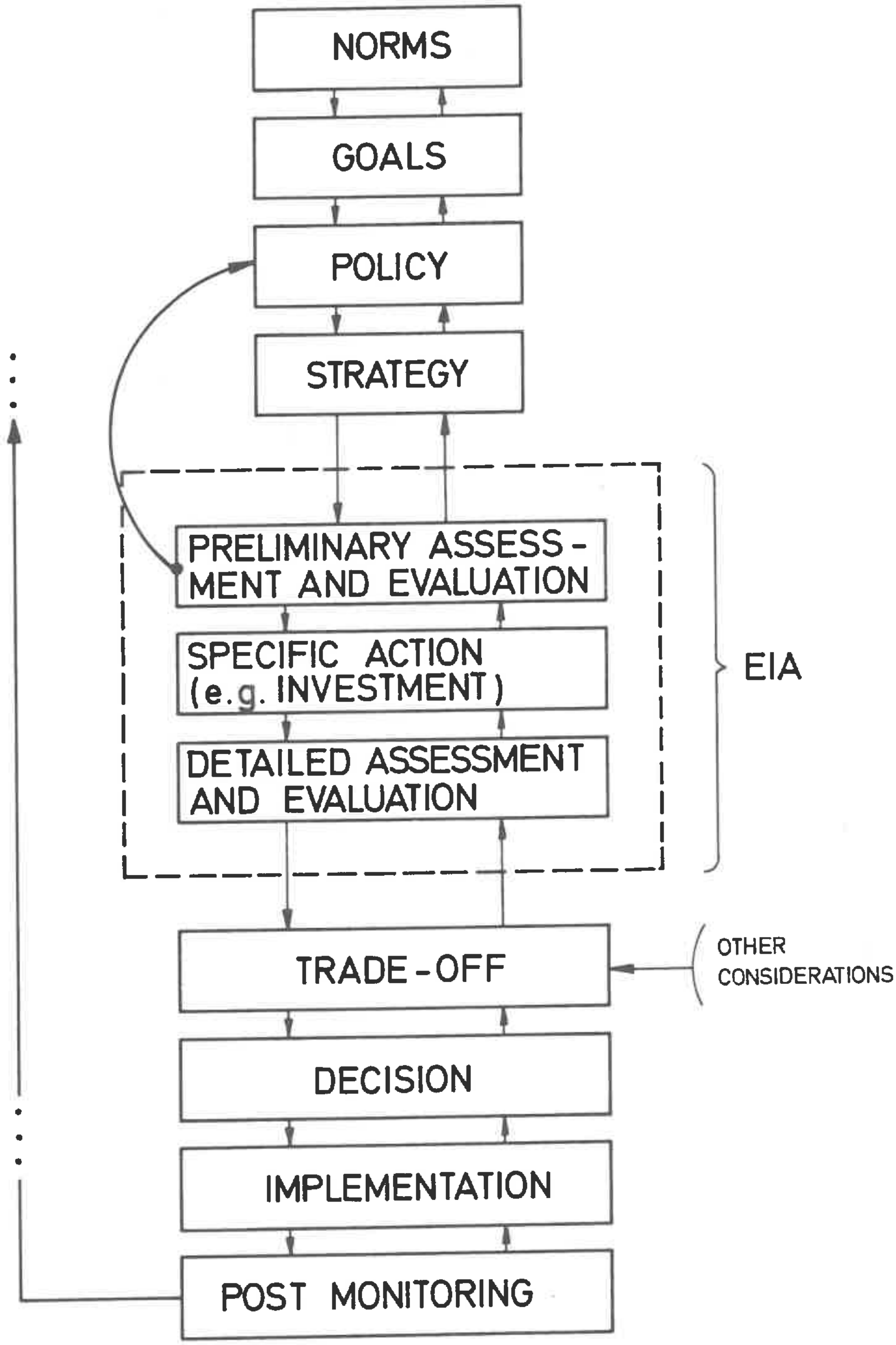


Fig. 1.4a FUNCTIONAL DIAGRAM OF EIA IN AN INTEGRATIVE PLANNING PROCESS

developing new energy sources shows that early massive investment requires less capital than delaying investments to a later point in time, thus allowing the allocation of more money into the development of low-pollution technologies.

Finally a set of thoroughly EI-assessed strategies remain, but which have not been assessed and evaluated from, say, a sociopolitical point of view. These must then be traded off against other issues and interests. Of course, the earlier the more important issues and interests are included in the analysis the greater is the chance of a proposed alternative to "survive" the final trade-off by those who have the mandate of decision.

Finally, a decision is made and implementation begins. The ensuing changes in the system are monitored, thus enabling us to increase our understanding of the environment and to learn how we can more effectively shape the future.

A critical look at Fig.1.4a reveals several problems and weaknesses of a purely functional approach to planning:

(i) The division of labor, the distribution of mandates (power), and the diversity of interests and needs in today's societies are only implicitly recognized. The "mandatory" approach must be included.

(ii) Because of the strong interdependence between the critical issues with which Mankind is confronted, an interdimensional systemic approach is needed. This means that comprehensive policy analysis cannot be decomposed into an issue-by-issue analysis (e.g., first economics, then environment, then energy, then food, etc.) but that a holistic, problem-oriented approach must be taken.

(iii) Finally, each functional step in planning requires a specific methodical approach suited to the specific function to be performed.

In the following we will explain briefly how the above aspects can be brought into a comprehensive planning approach (see also [9]).

To (i): Fig. 1.4b shows a so-called "procedural pathway", which is obtained by plotting each of the functional steps of a process against the corresponding performer(s) or "mandate(s)". One purpose for doing this, e.g., is to identify likely institutional (and other) constraints as well as their corresponding time delays. The following example might serve to illustrate the usefulness of this approach:(1) The press reports on the dangers of heating rivers by additional power plants, which alerts some public groups. (2) These groups demand from Parliament and ministries an investigation of the issue. (3) Power companies, miners' unions etc. activate their lobbies in the ministries to defend their interests. (4) Parliament demands decision aid from the ministries. (5) Before changing energy policy experts have to be consulted. (This step will take place repeatedly before a final policy will be decided upon). (6) A first set of new policies is formulated. (7,7') The proponent of a planned power plant, who belongs to a multinational corporation, applies for concession rights. (8) Environmental protection laws passed by Parliament must be considered in policy evaluation by the ministries. (9) The environmental protection agency brings in new doubts about the set of policies formulated by the ministries. (10) A second multinational corporation is told to lay open the reasons for its latest price increases. (11) The second "multi" finds out about the application of the first "multi". (12) "Multi" No. 2 puts pressure on "multi" No. 1 to modify its application for concession rights. (13) Slowly the

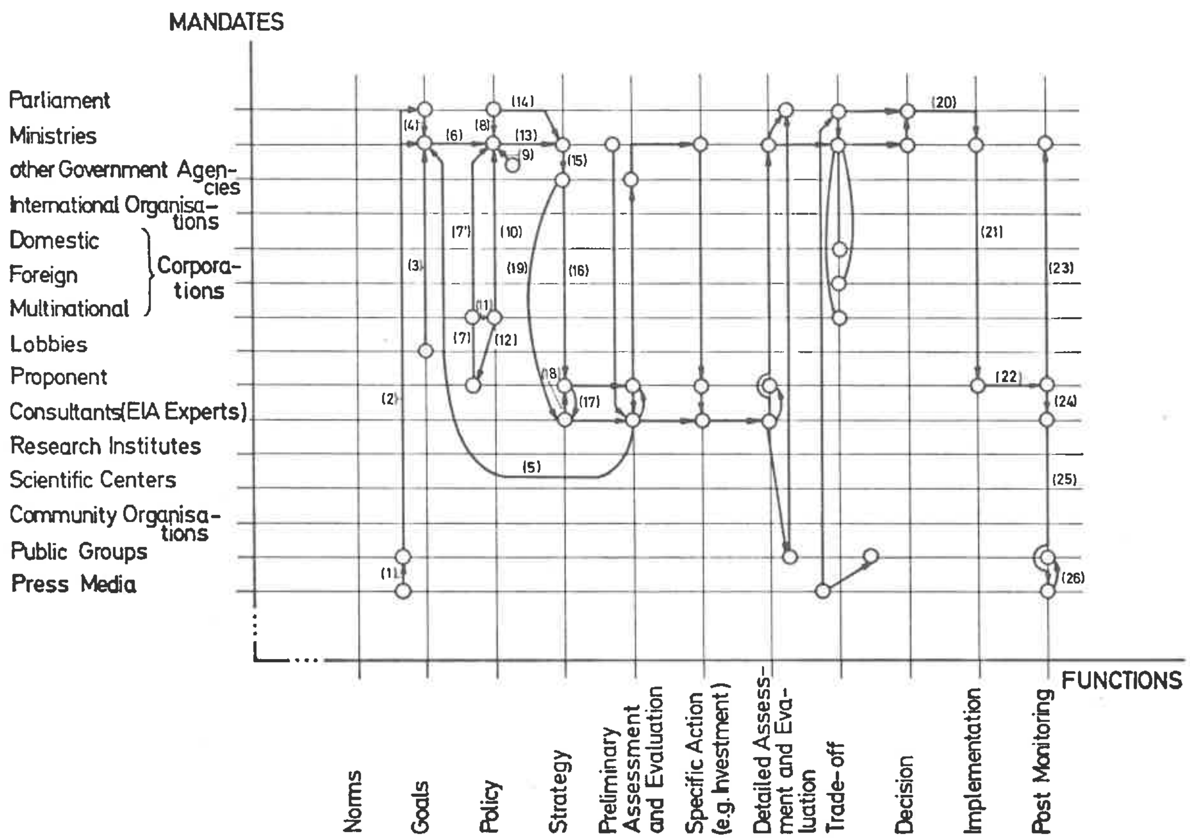


Fig.1.4 b PROCEDURAL DIAGRAM OF EIA IN INTEGRATIVE PLANNING

ministries begin to find specific strategies within each of the energy policies still under consideration. Example: Policy No. 1 might be to decrease oil imports in order to improve balance of payments. A strategy within this policy might be to invest heavily into coal mining and into R& D for coal liquefaction and gasification. (14) Parliament wants a study from the Ministry for Research and Technology on power plants. (15) This task is delegated to the appropriate government agencies. (16) These agencies ask for information from the power plant proponent. (17) The proponent turns to a consulting office for backing. (18) The consulting office furnishes a favorable expertise. (19) The government agencies also turn to consultants for help, and so on.

The value of going through such a "procedural pathway" should now be clear: Only by explicit recognition of the various interests and mandates involved in each of the steps can we discover the major constraints and time delays that must be overcome. These often influence the course of action more than the most rational arguments could. Therefore a careful analysis of the "procedural pathway" is indispensable for any planner. To complete the example: (20) Finally a decision is made in Parliament to accept an energy policy which meets certain environmental standards. (21) Green light is given for the building of a power plant. (22) The power plant is built. (23, 24) The ministries and EIA-experts monitor the operation of the plant. (25) The press gets new information. (26) The public gets informed about the energy situation development, and the "cycle" is complete (26→1).

The previous example was on a subnational level of detail. Of course, the same principle holds on a global-regional level.

To (ii): The systemic approach taken in the World Modeling Project has been reported elsewhere [60] . Fig. 1.4c shows the structure of the M-P World Model. Its modular character is ideal for analysing complex multi-issue situations. Note also that the hierarchy of Fig. 1.1 is reflected here. We also want to point out that the "dialog mode" is very well adapted to the functional steps in comprehensive planning, as a comparison of Figs. 1.4a and 1.4d makes clear. Moreover, since we apply the scenario approach to our dialog mode analysis, the erroneous results of issue-by-issue analysis can be avoided. Finally, "mandatory pathway" analysis can be performed by a "multi-group dialog mode" as illustrated in Fig. 1.4e. In [76] a description of the software developed for flexible multi-issue, multi-group scenario analysis with the M-P World Model is given.

To (iii): Of course we are not limited in our analysis to the methods of simulation modeling and scenario-writing, but rather can make use of many different available methods in the various functional steps shown in Fig. 1.4a. In the following list some examples are given:

Step	Useful methods
Norms, Goals	polls, ex post case studies, simulation of value control and value change
Policy, Strategy	contingency analysis, scenario analysis, policy Delphi
EIA	simulation, cross-impact, cost-risk-benefit, System Dynamics
Trade-off (between issues, interests, goals on different levels	Delphi, brainstorming, multigroup dialog mode, dynamic programming, Gaming

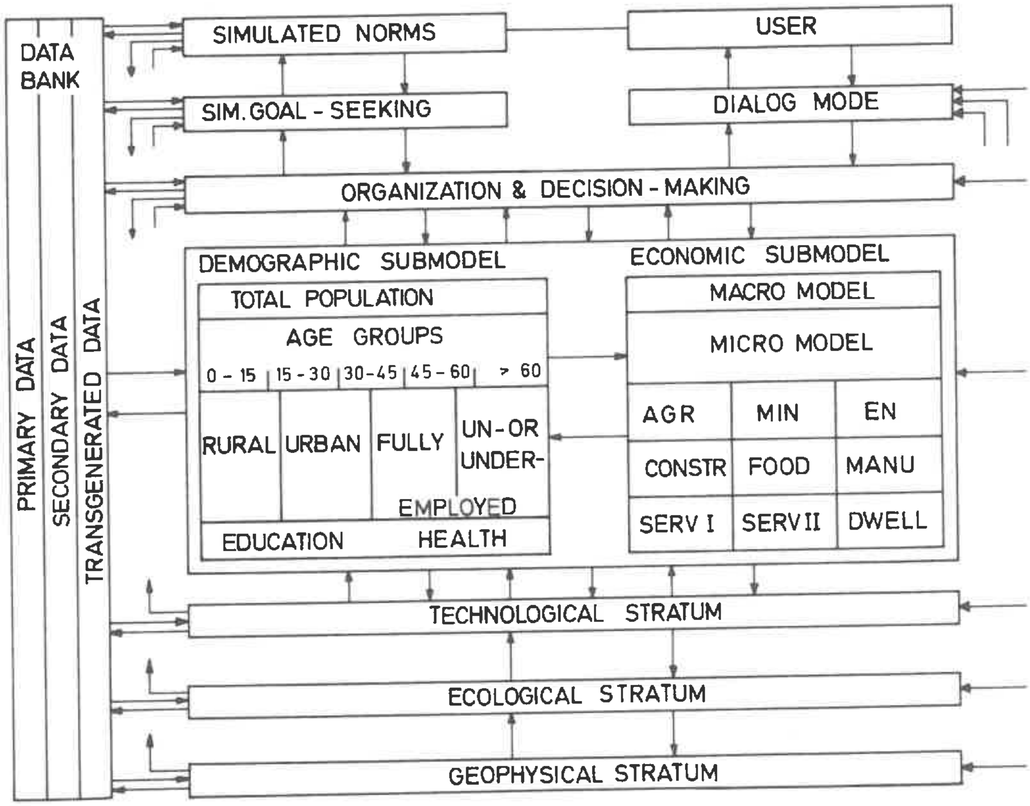


Fig. 1.4 c STRUCTURE OF THE M-P WORLD MODEL

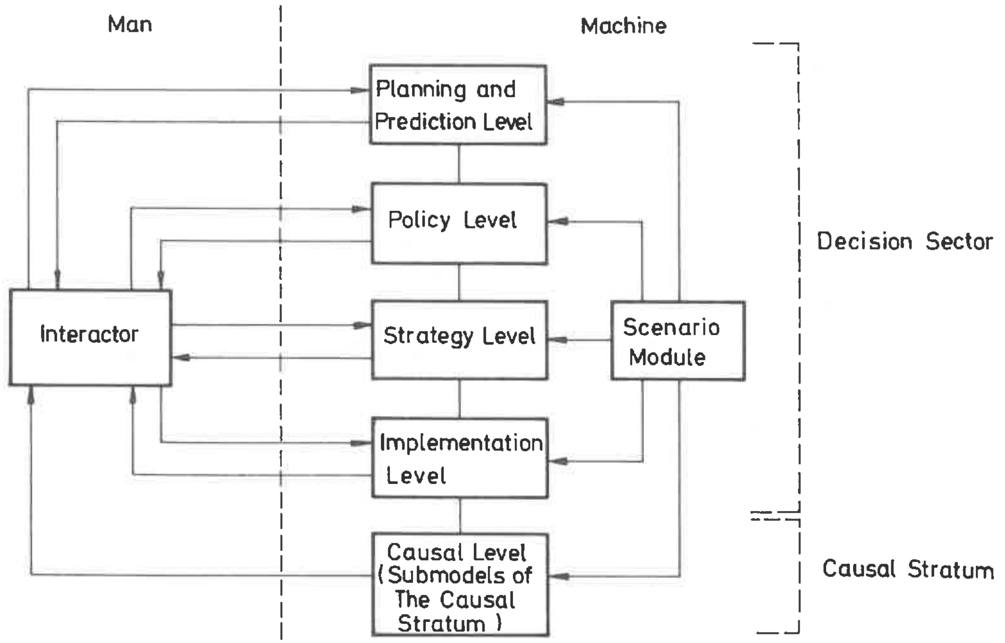


Fig. 1.4 d A Dialog Mode Which Accounts for Functional and Issuedependent Aspects of Planning

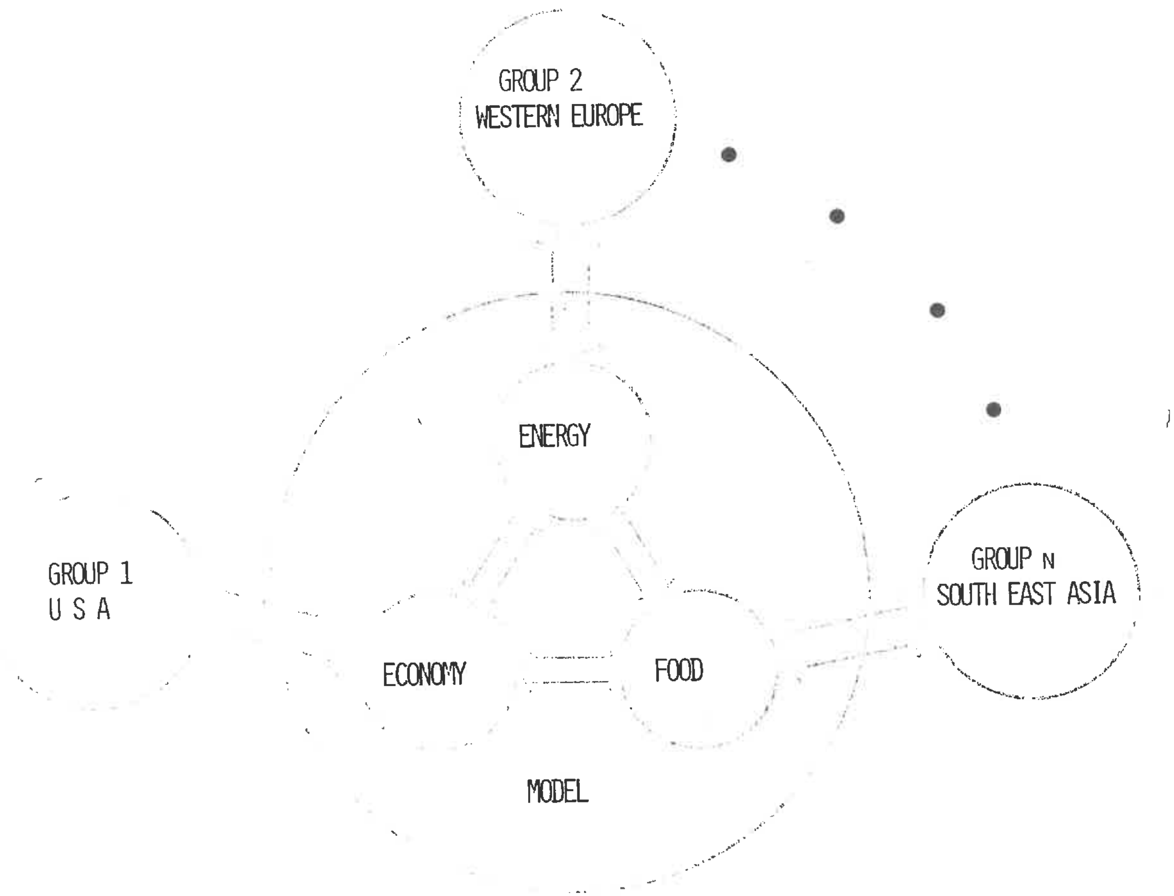


FIG. 1.4 E THE "MULTIGROUP DIALOG MODE"

Step	Useful methods
Decision	participative democracy, PPB
Implementation	acquisition, recruitment, and contract strategies
Post monitoring	statistical documentation and evaluation, cost-risk-benefit, gap analysis, contingency analysis

Here we owe an explanation to those readers who might feel that we have unduly digressed from the issue of environmental impact. We had several reasons for this:

(i) EIA is too difficult a problem for us to tackle alone. Therefore, we must acquaint ourselves with the ways of thinking and the interests of those whose cooperation we seek. We want to reach the decision makers, work with people from other disciplines, and invite public participation.

(ii) If our work is not to remain an academic exercise, we must come up with policy recommendations which find the support of many very different people, groups, and nations. The psychological barriers, though, will be unsurmountable if we do not learn to see others' interests and needs, to appreciate their approaches to the problems, and to recognize the specific roles they want to hold.

1.2 A Specific Scenario for Environmental Impact from Energy Use

The problems addressed in the energy policy scenarios described in the Energy Report [8] are on a regional level. It was therefore reasonable for us to start by asking on a regional scale what emissions would be produced as a result of these policies, what could be done to reduce the emission levels, and how high the abatement costs would be.

Fig. 1.5a shows the basic set-up for a dynamic energy emissions register (EER): The economic levels of activity determine the energy production needed for upholding this activity. The total energy production then is covered by a split of i primary energy sources which are used in j technologies. Each of these produce different amounts of k types of emissions (yielding an emissions matrix e_{ijk}) which can be summed, thus giving an emissions spectrum E_k that goes into the environment. Fig. 1.5b shows this in more detail. E.g., oil is used to produce electric power, the power plants emit CO_x, NO_x, SO_x, aerosols, waste heat etc., and these emissions contribute to the total emissions spectrum.

Obviously this is a completely "passive" scenario from the environmentalist's point of view, because energy policy or economic policy is of prime concern. The EER is attached open-endedly to the energy model as a linear input-throughput-output module, without any feedback to technology, energy,or economics. Also, the question of environmental impact is addressed only implicitly, since there is no accounting of what the emissions do to the environment. With this very simple set-up, however, we can already compute and compare the loading of environment caused by different energy policies.

The next task we set ourselves was to improve the model so that it could be used for trade-off analysis between issues of environment and economy, thus allowing also for "active" scenarios starting from environmental goals and then asking for the economic conditions to meet such goals. For this purpose we have begun with the development of ecological models. The set-up in Fig. 1.5b has now been enlarged by

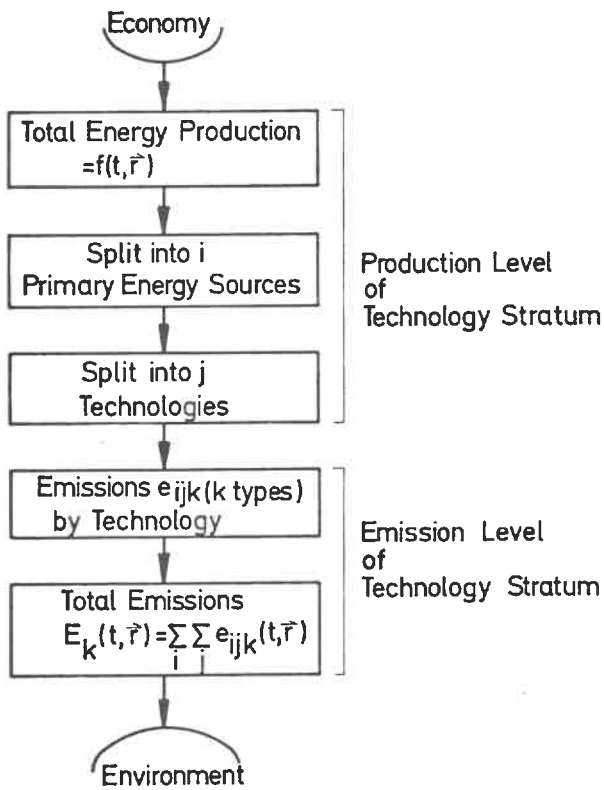


Fig. 1.5a A DYNAMIC EMISSION REGISTER FOR ENERGY PRODUCTION

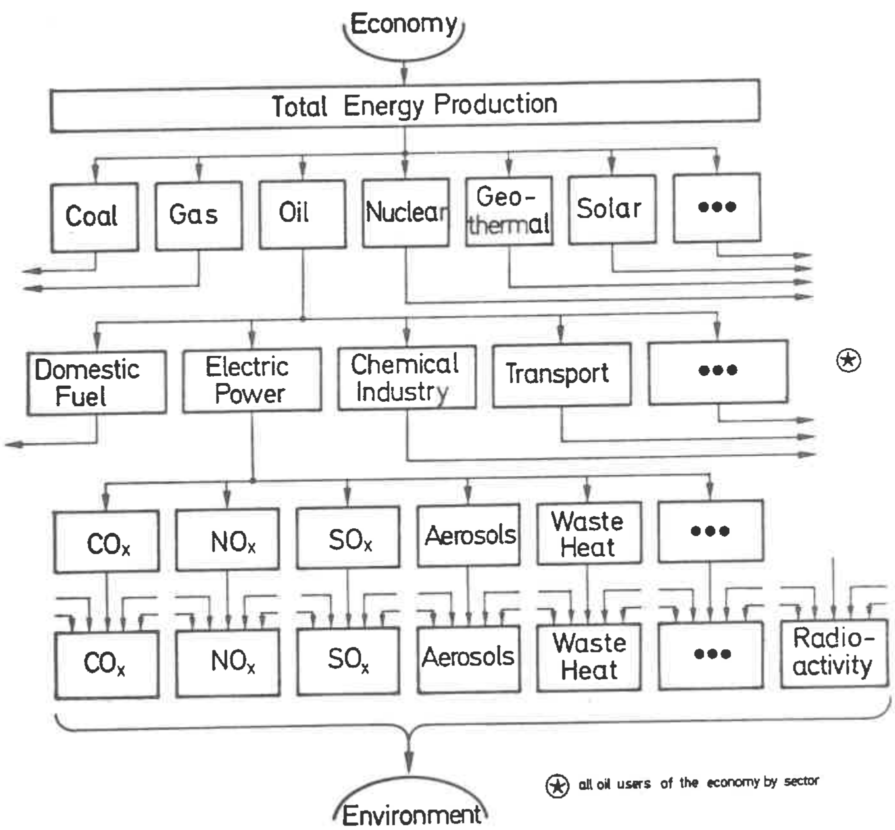


Fig. 1.5b DETAILS OF THE ENERGY EMISSION REGISTER

the scheme shown in Fig. 1.6, which we have already described in 1.1. While much of the knowledge needed to run such "active" scenarios is not yet available, the approach taken here is ideal for "closing in" on the EIA problem. This has a most valuable effect for ecological research: urgently needed investigations are identified, giving clues for R & D policy. Also, new findings in special areas of ecology can be used quickly and meaningfully in a broader context.

Our eventual scenario for environmental impact through human energy use will have the following format:

A. Description of the past and present for

a) energy and environment policy,

b) energy and environment standards,

c) availability of primary energy sources,

d) emissions from fuel production and consumption,

e) emissions distribution,

f) immissions and effects on biosphere,

g) environmental impact in terms of

- specific emission volumes and distributions,
- specific immission concentrations,
- affectability of eco-subsystems (and individual species) by specific immissions,
- stability (viability) of eco-subsystems w.r.t. specific immissions,
- sensitivity of eco-subsystems w.r.t. temporary/persistent immission loading,
- loadability and regenerability of ecosystems,

h) trade-off constraints from other issues.

This part of the scenario serves as a basis for part

B. Future alternatives

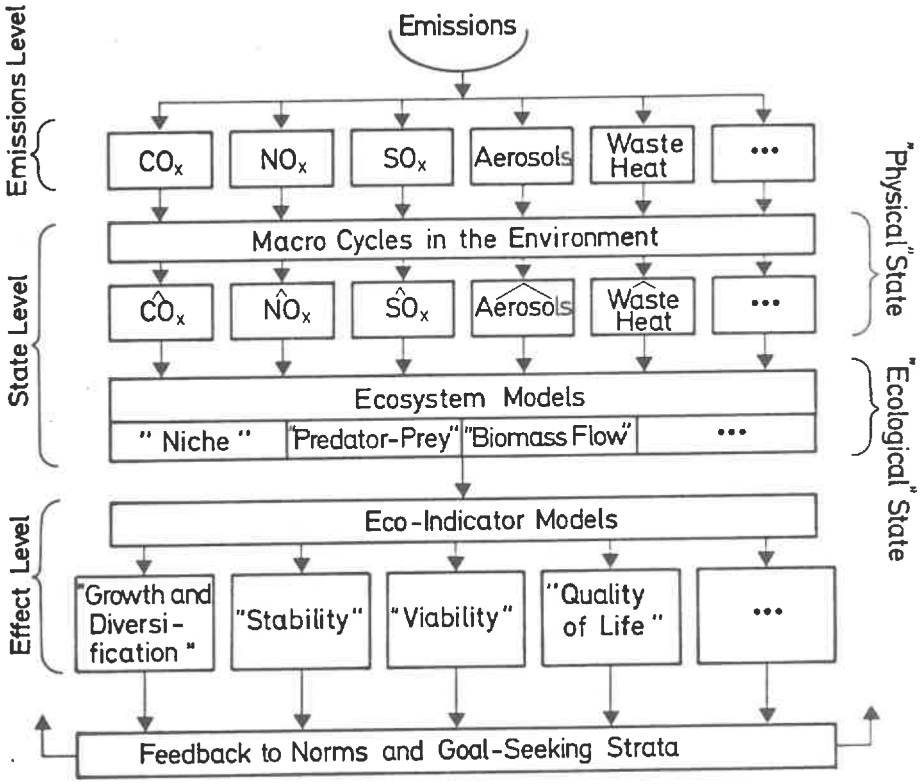


Fig. 1.6 COMPUTATIONAL PROCEDURE FOR DETERMINING AND ASSESSING ENVIRONMENTAL IMPACT

Again a) through h) are at the focus of concern, but here the weight is less on description and more on exploration, goals,and evaluation. A "river bed" analysis leads to the more likely paths of development, while an appraisal of the costs, benefits, and risks of alternative policies points to the more desirable options. These are then summarized in part

C. First concrete policy recommendations

For the more promising policies data are gathered;then they must be translated into computer programs and dialog modes, so that they can be tested in simulation runs. Here the verbal "input scenario", which is based mainly on the qualitative understanding of the scenario-writer, is used to prepare a scenario-oriented simulation model, which in turn produces a mainly quantitative "output scenario" of future alternative developments.

It is not entirely obvious why we started with an energy emissions register or an industrial production pollution register. Our choice can be justified by the following points:

(i) economic-industrial activity correlates with and is limited by energy use (see Fig. 1.7)

(ii) total industrial impact on environment correlates with impact of energy use on environment

(iii) energy impact constitutes a large share of total impact

(iv) energy impact will rapidly become dangerous as energy use increases (e.g. through the cumulative effects of CO_x).

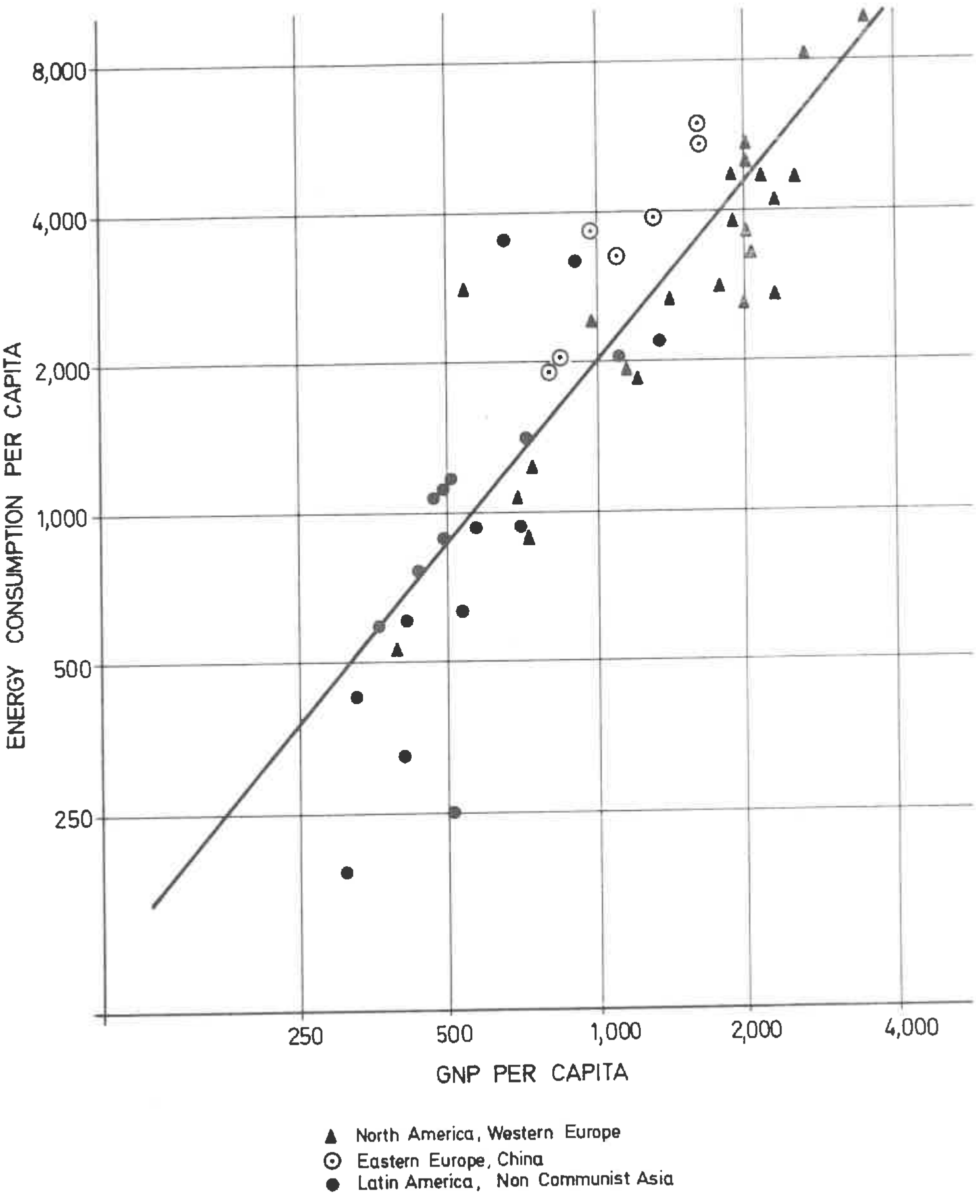


Fig. 1.7 GNP and energy consumption

(v) New forms of energy will be necessary for upholding and expanding economy. In choosing among the available options society might dangerously follow a path of least economic resistance, but the less costly energy forms might turn out to be more hazardous. The choices made will have far-reaching consequences.

(vi) Energy has been and will continue to be a critical issue in world relationships, e.g. because suppliers and consumers are far apart (Fig. 1.8). Also, energy policy decisively influences longterm national and bloc policy, e.g. independence vs cooperation. Environmental considerations will increasingly affect such policies.
Example: Japan is beginning to realize that its export-oriented economy also meant import of pollution. It is now transferring production to South East Asian countries.

(vii) The investments for future energy are so tremendous that the choice for one energy form vs. the other (e.g., nuclear vs. solar) constitutes a binding long-term committment. Such committments, however, must be made now and will foreclose other options for generations to come. Neglect of environmental factors in making a choice may well lead to disaster.

(viii) The emissions caused by energy use have ecological limits that will be approached rapidly if drastic pollution abatement is not introduced soon. One has to keep in mind, though, that some emission types such as waste heat cannot be reduced to arbitrary levels, and the reduction of most others is costly and energy-consuming (Fig. 1.9).

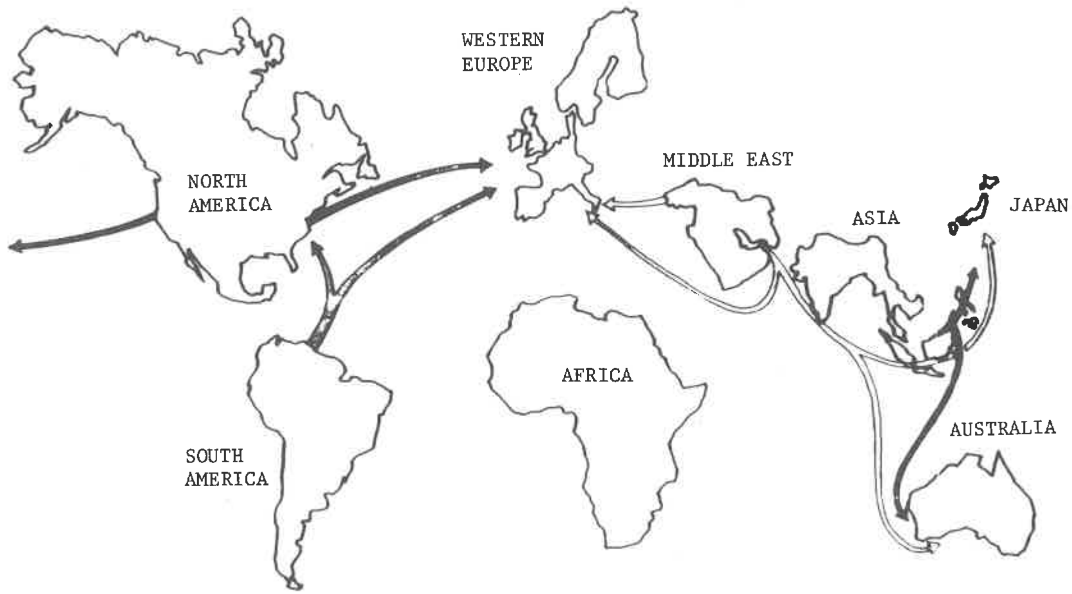


FIG. 1.8 A MAJOR INTERNATIONAL OIL MOVEMENTS - PRE-WORLD WAR II

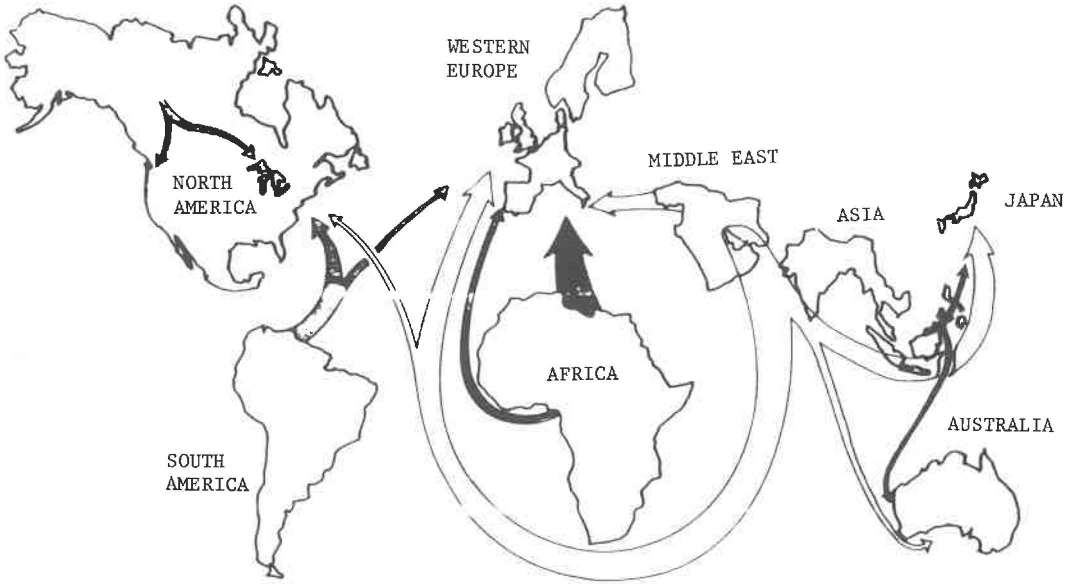


FIG. 1.8 B MAJOR INTERNATIONAL OIL MOVEMENTS - CURRENT

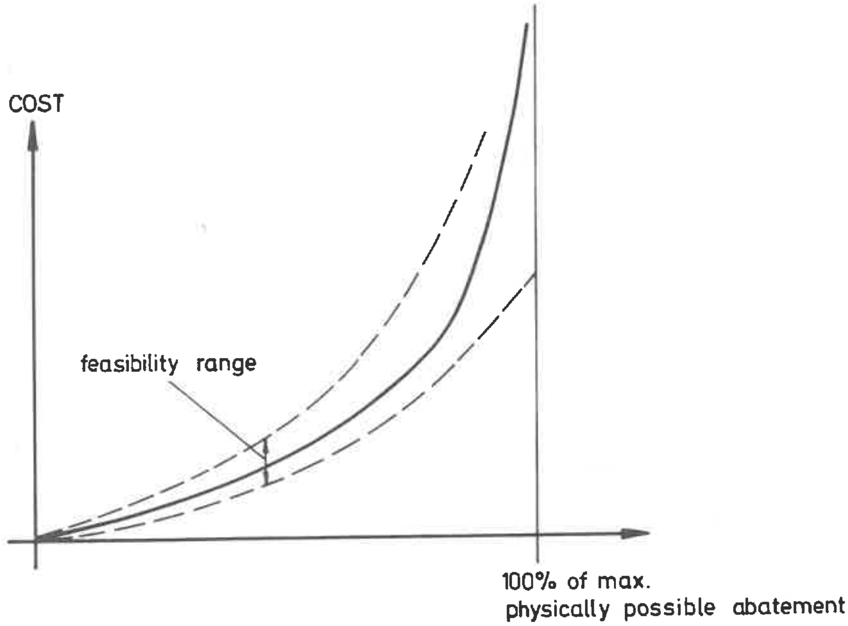


Fig. 1.9 POLLUTION - ABATEMENT COST FUNCTION

(ix) Even with a more efficient use of energy and a reduced demand per capita in today's industrialized countries, the increasing population will multiply world energy demand. (Thus one arrives at a factor of 30, assuming that world population stabilizes at 10 billion, that average per capita consumption climbs by a factor of 3 - to one half of todays' U.S. average -, and that more energy-consuming resource extraction contributes a factor of 4. Pure extrapolation of past trend yields a factor of 100 in slightly more than 50 years.). Thus even a moderate material standard of living will require vast amounts of energy, and this again raises the question of ecological carrying capacity and its effects on future ways of life.

1.3 Underlying Assumptions

(i) The scenarios of the Energy Supply Planning Report adequately describe some of the developments in the energy sector intended by today's decision makers of Regions 1, 2, and 7. The quality of these scenarios will improve after these regions have been coupled on-line, but off-line trade-off analysis is already possible. Therefore, the attachment of the energy emission register to the energy model is meaningful.

(ii) Most of the scenarios are conservative in the sense that only present-day energy production types are considered. Where other types have been included, no infrastructural change as required e.g. by a solar-energy-based hydrogen economy has been accounted for. Present research done in the Project deals with this issue and will prepare for more realistic scenarios.

(iii) Immission intensities and their effects correlate with the corresponding emission levels. Therefore, we must first calculate the emission spectrum. Work is under way to develop emission distribution models for critical emission types. Only after completion of this work will we be able to use present knowledge of immission processes and of toxicology to obtain more concrete results about effects in human-ecological subsystems, e.g., in urban and in industrial areas.

(iv) A calculation of the emissions caused by energy use alone is already an important input for pollution control policy, even if no comparison with the total pollution spectrum is made. It may be argued that pollution through toxic chemical wastes from industry, organic materials from agriculture etc. only increases with a corresponding increase of energy consumption in industry, agriculture etc., provided no technological changes take place in these fields.

(v) All emissions are treated separately. Chemical combination between them, synergistic and antagonistic effects are not taken into account (e.g., antagonism of CO_2 and H_2O in global heat balance). It is assumed that such effects can be adequately represented on the state and effect levels (see Fig. 1.6).

2. Model Structure of the Energy Emission Register

2.1 The Planned Energy Emission Model

The emission model can only be viewed in context with the economic, the energy supply, -demand, -use, and -resources models. Also, the ecological level of the total model will eventually have to be included in the considerations of coupling between submodels. Within the hierarchy of the world model the emission model lies between the technological and the ecological levels. In the following we describe the various functions of the submodels involved and their interrelationships.

Total energy demand is given by economic-technological activity and by energy policy goals. Vice versa, bottlenecks in the availability of energy resources affect the activity and structure of economy and the technologies in different sectors of economy. Energy demand depends very much on population development and on the people's expectations concerning quality of life, material standard of living, and on their behaviour patterns of energy consumptions. At present, no explicit sociopolitical control processes are included in the simulation model; this will be possible after the scenario technique has been improved to allow for a multi-group dialog mode (see F. Rechenmann's Dialog Mode Analysis [70]). Fig. 2.1 shows where the emission register will be "inserted" for future sophisticated energy scenarios.

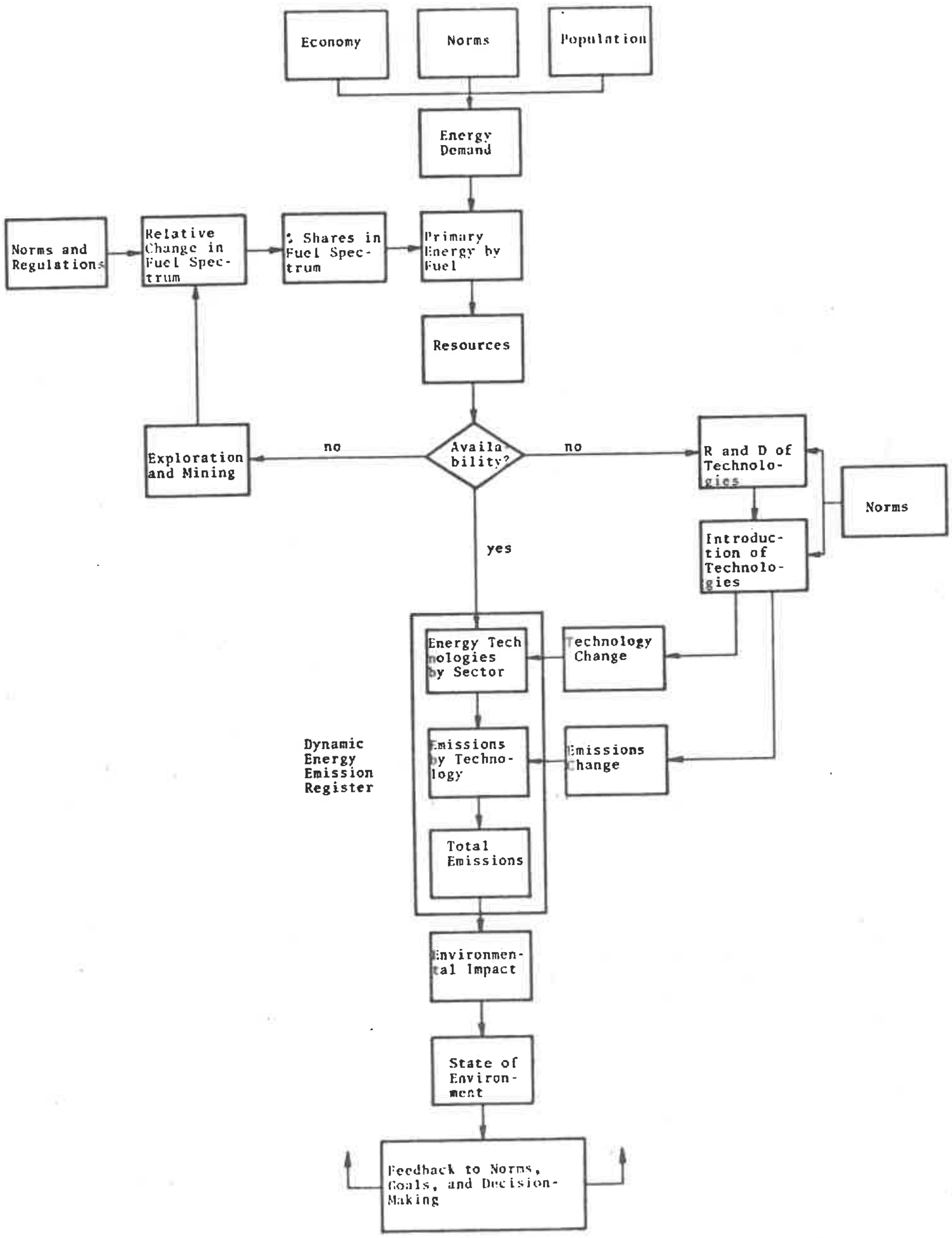


Fig. 2.1
Intended Use of Emission Register
for Energy Scenarios

All the factors listed yield a total energy demand which must be covered by the various types of energy. These energy types have their own, somewhat independent dynamics, which are governed by the following factors:

- Development of demand for a specific energy type and its competitors,
- Supply of energy resources.

The supply dynamics in turn are affected by the inertia of the economic system, by the decision maker's readiness to decide for change, and by the availability of energy resources.

The investigation of energy resources availability in turn has an effect on technological development. The latter is initiated at some point in time and then develops rather autonomously until perturbed (accelerated) by resources scarcity, competing technology, legislation or the like. This innovation process will not be represented in the model, but any particular technology must be included in the simulation if it is expected to mature within the time horizon addressed by the scenario. Both processes, the development of new technology as well as its large-scale introduction into economy, have their own reaction lags and reaction dynamics. These two determine the rate of change in energy technology.

Except for the dynamics described above, the fields of energy technology, technology-specific emissions, and total emissions by type constitute a linear input-output transfer system. Thus the emission register is a (physically) linear model with no dynamics of its own, but it reflects the dynamics described above in its time series output. (Since the costs for emission reduction are computed from nonlinear functions, the model is of course not linear from an economic point of view.)

These emissions go into the environment, where they either decay or are stored in some form or other. Because of the limits of decay rate and of storage capacity first the environment's system state and later perhaps its structure (e.g., extinction of species) changes.
Man, as a part of the natural environment, observes this state, is affected by it, and evaluates it. Sometimes the result of this is a changed attitude in environmental issues. This change in behaviour feeds back into the higher system strata (norms, goals, and decision-making). In this way energy use, economic development, the spectrum of primary energy, the development and introduction of technology etc. are influenced. Through this feedback the long-term dynamics of the system are determined. At present the scenario technique only allows for an off-line feedback. While much of this will remain off-line, the Dialog Mode Analysis (P. Gille, F. Rechenmann [70]) and the Simulation of Value-Controlled Decision-Making (H. Bossel, B. Hughes [10]) will give the decision-maker the option to include some of his assumptions on-line.

2.2 Status Quo of the Emission Register

2.2.1 General features

Two main problems of the energy issue are:

- the supply of primary energy sources
- the emissions resulting from energy transformation and use.

The supply of sufficient energy could be achieved by the development of new technologies: "production" of oil from tar sands and shale, liquification and gasification of coal, solar power generation, fast breeders, fusion reactors etc. Even though most of these energy sources are not yet available on large scale, in principle they could be after intensive R and D. All too often, though, the quest for alternative types of primary energy technology and the investigation of their respective technological and economical spin-offs has not been balanced by an equally intensive analysis of the emission problem. Once it is realized that man's total energy demand must be limited by environmental considerations, one does not only ask by what means energy production is technologically feasible but also how much energy may be produced in total without dangerously loading the environment. Here we describe a program which computes the emissions caused by the dynamics of energy use;it is intended as a decision-aiding instrument which allows the decision-maker to compute emissions as they result from a set of conceived alternative energy policies. This dynamic emission register can also compute the costs for specific emission abatements as a function of required or desired emission abatement standards.

2.2.2 Types of emissions

Emissions may be classified into 2 categories:
such with mainly local (regional) and others with also global impact. The following is an overview over those emissions which perhaps rank highest in their global danger potential and therefore must be included in the spectrum of the EEP:

(i) Waste Heat

Practically all energy transformed by man finally becomes waste heat. Between the time of energy use and its transformation into waste heat there can be a long time delay: e.g., the energy potential in synthetics is transformed into waste heat only after it has been burnt. In this sense every energy problem is also a waste heat problem. By example, in addition to the local problem of heating of rivers through power plants the possibility of global anthropogenic climate modification must be observed. In order to be able to compare the amount of energy set free by man with that of the natural energy cycle, the EEP compares these numbers with the corresponding solar irradiation in the respective region. Note that the simulation model does not yet attempt to address the question of the effects of anthropogenic energy production per se, but rather only quantitively compares man-made energy with solar energy.

(ii) Carbon Dioxyde

All fossile fuels consist mainly of carbon and carbon compounds. One combustion product of these always is carbon dioxyde. The combustion of fossile fuels has already led to a noticeable increase of CO_2 concentration in the atmosphere (at present 0.7 ppm/a).

If only 50 % of the CO_2 produced by combustion of fossile fuels remain in the atmosphere, then the CO_2 concentration will climb from 320 ppm to about 1500 ppm should all our estimated reserves be burnt [63].

This increase in concentration by itself is likely to have signigicant effects on climate. It tends to increase the temperature of the troposphere (green-house effect).

Various model computations indicate that a doubling of CO_2 concentration will lead to an increase in average temperature of about 2^oC [6] . Although in the last years a decline in temperature has been observed (Perhaps due to aerosols), the green-house effect may not be neglected in the long term.

An increase in CO_2 concentration, however, also positively effects the amount of biomass flow. This might be a positive aspect from the point of food production.

(iii) Aerosols

The emitted aerosols' diameters range from 10^{-6} to 10^{-2} cm. Of importance for the global energy balance is the range from 0.5 μm to 10 μm [28] . The aerosols around 0.5 μm have a cooling effect. The global albedo is estimated to have increased through these aerosols by about 1.5 % [28] This could explain the global cooling observed in the past years, since particle emission has increased up to 50 % in the Northern Hemisphere. Another main cause for this, besides the burning of fossile fuels, are the huge savannah fires laid by man which extend over several million km^2 [28]

(iv) Radio-Active Waste

Contrary to the effects of fossile fuel emissions, nuclear energy waste is not so much a global geophysical problem but more a safety problem. Only if this waste is not stored safely there definitely will be great danger for the biosphere. Therefore here the central question is: Can one safely allow the accumulation of vast amounts of radioactive waste, which are generated during the operation of reactors, can it be guaranted that this waste will be safely stored over a time span of several generations, and can misuse be excluded?

In the EEP we should distinguish between three waste categories:

- radio-active waste and emissions during reactor operation,
- waste and emissions through preparation and recycling of fission fuel,
- contamination of the reactor site and of the fuel production site after shut-down.

At present we only have data for the first two types, while the third will become acute when the first generation of nuclear power plants has to be shut down.
The EEP will eventually contribute to the clarification of the problems of radio-active waste and its storage. Hopefully our first computations will help a little to lead the discussion of nuclear energy back to a balanced investigation of environmental impact including the external nuclear fuel cycles, which contribute much more seriously to total impact than irradiation and emission during reactor operation.

2.2.3 Description of EEP

Four steps are involved in the computations of the emission register. First all emissions are computed individually, with energy as input data and emissions as output. Using the abbreviations of the program (viz. Section 2.3), the equations for the fossile fuels are

$$\bar{Z}\,\bar{Y}\,\bar{X} = E\,\bar{X}\,F\,\bar{Y} * F\,\bar{Z}\,\bar{Y}\,\bar{X},$$

and for nuclear energy

$$RADU = ENUC * FRADU,$$
$$RADP = ENUC * FRADP,$$
$$RADF = ENUC * FRADF.$$

These individual emissions are then added according to different schemes:

(i) Emissions by energy type

An important aspect of the emissions problem is to know the total emission load coming from an individual primary energy type. Comparison between the different types will then give us an indication of their relative contributions to the total load on environment. For the six emission types accounted for the separate emissions are summed over the five sectors:

$$\overline{Z}\,\overline{X}\,F = \sum_{j=1}^{5} \overline{Z}\,\overline{Y}_j\overline{X} .$$

By comparing these magnitudes for different simulation runs with different demand/supply scenarios we get a basis for discussion of the relative hazard of these primary energy types.

(ii) Emissions by technology

The EEP simulation program also allows the computation of emissions specific to various technologies (sectors). In addition to knowing how much each primary energy type contributes it is extremely important to know how much is emitted from each of the five user sectors. For this we have to sum over the primary energy types:

$$\overline{Z}\,\overline{Y} = \sum_{i=1}^{3} \overline{Z}\,\overline{Y}\,\overline{X}_i .$$

The feasibility of emission reduction, its cost, and its success vary considerably from one technology to another. Thus the summation of emissions by technology (sector) is necessary for a trade-off cost-benefit analysis of alternative emission reduction policies.

(iii) Total emissions

The sum of all emissions is given by

$$\overline{Z}TOT = \sum_{j=1}^{5} \overline{Z}\,\overline{Y}_j \;.$$

Here it makes no difference from which energy source or from which sector the emissions come.

(iv) Accumulated total emissions

In the scenarios played through for this report the emissions are accumulated over time. This is done separately for the different energy types, technologies, and for total emissions:

$$S\overline{Z}\,\overline{Y} = \sum_{1}^{t} \overline{Z}\,\overline{Y} \,,$$

$$S\overline{Z}\,\overline{X} = \sum_{1}^{t} \overline{Z}\,\overline{X} \,,$$

$$S\overline{Z} = \sum_{1}^{t} \overline{Z}TOT \,,$$

$$TR\overline{Z} = \sum_{j=1}^{5} (1-R\overline{Z}\overline{Y}_j) * \overline{Z}\,\overline{Y}_j$$

$$TG\overline{Z} = \sum_{j=1}^{5} FG\overline{Z}\overline{Y}_j * \overline{Z}\,\overline{Y}_j$$

$$SRAU = \sum_{1}^{t} RAOU$$

$$SRAP = \sum_{1}^{t} RAOP$$

$$SRAF = \sum_{1}^{t} RAOF$$

$$SR\bar{Z} = \sum_{1}^{t} TR\bar{Z}$$

$$SG\bar{Z} = \sum_{1}^{t} TG\bar{Z}$$

2.2.4 Description of the input variables

The input into the EEP consists of two parts:

- energy data from the ESP program,
- specific emission data.

By directly coupling the EEP to the ESP program the emissions corresponding to any energy scenario run in the ESP program can be computed. Conversely, however, several emission scenarios can be run for a single energy scenario.

The following data are inputed from ESP into EEP:

- energy amounts of the three fossile primary energy types:

solid
liquid } fuels in the following user sectors:
gaseous

electrical power generation,
heat plants,
transportation,
industry,
residential/commercial;

- nuclear energy;
- total useful energy;
- waste heat;
- total energy.

For the computation of the emissions we need the following additional data:

- specific emissions for the different primary energy types and sectors,
- degree of specific emission reduction and the corresponding cost.

2.3 Variables and Definitions

The variables used in the EEP program are listed here as vectors:

$\bar{X}$ = fossile primary energy sources (i types);

$\bar{X}$ = (S, L, G),

S = solid fuels,

L = liquid fuels,

G = gaseous fuels.

$\bar{Y}$ = user sectors (j sectors);

$\bar{Y}$ = (E, H, T, I, R),

E = electrical power generation,

H = central heat plants,

T = transportation,

I = industry,

R = residential, commercial.

$\bar{Z}$ = emissions (k types);

$\bar{Z}$ = (COM, CO2, SO2, CHX, XNO, AEO),

COM = carbon monoxide,

CO2 = carbon dioxide,

SO2 = sulphur dioxide,

CHX = hydrocarbons,

XNO = nitrogen oxides,

AEO = aerosols.

With these vector abbreviations the variables for fossile primary energy are

$F\bar{Z}\bar{Y}\bar{X}$ = specific emission coefficients (by type of energy, sector, and emission),

$E\bar{X}F\bar{Y}$ = energy source (by type of energy and sector),

$\bar{Z}\bar{Y}\bar{X}$ = emissions (by type of energy, sector, and emission),

$\bar{Z}\bar{X}F$ = emissions, summed over energy types,

$\bar{Z}\bar{Y}$ = emissions, summed over sectors,

$\bar{Z}TOT$ = total emissions, by energy type,

$S\bar{Z}\bar{Y}$ = accumulated total emissions, by sector,

$S\bar{Z}$ = accumulated total emissions,

$FG\bar{Z}\bar{Y}$ = relative emission reduction cost,

$G\bar{Z}\bar{Y}$ = emission reduction cost,

$G\bar{Z}$ = reduction cost, by emission type,

$TG\bar{Z}$ = total reduction cost,

$SG\bar{Z}$ = accumulated reduction cost, by energy type,

$R\bar{Z}\bar{Y}$ = degree of reduction,

$\bar{Z}R\bar{Y}$ = remaining emissions after reduction,

$SR\bar{Z}$ = accumulated emissions after reduction.

For nuclear energy we have

ENUC = nuclear energy,

FRADU = relative radioactive emissions during reactor operation,

FRADP = relative radioactive emissions and waste from fuel production and recycling,

FRADF = relative radioactive emissions and waste from shut-down reactors and fuel plants.

RADU = radioactive emissions during reactor operation,

RADP = radioactive emissions and waste from fuel production and recycling,

RADF = radioactive emissions and waste from shut-down reactors and fuel plants.

For fossile and nuclear energy we have

E U S E	=	total useful energy,
E W A S T	=	waste heat,
E T O T	=	total energy.

2.4 Block Diagrams and Equations of ER

Fig. 2.4.1 Emissions of solid fuel

Fig. 2.4.2 Emissions of liquid fuel

Fig. 2.4.3 Emissions of gaseous fuel

Fig. 2.4.4 Emissions of electric power generation

Fig. 2.4.5 Emissions of central heat plants

Fig. 2.4.6 Emissions of transportation

Fig. 2.4.7 Emissions of industry

Fig. 2.4.8 Emissions of residential/commercial

Fig. 2.4.9 Total emissions of CO and CO_2

Fig. 2.4.10 Total emissions of SO_2 and CH_x

Fig. 2.4.11 Total emissions of NO_x and AEO

Fig. 2.4.12 Accumulation of emissions

Fig. 2.4.13 Reduction of SO_2 emission

Fig. 2.4.14 Reduction of AEO emission

Fig. 2.4.15 Radioactive emissions

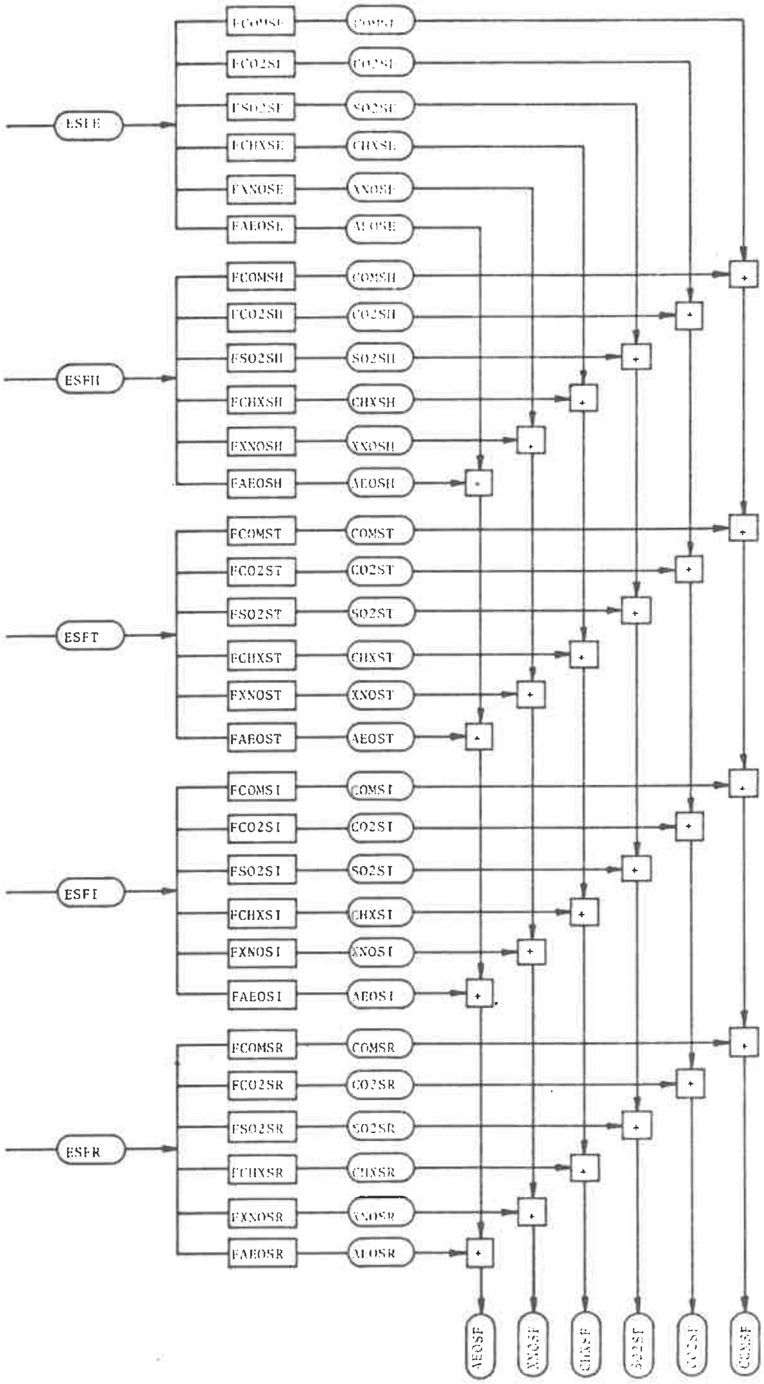


Fig. 2.4.1

Emissions of solid fuel

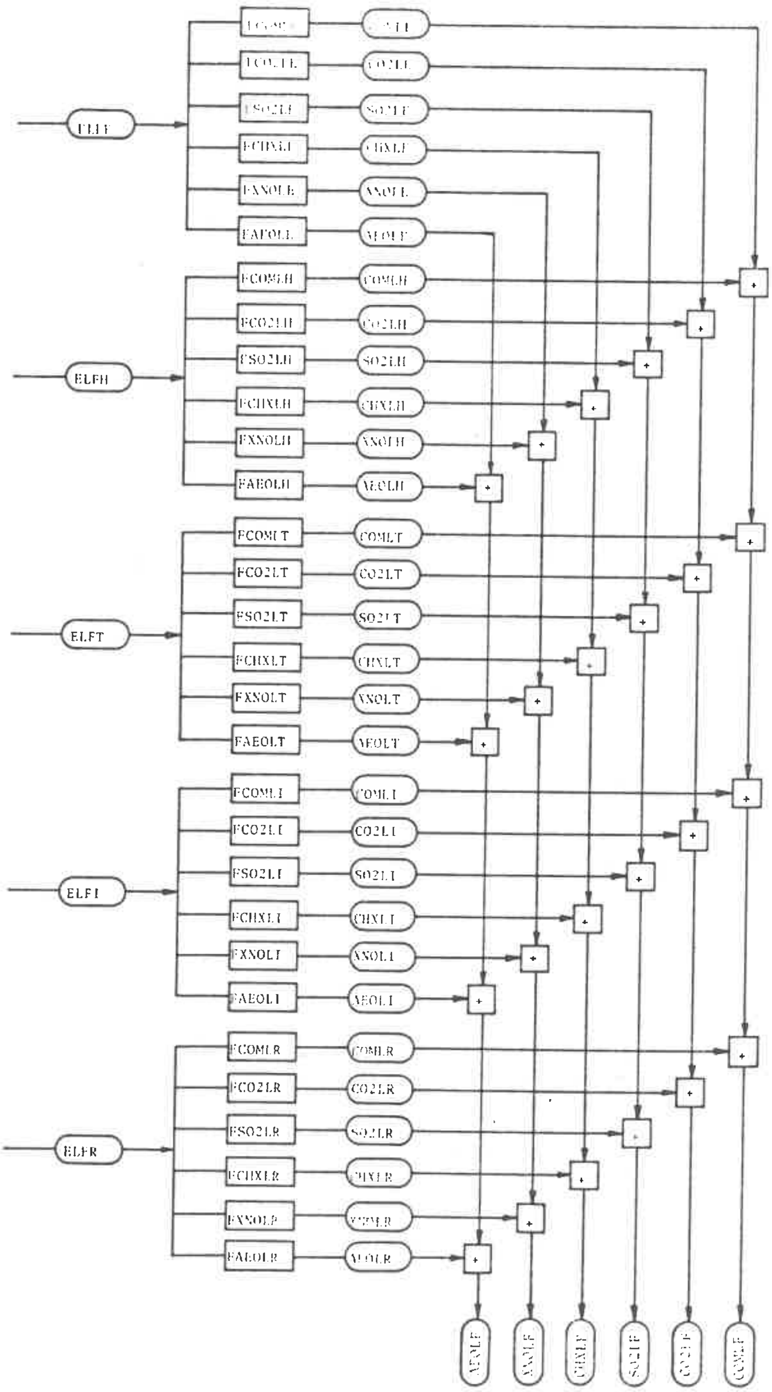


Fig. 2.4.2

Emissions of liquid fuel

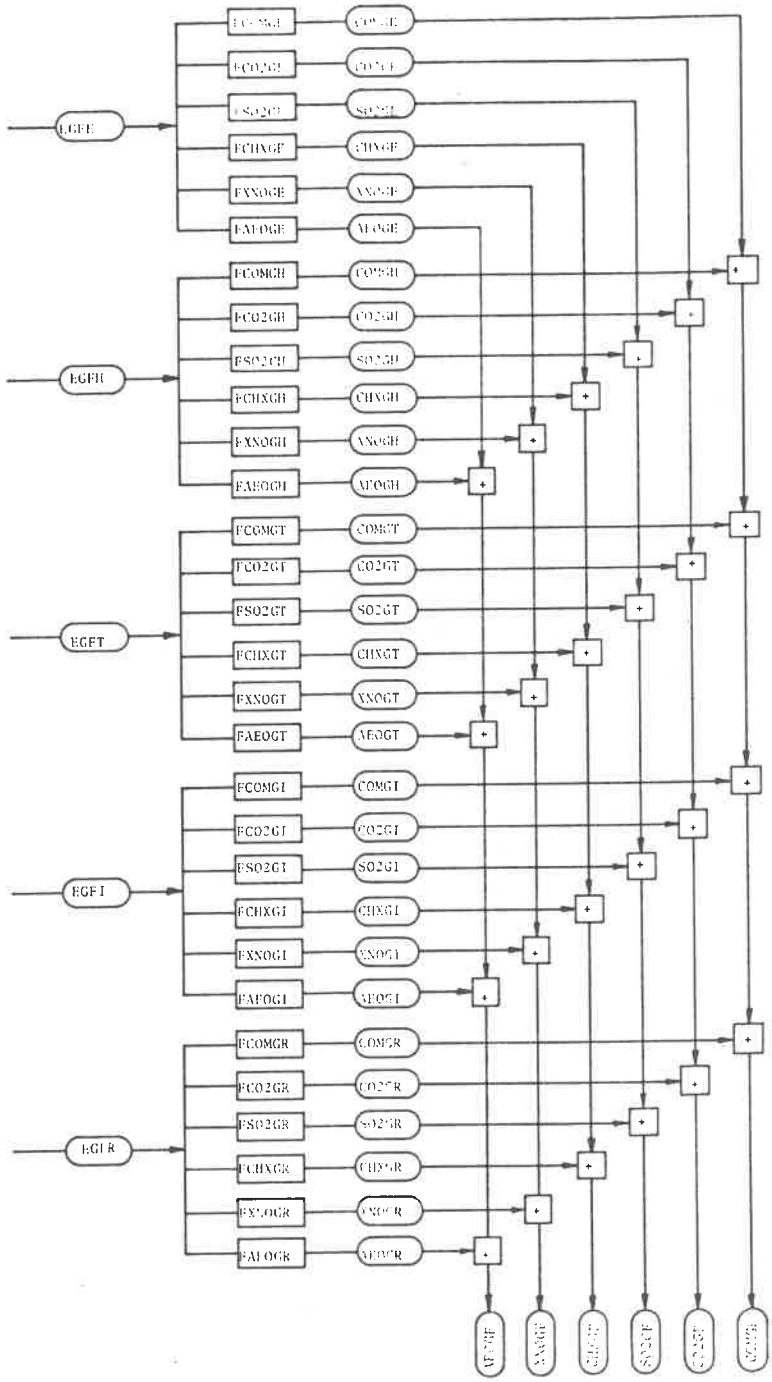


Fig. 2.4.3

Emissions of gaseous fuel

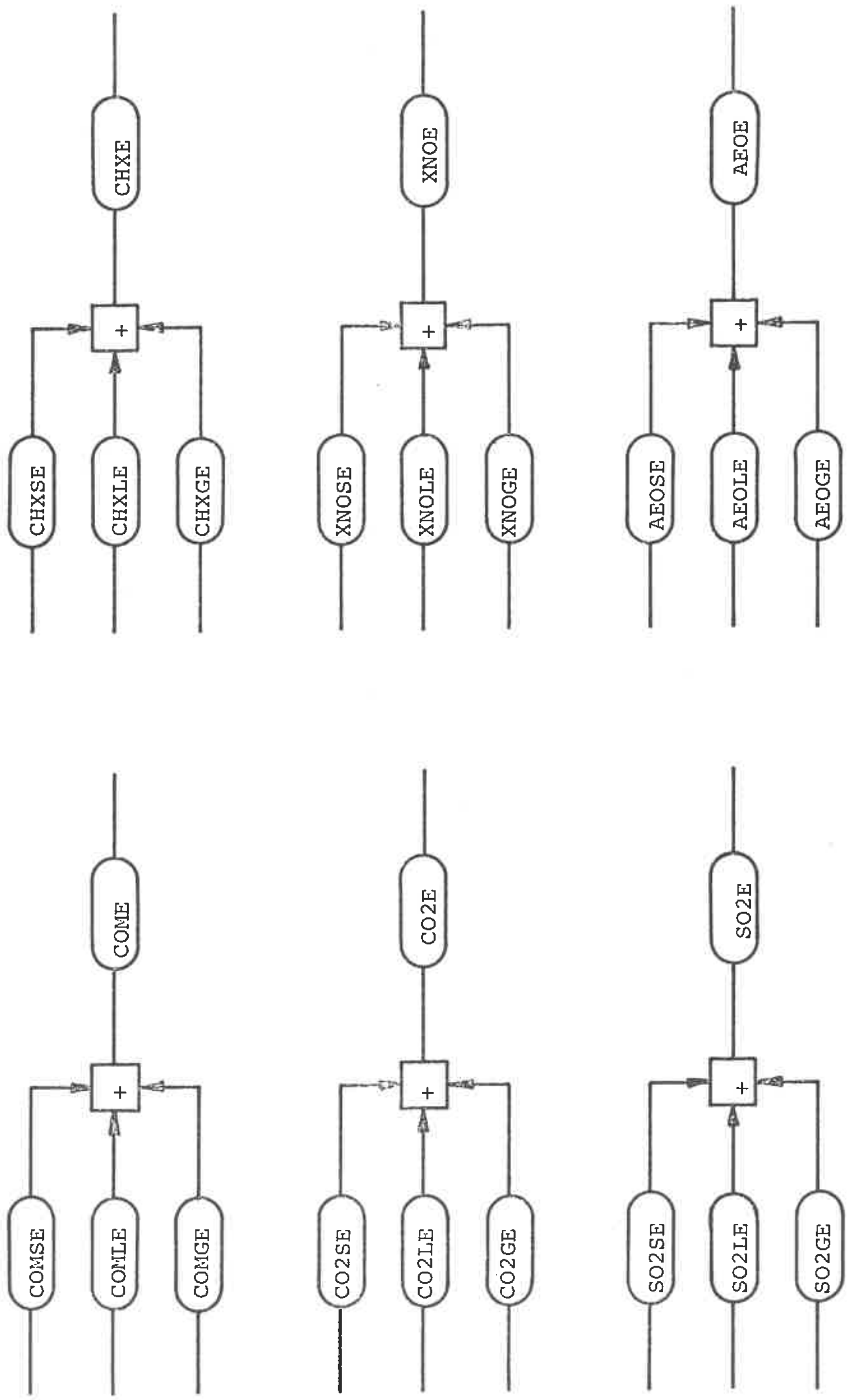


Fig. 2.4.4 Emissions of electric power generation

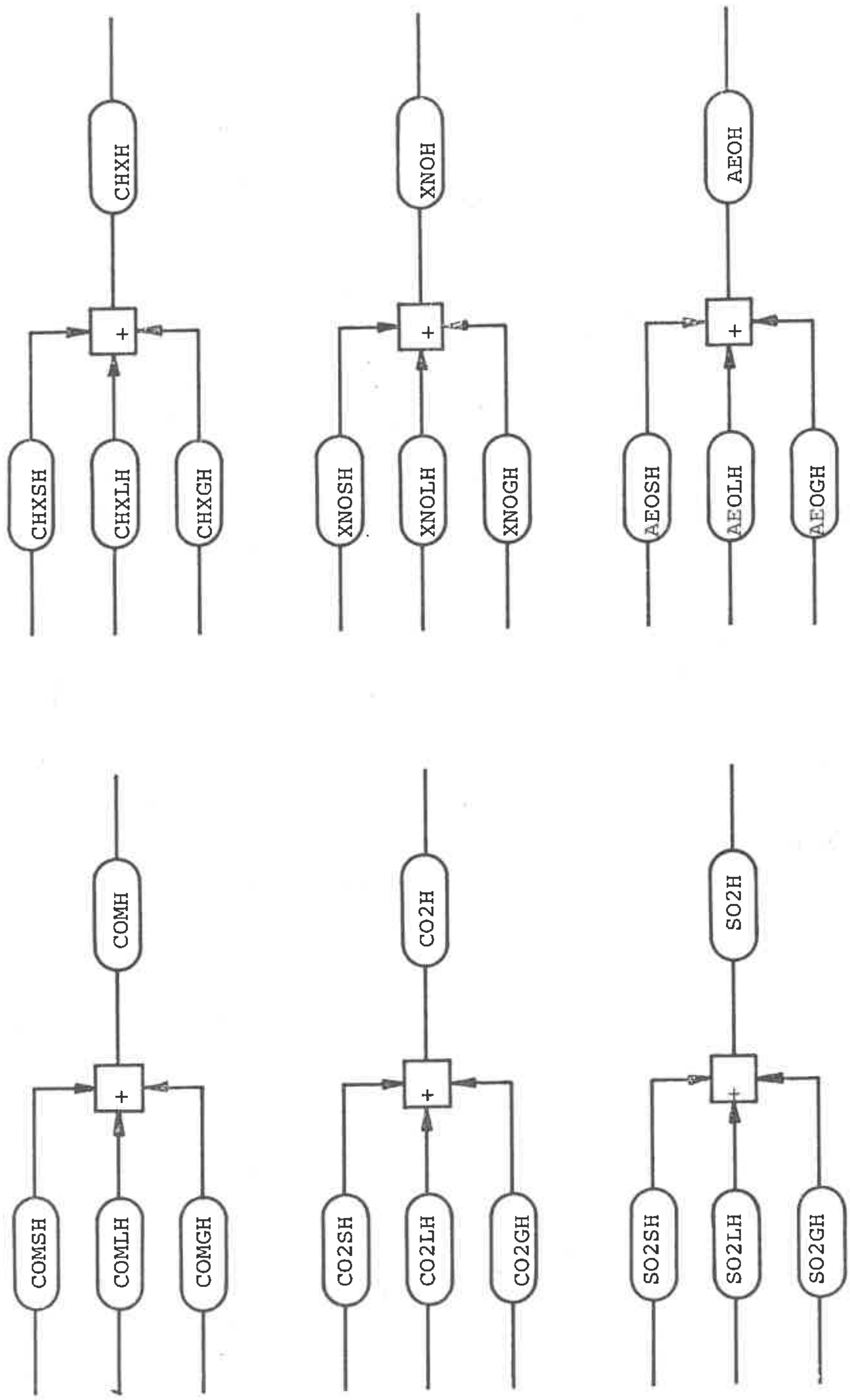


Fig. 2.4.5 Emissions of central heat plants

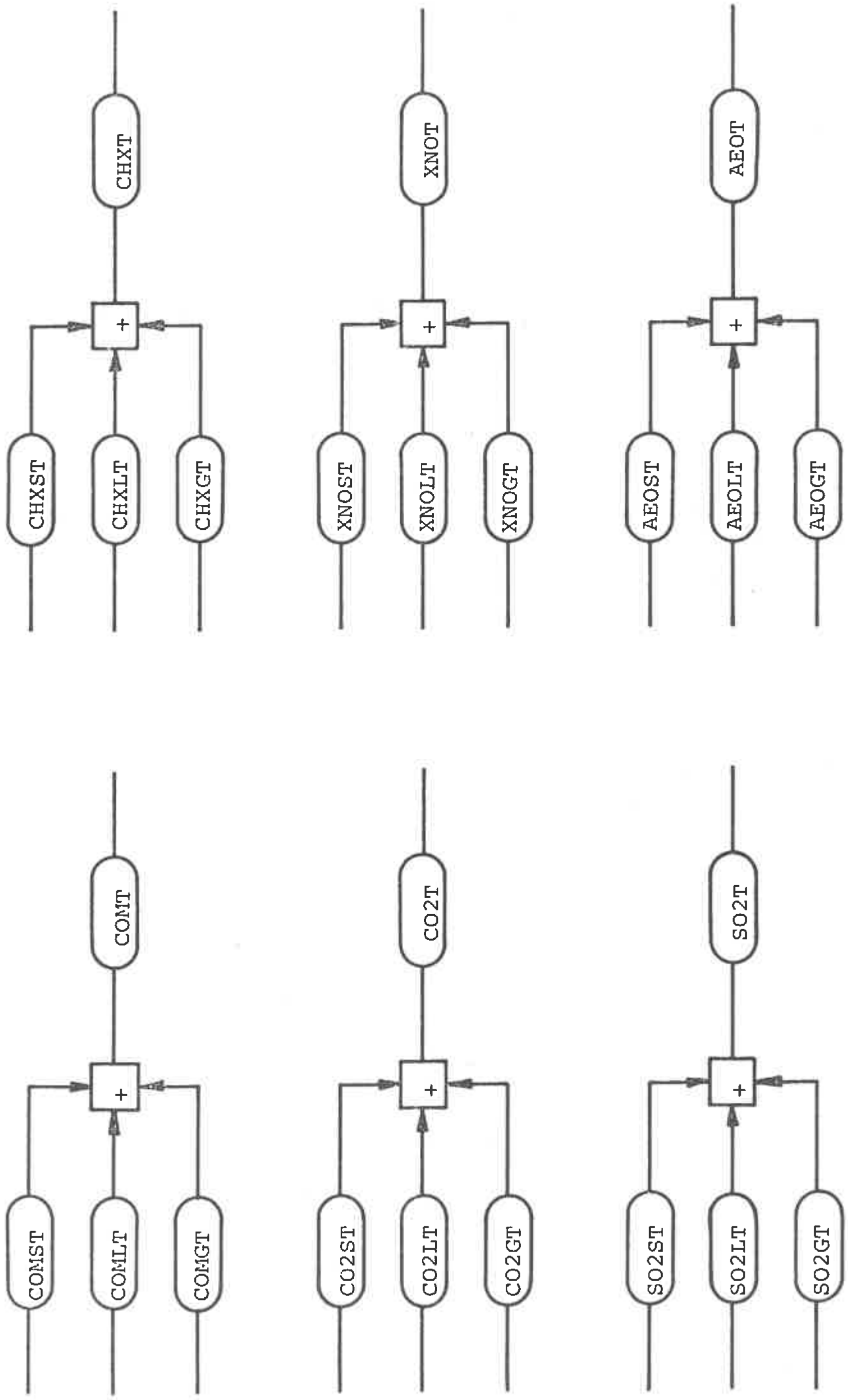


Fig. 2.4.6 Emissions of transportation

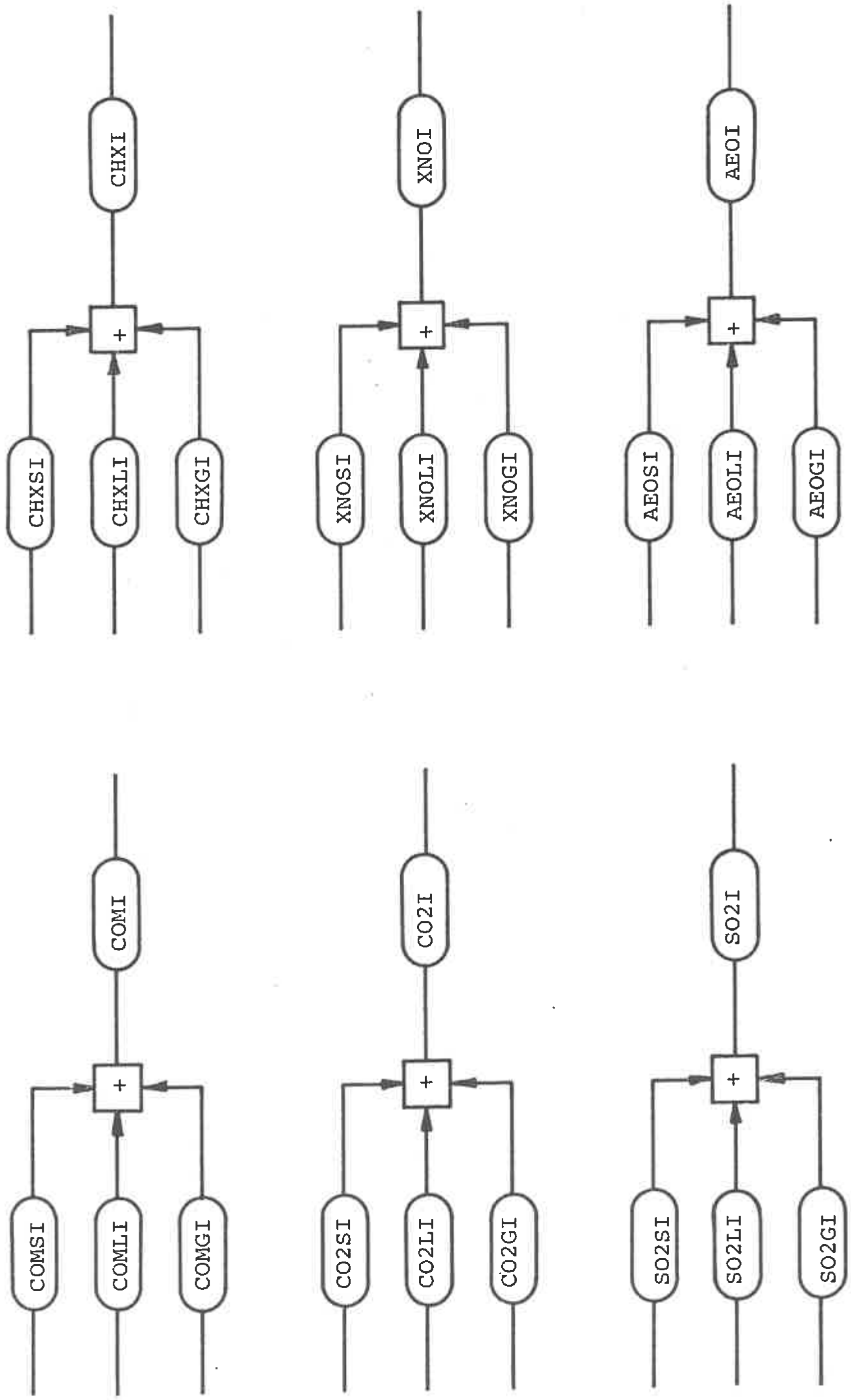


Fig. 2.4.7 Emissions of industry

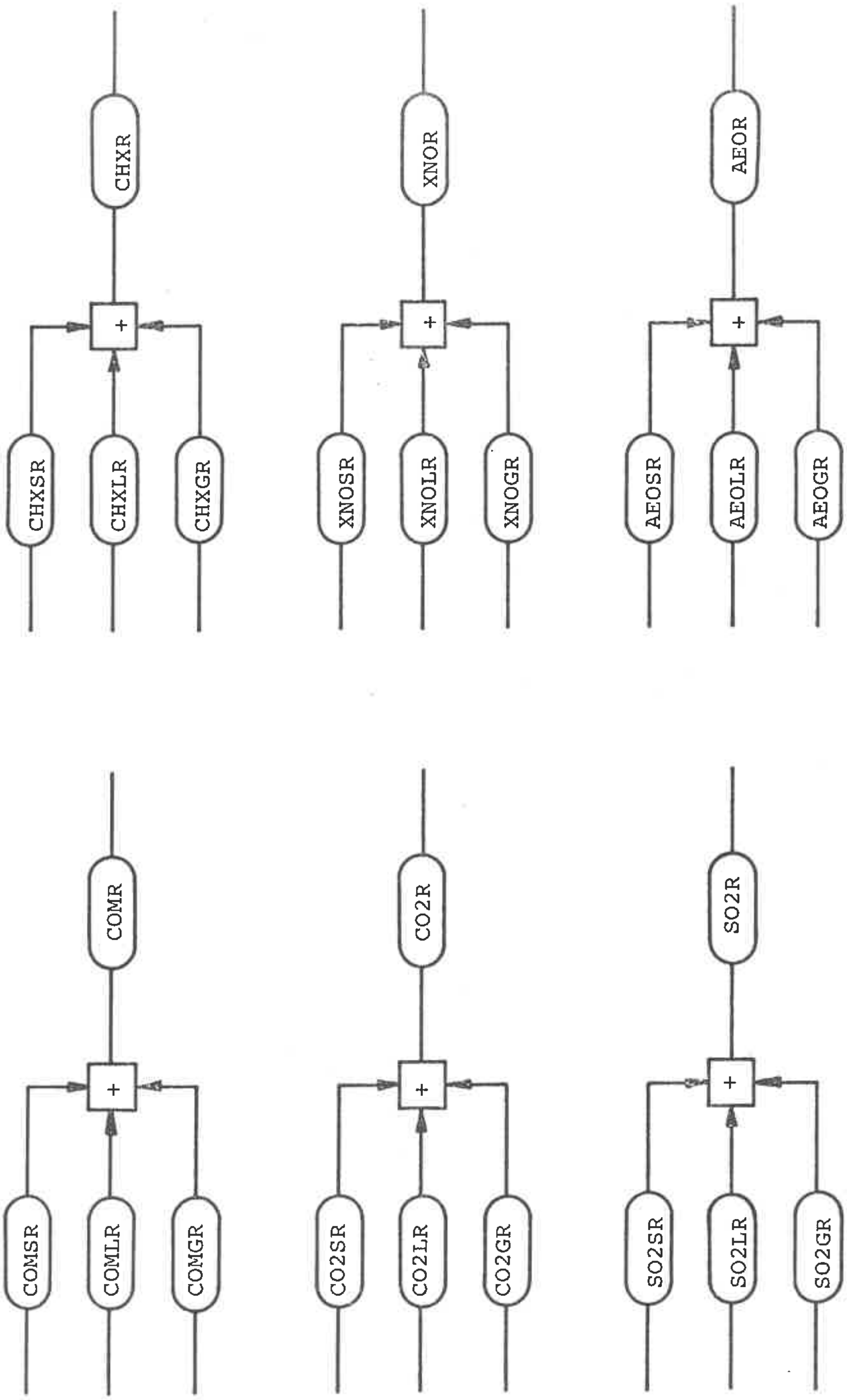


Fig. 2.4.8 Emissions of residential/commercial

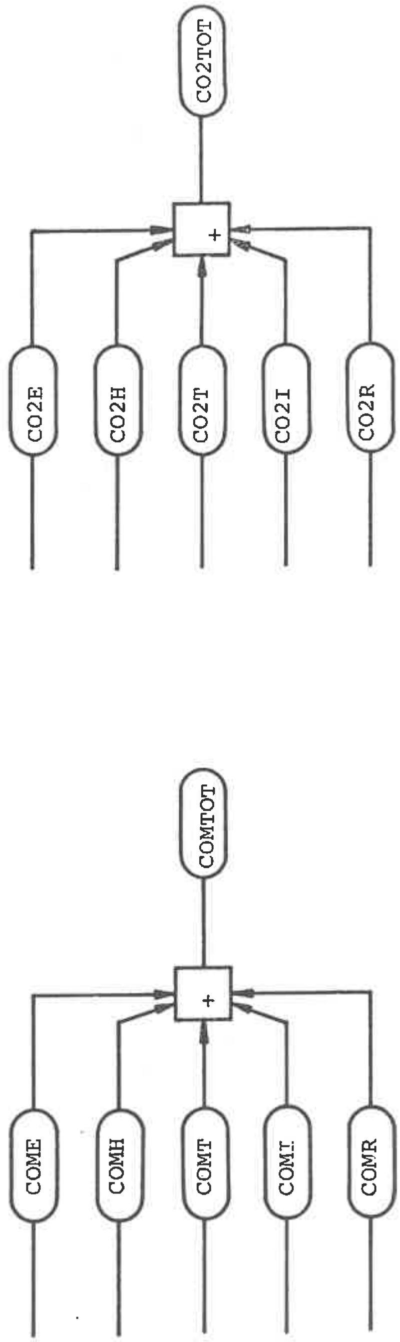


Fig. 2.4.9 Total emissions of CO and CO_2

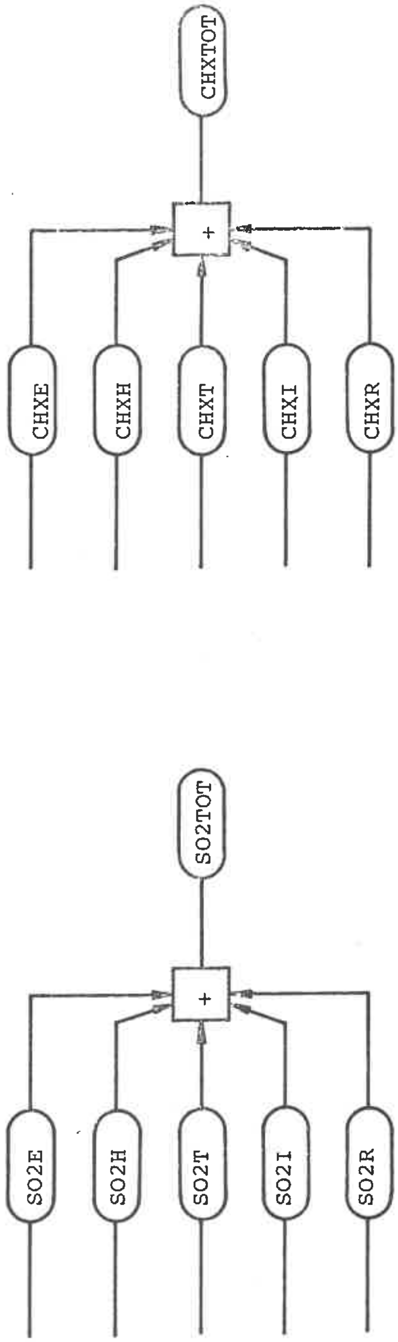


Fig. 2.4.10 Total emissions of SO_2 and CH_x

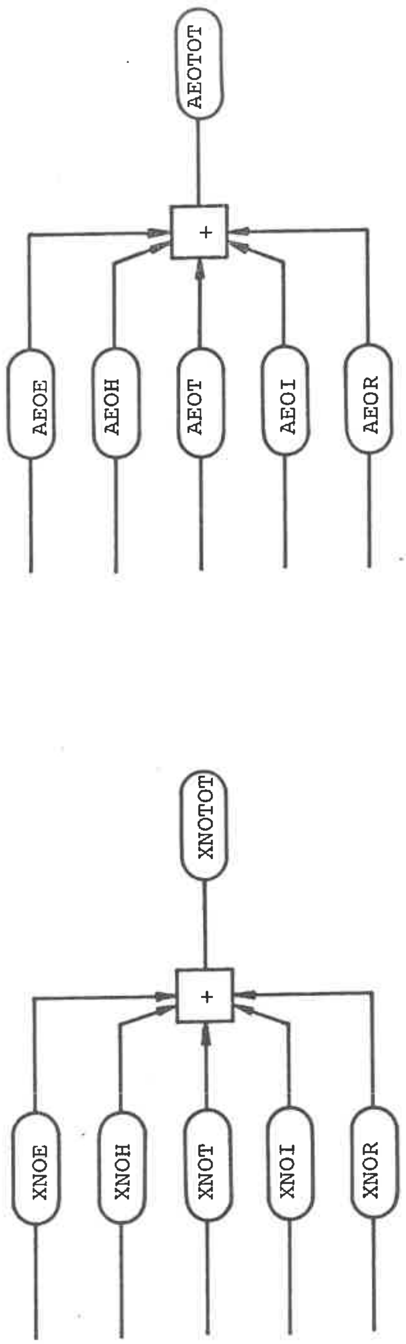


Fig. 2.4.11 Total emissions of NO_x and AEO

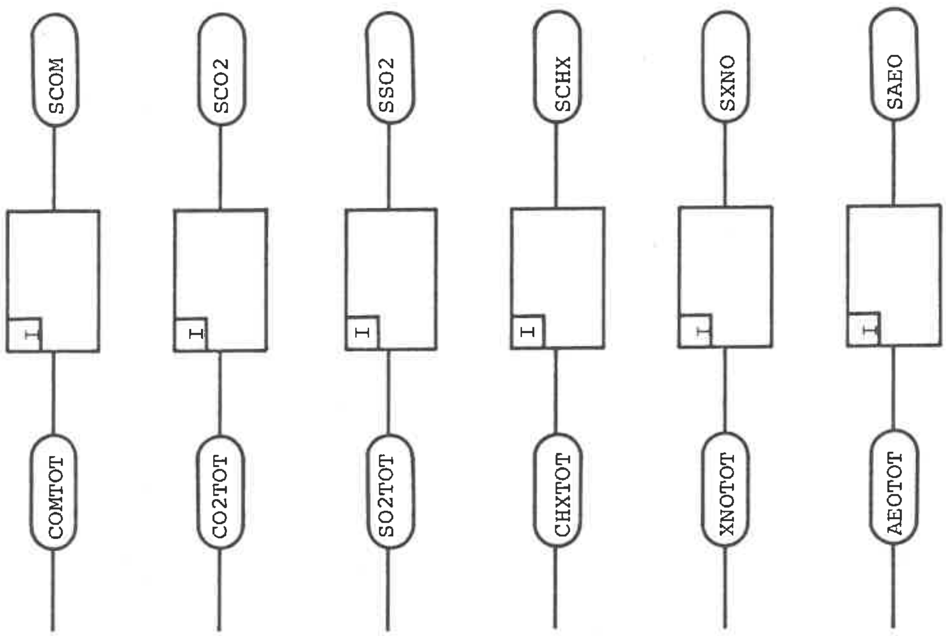


Fig. 2.4.12 Accumulation of emissions

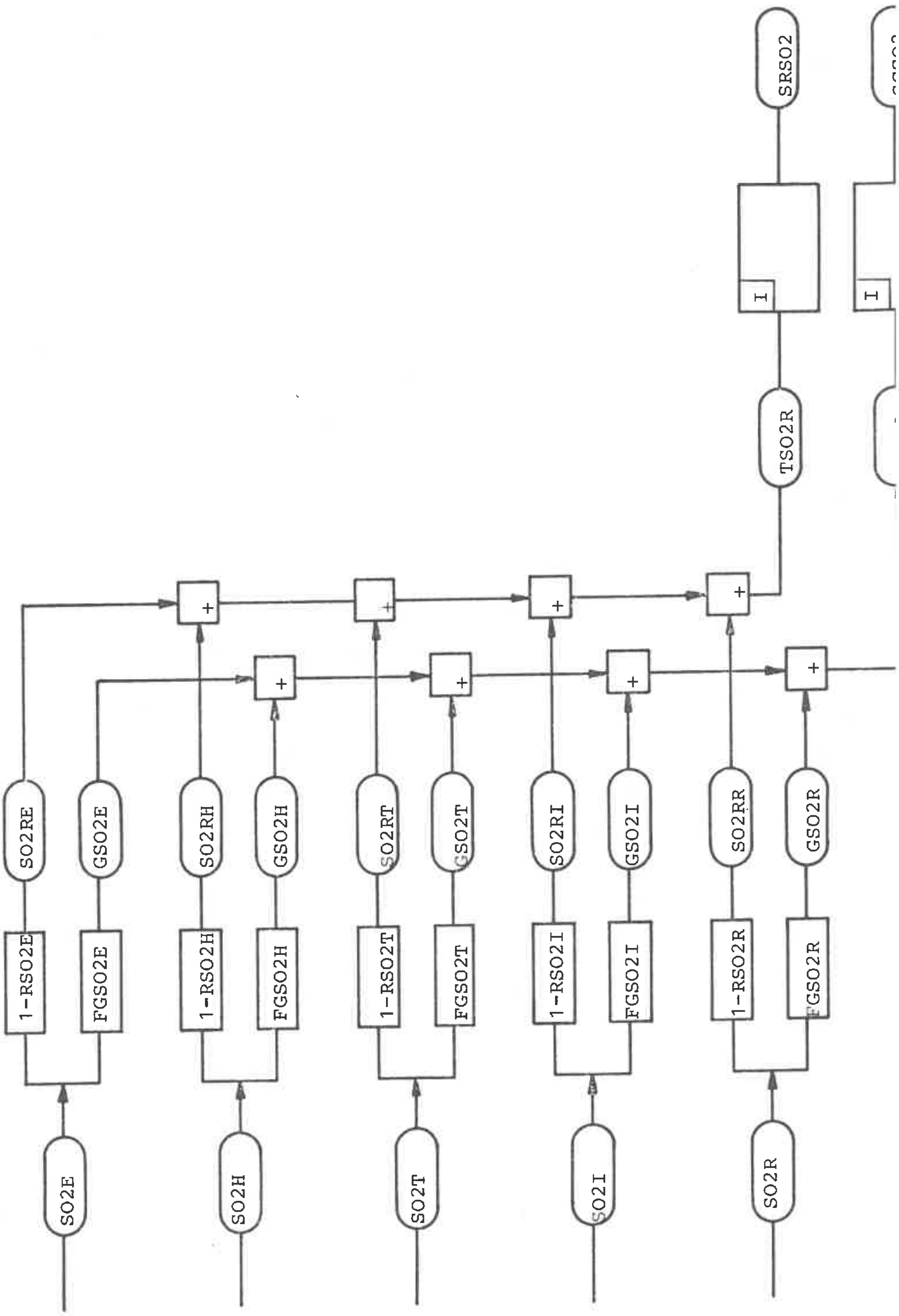


Fig. 2.4.13 Reduction of SO_2 emission

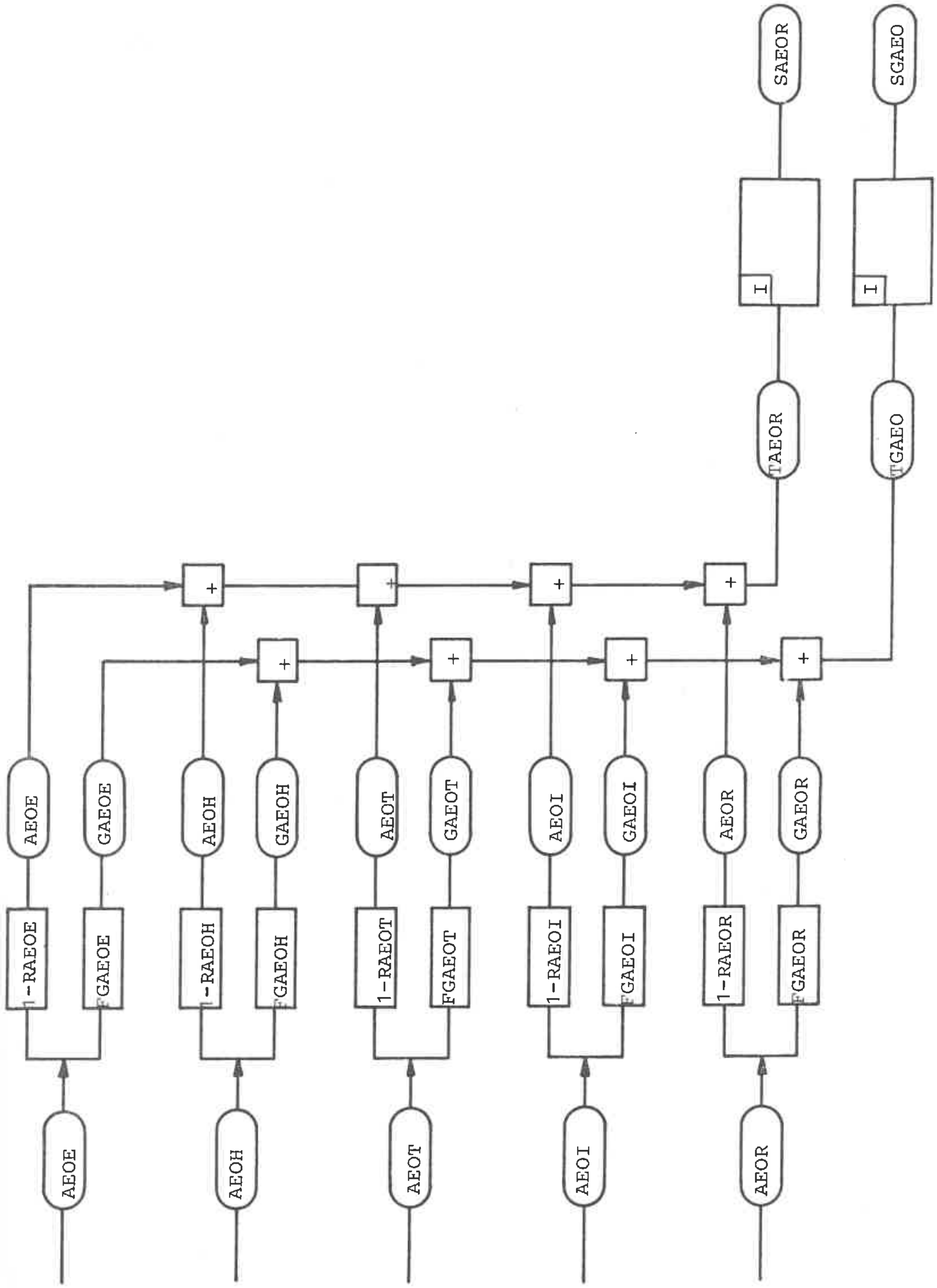


Fig. 2.4.14 Reduction of AEO emission

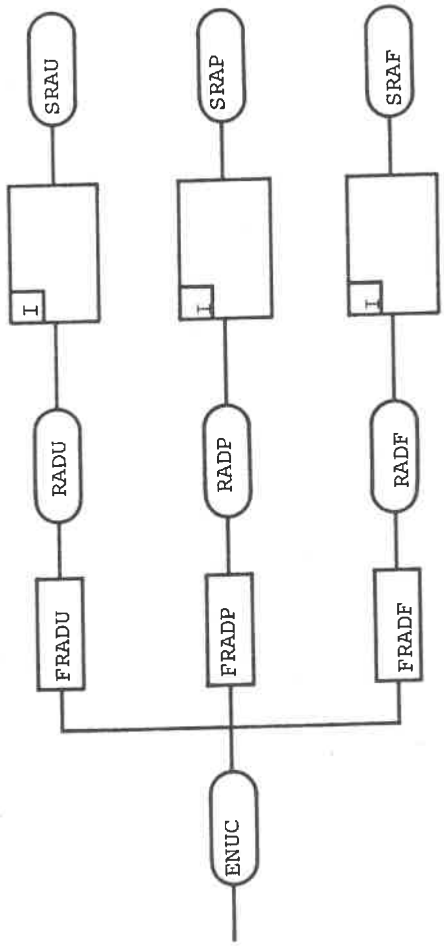


Fig. 2.4.15 Radioactive emissions

2.5 Listing

2.5.1 Main Program ESP

2.5.2 Subroutine READF

2.5.3 Subroutine CALEMI

2.5.4 Subroutine SUMMAT

2.5.5 Subroutine BILD

2.5.6 Subroutine ZERO

B 1192

2.5.1 Main Program ESP

```
FORTRAN IV G LEVEL  20.7           EMIS           DATE = 74116        21:48:01          PAGE 0001
FILE EMIS                                  CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

              C
              C      M - P WORLD MODEL
              C      *****************
              C
              C      ENERGY-EMISSION-PLANNING MODEL
              C
              C
              C
 0001                DIMENSION FELD(20),NDRU(20),EFG(18),ECE(18)
 0002                DIMENSION DENFRS(5,65),DENFRL(5,65),DENFRG(5,65),
                    1          DENFRT(5,65)
 0003                COMMON /DRU/ DEMSF(5,65),DEMLF(5,65),DEMGF(5,65),
                    1 DEMF(5,65),DEMH(5,65),DEMTF(5,65),DEMI(5,65),DEMRC(5,65)
 0004                COMMON / DE/ DEMS(5,65),DEMT(5,65),DEMR(5,65),NJ,
                    1DEMN(5,65),DEMNS(5,65)
 0005                COMMON /NUC/ FRADU,FRADP,FRADF,RADU,RADP,RADF
 0006                COMMON / FG/ FGSO2E,FGSO2H,FGSO2T,FGSO2I,FGSO2R,
                    1              GSO2E, GSO2H, GSO2T, GSO2I, GSO2R,
                    2             FGAEOE,FGAEOH,FGAEOT,FGAEOI,FGAEOR,
                    3              GAEOE, GAEOH, GAEOT, GAEOI, GAEOR
 0007                COMMON /RMOVE/ RCOME,RCO2E,RSO2E,RCHXE,RXNOE,RAEOE,
                    2               RCOMH,RCO2H,RSO2H,RCHXH,RXNOH,RAEOH,
                    3               RCOMT,RCO2T,RSO2T,RCHXT,RXNOT,RAEOT,
                    4               RCOMI,RCO2I,RSO2I,RCHXI,RXNOI,RAEOI,
                    5               RCOMR,RCO2R,RSO2R,RCHXR,RXNOR,RAEOR,
                    6               SO2RE,SO2RH,SO2RT,SO2RI,SO2RR,
                    7               AEORE,AEORH,AEORT,AEORI,AEORR
 0008                COMMON /ENER/ ESFE,ELFE,EGFE,
                    2              ESFH,ELFH,EGFH,
                    3              ESFT,ELFT,EGFT,
                    4              ESFI,ELFI,EGFI,
                    5              ESFR,ELFR,EGFR,ENUC
 0009                COMMON /FSOL/ FCOMSE,FCO2SE,FSO2SE,FCHXSE,FXNOSE,FAEOSE,
                    2              FCOMSH,FCO2SH,FSO2SH,FCHXSH,FXNOSH,FAEOSH,
                    3              FCOMST,FCO2ST,FSO2ST,FCHXST,FXNOST,FAEOST,
                    4              FCOMSI,FCO2SI,FSO2SI,FCHXSI,FXNOSI,FAEOSI,
                    5              FCOMSR,FCO2SR,FSO2SR,FCHXSR,FXNOSR,FAEOSR
 0010                COMMON /FLIQ/ FCOMLE,FCO2LE,FSO2LE,FCHXLE,FXNOLE,FAEOLE,
                    2              FCOMLH,FCO2LH,FSO2LH,FCHXLH,FXNOLH,FAEOLH,
                    3              FCOMLT,FCO2LT,FSO2LT,FCHXLT,FXNOLT,FAEOLT,
                    4              FCOMLI,FCO2LI,FSO2LI,FCHXLI,FXNOLI,FAEOLI,
                    5              FCOMLR,FCO2LR,FSO2LR,FCHXLR,FXNOLR,FAEOLR
 0011                COMMON /FGAS/ FCOMGE,FCO2GE,FSO2GE,FCHXGE,FXNOGE,FAEOGE,
                    2              FCOMGH,FCO2GH,FSO2GH,FCHXGH,FXNOGH,FAEOGH,
                    3              FCOMGT,FCO2GT,FSO2GT,FCHXGT,FXNOGT,FAEOGT,
                    4              FCOMGI,FCO2GI,FSO2GI,FCHXGI,FXNOGI,FAEOGI,
                    5              FCOMGR,FCO2GR,FSO2GR,FCHXGR,FXNOGR,FAEOGR
 0012                COMMON / SOL/ COMSE,CO2SE,SO2SE,CHXSE,XNOSE,AEOSE,
                    2              COMSH,CO2SH,SO2SH,CHXSH,XNOSH,AEOSH,
                    3              COMST,CO2ST,SO2ST,CHXST,XNOST,AEOST,
                    4              COMSI,CO2SI,SO2SI,CHXSI,XNOSI,AEOSI,
                    5              COMSR,CO2SR,SO2SR,CHXSR,XNOSR,AEOSR
```

```
FILE EMIS                                                 CMS VERSION 3-LEVEL 2 -- 15 MAY 1973
 0013            COMMON / LIQ/ COMLE,CO2LE,SO2LE,CHXLE,XNOLE,AEOLE,                     EMI00530
               2               COMLH,CO2LH,SO2LH,CHXLH,XNOLH,AEOLH,                     EMI00540
               3               COMLT,CO2LT,SO2LT,CHXLT,XNOLT,AEOLT,                     EMI00550
               4               COMLI,CO2LI,SO2LI,CHXLI,XNOLI,AEOLI,                     EMI00560
               5               COMLR,CO2LR,SO2LR,CHXLR,XNOLR,AEOLR                      EMI00570
 0014            COMMON / GAS/ COMGE,CO2GE,SO2GE,CHXGE,XNOGE,AEOGE,                     EMI00580
               2               COMGH,CO2GH,SO2GH,CHXGH,XNOGH,AEOGH,                     EMI00590
               3               COMGT,CO2GT,SO2GT,CHXGT,XNOGT,AEOGT,                     EMI00600
               4               COMGI,CO2GI,SO2GI,CHXGI,XNOGI,AEOGI,                     EMI00610
               5               COMGR,CO2GR,SO2GR,CHXGR,XNOGR,AEOGR                      EMI00620
 0015            COMMON / SUM/ SCOME,SCO2E,SSO2E,SCHXE,SXNOE,SAEOE,                     EMI00630
               2               SCOMH,SCO2H,SSO2H,SCHXH,SXNOH,SAEOH,                     EMI00640
               3               SCOMT,SCO2T,SSO2T,SCHXT,SXNOT,SAEOT,                     EMI00650
               4               SCOMI,SCO2I,SSO2I,SCHXI,SXNOI,SAEOI,                     EMI00660
               5               SCOMR,SCO2R,SSO2R,SCHXR,SXNOR,SAEOR,                     EMI00670
               6               SCOMS,SCO2S,SSO2S,SCHXS,SXNOS,SAEOS,                     EMI00680
               7               SCOML,SCO2L,SSO2L,SCHXL,SXNOL,SAEOL,                     EMI00690
               8               SCOMG,SCO2G,SSO2G,SCHXG,SXNOG,SAEOG,                     EMI00700
               9               SCOM ,SCO2 ,SSO2 ,SCHX ,SXNO ,SAEO,SGSO2,SGAEO,          EMI00710
               1               SRSO2,SRAEO                                              EMI00720
 0016            COMMON / TOT/ COMTOT,CO2TOT,SO2TOT,CHXTOT,XNOTOT,AEOTOT,               EMI00730
               2               COMSF ,CO2SF ,SO2SF ,CHXSF ,XNOSF ,AEOSF ,               EMI00740
               3               COMLF ,CO2LF ,SO2LF ,CHXLF ,XNOLF ,AEOLF ,               EMI00750
               4               COMGF ,CO2GF ,SO2GF ,CHXGF ,XNOGF ,AEOGF ,               EMI00760
               5               COME  ,CO2E  ,SO2E  ,CHXE  ,XNOE  ,AEOE  ,               EMI00770
               6               COMH  ,CO2H  ,SO2H  ,CHXH  ,XNOH  ,AEOH  ,               EMI00780
               7               COMT  ,CO2T  ,SO2T  ,CHXT  ,XNOT  ,AEOT  ,               EMI00790
               8               COMI  ,CO2I  ,SO2I  ,CHXI  ,XNOI  ,AEOI  ,               EMI00800
               9               COMR  ,CO2R  ,SO2R  ,CHXR  ,XNOR  ,AEOR                  EMI00810
 0017     1000  FORMAT(20A4)                                                            EMI00820
 0018     2000  FORMAT(1H1,///,1X,20A4)                                                 EMI00830
 0019     2001  FORMAT(1X,20A4)                                                         EMI00840
 0020           READ  (4,1000) (FELD(J),J=1,20)                                         EMI00850
 0021           WRITE(8,2000) (FELD(J),J=1,20)                                          EMI00860
 0022           READ  (4,1000) (FELD(J),J=1,20)                                         EMI00870
 0023           WRITE(8, 2001) (FELD(J),J=1,20)                                         EMI00880
 0024           READ  (4,1000) (FELD(J),J=1,20)                                         EMI00890
 0025           WRITE(8, 2001) (FELD(J),J=1,20)                                         EMI00900
 0026     3000  FORMAT(1X,'STELLE ',A2)                                                 EMI00910
 0027     2030  FORMAT(' READ WATT / M**2')                                             EMI00920
 0028     2031  FORMAT(' READ MIO KM**2')                                               EMI00930
 0029     2032  FORMAT(F10.1)                                                           EMI00940
 0030           WRITE(6,2030)                                                           EMI00950
 0031           READ (5,2032) WATT                                                      EMI00960
 0032           WRITE(6,2031)                                                           EMI00970
 0033           READ (5,2032) AREA                                                      EMI00980
 0034     2033  FORMAT(1X,/,1X,F6.2,'MIO KM**2      ',                                  EMI00990
               1                       F6.2,'WATT/M**2')                                EMI01000
 0035           WRITE(8,2033) AREA,WATT                                                 EMI01010
 0036             CALL READF                                                            EMI01020
 0037     1001  FORMAT(I5,1X,I1,2X,7F10.5,/,                                            EMI01030
               1                    9X,7F10.5,/,                                        EMI01040
```

B 1194

FILE EMIS CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
        2                     9X,7E10.5)
          CALL  ZERO
           READ(4,1000)  (REG(I),I=1,18)
          READ(4,1000)  (SCE(I),I=1,18)
          DO 10 I=1,5
          DO 10 J=1,65
   10     DENERS(I,J)=0.0
C
          DO 20 I=1,5
          DO 20 J=1,65
   20     DENERL(I,J)=0.0
C
          DO 30 I=1,5
          DO 30 J=1,65
   30     DENERG(I,J)=0.0
C
          DO 40 I=1,5
          DO 40 J=1,65
   40     DENERT(I,J)=0.0
          DO 41 I=1,5
          DO 41 J=1,65
   41     DEMT(I,J)=0.0
C
C
          DO 42 I=1,5
          DO 42 J=1,65
   42     DEMS(I,J)=0.0
C
C
          DO 43 I=1,5
          DO 43 J=1,65
   43     DEMR(I,J)=0.0
C
C
          DO 44 I=1,5
          DO 44 J=1,65
   44     DEMF(I,J)=0.0
C
C
          DO 45 I=1,5
          DO 45 J=1,55
   45     DEMH(I,J)=0.0
C
C
          DO 46 I=1,5
          DO 46 J=1,65
   46     DEMJ(I,J)=0.0
C
C
          DO 47 I=1,5
          DO 47 J=1,65
   47     DEMI(I,J)=0.0
```

B 1195


```
FILE EMIS                                        CMS VERSION 3-LEVEL 2 -- 15 MAY 1973
               C                                                                           EMI01570
               C                                                                           EMI01580
  0074                DO 48 I=1,5                                                          EMI01590
  0075                DO 48 J=1,65                                                         EMI01600
  0076         48     DEMR(I,J)=0.0                                                        EMI01610
               C                                                                           EMI01620
               C                                                                           EMI01630
  0077                DO 49 I=1,5                                                          EMI01640
  0078                DO 49 J=1,65                                                         EMI01650
  0079         49     DEMSF(I,J)=0.0                                                       EMI01660
               C                                                                           EMI01670
               C                                                                           EMI01680
  0080                DO 50 I=1,5                                                          EMI01690
  0081                DO 50 J=1,65                                                         EMI01700
  0082         50     DEMLF(I,J)=0.0                                                       EMI01710
               C                                                                           EMI01720
               C                                                                           EMI01730
  0083                DO 51 I=1,5                                                          EMI01740
  0084                DO 51 J=1,65                                                         EMI01750
  0085         51     DEMGF(I,J)=0.0                                                       EMI01760
               C                                                                           EMI01770
               C                                                                           EMI01780
  0086                 DO 52 I=1,5                                                         EMI01790
  0087                DO 52 J=1,65                                                         EMI01800
  0088         52     DEMN(I,J)=0.0                                                        EMI01810
               C                                                                           EMI01820
               C                                                                           EMI01830
  0089                DO 53 I=1,5                                                          EMI01840
  0090                DO 53 J=1,65                                                         EMI01850
  0091         53     DEMNS(I,J)=0.0                                                       EMI01860
               C                                                                           EMI01870
               C                                                                           EMI01880
  0092                NEND=0                                                               EMI01890
  0093         2002   FORMAT (1X,11F10.2)                                                  EMI01900
  0094         2003   FORMAT (1X,'       SCON      SCO2      SSO2      SCHX       SXEO',   EMI01910
                     2 '       SALO      SRAP      SRAF      SGSO2     SGAEO',            EMI01920
                     3//,1X)                                                               EMI01930
  0095                WRITE(6,2002)                                                        EMI01940
  0096                NJ=0                                                                 EMI01950
  0097         2004   FORMAT(1X,'SOLID FUEL INPUT',/,1X,                                   EMI01960
                     1'1=ESFE 2=ESFH 3=ESFT 4=ESFI 5=ESFR',/1X)                            EMI01970
  0098         2005   FORMAT(1X,'LIQUID FUEL INPUT',/,1X,                                  EMI01980
                     1'1=ELFE 2=ELFH 3=ELFT 4=ELFI 5=ELFR',/1X)                            EMI01990
  0099         2006   FORMAT(1X,'GASEOUS FUEL INPUT',/,1X,                                 EMI02000
                     1'1=EGFE 2=EGFH 3=EGFT 4=EGFI 5=EGFR',/1X)                            EMI02010
  0100         2007   FORMAT(1X,'NUCLEAR AND TOTAL ENERGY INPUT',/,1X,                     EMI02020
                     1'1=ENUC 2=EUSP 3=EWAST 4=ETOT        ',/1X,                          EMI02030
                     2'5=SOLAR IRRADIATION / ETOT * 1000',/1X)                             EMI02040
  0101         2009   FORMAT(1X,'ACCUMULATED EMISSIONS',/1X)                               EMI02050
  0102         2010   FORMAT(1X,'REDUCED EMISSIONS',/1X)                                   EMI02060
  0103         2008   FORMAT(1X,                                                           EMI02070
                     1'1=CO2 2=SO2 3=CHX 4=NOX 5=AEO')                                     EMI02080
```

```
0104     2011  FORMAT(1X,'NDPU(20) INPUT')                                      EMI02090
0105     2012  FORMAT(1X,20I1)                                                  EMI02100
0106           WRITE(6,2011)                                                    EMI02110
0107           READ 2012, (NDRU(J),J=1,20)                                      EMI02120
0108           WRITE(6,2012) (NDRU(J),J=1,20)                                   EMI02130
0109     104   READ(4,1001,END=101)JAHR,NR,ESFE,ESFH,ESFT,ESFI,ESFR,            EMI02140
              2           ELFE,ELFH,ELFT,ELFI,ELFR,                             EMI02150
              3           EGFE,EGFH,EGFT,EGFI,EGFR,                             EMI02160
              5 ENUC,          EUSE,EWAST,ETOT                                  EMI02170
         C 200   FORMAT(1X,I4,19(1X,F5.3))                                      EMI02180
         C     WRITE(8,200) JAHR,ESFE,ESFH,ESFT,ESFI,ESFR,                      EMI02190
         C    1                     ELFE,ELFH,ELFT,ELFI,ELFR,                   EMI02200
         C    2                     EGFE,EGFH,EGFT,EGFI,EGFR,                   EMI02210
         C    3                     ENUC,EUSE,EWAST,ETOT                        EMI02220
0110           GOTO 102                                                         EMI02230
0111     101   NEND=1                                                           EMI02240
0112           REWIND 4                                                         EMI02250
0113           GOTO 103                                                         EMI02260
0114     102   NJ=NJ+1                                                          EMI02270
0115           CALL CALEMI                                                      EMI02280
0116           CALL SUMMAT                                                      EMI02290
         C     CALL DRUCK                                                       EMI02300
0117           DENERS(1,NJ)=ESFE                                                EMI02310
0118           DENERS(2,NJ)=ESFH                                                EMI02320
0119           DENERS(3,NJ)=ESFT                                                EMI02330
0120           DENERS(4,NJ)=ESFI                                                EMI02340
0121           DENERS(5,NJ)=ESFR                                                EMI02350
         C                                                                      EMI02360
         C                                                                      EMI02370
0122           DENERL(1,NJ)=ELFE                                                EMI02380
0123           DENERL(2,NJ)=ELFH                                                EMI02390
0124           DENERL(3,NJ)=ELFT                                                EMI02400
0125           DENERL(4,NJ)=ELFI                                                EMI02410
0126           DENERL(5,NJ)=ELFR                                                EMI02420
         C                                                                      EMI02430
         C                                                                      EMI02440
0127           DENERG(1,NJ)=EGFE                                                EMI02450
0128           DENERG(2,NJ)=EGFH                                                EMI02460
0129           DENERG(3,NJ)=EGFT                                                EMI02470
0130           DENERG(4,NJ)=EGFI                                                EMI02480
0131           DENERG(5,NJ)=EGFR                                                EMI02490
         C                                                                      EMI02500
         C                                                                      EMI02510
0132           DENERT(1,NJ)=ENUC                                                EMI02520
0133           DENERT(2,NJ)=EUSE                                                EMI02530
0134           DENERT(3,NJ)=EWAST                                               EMI02540
0135           DENERT(4,NJ)=ETOT                                                EMI02550
0136           DENERT(5,NJ)=95.8*ETOT/(WATT*AREA)                               EMI02560
0137     2041  FORMAT(1H1,18A4,/,1X,18A4)                                       EMI02570
0138     2040  FORMAT(1X,'ENERGY UNITS ARE BILLIONS',                           EMI02580
              1          ' OF METRIC TONS OF COAL EQUIVALENT')                  EMI02590
0139     2042  FORMAT(1X,'EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS')  EMI02600
```

FILE EMIS CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
2043  FORMAT(1X,'EMISSION UNITS ARE MCI')                              EMI02610
2044  FORMAT(1X,'EMISSIONS IN 10**6 TONS,COSTS IN 10**9 US DOLLARS')   EMI02620
2045  FORMAT(1X,'1=TPSO2 2=TRAEO 3=GSO2 4=GAEO')                       EMI02630
CC201 FORMAT(1X,5F8.4)                                                 EMI02640
103   IF(NEND.EQ.0) GOTO 104                                           EMI02650
C     DO 70 I=1,NJ                                                     EMI02660
C70    WRITE (8,201) (DENERS(K,I),K=1,5)                               EMI02670
       IF(NDRU(1).NE.1) GOTO 55                                        EMI02680
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI02690
      WRITE(8,2004)                                                    EMI02700
      WRITE(8,2040)                                                    EMI02710
      CALL BILD(DENERS)                                                EMI02720
55    IF(NDRU(2).NE.1) GOTO 56                                         EMI02730
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI02740
      WRITE(8,2005)                                                    EMI02750
      WRITE(8,2040)                                                    EMI02760
      CALL BILD(DENEPL)                                                EMI02770
C                                                                      EMI02780
56    IF(NDRU(3).NE.1) GOTO 57                                         EMI02790
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI02800
      WRITE(8,2006)                                                    EMI02810
      WRITE(8,2040)                                                    EMI02820
      CALL BILD(DENERG)                                                EMI02830
C                                                                      EMI02840
57    IF(NDRU(4).NE.1) GOTO 58                                         EMI02850
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI02860
      WRITE(8,2007)                                                    EMI02870
      WRITE(8,2040)                                                    EMI02880
      CALL BILD(DENERT)                                                EMI02890
C                                                                      EMI02900
58    IF(NDRU(5).NE.1) GOTO 59                                         EMI02910
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI02920
      WRITE(8,2042)                                                    EMI02930
      WRITE(8,2008)                                                    EMI02940
      WRITE(8,2024)                                                    EMI02950
2024  FORMAT(1X,'TOTALS OF EMISSONS / YEAR')                           EMI02960
      CALL BILD(DEMT)                                                  EMI02970
C                                                                      EMI02980
59    IF(NDRU(6).NE.1) GOTO 60                                         EMI02990
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI03000
      WRITE(8,2042)                                                    EMI03010
      WRITE(8,2008)                                                    EMI03020
      WRITE(8,2009)                                                    EMI03030
      CALL BILD(DEMS)                                                  EMI03040
C                                                                      EMI03050
60    IF(NDRU(7).NE.1) GOTO 61                                         EMI03060
      WRITE(8,2041)  (REG(I),I=1,18),(SCE(J),J=1,18)                   EMI03070
      WRITE(8,2045)                                                    EMI03080
      WRITE(8,2044)                                                    EMI03090
      WRITE(8,2010)                                                    EMI03100
      CALL BILD(DEMR)                                                  EMI03110
C                                                                      EMI03120
```

```
FILE EMIS                          CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0183    61    IF(NDRU(8).NE.1) GOTO 62                                      EMI03130
 0184          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03140
 0185          WRITE(8,2042)                                                 EMI03150
 0186          WRITE(8,2008)                                                 EMI03160
 0187          WRITE(8,2013)                                                 EMI03170
 0188  2013    FORMAT(1X,'EMISSIONS OF SOLID FUEL')                          EMI03180
 0189          CALL BILD(DEMSF)                                              EMI03190
       C                                                                     EMI03200
       C                                                                     EMI03210
 0190    62    IF(NDRU(9).NE.1) GOTO 63                                      EMI03220
 0191          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03230
 0192          WRITE(8,2042)                                                 EMI03240
 0193          WRITE(8,2008)                                                 EMI03250
 0194          WRITE(8,2014)                                                 EMI03260
 0195  2014    FORMAT(1X,'EMISSIONS OF LIQUID FUEL')                         EMI03270
 0196           CALL BILD(DEMLF)                                             EMI03280
                                                                             EMI03290
       C                                                                     EMI03300
       C                                                                     EMI03310
 0197    63    IF(NDRU(10).NE.1) GOTO 64                                     EMI03320
 0198          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03330
 0199          WRITE(8,2042)                                                 EMI03340
 0200          WRITE(8,2008)                                                 EMI03350
 0201          WRITE(8,2015)                                                 EMI03360
 0202  2015    FORMAT(1X,'EMISSIONS OF GASEOUS FUEL')                        EMI03370
 0203          CALL BILD(DEMGF)                                              EMI03380
       C                                                                     EMI03390
       C                                                                     EMI03400
 0204    64    IF(NDRU(11).NE.1) GOTO 65                                     EMI03410
 0205          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03420
 0206          WRITE(8,2042)                                                 EMI03430
 0207          WRITE(8,2008)                                                 EMI03440
 0208          WRITE(8,2016)                                                 EMI03450
 0209  2016    FORMAT(1X,'EMISSIONS OF ELECTRIC POWER GENERATION')           EMI03460
 0210          CALL BILD(DEME)                                               EMI03470
       C                                                                     EMI03480
       C                                                                     EMI03490
 0211    65    IF(NDRU(12).NE.1) GOTO 66                                     EMI03500
 0212          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03510
 0213          WRITE(8,2042)                                                 EMI03520
 0214          WRITE(8,2008)                                                 EMI03530
 0215          WRITE(8,2017)                                                 EMI03540
 0216  2017    FORMAT(1X,'EMISSIONS OF CENTRAL HEAT PLANTS')                 EMI03550
 0217          CALL BILD(DEMH)                                               EMI03560
       C                                                                     EMI03570
       C                                                                     EMI03580
 0218    66    IF(NDRU(13).NE.1) GOTO 67                                     EMI03590
 0219          WRITE(8,2041) (REG(I),I=1,18),(SCE(J),J=1,18)                 EMI03600
 0220          WRITE(8,2042)                                                 EMI03610
 0221          WRITE(8,2008)                                                 EMI03620
 0222          WRITE(8,2018)                                                 EMI03630
 0223  2018    FORMAT(1X,'EMISSIONS OF TRANSPORTATION')                      EMI03640
 0224          CALL BILD(DEMTB)
```

B 1198

FILE EMIS CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
                C                                                                   EMI03650
                C                                                                   EMI03660
  0225          67    IF(NDRU(14).NE.1) GOTO 68                                     EMI03670
  0226                WRITE(8,2041)  (REG(I),I=1,18), (SCE(J),J=1,18)               EMI03680
  0227                WRITE(8,2042)                                                 EMI03690
  0228                WRITE(8,2008)                                                 EMI03700
  0229                WRITE(8,2019)                                                 EMI03710
  0230          2019  FORMAT(1X,'EMISSIONS OF INDUSTRY')                            EMI03720
  0231                CALL BILD(DEMI)                                               EMI03730
                C                                                                   EMI03740
                C                                                                   EMI03750
  0232          68    IF(NDRU(15).NE.1) GOTO 69                                     EMI03760
  0233                WRITE(8,2041)  (REG(I),I=1,18), (SCE(J),J=1,18)               EMI03770
  0234                WRITE(8,2042)                                                 EMI03780
  0235                WRITE(8,2008)                                                 EMI03790
  0236                WRITE(8,2020)                                                 EMI03800
  0237          2020  FORMAT(1X,'EMISSIONS OF RESIDENTIAL/COMMERCIAL')              EMI03810
  0238                CALL BILD(DEMPC)                                              EMI03820
                C                                                                   EMI03830
                C                                                                   EMI03840
  0239          69    IF(NDRU(16).NE.1) GOTO 70                                     EMI03850
  0240                WRITE(8,2041)  (REG(I),I=1,18), (SCE(J),J=1,18)               EMI03860
  0241                WRITE(8,2021)                                                 EMI03870
  0242                WRITE(8,2043)                                                 EMI03880
  0243                WRITE(8,2022)                                                 EMI03890
  0244          2021  FORMAT(1H1,1X,'1=NUCU 2=NUCP 3=NUCF')                         EMI03900
  0245          2022  FORMAT(    1X,'EMISSIONS OF NUCLEAR POWER GENERATION')        EMI03910
  0246                CALL BILD(DEMN)                                               EMI03920
                C                                                                   EMI03930
                C                                                                   EMI03940
  0247          70    IF(NDRU(17).NE.1) GOTO 71                                     EMI03950
  0248                WRITE(8,2041)  (REG(I),I=1,18), (SCE(J),J=1,18)               EMI03960
  0249                WRITE(8,2021)                                                 EMI03970
  0250                WRITE(8,2043)                                                 EMI03980
  0251                WRITE(8,2023)                                                 EMI03990
  0252          2023  FORMAT(1X,'ACCUMULATED OF NUCLEAR EMISSIONS')                 EMI04000
  0253                CALL BILD(DEMNS)                                              EMI04010
                C                                                                   EMI04020
                C                                                                   EMI04030
  0254          71    CONTINUE                                                      EMI04040
  0255                END                                                           EMI04050
```

2.5.2 SubroutineREADF

```
FORTRAN IV G LEVEL  20.7                READF               DATE = 74116         21:52:34               PAGE 0001

FILE READF                                           CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0001               SUBROUTINE READF
 0002               COMMON /NUC/ FRADU,FRADP,FRADF,RADU,RADP,RADF
 0003               COMMON / FG/ FGSO2E,FGSO2H,FGSO2T,FGSO2I,FGSO2R,
                   2              GSO2E, GSO2H, GSO2T, GSO2I, GSO2R,
                   3             FGAEOF,FGAEOH,FGAEOT,FGAEOI,FGAEOR,
                   4              GAEOE, GAEOH, GAEOT, GAEOI, GAEOR
 0004               COMMON /FSOL/ FCOMSE,FCO2SE,FSO2SE,FCHXSE,FXNOSE,FAEOSE,
                   2              FCOMSH,FCO2SH,FSO2SH,FCHXSH,FXNOSH,FAEOSH,
                   3              FCOMST,FCO2ST,FSO2ST,FCHXST,FXNOST,FAEOST,
                   4              FCOMSI,FCO2SI,FSO2SI,FCHXSI,FXNOSI,FAEOSI,
                   5              FCOMSR,FCO2SR,FSO2SR,FCHXSR,FXNOSR,FAEOSR
 0005               COMMON /FLIQ/ FCOMLE,FCO2LE,FSO2LE,FCHXLE,FXNOLE,FAEOLE,
                   2              FCOMLH,FCO2LH,FSO2LH,FCHXLH,FXNOLH,FAEOLH,
                   3              FCOMLT,FCO2LT,FSO2LT,FCHXLT,FXNOLT,FAEOLT,
                   4              FCOMLI,FCO2LI,FSO2LI,FCHXLI,FXNOLI,FAEOLI,
                   5              FCOMLR,FCO2LR,FSO2LR,FCHXLR,FXNOLR,FAEOLR
 0006               COMMON /FGAS/ FCOMGE,FCO2GE,FSO2GE,FCHXGE,FXNOGE,FAEOGE,
                   2              FCOMGH,FCO2GH,FSO2GH,FCHXGH,FXNOGH,FAEOGH,
                   3              FCOMGT,FCO2GT,FSO2GT,FCHXGT,FXNOGT,FAEOGT,
                   4              FCOMGI,FCO2GI,FSO2GI,FCHXGI,FXNOGI,FAEOGI,
                   5              FCOMGR,FCO2GR,FSO2GR,FCHXGR,FXNOGR,FAEOGR
 0007               COMMON /RMOVE/ RCOME,RCO2E,RSO2E,RCHXE,RXNOE,RAEOE,
                   2               RCOMH,RCO2H,RSO2H,RCHXH,RXNOH,RAEOH,
                   3               RCOMT,RCO2T,RSO2T,RCHXT,RXNOT,RAEOT,
                   4               RCOMI,RCO2I,RSO2I,RCHXI,RXNOI,RAEOI,
                   5               RCOMR,RCO2R,RSO2R,RCHXR,RXNOR,RAEOR,
                   6               SO2RE,SO2RH,SO2RT,SO2RI,SO2RR,
                   7               AEORE,AEORH,AEORT,AEORI,AEORR
 0008        1000   FORMAT(6F7.3)
 0009        2000   FORMAT(1X,1X,1X,15X,'   CO      CO2      SO2       CH       NO '
                   1,'     AEO',
                   1 /,1X,        14HELECTRIC       ,6F8.3,
                   2 /,1X,        14HHEAT PLANT     ,6F8.3,
                   3 /,1X,        14HTRANSPORT.     ,6F8.3,
                   4 /,1X,        14HINDUSTRY       ,6F8.3,
                   5 /,1X,        14HRES./COM.      ,6F8.3,       1X,1X)
 0010        2001   FORMAT(/,1X,'EMISSIONS OF SOLID FUEL',
                   1        /,1X,'***********************')
 0011        2002   FORMAT(/,1X,'EMISSIONS OF LIQUID FUEL',
                   1        /,1X,'************************')
 0012        2003   FORMAT(/,1X,'EMISSIONS OF GASEOUS FUEL',
                   1        /,1X,'*************************')
 0013               READ(4,1000)  RCOME,RCO2E,RSO2E,RCHXE,RXNOE,RAEOE
 0014               READ(4,1000)  RCOMH,RCO2H,RSO2H,RCHXH,RXNOH,RAEOH
 0015               READ(4,1000)  RCOMT,RCO2T,RSO2T,RCHXT,RXNOT,RAEOT
 0016               READ(4,1000)  RCOMI,RCO2I,RSO2I,RCHXI,RXNOI,RAEOI
 0017               READ(4,1000)  RCOMR,RCO2R,RSO2R,RCHXR,RXNOR,RAEOR
 0018               WRITE(8,2004)
 0019        2004   FORMAT(/,1X,'REDUCTION FACTORS',
                   1        /,1X,'*****************')
 0020               WRITE(8,2000)RCOME,RCO2E,RSO2E,RCHXE,RXNOE,RAEOE,
                   X            RCOMH,RCO2H,RSO2H,RCHXH,RXNOH,RAEOH,
```

```
              X           RCOMT,RCO2T,RSO2T,RCHXT,RXNOT,RAEOT,
              X           RCOMI,RCO2I,RSO2I,RCHXI,RXNOI,RAEOI,
              X           RCOMR,RCO2R,RSO2R,RCHXR,RXNOR,RAEOR
 0021          READ(4,1000)  FGSO2E,FGSO2H,FGSO2T,FGSO2I,FGSO2R
 0022          READ(4,1000)  FGAEOE,FGAEOH,FGAEOT,FGAEOI,FGAEOR
 0023    2005  FORMAT(/,1X,'REDUCTION COSTS',
              1        /,1X,'****************')
 0024    2006  FORMAT(1X,1X,1X,17X,    'SO2      AEO',
              1 /,1X, 14HELECTRIC       ,2F8.3,
              2 /,1X,      14HHEAT PLANT     ,2F8.3,
              3/,1X,       14HTRANSPORT.     ,2F8.3,
              4 /,1X,      14HINDUSTRY       ,2F8.3,
              5 /,1X,      14HRES./COM.      ,2F8.3,       1X,1X)
 0025          WRITE(8,2005)
 0026          WRITE(8,2006)  FGSO2E,FGAEOE,
              2              FGSO2H,FGAEOH,
              3              FGSO2T,FGAEOT,
              4              FGSO2I,FGAEOI,
              5              FGSO2R,FGAEOR
        C
 0027          READ(4,1000)  FCOMSE,FCO2SE,FSO2SE,FCHXSE,FXNOSE,FAEOSE
 0028          READ(4,1000)  FCOMSH,FCO2SH,FSO2SH,FCHXSH,FXNOSH,FAEOSH
 0029          READ(4,1000)  FCOMST,FCO2ST,FSO2ST,FCHXST,FXNOST,FAEOST
 0030          READ(4,1000)  FCOMST,FCO2SI,FSO2SI,FCHXSI,FXNOSI,FAEOSI
 0031          READ(4,1000)  FCOMSR,FCO2SR,FSO2SR,FCHXSR,FXNOSR,FAEOSR
        C
 0032          READ(4,1000)  FCOMLE,FCO2LE,FSO2LE,FCHXLE,FXNOLE,FAEOLE
 0033          READ(4,1000)  FCOMLH,FCO2LH,FSO2LH,FCHXLH,FXNOLH,FAEOLH
 0034          READ(4,1000)  FCOMLT,FCO2LT,FSO2LT,FCHXLT,FXNOLT,FAEOLT
 0035          READ(4,1000)  FCOMLI,FCO2LI,FSO2LI,FCHXLI,FXNOLI,FAEOLI
 0036          READ(4,1000)  FCOMLR,FCO2LR,FSO2LR,FCHXLR,FXNOLR,FAEOLR
        C
 0037          READ(4,1000)  FCOMGE,FCO2GE,FSO2GE,FCHXGE,FXNOGE,FAEOGE
 0038          READ(4,1000)  FCOMGH,FCO2GH,FSO2GH,FCHXGH,FXNOGH,FAEOGH
 0039          READ(4,1000)  FCOMGT,FCO2GT,FSO2GT,FCHXGT,FXNOGT,FAEOGT
 0040          READ(4,1000)  FCOMGT,FCO2GI,FSO2GI,FCHXGI,FXNOGI,FAEOGI
 0041          READ(4,1000)  FCOMGR,FCO2GR,FSO2GR,FCHXGR,FXNOGR,FAEOGR
        C
 0042          WRITE(8,2001)
 0043          WRITE(8,2000) FCOMSE,FCO2SE,FSO2SE,FCHXSE,FXNOSE,FAEOSE,
              2              FCOMSH,FCO2SH,FSO2SH,FCHXSH,FXNOSH,FAEOSH,
              3              FCOMST,FCO2ST,FSO2ST,FCHXST,FXNOST,FAEOST,
              4              FCOMSI,FCO2SI,FSO2SI,FCHXSI,FXNOSI,FAEOSI,
              5              FCOMSR,FCO2SR,FSO2SR,FCHXSR,FXNOSR,FAEOSR
        C
 0044          WRITE(8,2002)
 0045          WRITE(8,2000) FCOMLE,FCO2LE,FSO2LE,FCHXLE,FXNOLE,FAEOLE,
              2              FCOMLH,FCO2LH,FSO2LH,FCHXLH,FXNOLH,FAEOLH,
              3              FCOMLT,FCO2LT,FSO2LT,FCHXLT,FXNOLT,FAEOLT,
              4              FCOMLI,FCO2LI,FSO2LI,FCHXLI,FXNOLI,FAEOLI,
              5              FCOMLR,FCO2LR,FSO2LR,FCHXLR,FXNOLR,FAEOLR
        C
```

B 1201

```
 0046              WRITE(8,2003)                                                      REA01050
 0047              WRITE(8,2000) FCOMGE,FCO2GE,FSO2GE,FCHXGE,FXNOGE,FAEOGE,           REA01060
                 2              FCOMGH,FCO2GH,FSO2GH,FCHXGH,FXNOGH,FAEOGH,            REA01070
                 3              FCOMGT,FCO2GT,FSO2GT,FCHXGT,FXNOGT,FAEOGT,            REA01080
                 4              FCOMGI,FCO2GI,FSO2GI,FCHXGI,FXNOGI,FAEOGI,            REA01090
                 5              FCOMGR,FCO2GR,FSO2GR,FCHXGR,FXNOGR,FAEOGR             REA01100
 0048              WRITE(8,2008)                                                      REA01110
 0049        2007  FORMAT(/1X,9X,'      FRADU       FRADP       FRADF',1X,1X,        REA01120
                 1  /,10X,3F11.3,//,1X)                                               REA01130
 0050        2008  FORMAT(/,' NUCLEAR EMISSIONS',                                     REA01140
                 1              /1X,'*****************')                              REA01150
 0051              READ(4,1000) FRADU,FRADP,FRADF                                     REA01160
 0052              WRITE (8,2007) FRADU,FRADP,FRADF                                   REA01170
             C                                                                        REA01180
 0053              RETURN                                                             REA01190
 0054              END                                                                REA01200
```

B 1202

2.5.3 Subroutine CALEMI

```
FORTRAN IV G LEVEL  20.7            CALEMI          DATE = 74116        21:51:42            PAGE 0001

FILE CALEMI                                   CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0001             SUBROUTINE CALEMI                                                    CAL00010
 0002             COMMON /RMOVE/ RCOME,RCO2E,RSO2E,RCHXE,RXNOE,RAEOE,                  CAL00020
                 2               RCOMH,RCO2H,RSO2H,RCHXH,RXNOH,RAEOH,                  CAL00030
                 3               RCOMT,RCO2T,RSO2T,RCHXT,RXNOT,RAEOT,                  CAL00040
                 4               RCOMI,RCO2I,RSO2I,RCHXI,RXNOI,RAEOI,                  CAL00050
                 5               RCOMR,RCO2R,RSO2R,RCHXR,RXNOR,RAEOR,                  CAL00060
                 6SO2RE,SO2RH,SO2RT,SO2RI,SO2RR,                                       CAL00070
                 7AEORE,AEORH,AEORT,AEORI,AEORR                                        CAL00080
 0003             COMMON/DRU/DEMSF(5,65),DEMLF(5,65),DEMGF(5,65),                      CAL00090
                 1 DEME(5,65),DEMH(5,65),DEMTI(5,65),DEMI(5,65),DEMRU(5,65)            CAL00100
 0004             COMMON / DR/ DEMS(5,65),DEMT(5,65),DEMR(5,65),NJ,                    CAL00110
                 2             DEMP(5,65),DEMNS(5,65)                                  CAL00120
 0005             COMMON /NUC/ FRADU,FRADP,FHADP,RADU,RADP,RADF                        CAL00130
 0006             COMMON /ENER/ ESFE,ELFE,EGFE,                                        CAL00140
                 2              ESFH,ELFH,EGFH,                                        CAL00150
                 3              ESFT,ELFT,EGFT,                                        CAL00160
                 4              ESFI,ELFI,EGFI,                                        CAL00170
                 5              ESFR,ELFR,EGFR,ENUC                                    CAL00180
 0007             COMMON /FSOL/ FCOMSE,FCO2SE,FSO2SE,FCHXSE,FXNOSE,FAEOSE,             CAL00190
                 2              FCOMSH,FCO2SH,FSO2SH,FCHXSH,FXNOSH,FAEOSH,             CAL00200
                 3              FCOMST,FCO2ST,FSO2ST,FCHXST,FXNOST,FAEOST,             CAL00210
                 4              FCOMSI,FCO2SI,FSO2SI,FCHXSI,FXNOSI,FAEOSI,             CAL00220
                 5              FCOMSR,FCO2SR,FSO2SR,FCHXSR,FXNOSR,FAEOSR              CAL00230
 0008             COMMON /FLIQ/ FCOMLE,FCO2LE,FSO2LE,FCHXLE,FXNOLE,FAEOLE,             CAL00240
                 2              FCOMLH,FCO2LH,FSO2LH,FCHXLH,FXNOLH,FAEOLH,             CAL00250
                 3              FCOMLT,FCO2LT,FSO2LT,FCHXLT,FXNOLT,FAEOLT,             CAL00260
                 4              FCOMLI,FCO2LI,FSO2LI,FCHXLI,FXNOLI,FAEOLI,             CAL00270
                 5              FCOMLR,FCO2LR,FSO2LR,FCHXLR,FXNOLR,FAEOLR              CAL00280
 0009             COMMON /FGAS/ FCOMGE,FCO2GE,FSO2GE,FCHXGE,FXNOGE,FAEOGE,             CAL00290
                 2              FCOMGH,FCO2GH,FSO2GH,FCHXGH,FXNOGH,FAEOGH,             CAL00300
                 3              FCOMGT,FCO2GT,FSO2GT,FCHXGT,FXNOGT,FAEOGT,             CAL00310
                 4              FCOMGI,FCO2GI,FSO2GI,FCHXGI,FXNOGI,FAEOGI,             CAL00320
                 5              FCOMGR,FCO2GR,FSO2GR,FCHXGR,FXNOGR,FAEOGR              CAL00330
 0010             COMMON / SOL/ COMSE,CO2SE,SO2SE,CHXSE,XNOSE,AEOSE,                   CAL00340
                 2              COMSH,CO2SH,SO2SH,CHXSH,XNOSH,AEOSH,                   CAL00350
                 3              COMST,CO2ST,SO2ST,CHXST,XNOST,AEOST,                   CAL00360
                 4              COMSI,CO2SI,SO2SI,CHXSI,XNOSI,AEOSI,                   CAL00370
                 5              COMSR,CO2SR,SO2SR,CHXSR,XNOSR,AEOSR                    CAL00380
 0011             COMMON / LIQ/ COMLE,CO2LE,SO2LE,CHXLE,XNOLE,AEOLE,                   CAL00390
                 2              COMLH,CO2LH,SO2LH,CHXLH,XNOLH,AEOLH,                   CAL00400
                 3              COMLT,CO2LT,SO2LT,CHXLT,XNOLT,AEOLT,                   CAL00410
                 4              COMLI,CO2LI,SO2LI,CHXLI,XNOLI,AEOLI,                   CAL00420
                 5              COMLR,CO2LR,SO2LR,CHXLR,XNOLR,AEOLR                    CAL00430
 0012             COMMON / GAS/ COMGE,CO2GE,SO2GE,CHXGE,XNOGE,AEOGE,                   CAL00440
                 2              COMGH,CO2GH,SO2GH,CHXGH,XNOGH,AEOGH,                   CAL00450
                 3              COMGT,CO2GT,SO2GT,CHXGT,XNOGT,AEOGT,                   CAL00460
                 4              COMGI,CO2GI,SO2GI,CHXGI,XNOGI,AEOGI,                   CAL00470
                 5              COMGR,CO2GR,SO2GR,CHXGR,XNOGR,AEOGR                    CAL00480
 0013             COMMON / TOT/ COMTOT,CO2TOT,SO2TOT,CHXTOT,XNOTOT,AEOTOT,             CAL00490
                 2              COMSP ,CO2SP ,SO2SP ,CHXSP ,XNOSP ,AEOSP ,             CAL00500
                 3              COMLP ,CO2LP ,SO2LP ,CHXLP ,XNOLP ,AEOLP ,             CAL00510
                 4              COMGP ,CO2GP ,SO2GP ,CHXGP ,XNOGP ,AEOGP ,             CAL00520
```

B 1204

CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

FILE CALEMI

```
              5             COME  ,CO2E  ,SO2E  ,CHXE  ,XNOE  ,AEOE  ,            CAL00530
              6             COMH  ,CO2H  ,SO2H  ,CHXH  ,XNOH  ,AEOH  ,            CAL00540
              7             COMT  ,CO2T  ,SO2T  ,CHXT  ,XNOT  ,AEOT  ,            CAL00550
              8             COMI  ,CO2I  ,SO2I  ,CHXI  ,XNOI  ,AEOI  ,            CAL00560
              9             COMR  ,CO2R  ,SO2R  ,CHXR  ,XNOR  ,AEOR               CAL00570
                    C                                                             CAL00580
                    C     CALCULATION OF EMISSIONS                                CAL00590
                    C                                                             CAL00600
                    C     SOLID FUEL                                              CAL00610
                    C                                                             CAL00620
                    C     ELECTRIC POWER GENERATION                               CAL00630
 0014                     COMSE = ESFE * PCOMSE                                   CAL00640
 0015                     CO2SE = ESFE * PCO2SE                                   CAL00650
 0016                     SO2SE = ESFE * PSO2SE                                   CAL00660
 0017                     CHXSE = ESFE * PCHXSE                                   CAL00670
 0018                     XNOSE = ESFE * PXNOSE                                   CAL00680
 0019                     AEOSE = ESFE * PAEOSE                                   CAL00690
                    C                                                             CAL00700
                    C     HEAT PLANT                                              CAL00710
 0020                     COMSH = ESPH * PCOMSH                                   CAL00720
 0021                     CO2SH = ESPH * PCO2SH                                   CAL00730
 0022                     SO2SH = ESPH * PSO2SH                                   CAL00740
 0023                     CHXSH = ESPH * PCHXSH                                   CAL00750
 0024                     XNOSH = ESPH * PXNOSH                                   CAL00760
 0025                     AEOSH = ESPH * PAEOSH                                   CAL00770
                    C                                                             CAL00780
                    C     TRANSPORTATION                                          CAL00790
 0026                     COMST = ESPT * PCOMST                                   CAL00800
 0027                     CO2ST = ESPT * PCO2ST                                   CAL00810
 0028                     SO2ST = ESPT * PSO2ST                                   CAL00820
 0029                     CHXST = ESPT * PCHXST                                   CAL00830
 0030                     XNOST = ESPT * PXNOST                                   CAL00840
 0031                     AEOST = ESPT * PAEOST                                   CAL00850
                    C                                                             CAL00860
                    C     INDUSTRY                                                CAL00870
 0032                     COMSI = ESPI * PCOMSI                                   CAL00880
 0033                     CO2SI = ESPI * PCO2SI                                   CAL00890
 0034                     SO2SI = ESPI * PSO2SI                                   CAL00900
 0035                     CHXSI = ESPI * PCHXSI                                   CAL00910
 0036                     XNOSI = ESPI * PXNOSI                                   CAL00920
 0037                     AEOSI = ESPI * PAEOSI                                   CAL00930
                    C                                                             CAL00940
                    C     RESIDENTIAL/COMMERCIAL                                  CAL00950
 0038                     COMSR = ESPR * PCOMSR                                   CAL00960
 0039                     CO2SR = ESPR * PCO2SR                                   CAL00970
 0040                     SO2SR = ESPR * PSO2SR                                   CAL00980
 0041                     CHXSR = ESPR * PCHXSR                                   CAL00990
 0042                     XNOSR = ESPR * PXNOSR                                   CAL01000
 0043                     AEOSR = ESPR * PAEOSR                                   CAL01010
                    C                                                             CAL01020
                    C     TOTAL EMISSIONS                                         CAL01030
 0044                     COMSP =(COMSE+COMSH+COMST+COMSI+COMSR)                  CAL01040
```

FILE CALEMI CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
0045         CO2SP  =(CO2SE+CO2SH+CO2ST+CO2SI+CO2SR)
0046         SO2SP  =(SO2SE+SO2SH+SO2ST+SO2SI+SO2SR)
0047         CHXSP  =(CHXSE+CHXSH+CHXST+CHXSI+CHXSR)
0048         XNOSP  =(XNOSE+XNOSH+XNOST+XNOSI+XNOSR)
0049         AEOSP  =(AEOSE+AEOSH+AEOST+AEOSI+AEOSR)
       C
       C     LIQUID FUEL
       C
       C     ELECTRIC POWER GENERATION
0050         COMLE = ELFE * FCOMLE
0051         CO2LE = ELFE * FCO2LE
0052         SO2LE = ELFE * FSO2LE
0053         CHXLE = ELFE * FCHXLE
0054         XNOLE = ELFE * FXNOLE
0055         AEOLE = ELFE * FAEOLE
       C
       C     HEAT PLANT
0056         COMLH = ELFH * FCOMLH
0057         CO2LH = ELFH * FCO2LH
0058         SO2LH = ELFH * FSO2LH
0059         CHXLH = ELFH * FCHXLH
0060         XNOLH = ELFH * FXNOLH
0061         AEOLH = ELFH * FAEOLH
       C
       C     TRANSPORTATION
0062         COMLT = ELFT * FCOMLT
0063         CO2LT = ELFT * FCO2LT
0064         SO2LT = ELFT * FSO2LT
0065         CHXLT = ELFT * FCHXLT
0066         XNOLT = ELFT * FXNOLT
0067         AEOLT = ELFT * FAEOLT
       C
       C     INDUSTRY
0068         COMLI = ELFI * FCOMLI
0069         CO2LI = ELFI * FCO2LI
0070         SO2LI = ELFI * FSO2LI
0071         CHXLI = ELFI * FCHXLI
0072         XNOLI = ELFI * FXNOLI
0073         AEOLI = ELFI * FAEOLI
       C
       C     RESIDENTIAL/COMMERCIAL
0074         COMLR = ELFR * FCOMLR
0075         CO2LR = ELFR * FCO2LR
0076         SO2LR = ELFR * FSO2LR
0077         CHXLR = ELFR * FCHXLR
0078         XNOLR = ELFR * FXNOLR
0079         AEOLR = ELFR * FAEOLR
       C
       C     TOTAL EMISSIONS
0080         COMLP =  (COMLE+COMLH+COMLT+COMLI+COMLP)
0081         CO2LP =  (CO2LE+CO2LH+CO2LT+CO2LI+CO2LR)
0082         SO2LP =(SO2LE+SO2LH+SO2LT+SO2LI+SO2LR )
```

B 1205

FILE CALEMI CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
0083         CHXLF =(CHXLE+CHXLH+CHXLT+CHXLI+CHXLR )                     CAL01570
0084         XNOLF =(XNOLE+XNOLH+XNOLT+XNOLI+XNOLR )                     CAL01580
0085         AEOLF =(AEOLE+AEOLH+AEOLT+AEOLI+AEOLR )                     CAL01590
       C                                                                 CAL01600
       C     GASEOUS FUEL                                                CAL01610
       C                                                                 CAL01620
       C     ELECTRIC POWER GENERATION                                   CAL01630
0086         COMGE = EGFE * FCOMGE                                       CAL01640
0087         CO2GE = EGFE * FCO2GE                                       CAL01650
0088         SO2GE = EGFE * FSO2GE                                       CAL01660
0089         CHXGE = EGFE * FCHXGE                                       CAL01670
0090         XNOGE = EGFE * FXNOGE                                       CAL01680
0091         AEOGE = EGFE * FAEOGE                                       CAL01690
       C                                                                 CAL01700
       C     HEAT PLANT                                                  CAL01710
0092         COMGH = EGFH * FCOMGH                                       CAL01720
0093         CO2GH = EGFH * FCO2GH                                       CAL01730
0094         SO2GH = EGFH * FSO2GH                                       CAL01740
0095         CHXGH = EGFH * FCHXGH                                       CAL01750
0096         XNOGH = EGFH * FXNOGH                                       CAL01760
0097         AEOGH = EGFH * FAEOGH                                       CAL01770
       C                                                                 CAL01780
       C     TRANSPORTATION                                              CAL01790
0098         COMGT = EGFT * FCOMGT                                       CAL01800
0099         CO2GT = EGFT * FCO2GT                                       CAL01810
0100         SO2GT = EGFT * FSO2GT                                       CAL01820
0101         CHXGT = EGFT * FCHXGT                                       CAL01830
0102         XNOGT = EGFT * FXNOGT                                       CAL01840
0103         AEOGT = EGFT * FAEOGT                                       CAL01850
       C                                                                 CAL01860
       C     INDUSTRY                                                    CAL01870
0104         COMGI = EGFI * FCOMGI                                       CAL01880
0105         CO2GI = EGFI * FCO2GI                                       CAL01890
0106         SO2GI = EGFI * FSO2GI                                       CAL01900
0107         CHXGI = EGFI * FCHXGI                                       CAL01910
0108         XNOGI = EGFI * FNOXGI                                       CAL01920
0109         AEOGI = EGFI * FAEOGI                                       CAL01930
       C                                                                 CAL01940
       C     RESIDENTIAL/COMMERCIAL                                      CAL01950
0110         COMGR = EGFR * FCOMGR                                       CAL01960
0111         CO2GR = EGFR * FCO2GR                                       CAL01970
0112         SO2GR = EGFR * FSO2GR                                       CAL01980
0113         CHXGR = EGFR * FCHXGR                                       CAL01990
0114         XNOGR = EGFR * FXNOGR                                       CAL02000
0115         AEOGR = EGFR * FAEOGR                                       CAL02010
       C                                                                 CAL02020
       C     TOTAL EMISSIONS                                             CAL02030
0116         COMGF =(COMGE+COMGH+COMGT+COMGI+COMGR)                      CAL02040
0117         CO2GF =(CO2GE+CO2GH+CO2GT+CO2GI+CO2GR)                      CAL02050
0118         SO2GF =(SO2GE+SO2GH+SO2GT+SO2GI+SO2GR)                      CAL02060
0119         CHXGF =(CHXGE+CHXGH+CHXGT+CHXGI+CHXGR)                      CAL02070
0120         XNOGF =(XNOGE+XNOGH+XNOGT+XNOGI+XNOGR)                      CAL02080
```

B 1207

```
FORTRAN IV G LEVEL  20.7              CALEMI           DATE = 74116        21:51:42            PAGE 0005

FILE CALEMI                                              CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0121             AEOGP =(AEOGE+AEOGH+AEOGT+AEOGI+AEOGR)                                   CAL02090
            C                                                                              CAL02100
            C     TOTAL EMISSIONS                                                          CAL02110
            C                                                                              CAL02120
            C     ELECTRIC                                                                 CAL02130
 0122             COME = COMSE + COMLE + CCMGE                                             CAL02140
 0123             CO2E = CO2SE + CO2LE + CO2GE                                             CAL02150
 0124             SO2E = SO2SE + SO2LE + SO2GE                                             CAL02160
 0125             CHXE = CHXSE + CHXLE + CHXGE                                             CAL02170
 0126             XNOE = XNOSE + XNOLE + XNOGE                                             CAL02180
 0127             AEOE = AEOSE + AEOLE + AEOGE                                             CAL02190
            C                                                                              CAL02200
            C     HEAT PLANT                                                               CAL02210
 0128             COMH = COMSH + COMLH + CCMGH                                             CAL02220
 0129             CO2H = CO2SH + CO2LH + CO2GH                                             CAL02230
 0130             SO2H = SO2SH + SO2LH + SO2GH                                             CAL02240
 0131             CHXH = CHXSH + CHXLH + CHXGH                                             CAL02250
 0132             XNOH = XNOSH + XNOLH + XNOGH                                             CAL02260
 0133             AEOH = AEOSH + AEOLH + AEOGH                                             CAL02270
            C                                                                              CAL02280
            C     TRANSPORTATION                                                           CAL02290
 0134             COMT = COMST + COMLT + CCMGT                                             CAL02300
 0135             CO2T = CO2ST + CO2LT + CO2GT                                             CAL02310
 0136             SO2T = SO2ST + SO2LT + SO2GT                                             CAL02320
 0137             CHXT = CHXST + CHXLT + CHXGT                                             CAL02330
 0138             XNOT = XNOST + XNOLT + XNOGT                                             CAL02340
 0139             AEOT = AEOST + AEOLT + AEOGT                                             CAL02350
            C                                                                              CAL02360
            C     INDUSTRY                                                                 CAL02370
 0140             COMI = COMSI + COMLI + CCMGI                                             CAL02380
 0141             CO2I = CO2SI + CO2LI + CO2GI                                             CAL02390
 0142             SO2I = SO2SI + SO2LI + SO2GI                                             CAL02400
 0143             CHXI = CHXSI + CHXLI + CHXGI                                             CAL02410
 0144             XNOI = XNOSI + XNOLI + XNOGI                                             CAL02420
 0145             AEOI = AEOSI + AEOLI + AEOGI                                             CAL02430
            C                                                                              CAL02440
            C     RESIDENTIAL/COMMERCIAL                                                   CAL02450
 0146             COMR = COMSR + COMLR + CCMGR                                             CAL02460
 0147             CO2R = CO2SR + CO2LR + CO2GR                                             CAL02470
 0148             SO2R = SO2SR + SO2LR + SO2GR                                             CAL02480
 0149             CHXR = CHXSR + CHXLR + CHXGR                                             CAL02490
 0150             XNOR = XNOSR + XNOLR + XNOGR                                             CAL02500
 0151             AEOR = AEOSR + AEOLR + AEOGR                                             CAL02510
            C                                                                              CAL02520
            C     TOTAL EMISSIONS                                                          CAL02530
 0152             COMTOT =(COME + COMH + CCMT + COMI + COMR)                               CAL02540
 0153             CO2TOT =(CO2E + CO2H + CO2T + CO2I + CO2R)                               CAL02550
 0154             SO2TOT =(SO2E + SO2H + SO2T + SO2I + SO2R)                               CAL02560
 0155             CHXTOT =(CHXE + CHXH + CHXT + CHXI + CHXR)                               CAL02570
 0156             XNOTOT =(XNOE + XNOH + XNOT + XNOI + XNOR)                               CAL02580
 0157             AEOTOT =(AEOE + AEOH + AEOT + AEOI + AEOR)                               CAL02590
            C                                                                              CAL02600
```

FILE CALEMI CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
            C                                                              CAL02610
      0158        RADU  = ENUC * FRADU                                     CAL02620
      0159        RADP  = ENUC * FRADP                                     CAL02630
      0160         RADF  = ENUC * FRADF                                    CAL02640
            C                                                              CAL02650
            C     REDUCTION OF EMISSION                                    CAL02660
      0161        SO2RE=SO2E*(1-RSO2E)                                     CAL02670
      0162        SO2RH=SO2H*(1-RSO2H)                                     CAL02680
      0163        SO2RT=SO2T*(1-RSO2T)                                     CAL02690
      0164        SO2RI=SO2I*(1-RSO2I)                                     CAL02700
      0165        SO2RR=SO2R*(1-RSO2R)                                     CAL02710
            C                                                              CAL02720
            C                                                              CAL02730
      0166        AEORE=AEOE*(1-RAEOE)                                     CAL02740
      0167        AEORH=AEOH*(1-RAEOH)                                     CAL02750
      0168        AEORT=AEOT*(1-RAEOT)                                     CAL02760
      0169        AEORI=AEOI*(1-RAEOI)                                     CAL02770
      0170        AEORR=AEOR*(1-RAEOR)                                     CAL02780
            C                                                              CAL02790
            C                                                              CAL02800
      0171        DEMSF(1,NJ)=CO2SF                                        CAL02810
      0172        DEMSF(2,NJ)=SO2SF                                        CAL02820
      0173        DEMSF(3,NJ)=CHXSF                                        CAL02830
      0174        DEMSF(4,NJ)=XNOSF                                        CAL02840
      0175        DEMSF(5,NJ)=AEOSF                                        CAL02850
            C                                                              CAL02860
            C                                                              CAL02870
      0176        DEMLF(1,NJ)=CO2LF                                        CAL02880
      0177        DEMLF(2,NJ)=SO2LF                                        CAL02890
      0178        DEMLF(3,NJ)=CHXLF                                        CAL02900
      0179        DEMLF(4,NJ)=XNOLF                                        CAL02910
      0180        DEMLF(5,NJ)=AEOLF                                        CAL02920
            C                                                              CAL02930
            C                                                              CAL02940
      0181        DEMGF(1,NJ)=CO2GF                                        CAL02950
      0182        DEMGF(2,NJ)=SO2GF                                        CAL02960
      0183        DEMGF(3,NJ)=CHXGF                                        CAL02970
      0184        DEMGF(4,NJ)=XNOGF                                        CAL02980
      0185        DEMGF(5,NJ)=AEOGF                                        CAL02990
            C                                                              CAL03000
            C                                                              CAL03010
      0186        DEME (1,NJ)=CO2E                                         CAL03020
      0187        DEME (2,NJ)=SO2E                                         CAL03030
      0188        DEME (3,NJ)=CHXE                                         CAL03040
      0189        DEME (4,NJ)=XNOE                                         CAL03050
      0190        DEMF (5,NJ)=AEOE                                         CAL03060
            C                                                              CAL03070
            C                                                              CAL03080
      0191        DEMH (1,NJ)=CO2H                                         CAL03090
      0192        DEMH (2,NJ)=SO2H                                         CAL03100
      0193        DEMH (3,NJ)=CHXH                                         CAL03110
      0194        DEMH (4,NJ)=XNOH                                         CAL03120
```

B 1208

```
  FORTRAN IV G LEVEL  20.7            CALEMI          DATE = 74116        21:51:42            PAGE 0007
 FILE CALEMI                                   CMS VERSION 3-LEVEL 2 -- 15 MAY 1973
   0195               DEMH(5,NJ)=AEOH                                                  CAL03130
            C                                                                          CAL03140
            C                                                                          CAL03150
   0196               DEMTR(1,NJ)=CO2T                                                 CAL03160
   0197               DEMTR(2,NJ)=SO2T                                                 CAL03170
   0198               DEMTR(3,NJ)=CHXT                                                 CAL03180
   0199               DEMTR(4,NJ)=XNCT                                                 CAL03190
   0200               DEMTR(5,NJ)=AEOT                                                 CAL03200
            C                                                                          CAL03210
            C                                                                          CAL03220
   0201               DEMI(1,NJ)=CO2I                                                  CAL03230
   0202               DEMI(2,NJ)=SO2I                                                  CAL03240
   0203               DEMI(3,NJ)=CHXI                                                  CAL03250
   0204               DEMI(4,NJ)=XNOI                                                  CAL03260
   0205               DEMI(5,NJ)=AEOI                                                  CAL03270
            C                                                                          CAL03280
            C                                                                          CAL03290
   0206               DEMRC(1,NJ)=CO2R                                                 CAL03300
   0207               DEMRC(2,NJ)=SO2R                                                 CAL03310
   0208               DEMRC(3,NJ)=CHXR                                                 CAL03320
   0209               DEMRC(4,NJ)=XNOR                                                 CAL03330
   0210               DEMRC(5,NJ)=AEOR                                                 CAL03340
   0211               RETURN                                                           CAL03350
   0212               END                                                              CAL03360
```

2.5.4 Subroutine SUMMAT

```
FORTRAN IV G LEVEL  20.7              SUMMAT           DATE = 74116        21:51:07            PAGE 0001

FILE SUMMAT                                            CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0001            SUBROUTINE SUMMAT
 0002            COMMON / DE/ DEMS(5,65),DEMT(5,65),DEMP(5,65),NJ,
                2DEMH(5,65),DEMNS(5,65)
 0003            COMMON /NUC/ FRADU,FRADP,FRADF,RADU,RADP,RADF
 0004            COMMON / FG/ FGSO2E,FGSO2H,FGSO2T,FGSO2I,FGSO2R,
                2             GSO2E, GSO2H, GSO2T, GSO2I, GSO2R,
                3            FGAEOE,FGAEOH,FGAEOT,FGAEOI,FGAEOR,
                4             GAEOE, GAEOH, GAEOT, GAEOI, GAEOR
 0005            COMMON / SUM/ SCOME,SCO2E,SSO2E,SCHXE,SXNOE,SAEOE,
                2             SCOMH,SCO2H,SSO2H,SCHXH,SXNOH,SAEOH,
                3             SCOMT,SCO2T,SSO2T,SCHXT,SXNOT,SAEOT,
                4             SCOMI,SCO2I,SSO2I,SCHXI,SXNOI,SAEOI,
                5             SCOMR,SCO2R,SSO2R,SCHXR,SXNOR,SAEOR,
                6             SCOMS,SCO2S,SSO2S,SCHXS,SXNOS,SAEOS,
                7             SCOML,SCO2L,SSO2L,SCHXL,SXNOL,SAEOL,
                8             SCOMG,SCO2G,SSO2G,SCHXG,SXNOG,SAEOG,
                9             SCOM ,SCO2 ,SSO2 ,SCHX ,SXNO ,SAEO,SGSO2,SGAEO,
                1             SRSO2,SRAEO
 0006            COMMON / TOT/ COMTOT,CO2TOT,SO2TOT,CHXTOT,XNOTOT,AEOTOT,
                2             COMSF ,CO2SF ,SO2SF ,CHXSF ,XNOSF ,AEOSF ,
                3             COMLF ,CO2LF ,SO2LF ,CHXLF ,XNOLF ,AEOLF ,
                4             COMGF ,CO2GF ,SO2GF ,CHXGF ,XNOGF ,AEOGF ,
                5             COME  ,CO2E  ,SO2E  ,CHXE  ,XNOE  ,AEOE  ,
                6             COMH  ,CO2H  ,SO2H  ,CHXH  ,XNOH  ,AEOH  ,
                7             COMT  ,CO2T  ,SO2T  ,CHXT  ,XNOT  ,AEOT  ,
                8             COMI  ,CO2I  ,SO2I  ,CHXI  ,XNOI  ,AEOI  ,
                9             COMR  ,CO2R  ,SO2R  ,CHXR  ,XNOR  ,AEOR
           C
           C      SUMMATION DER EMISSIONEN
           C
           C      NACH TECHNOLOGIEN
           C
           C      ELECTRIC
 0007             SCOME = SCOME + COME
 0008             SCO2E = SCO2E + CO2E
 0009             SSO2E = SSO2E + SO2E
 0010             SCHXE = SCHXE + CHXE
 0011             SXNOE = SXNOE + XNOE
 0012             SAEOE = SAEOE + AEOE
           C
           C      HEAT PLANT
 0013             SCOMH = SCOMH + COMH
 0014             SCO2H = SCO2H + CO2H
 0015             SSO2H = SSO2H + SO2H
 0016             SCHXH = SCHXH + CHXH
 0017             SXNOH = SXNOH + XNOH
 0018             SAEOH = SAEOH + AEOH
           C
           C      TRASPORTATION
 0019             SCOMT = SCOMT + COMT
 0020             SCO2T = SCO2T + CO2T
 0021             SSO2T = SSO2T + SO2T
```

B 1211


```
FILE SUMMAT                                            CMS VERSION 3-LEVEL 2 -- 15 MAY 1973
 0022                SCHXT = SCHXT + CHXT                                                  SUM00530
 0023                SXNOT = SXNOT + XNOT                                                  SUM00540
 0024                SAEOT = SAEOT + AEOT                                                  SUM00550
               C                                                                           SUM00560
               C     INDUSTRY                                                              SUM00570
 0025                SCOMI = SCOMI + COMI                                                  SUM00580
 0026                SCO2I = SCO2I + CO2I                                                  SUM00590
 0027                SSO2I = SSO2I + SO2I                                                  SUM00600
 0028                SCHXI = SCHXI + CHXI                                                  SUM00610
 0029                SXNOI = SXNOI + XNOI                                                  SUM00620
 0030                SAEOI = SAEOI + AEOI                                                  SUM00630
               C                                                                           SUM00640
               C     RESIDENTIAL/COMMERCIAL                                                SUM00650
 0031                SCOMR = SCOMR + COMR                                                  SUM00660
 0032                SCO2R = SCO2R + CO2R                                                  SUM00670
 0033                SSO2R = SSO2R + SO2R                                                  SUM00680
 0034                SCHXR = SCHXR + CHXR                                                  SUM00690
 0035                SXNOR = SXNOR + XNOR                                                  SUM00700
 0036                SAEOR = SAEOR + AEOR                                                  SUM00710
               C                                                                           SUM00720
               C     NACH PRIMAER-ENERGIE-TRAEGERN                                         SUM00730
               C                                                                           SUM00740
               C     SOLID FUEL                                                            SUM00750
 0037                SCOMS = SCOMS + COMS                                                  SUM00760
 0038                SCO2S = SCO2S + CO2S                                                  SUM00770
 0039                SSO2S = SSO2S + SO2S                                                  SUM00780
 0040                SCHXS = SCHXS + CHXS                                                  SUM00790
 0041                SXNOS = SXNOS + XNOS                                                  SUM00800
 0042                SAEOS = SAEOS + AEOS                                                  SUM00810
               C                                                                           SUM00820
               C     LIQUID FUEL                                                           SUM00830
 0043                SCOML = SCOML + COML                                                  SUM00840
 0044                SCO2L = SCO2L + CO2L                                                  SUM00850
 0045                SSO2L = SSO2L + SO2L                                                  SUM00860
 0046                SCHXL = SCHXL + CHXL                                                  SUM00870
 0047                SXNOL = SXNOL + XNOL                                                  SUM00880
 0048                SAEOL = SAEOL + AEOL                                                  SUM00890
               C                                                                           SUM00900
               C     GASEOUS FUEL                                                          SUM00910
 0049                SCOMG = SCOMG + COMG                                                  SUM00920
 0050                SCO2G = SCO2G + CO2G                                                  SUM00930
 0051                SSO2G = SSO2G + SO2G                                                  SUM00940
 0052                SCHXG = SCHXG + CHXG                                                  SUM00950
 0053                SXNOG = SXNOG + XNOG                                                  SUM00960
 0054                SAEOG = SAEOG + AEOG                                                  SUM00970
               C                                                                           SUM00980
               C     OF TOTAL                                                              SUM00990
 0055                SCOM  = SCOM  +COMTOT                                                 SUM01000
 0056                SCO2  = SCO2  +CO2TOT                                                 SUM01010
 0057                SSO2  = SSO2  +SO2TOT                                                 SUM01020
 0058                SCHX  = SCHX  +CHXTOT                                                 SUM01030
 0059                SXNO  = SXNO  +XNOTOT                                                 SUM01040
```

FILE SUMMAT   CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
0060          SAEO  = SAEO  +AEOTOT                                        SUMO1050
        C                                                                  SUMO1060
0061          DEMS(1,NJ)=SCO2                                              SUMO1070
0062          DEMS(2,NJ)=SSO2                                              SUMO1080
0063          DEMS(3,NJ)=SCHX                                              SUMO1090
0064          DEMS(4,NJ)=SXNO                                              SUMO1100
0065          DEMS(5,NJ)=SAEO                                              SUMO1110
        C                                                                  SUMO1120
        C                                                                  SUMO1130
0066          DEMT(1,NJ)=CO2TOT                                            SUMO1140
0067          DEMT(2,NJ)=SO2TOT                                            SUMO1150
0068          DEMT(3,NJ)=CHXTOT                                            SUMO1160
0069          DEMT(4,NJ)=XNOTOT                                            SUMO1170
0070          DEMT(5,NJ)=AEOTOT                                            SUMO1180
        C                                                                  SUMO1190
        C                                                                  SUMO1200
        C                                                                  SUMO1210
        C                                                                  SUMO1220
0071          SPAU = SRAU + RADU                                           SUMO1230
0072          SRAP = SRAP + RADP                                           SUMO1240
0073          SRAF = SRAF + RADF                                           SUMO1250
0074          GSO2E = SO2E *FGSO2E                                         SUMO1260
0075          GSO2H = SO2H *FGSO2H                                         SUMO1270
0076          GSO2T = SO2T *FGSO2T                                         SUMO1280
0077          GSO2I = SO2I *FGSO2I                                         SUMO1290
0078          GSO2R = SO2R *FGSO2R                                         SUMO1300
0079          GAEOE = AEOE *FGAEOE                                         SUMO1310
0080          GAEOH = AEOH *FGAEOH                                         SUMO1320
0081          GAEOT = AEOT *FGAEOT                                         SUMO1330
0082          GAEOI = AEOI *FGAEOI                                         SUMO1340
0083          GAEOR = AEOR *FGAEOR                                         SUMO1350
0084          GSO2=GSO2E+GSO2H+GSO2T+GSO2I+GSO2R                           SUMO1360
0085          GAEO=GAEOE+GAEOH+GAEOT+GAEOI+GAEOR                           SUMO1370
0086          SGSO2=SGSO2+GSO2                                             SUMO1380
0087          SGAEO=SGAEO+GAEO                                             SUMO1390
0088          TRSO2=SO2RE+SO2RH+SO2RT+SO2RI+SO2RR                          SUMO1400
0089          TRAEO=AEORE+AEORH+AEORT+AEORI+AEORR                          SUMO1410
0090          SRSO2=SRSO2+TRSO2                                            SUMO1420
0091          SRAEO=SRAEO+TRAEO                                            SUMO1430
        C                                                                  SUMO1440
        C                                                                  SUMO1450
0092          DEMR(1,NJ)=TRSO2                                             SUMO1460
0093          DEMR(2,NJ)=TRAEO                                             SUMO1470
0094          DEMR(3,NJ)=GSO2                                              SUMO1480
0095          DEMR(4,NJ)=GAEO                                              SUMO1490
0096          DEMN(1,NJ)=RADU                                              SUMO1500
0097          DEMN(2,NJ)=RADP                                              SUMO1510
0098          DEMN(3,NJ)=RADF                                              SUMO1520
        C                                                                  SUMO1530
        C                                                                  SUMO1540
0099          DEMNS(1,NJ)=SRAU                                             SUMO1550
0100          DEMNS(2,NJ)=SRAP                                             SUMO1560
```

B 1212

B 1213

```
FORTRAN IV G LEVEL  20.7              SUMMAT           DATE = 74116         21:51:07           PAGE 0004

FILE SUMMAT                                            CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

  0101            DEMNS(3,NJ)=SRAF                                                  SUM01570
  0102            RETURN                                                            SUM01580
  0103            END                                                               SUM01590
```

2.5.5 Subroutine BILD

```
FORTRAN IV G LEVEL  20.7              BILD              DATE = 74116        21:49:59             PAGE 0001
*... BILD                                        CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

             SUBROUTINE BILD (EING)                                               BIL00010
             DIMENSION FELD(67,61),EING(5,65),Z(61),CL(10)                        BIL00020
             REAL*4 MIN,MAX                                                       BIL00030
             DATA CL/'1','2','3' ,'4','5','6','7','8','9','0'/                    BIL00040
             DATA STR/'|'/,Q/'-'/,AL/'X'/,BL/' '/                                 BIL00050
             DO   5  I=1,61                                                       BIL00060
             DO   5  J=1,67                                                       BIL00070
      5      FELD(J,I)=BL                                                         BIL00080
             MAX=EING(1,1)                                                        BIL00090
             DO2    J=1,65                                                        BIL00100
             DO2    I=1,5                                                         BIL00110
             X=MAX-EING(I,J)                                                      BIL00120
             IF (X.LT.0) MAX=EING(I,J)                                            BIL00130
      2      CONTINUE                                                             BIL00140
             MIN=EING(1,1)                                                        BIL00150
             DO3    J=1,65                                                        BIL00160
             DO3    I=1,5                                                         BIL00170
             X=MIN-EING(I,J)                                                      BIL00180
             IF (X.GT.0) MIN=EING(I,J)                                            BIL00190
      3      CONTINUE                                                             BIL00200
             DIFF=MAX-MIN                                                         BIL00210
             SPR=DIFF/60.                                                         BIL00220
             Z(1)=MAX                                                             BIL00230
             DO4    K=2,61                                                        BIL00240
             Z(K)=Z(K-1)-SPR                                                      BIL00250
      4      CONTINUE                                                             BIL00260
             Y=SPR/2.                                                             BIL00270
             DO10    N=1,61                                                       BIL00280
             FELD(1,N)=Z(N)                                                       BIL00290
     10      CONTINUE                                                             BIL00300
             DO11    N=1,60                                                       BIL00310
             DO11    M=2,67,5                                                     BIL00320
             FELD(M,N)=STR                                                        BIL00330
     11      CONTINUE                                                             BIL00340
             DO12    N=1,61,10                                                    BIL00350
             DO12    M=2,67                                                       BIL00360
             FELD(M,N)=Q                                                          BIL00370
     12      CONTINUE                                                             BIL00380
             M=2                                                                  BIL00390
             DO13    J=1,65                                                       BIL00400
             M=M+1                                                                BIL00410
             DO13    I=1,5                                                        BIL00420
             N=0                                                                  BIL00430
             DO13    K=1,61                                                       BIL00440
             N=N+1                                                                BIL00450
             A =EING(I,J)-Z(K)                                                    BIL00460
             IF (A .LT.-Y)  GOTO13                                                BIL00470
             IF (A .GT.+Y)  GOTO13                                                BIL00480
             FELD(M,N)=CL(I)                                                      BIL00490
     13      CONTINUE                                                             BIL00500
             WRITE(8,30) FELD                                                     BIL00510
     30      FORMAT(1XE10.4,66A1)                                                 BIL00520
```

```
FILE BILD                                   CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

  0053               WRITE(8,31)                                                      BIL00530
  0054         31    FORMAT(5X,                                                       BIL00540
                    1'   1970   75   80   85   90   95 2000   05   10   15   20   ',  BIL00550
                    X  '25   30   35')                                                BIL00560
  0055               RETURN                                                           BIL00570
  0056               END                                                              BIL00580
```

2.5.6 Subroutine ZERO

```
FORTRAN IV G LEVEL  20.7            ZERO            DATE = 74116        21:53:05            PAGE 0001
FILE ZERO                                           CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

 0001            SUBROUTINE ZERO                                                            ZERO0010
 0002            COMMON / SUM/ SCOME,SCO2E,SSO2E,SCHXE,SXNOE,SAEOE,                         ZERO0020
                2              SCOMH,SCO2H,SSO2H,SCHXH,SXNOH,SAEOH,                         ZERO0030
                3              SCOMT,SCO2T,SSO2T,SCHXT,SXNOT,SAEOT,                         ZERO0040
                4              SCOMI,SCO2I,SSO2I,SCHXI,SXNOI,SAEOI,                         ZERO0050
                5              SCOMR,SCO2R,SSO2R,SCHXR,SXNOR,SAEOR,                         ZERO0060
                6              SCOMS,SCO2S,SSO2S,SCHXS,SXNOS,SAEOS,                         ZERO0070
                7              SCOML,SCO2L,SSO2L,SCHXL,SXNOL,SAEOL,                         ZERO0080
                8              SCOMG,SCO2G,SSO2G,SCHXG,SXNOG,SAEOG,                         ZERO0090
                9              SCOM ,SCO2 ,SSO2 ,SCHX ,SXNO ,SAEO,SGSO2,SGAEO,              ZERO0100
                1              SRSO2,SRAEO                                                  ZERO0110
          C                                                                                 ZERO0120
          C      LOESCHEN ALLER SUMMENFELDER                                                ZERO0130
 0003            SCOME=0.0                                                                  ZERO0140
 0004            SCO2E=0.0                                                                  ZERO0150
 0005            SSO2E=0.0                                                                  ZERO0160
 0006            SCHXE=0.0                                                                  ZERO0170
 0007            SXNOE=0.0                                                                  ZERO0180
 0008            SAEOE=0.0                                                                  ZERO0190
 0009            SCOMH=0.0                                                                  ZERO0200
 0010            SCO2H=0.0                                                                  ZERO0210
 0011            SSO2H=0.0                                                                  ZERO0220
 0012            SCHXH=0.0                                                                  ZERO0230
 0013            SXNOH=0.0                                                                  ZERO0240
 0014            SAEOH=0.0                                                                  ZERO0250
 0015            SCOMT=0.0                                                                  ZERO0260
 0016            SCO2T=0.0                                                                  ZERO0270
 0017            SSO2T=0.0                                                                  ZERO0280
 0018            SCHXT=0.0                                                                  ZERO0290
 0019            SXNOT=0.0                                                                  ZERO0300
 0020            SAEOT=0.0                                                                  ZERO0310
 0021            SCOMI=0.0                                                                  ZERO0320
 0022            SCO2I=0.0                                                                  ZERO0330
 0023            SSO2I=0.0                                                                  ZERO0340
 0024            SCHXI=0.0                                                                  ZERO0350
 0025            SXNOI=0.0                                                                  ZERO0360
 0026            SAEOI=0.0                                                                  ZERO0370
 0027            SCOMR=0.0                                                                  ZERO0380
 0028            SCO2R=0.0                                                                  ZERO0390
 0029            SSO2R=0.0                                                                  ZERO0400
 0030            SCHXR=0.0                                                                  ZERO0410
 0031            SXNOR=0.0                                                                  ZERO0420
 0032            SAEOR=0.0                                                                  ZERO0430
 0033            SCOMS=0.0                                                                  ZERO0440
 0034            SCO2S=0.0                                                                  ZERO0450
 0035            SSO2S=0.0                                                                  ZERO0460
 0036            SCHXS=0.0                                                                  ZERO0470
 0037            SXNOS=0.0                                                                  ZERO0480
 0038            SAEOS=0.0                                                                  ZERO0490
 0039            SCOML=0.0                                                                  ZERO0500
 0040            SCO2L=0.0                                                                  ZERO0510
 0041            SSO2L=0.0                                                                  ZERO0520
```

FILE ZERO CMS VERSION 3-LEVEL 2 -- 15 MAY 1973

```
0042      SCHXL=0.0                          ZER00530
0043      SXNOL=0.0                          ZER00540
0044      SAROL=0.0                          ZER00550
0045      SCOMG=0.0                          ZER00560
0046      SCO2G=0.0                          ZER00570
0047      SSO2G=0.0                          ZER00580
0048      SCHXG=0.0                          ZER00590
0049      SXNOG=0.0                          ZER00600
0050      SAROG=0.0                          ZER00610
0051      SCOM =0.0                          ZER00620
0052      SCO2 =0.0                          ZER00630
0053      SSO2 =0.0                          ZER00640
0054      SCHX =0.0                          ZER00650
0055      SXNO =0.0                          ZER00660
0056      SARO =0.0                          ZER00670
0057      SGSO2=0.0                          ZER00680
0058      SGARO=0.0                          ZER00690
0059      SRSO2=0.0                          ZER00700
0060      SRAEO=0.0                          ZER00710
0061      RETURN                             ZER00720
0062      END                                ZER00730
```

3. SCENARIO SPECIFICATION

3.1 Classification of Scenarios

Roughly one can define two broader classes of scenarios for EIA:

(i) those concerned with the computation of emissions, required emission abatement levels, and the corresponding abatement costs. Such scenarios can be run with the emission register in its present state.

(ii) those concerned with feedbacks into higher levels, e.g. the effects of abatement measures on the productivity of capital, or the effects of pollution on energy consumption behaviour etc. Such scenarios cannot yet be analysed online with our present energy emission register. For these we will have to link the energy emission register with the submodels for energy demand, energy supply, resources, economy, and population. Work is under way to achieve this integration of submodels, so that in the near future more realistic scenarios can be analysed.

Back to class (i): The scenarios of this class can be subdivided according to the decision tree in Fig. 3.1. Two decision levels can be recognized. In the upper level three basic decisions are possible:

a. No investments for abatement. All emissions go into the environment.

b. A given degree of emission abatement is decided for. The necessary abatement costs can then be computed.

c. An investment of given magnitude for emission abatement is decided upon. The degree of emission reduction is then a secondary quantity which can be computed.

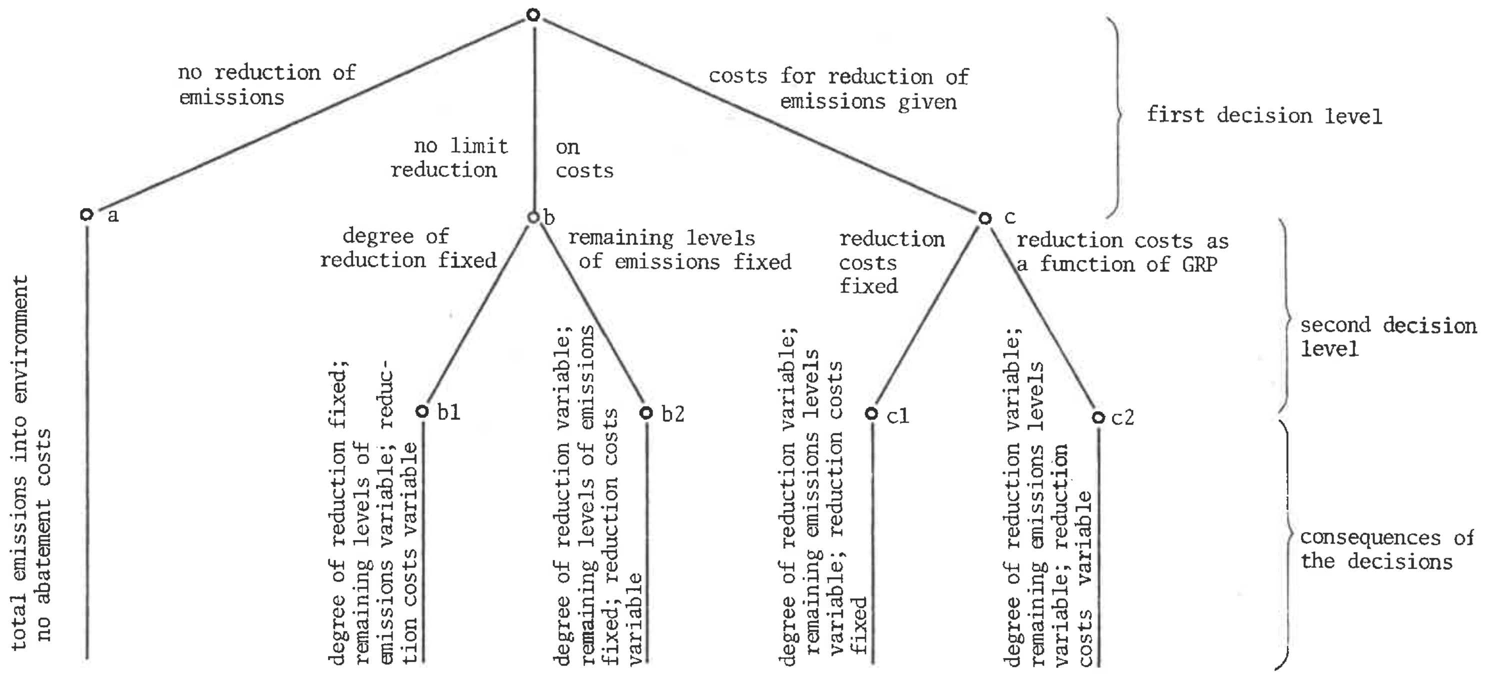


FIG. 3.1 A DECISION TREE FOR CLASSIFYING EMISSION SCENARIOS

On the second decision level further decisions based on the decision made on the first level can follow:

b 1. The degree of emission reduction is fixed, but the costs are variable, depending on the levels of activity in the different sectors of energy consumption.

b 2. Environmental protection laws set a threshold of emissions that may not be exceeded. Again, the reduction costs are a function of the levels of energy consumption.

c 1. The investments for abatement are fixed in advance. Now the emission levels vary with the levels of energy consumption.

c 2. Abatement costs are fixed in advance to be some function of Gross Regional Product. The emission levels can then be computed as a secondary quantity.

Fig. 3.1 shows how one can generate sub-scenarios within a frame scenario systematically with a decision tree. Each path in such a tree then corresponds to one specific scenario.

3.2 Selection and Specification of Inputs

The energy data are taken from the ESP program as external time series. These data were described in detail in ch. 2.2.4.

For the computation of sectoral emissions we needed emission coefficients for each primary energy source (see table below):

EMISSIONS OF SOLID FUEL
****

	CO	CO2	SO2	CH	NO	AFO
ELECTRIC	0.200	3.000	20.000	0.100	8.500	4.500
HEAT PLANT	0.200	3.000	20.000	0.100	8.500	4.500
TRANSPORT.	20.000	3.000	1.100	6.000	12.000	5.000
INDUSTRY	1.400	3.000	25.000	0.400	7.000	10.000
RES./COM.	5.000	3.000	20.000	5.000	3.500	20.000

EMISSIONS OF LIQUID FUEL
****

	CO	CO2	SO2	CH	NO	AFO
ELECTRIC	0.100	3.200	23.000	0.200	7.000	2.000
HEAT PLANT	0.100	3.200	23.000	0.200	7.500	2.000
TRANSPORT.	150.000	3.200	3.500	15.000	20.000	4.000
INDUSTRY	0.200	3.200	16.000	0.300	7.000	2.000
RES./COM.	0.300	3.200	0.600	2.000	0.200	2.000

EMISSIONS OF GASEOUS FUEL
****

	CO	CO2	SO2	CH	NO	AFO
ELECTRIC	0.100	2.700	0.100	0.0	5.000	0.100
HEAT PLANT	0.100	2.700	0.100	0.0	5.000	0.100
TRANSPORT.	5.000	2.700	0.100	0.0	5.000	0.100
INDUSTRY	0.0	2.700	0.100	0.0	5.000	0.200
RES./COM.	0.0	2.700	0.100	2.000	1.500	0.200

NUCLEAR EMISSIONS
****

FRADU	FRADP	FRADF
14.700	144.000	0.0

These coefficients were obtained from [74] and [75] .

4. Computer Runs

4.1 Description of the Underlying Energy Scenarios

(i) Western Europe

This scenario assumes gradual conversion of the Western European economy to synthetic liquid and gaseous fuels from coal. Full imports are discontinued by 2000. No new nuclear facilities are put into operation, existing ones produce until 1985. Rejected heat from power stations is partially used. The liquid fuel produced supplies mainly the transportation sector after 2000.

(ii) Western Europe

In this scenario the primary energy input is held at the 5 kw/cap level. Service equivalent to the present 10 kw/cap level would result if 50% overall savings in user efficiency could be introduced.

(iii) United States

This is a standard energy scenario JCAE 7 of the Joint Committee on Atomic Energy. The JCAE scenario is specified to the year 2000, taking into account the depletion of oil and gas reserves. The scenario assumes a substantial role of nuclear energy and an increasing role of coal.

(iv) United States

This is a non-nuclear energy alternative scenario, supplying approximately the same amount of secondary energies to users as the JCAE scenario, and making extensive use of advanced energy technologies.

4.2 Comments

According to the classification in chapter 3, all of the following computer simulation runs result from "passive" EIA scenarios, because they are based on energy policies from the ESP program. The ER only computes the environmental load of these policies. Even though our model does not yet allow for online feedback of emissions to the energy policies of the ESP program, it is already useful for comparing given energy policies w.r.t. the environmental loads they generate. The resulting emissions can be compared quantitatively. In this way it is possible to base energy policy on environmental considerations in addition to those of resources availability and economic feasibility.

4.3 Runs

1. Western Europe
   Gradual Conversion to Synthetic Fuels,
   No Nuclear Energy

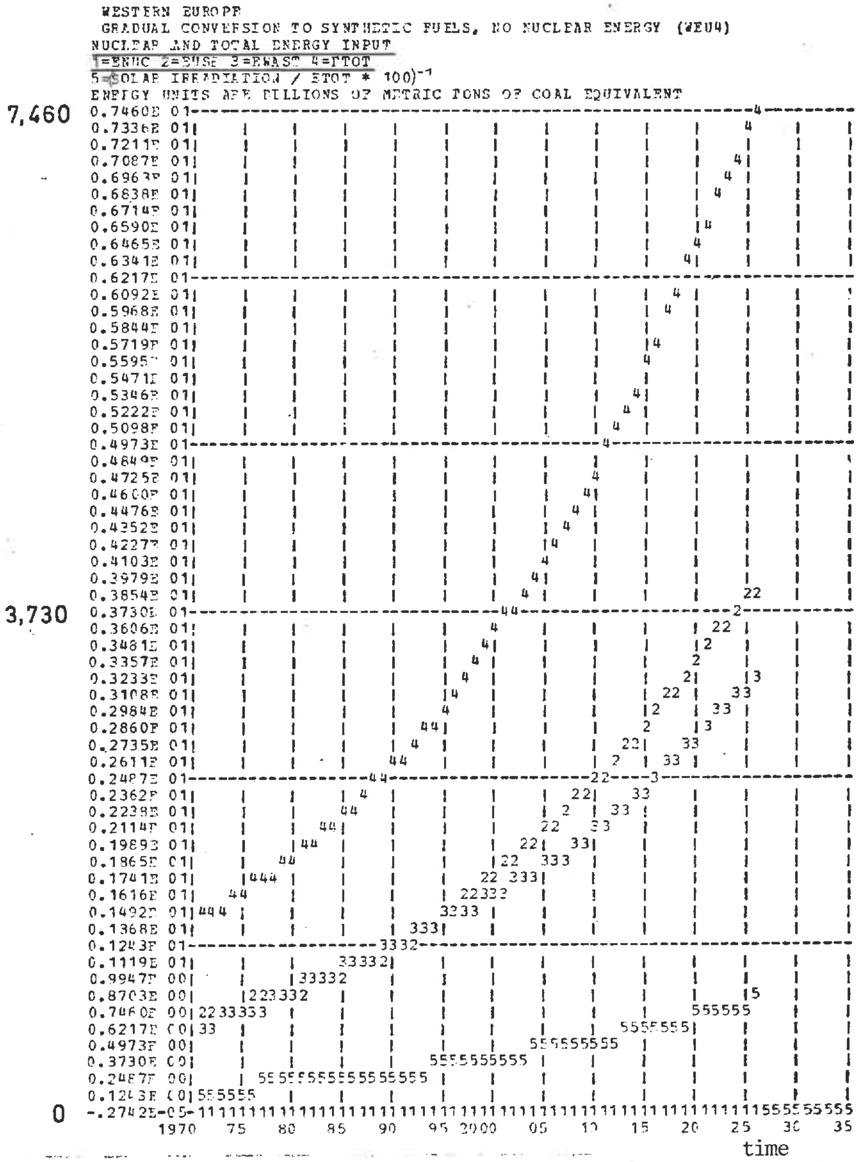
2. Western Europe
   Consumption corr. to 5 kw/Cap or 10 kw/Cap
   at 40 % Savings in Use

3. United States
   Advanced Technology Mix Without Nuclear Power

4. United States
   JCAE Scenario Extended to 2025

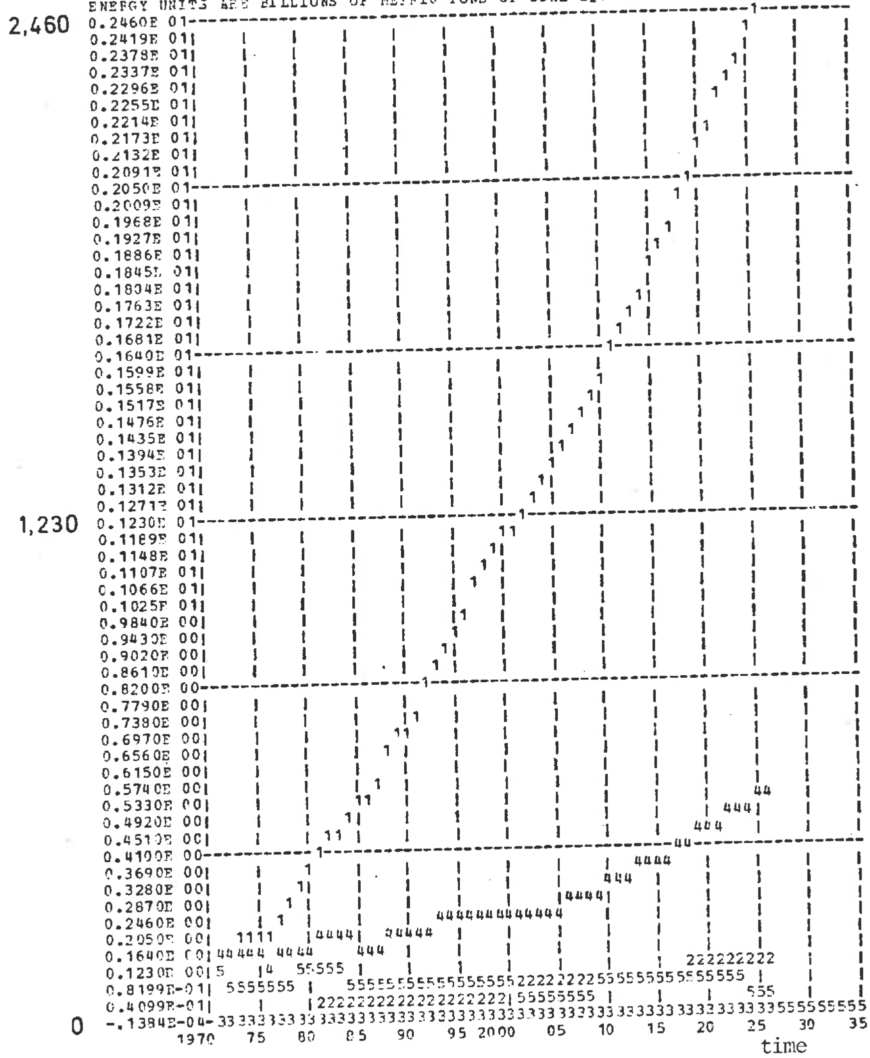
1. Western Europe

Gradual Conversion to Synthetic Fuels, No Nuclear Energy



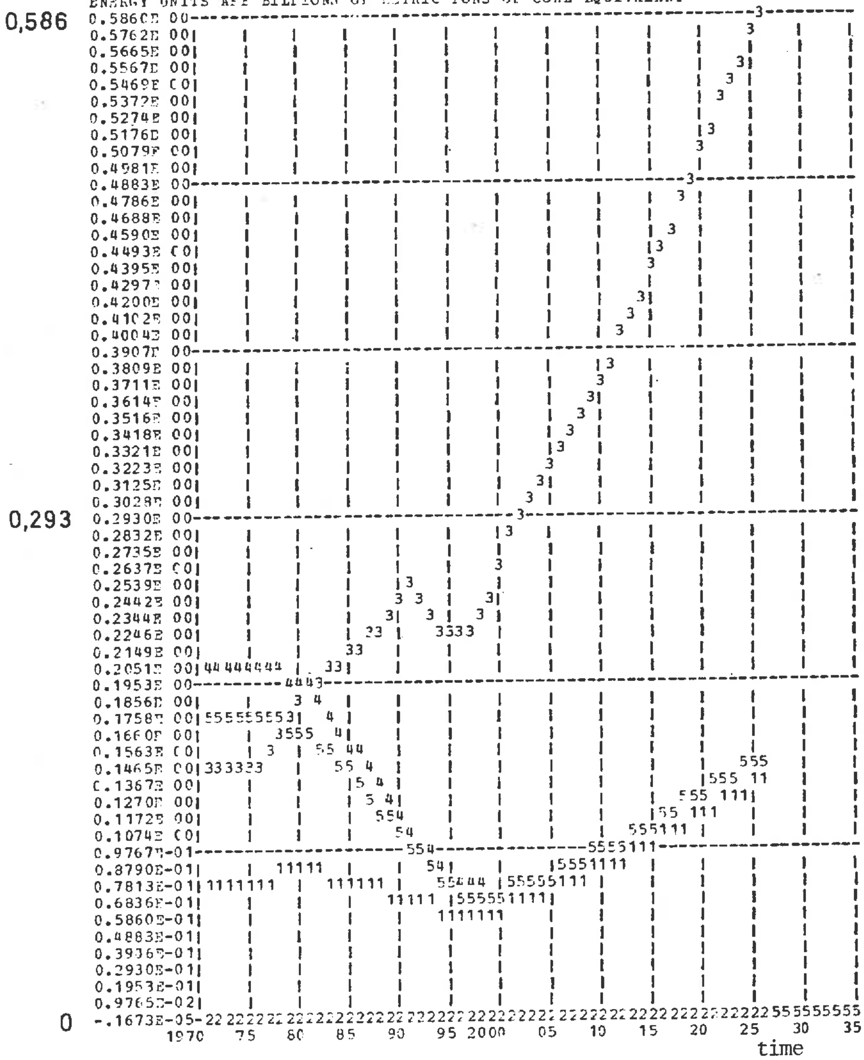
Nuclear and Total Energy Input

WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WEU4)
SOLID FUEL INPUT
1=ESFE 2=ESFH 3=ESFT 4=ESFI 5=ESFR
ENERGY UNITS ARE BILLIONS OF METRIC TONS OF COAL EQUIVALENT

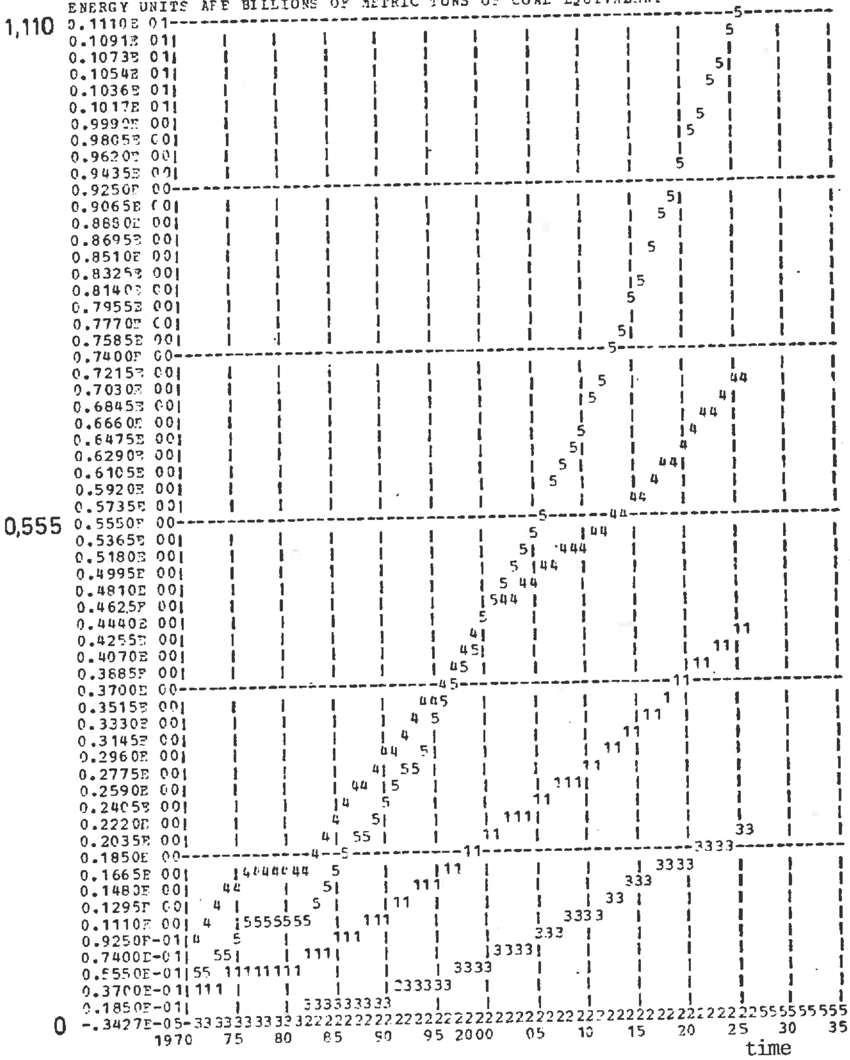


B 1227

WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WEU4)
LIQUID FUEL INPUT
1=ELFE 2=ELFH 3=ELFT 4=ELFI 5=ELFR
ENERGY UNITS ARE BILLIONS OF METRIC TONS OF COAL EQUIVALENT

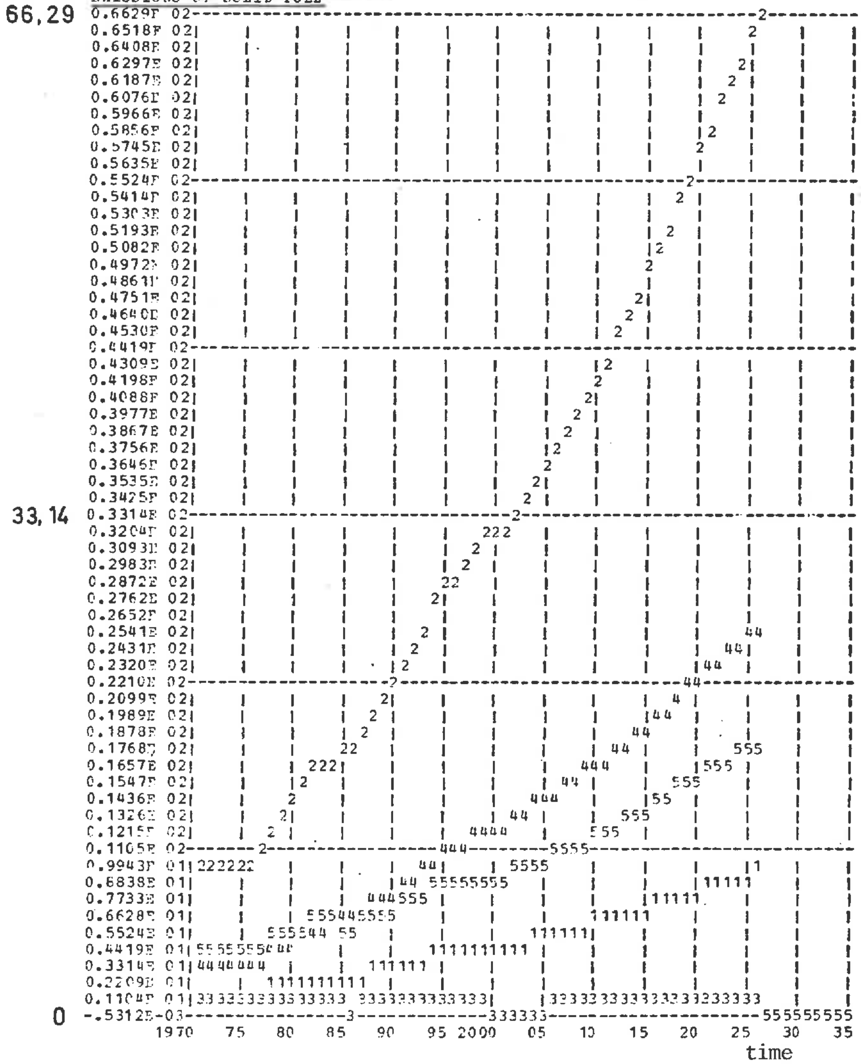


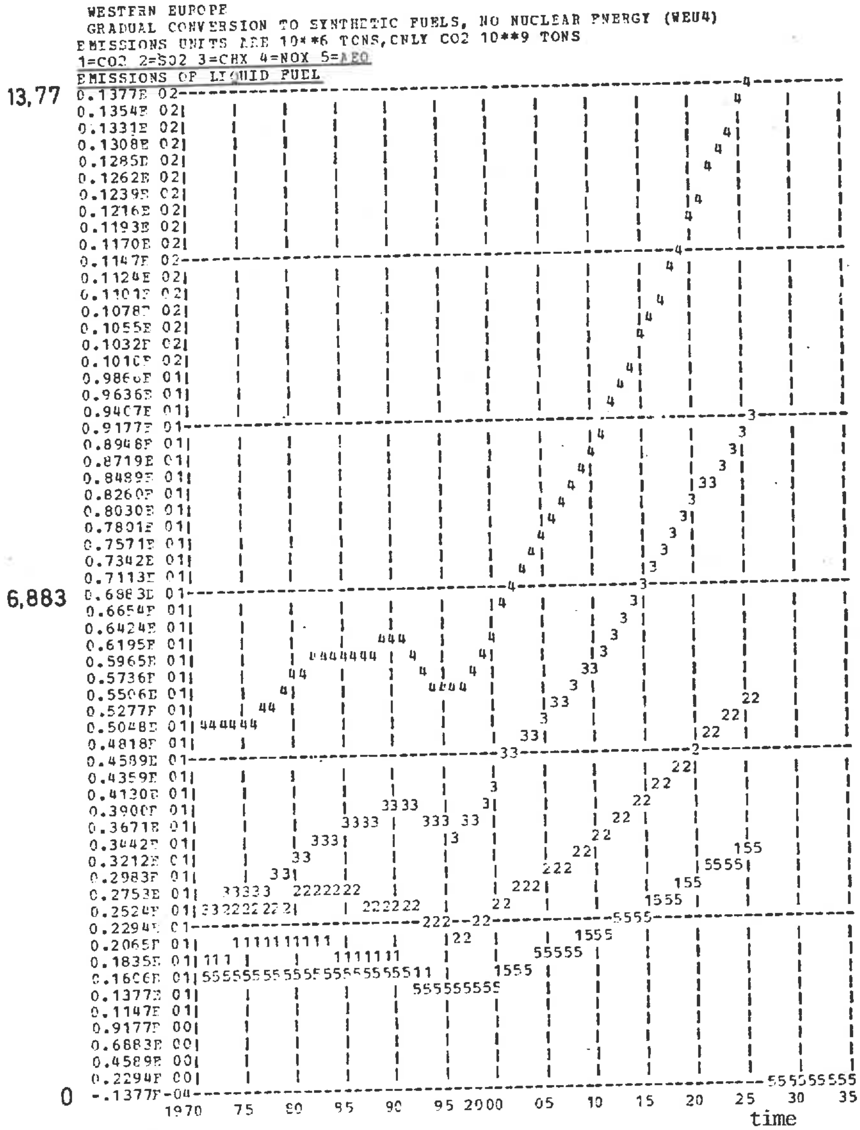
WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WE04)
GASEOUS FUEL INPUT
1=EGFP 2=EGFH 3=EGPT 4=EGPI 5=EGFR
ENERGY UNITS ARE BILLIONS OF METRIC TONS OF COAL EQUIVALENT



Gaseous Fuel Input

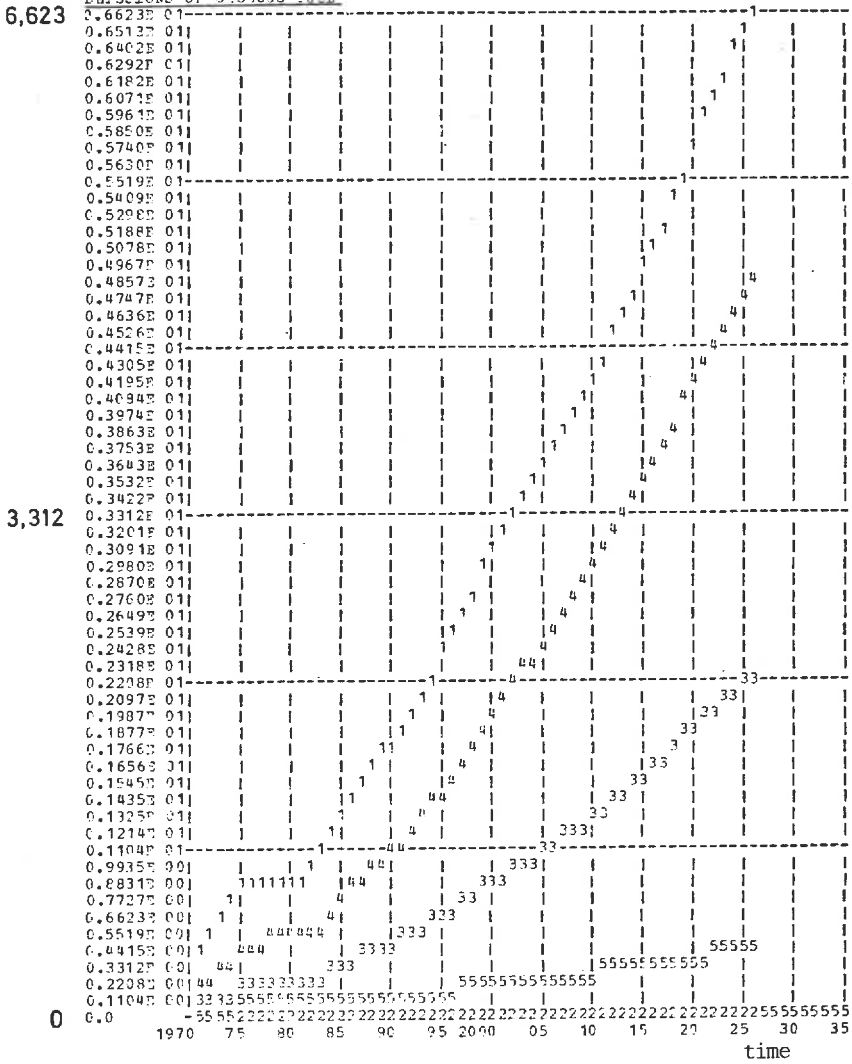
WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WEU4)
EMISSIONS UNITS ARE 10**6 TONS, ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AEO
EMISSIONS OF SOLID FUEL



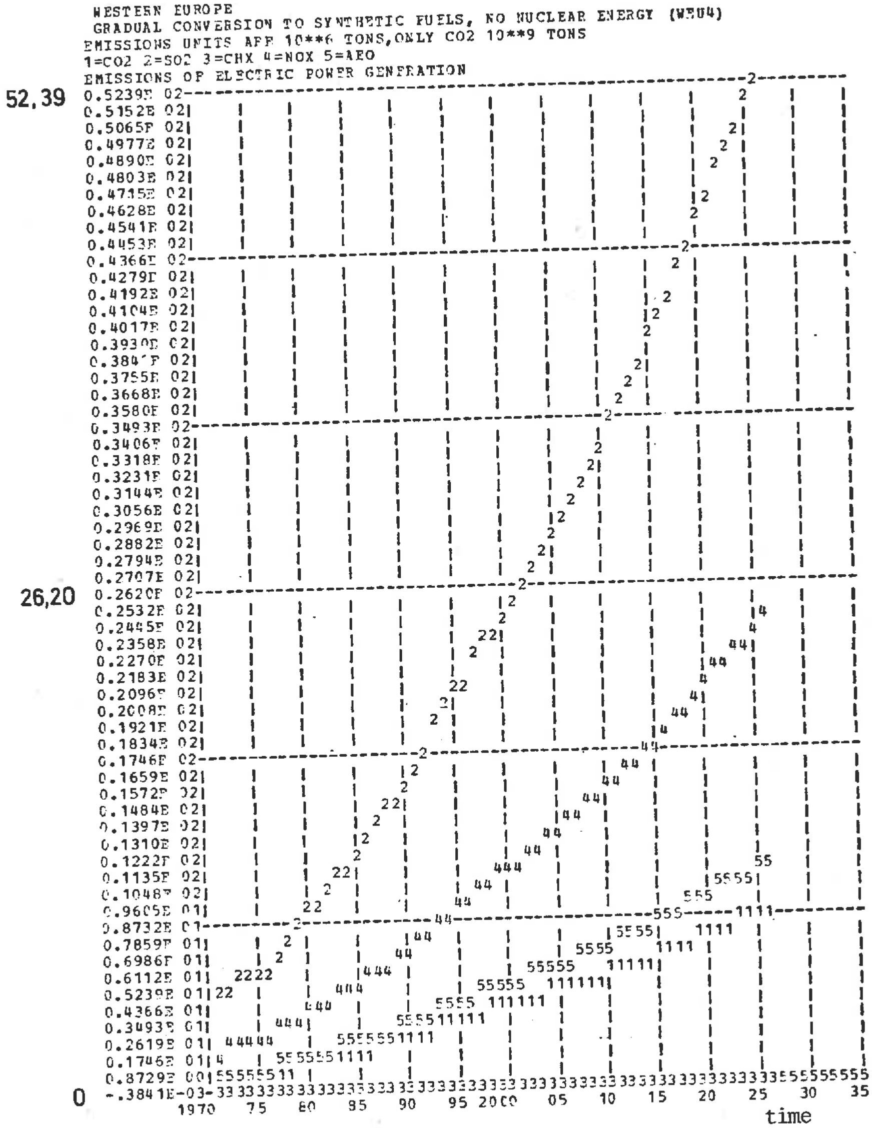


Emissions of Liquid Fuel

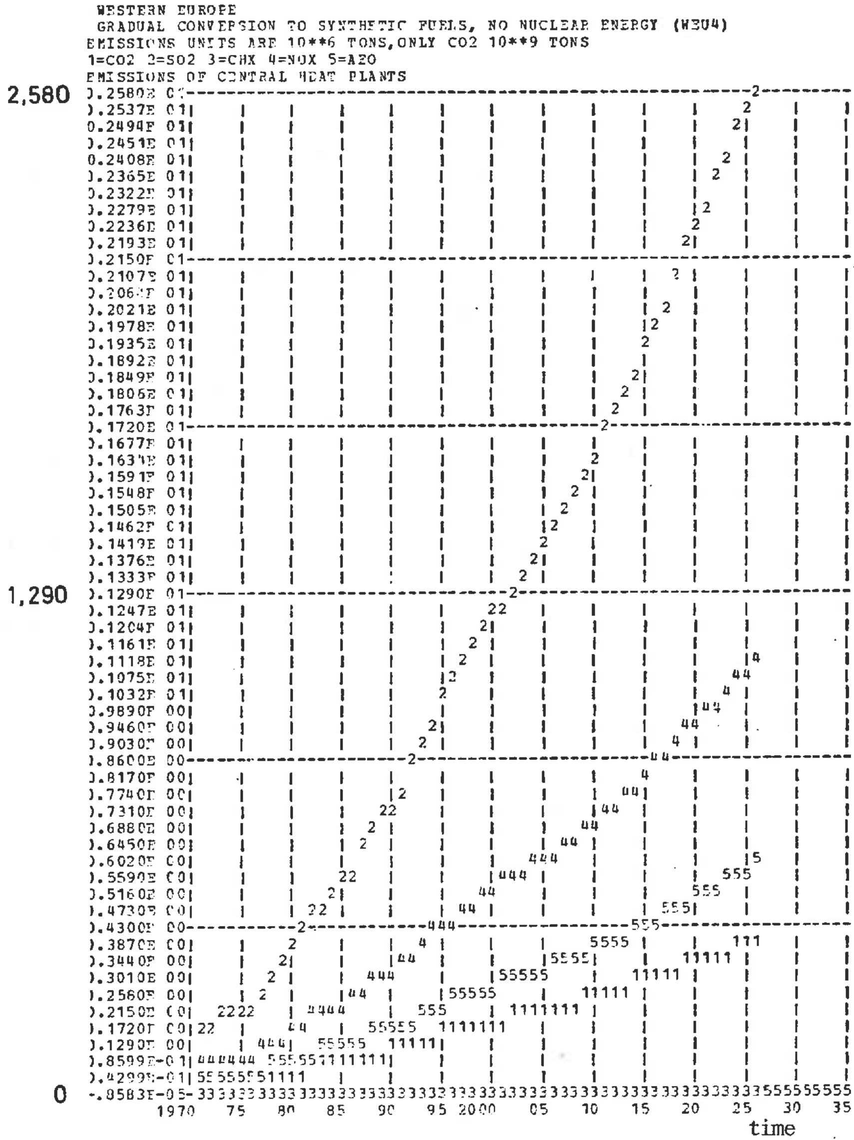
WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WEU4)
EMISSIONS UNITS ARE 10**6 TONS, ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AEO
EMISSIONS OF GASEOUS FUEL



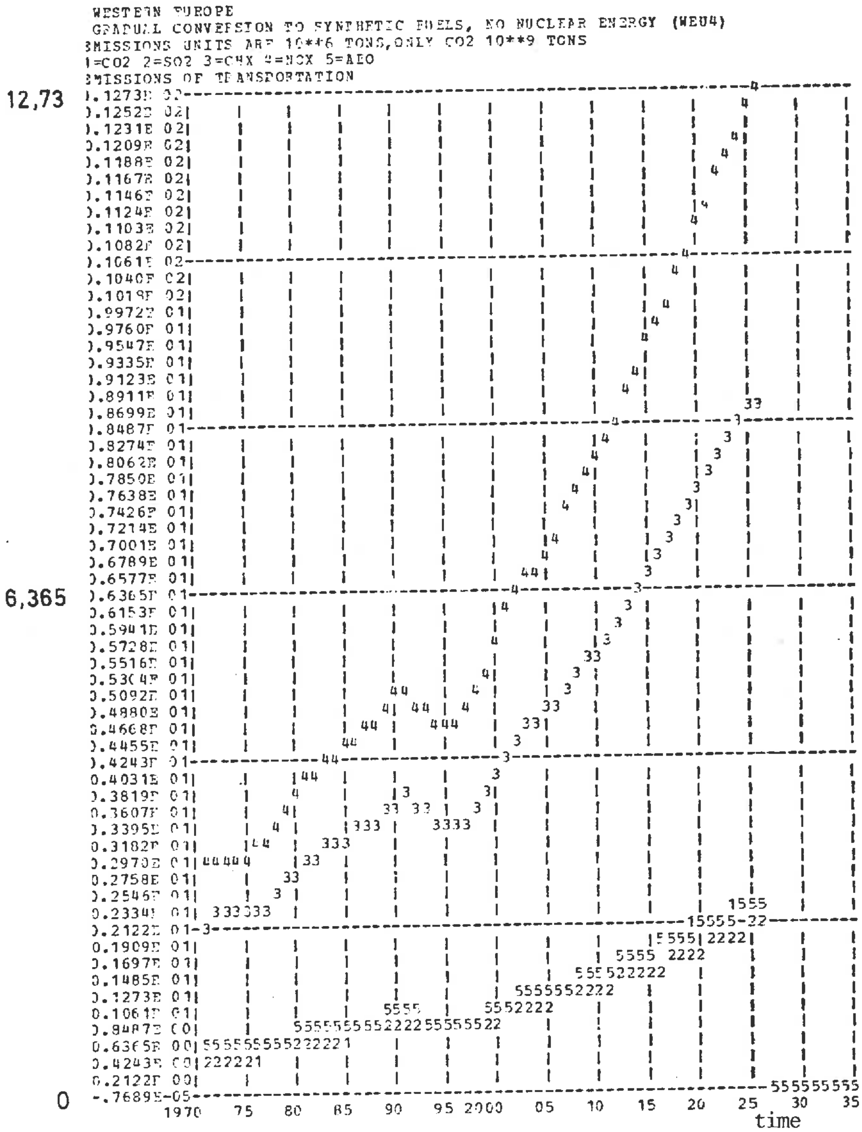
Emissions of Gaseous Fuel



Emissions of Electric Power Generation

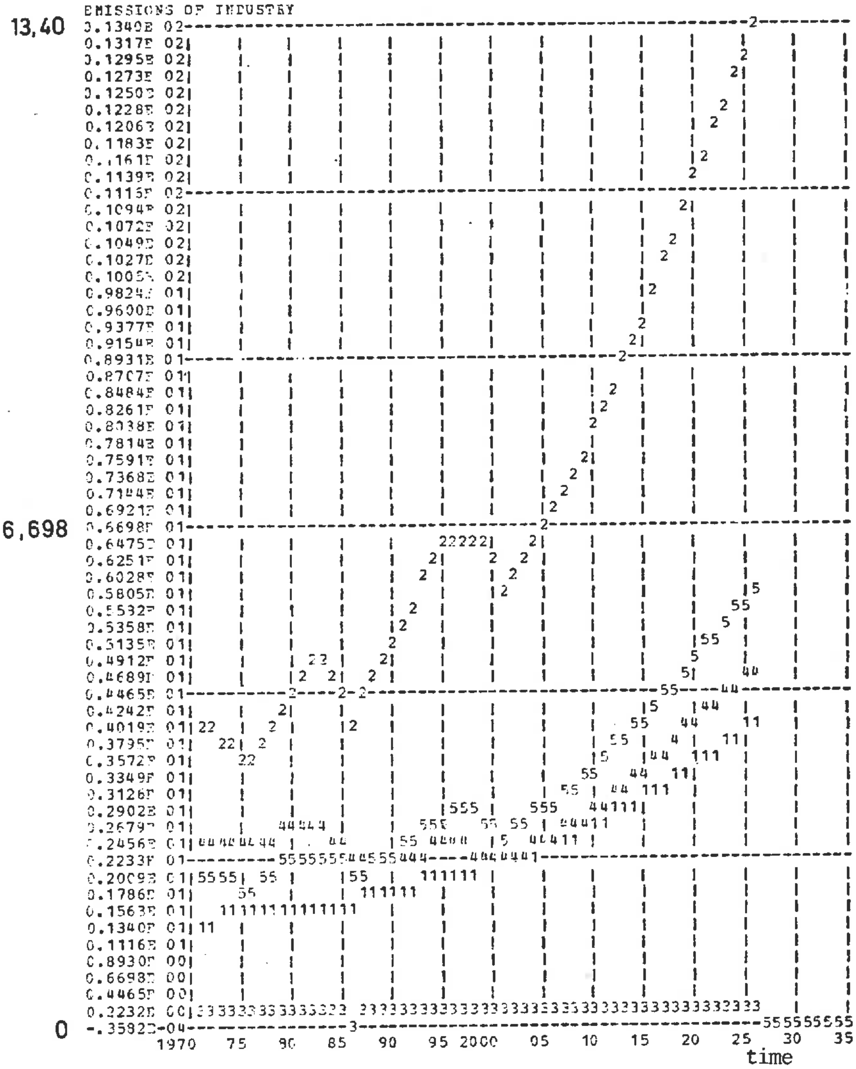


Emissions of Central Heat Plants

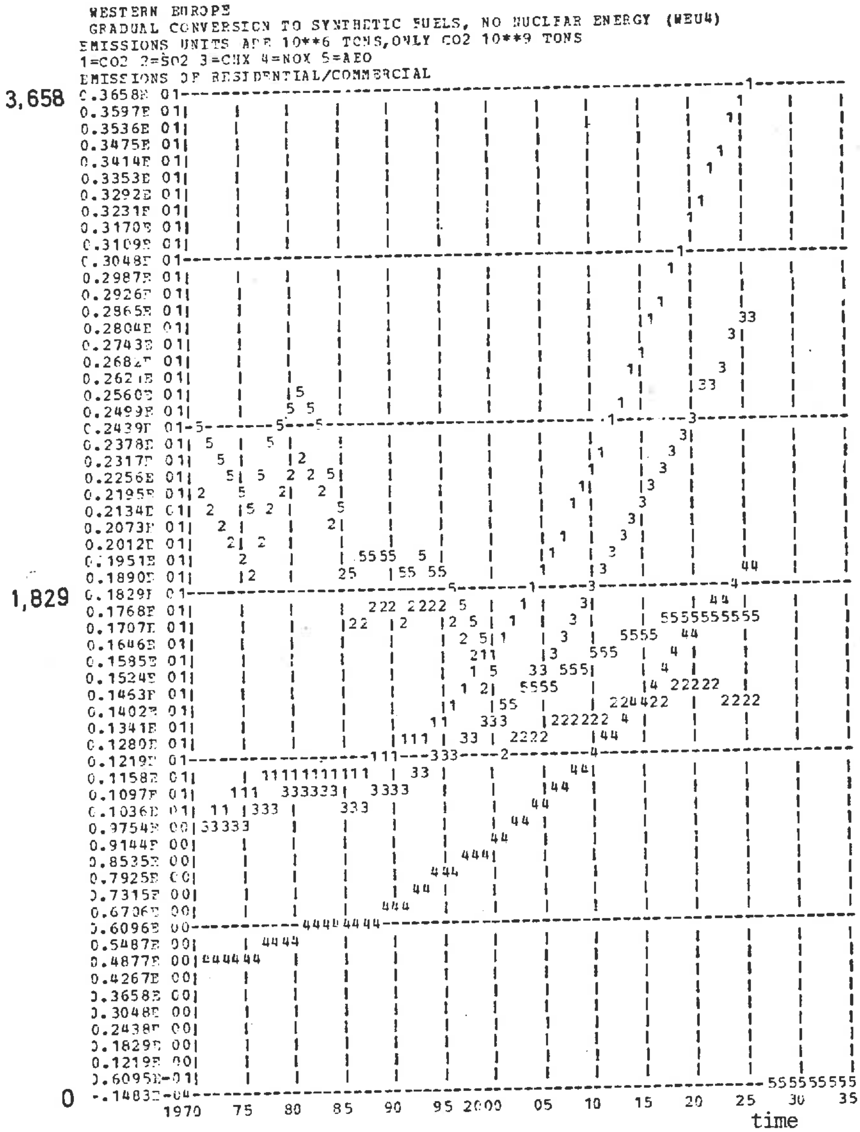


Emissions of Transportation

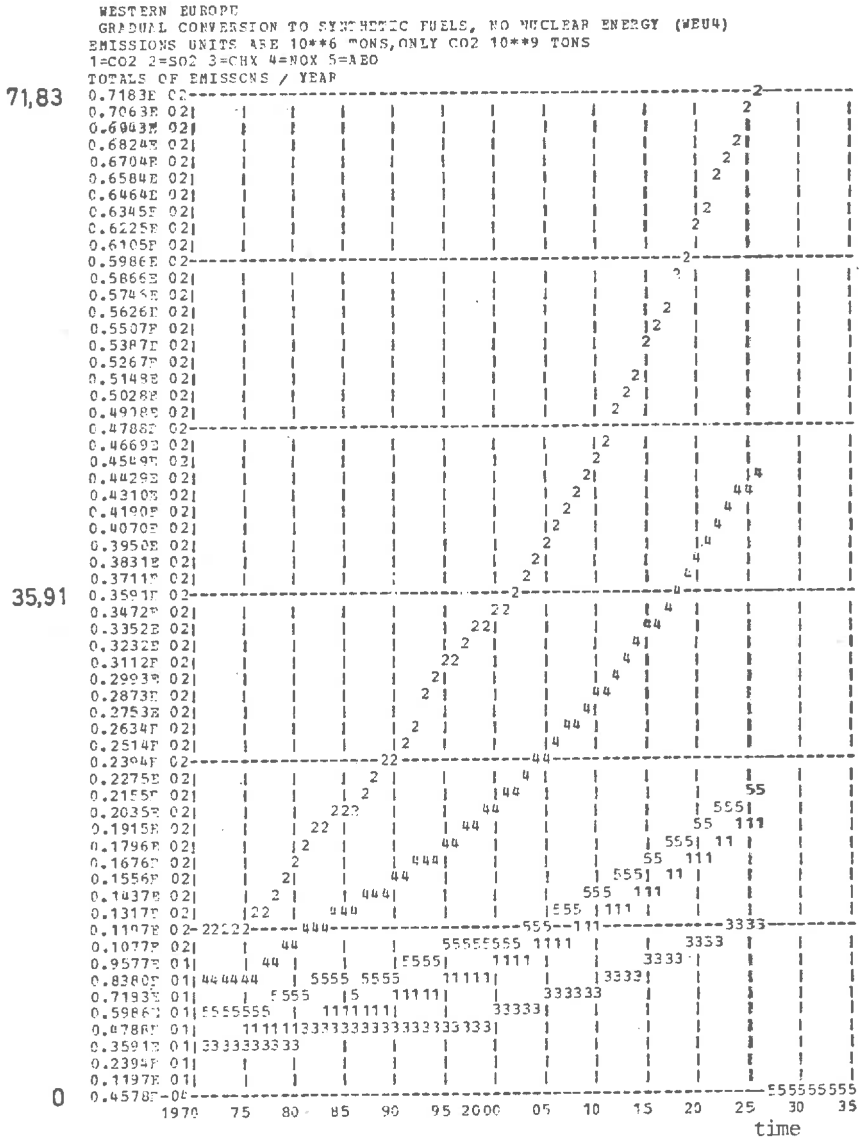
WESTERN EUROPE
GRADUAL CONVERSION TO SYNTHETIC FUELS, NO NUCLEAR ENERGY (WEU4)
EMISSIONS UNITS ARE 10**6 TONS, ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AEO
EMISSIONS OF INDUSTRY



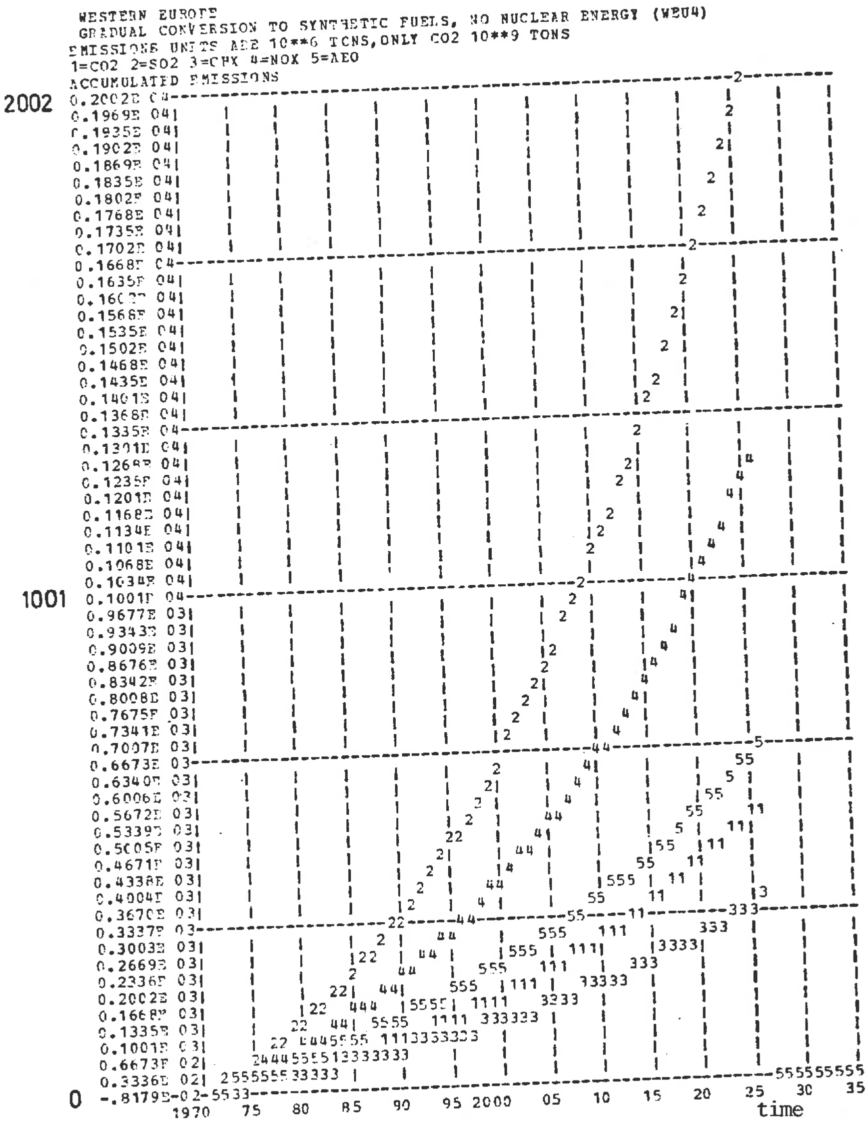
Emissions of Industry



Emissions of Residential / Commercial



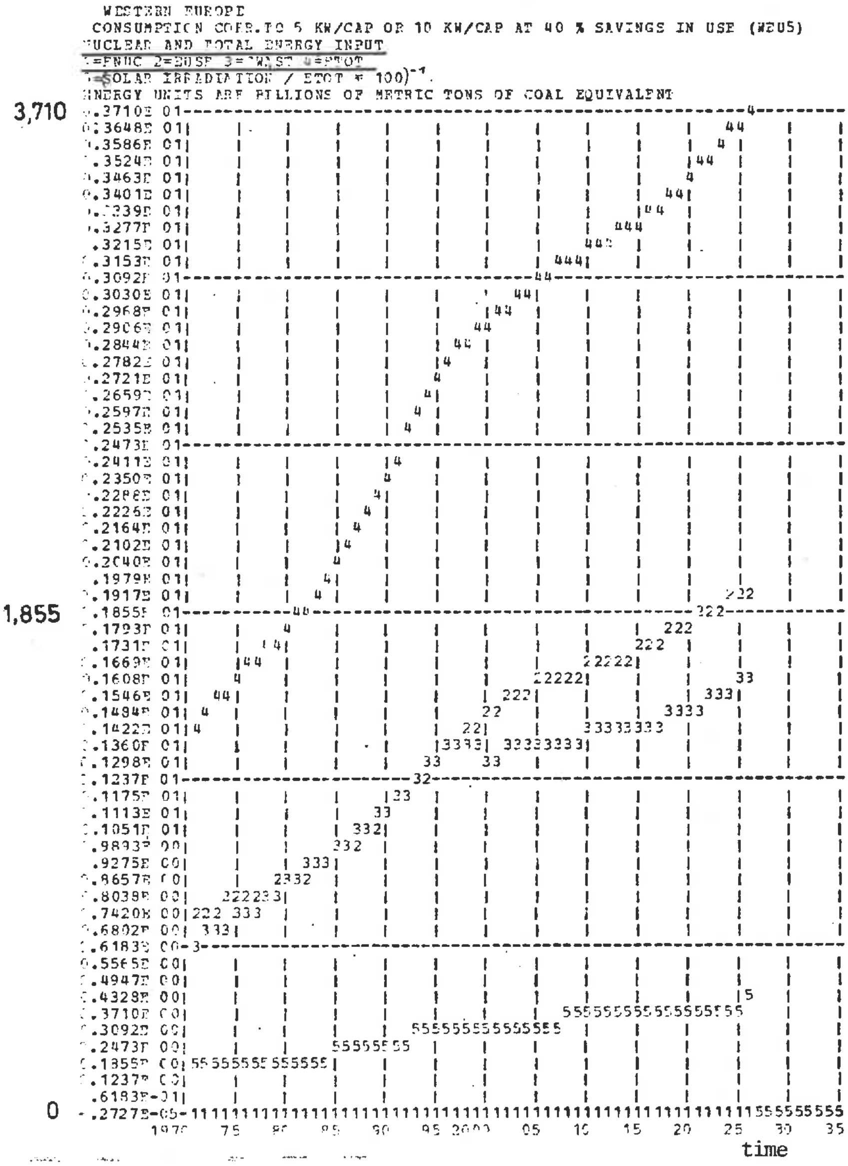
Totals of Emissions / Year



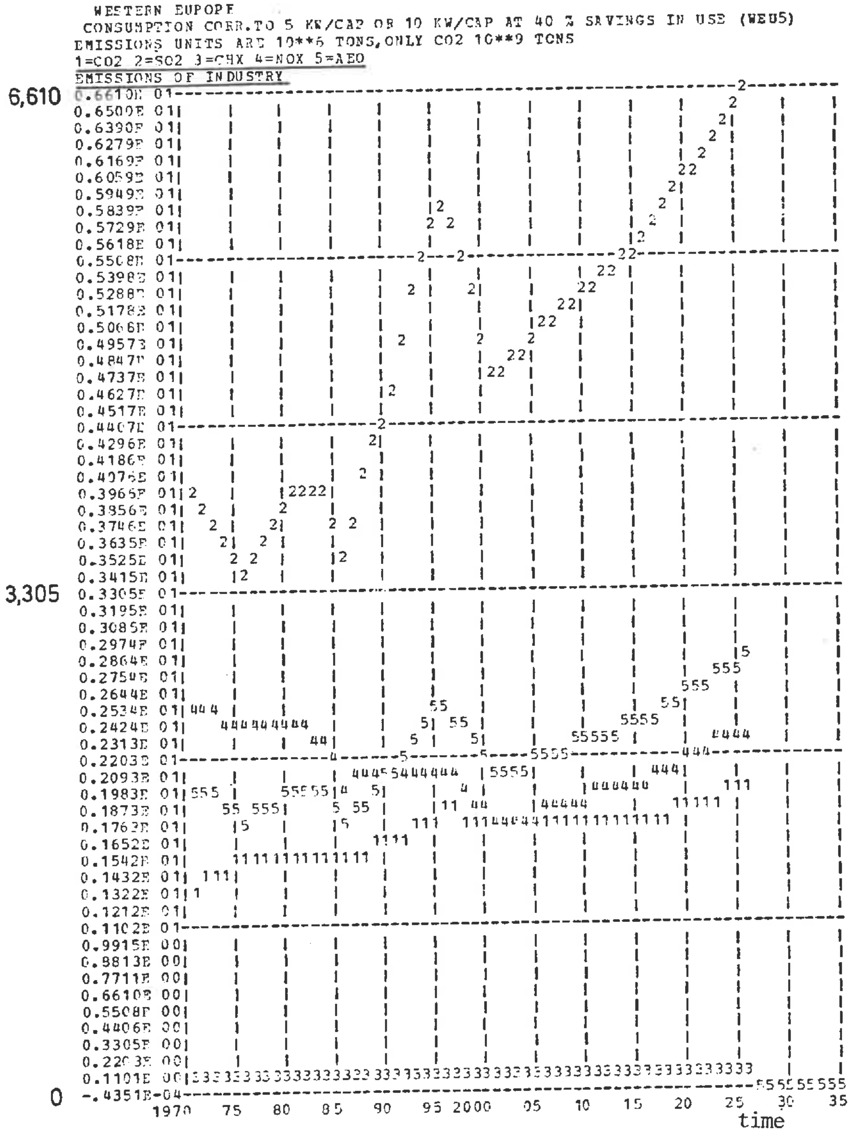
Accumulated Emissions

2. <u>Western Europe</u>

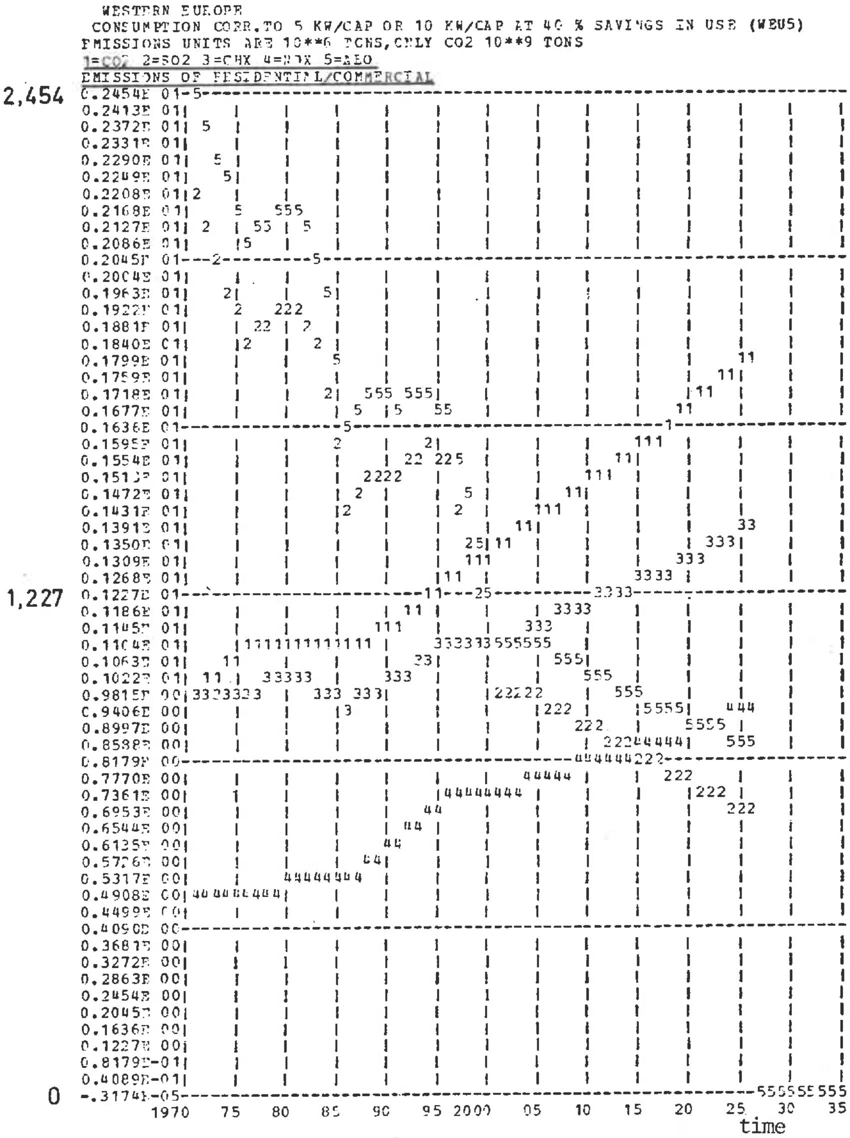
Consumption corr. to 5 kw/Cap or 10 kw/Cap at 50 % Savings in Use



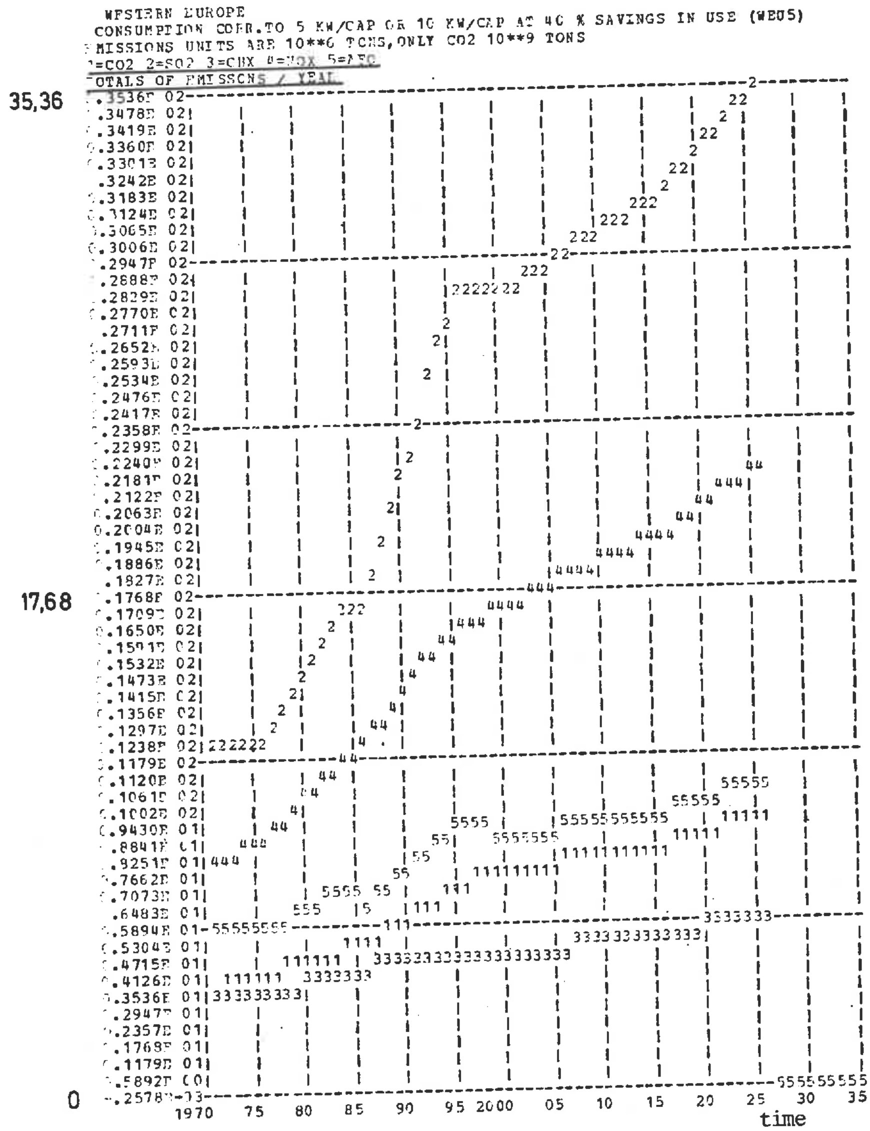
<u>Nuclear and Total Energy Input</u>



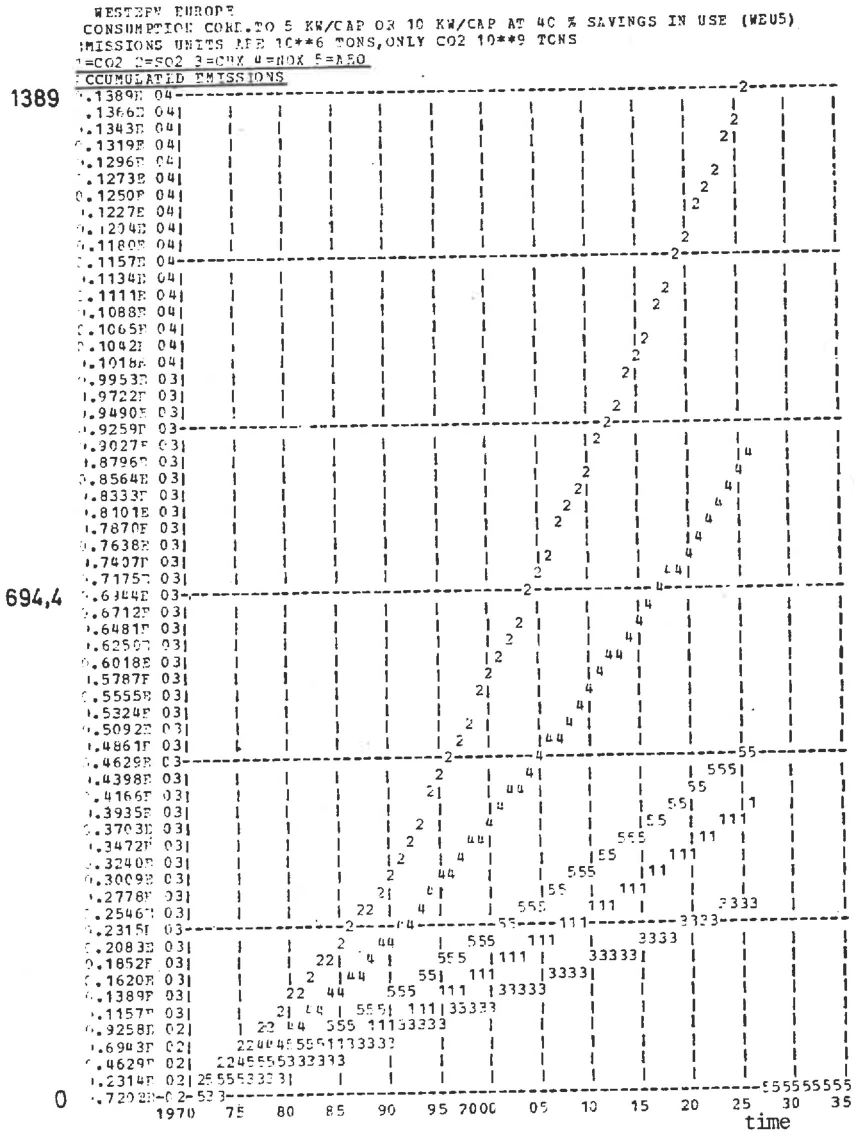
Emissions of Industry



Emissions of Residential/Commercial



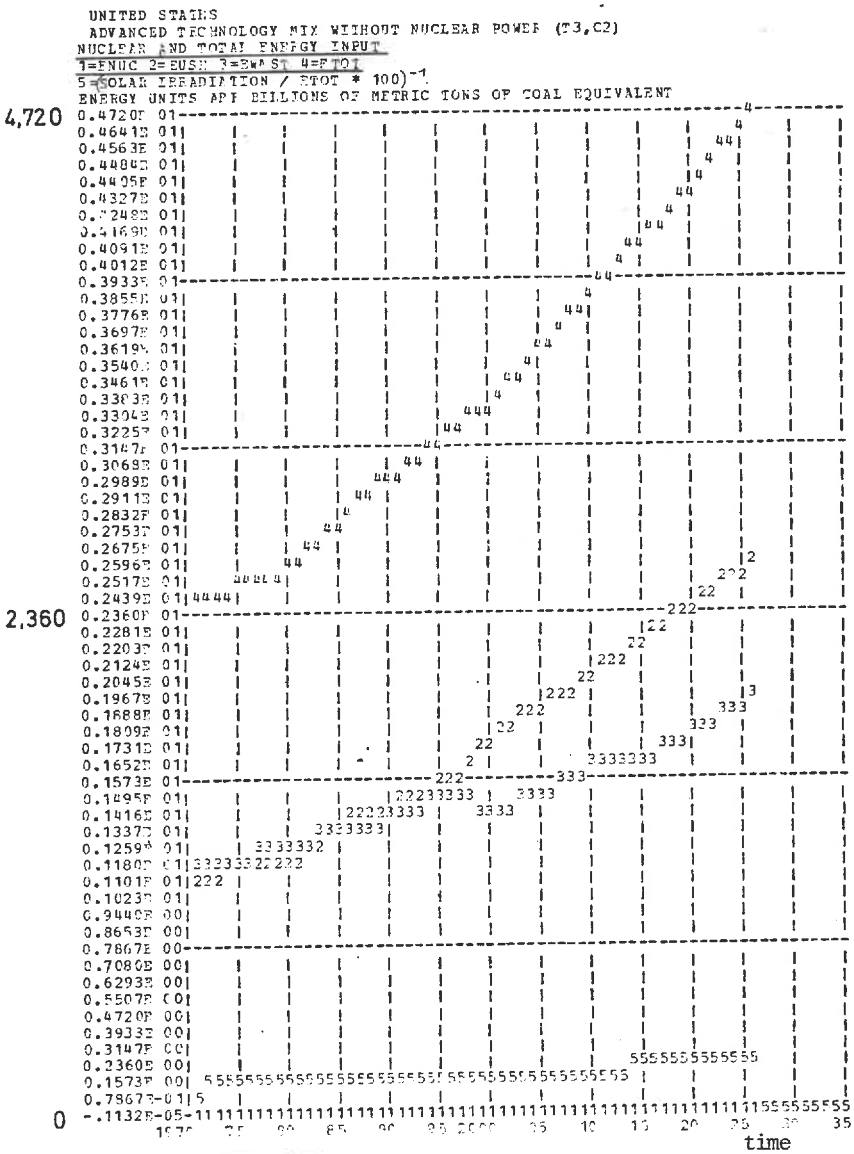
Totals of Emissions/Year



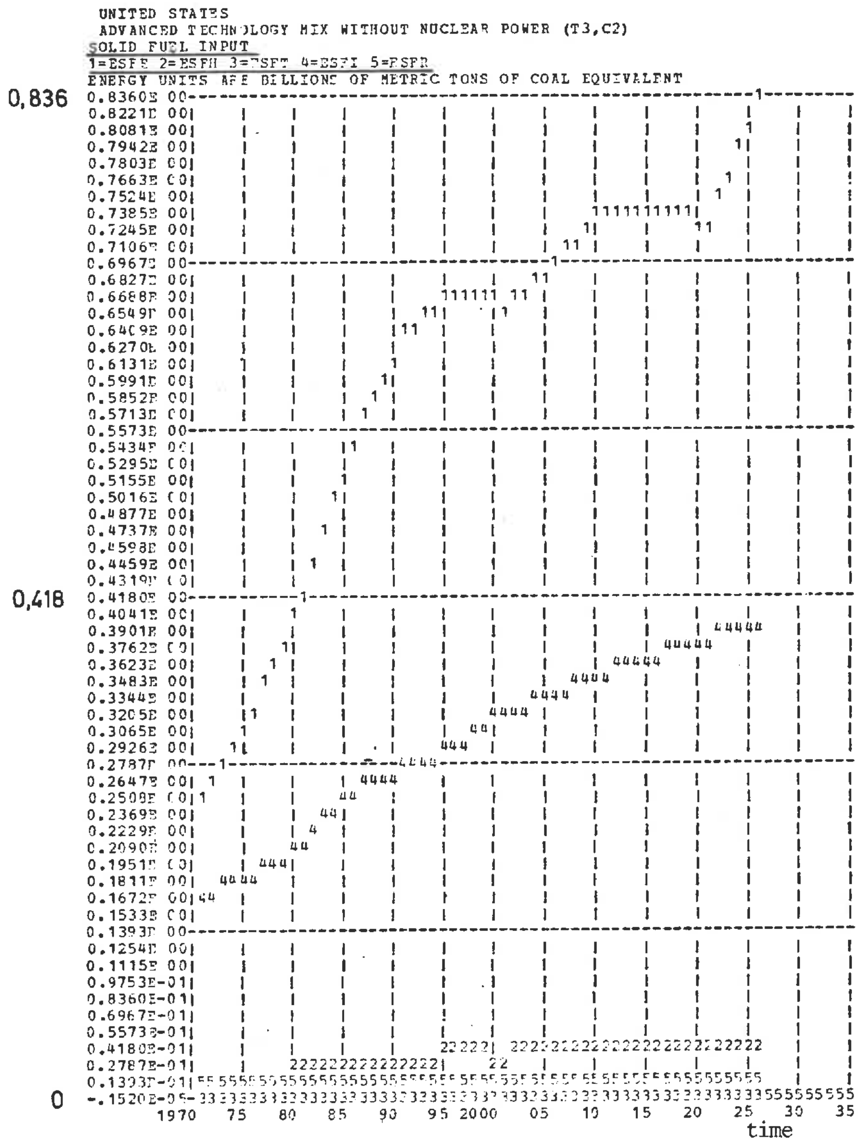
Accumulated Emissions

3. United States

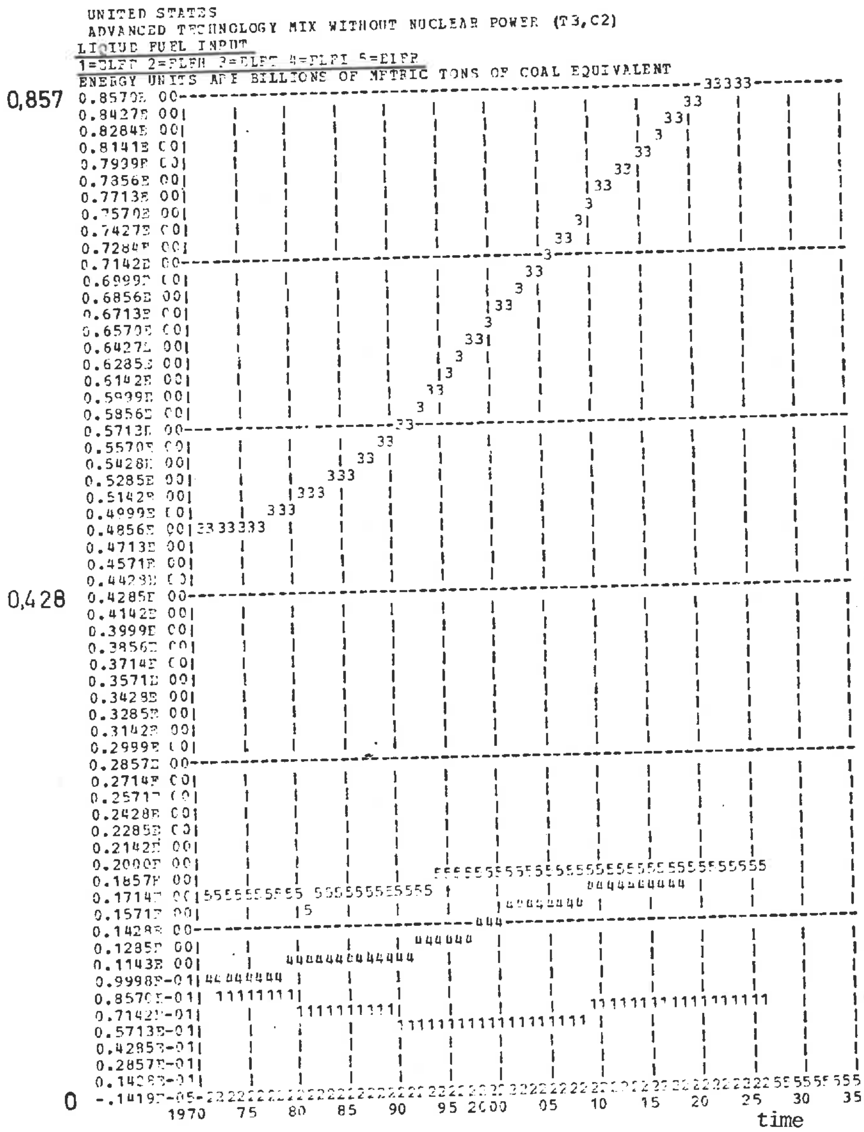
Advanced Technology Mix Without Nuclear Power



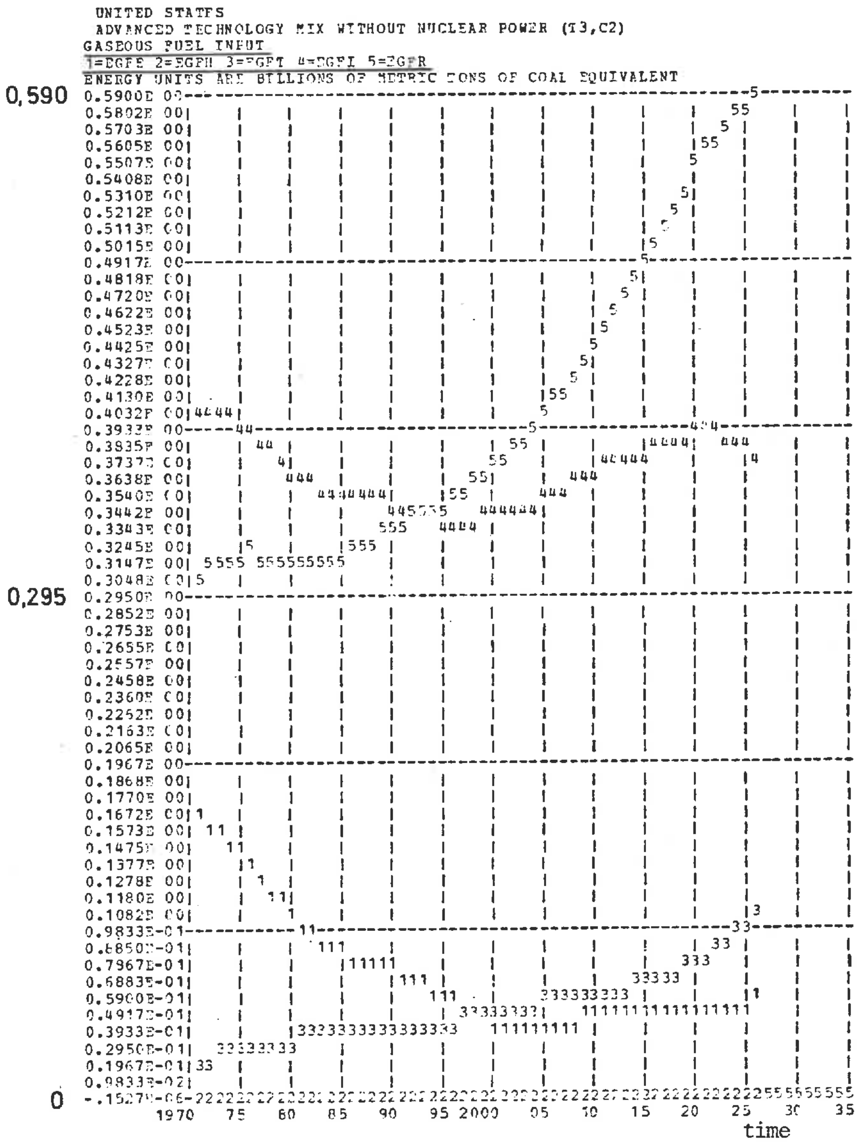
Nuclear and Total Energy Input



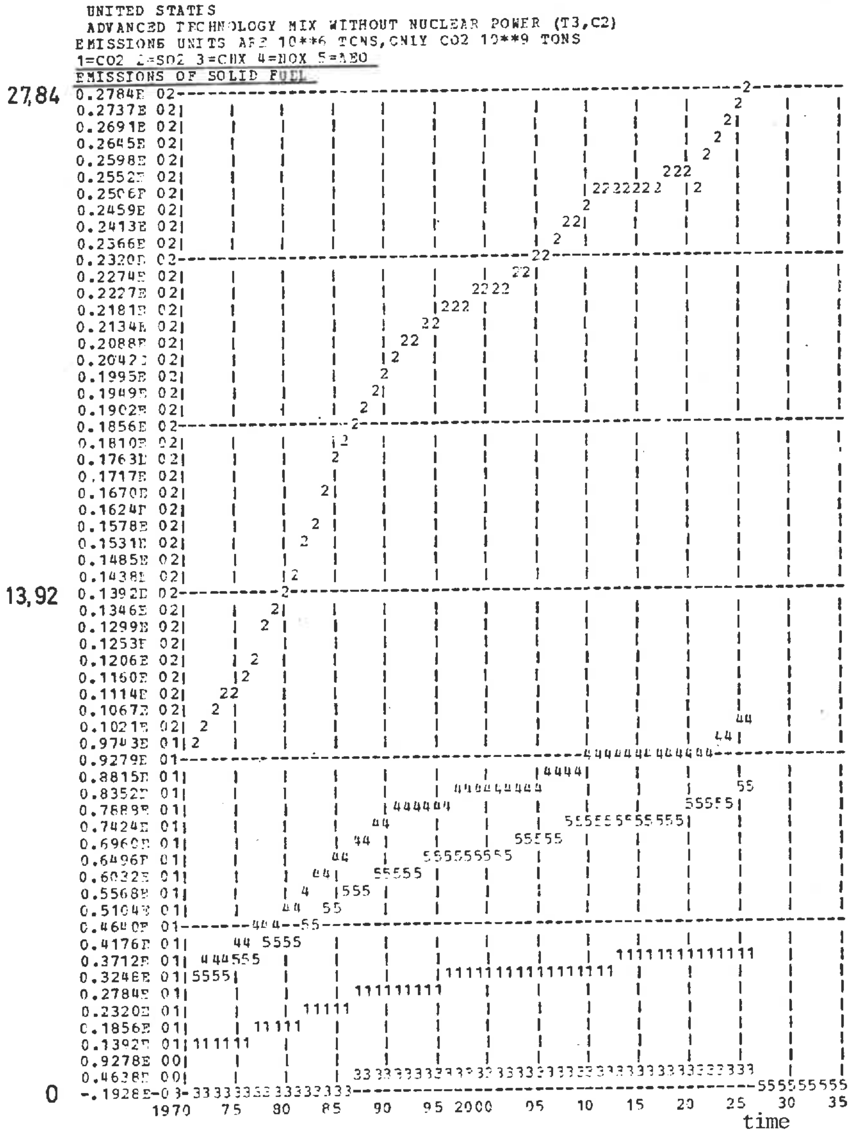
Solid Fuel Input



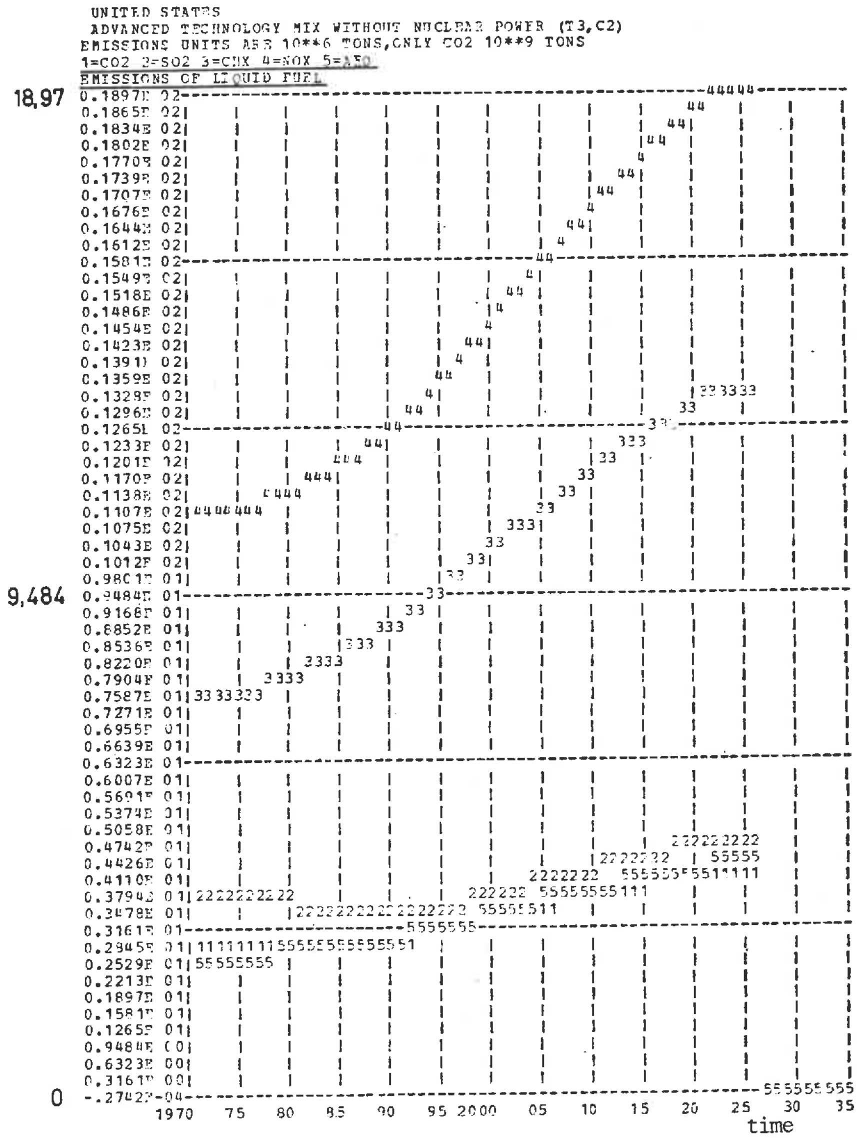
Liquid Fuel Input



Gaseous Fuel Input

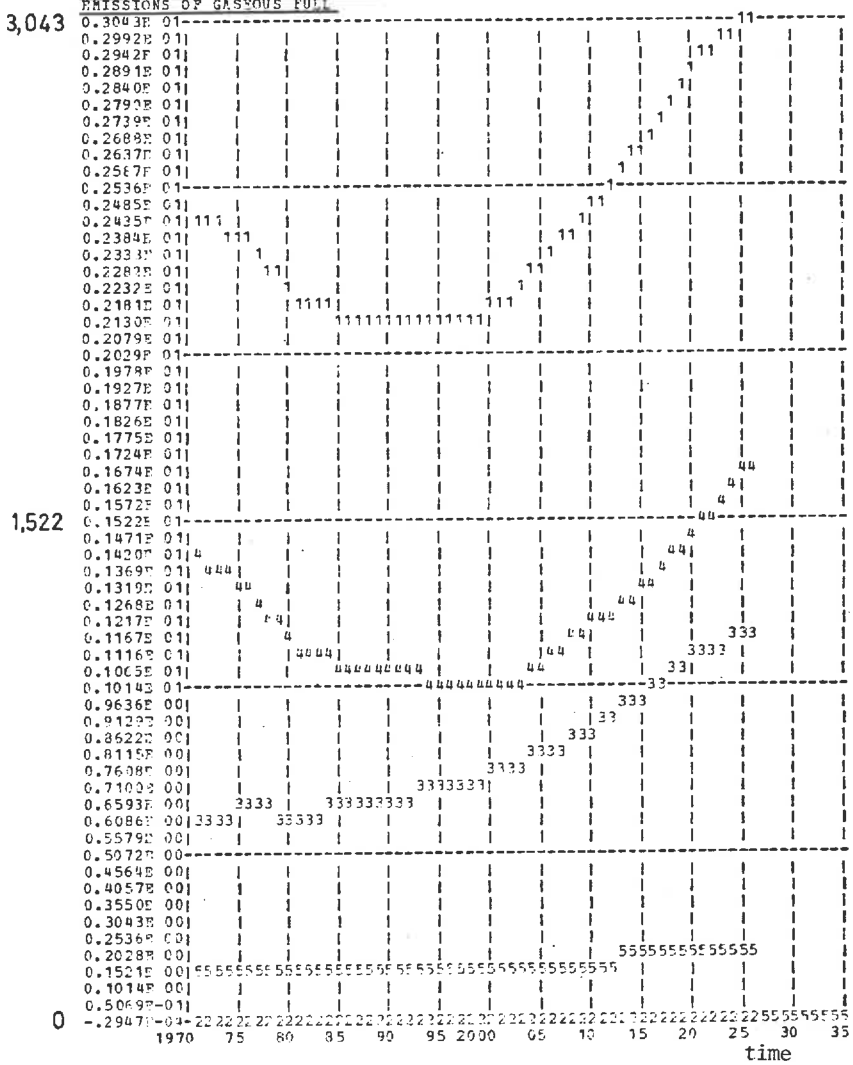


Emissions of Solid Fuel



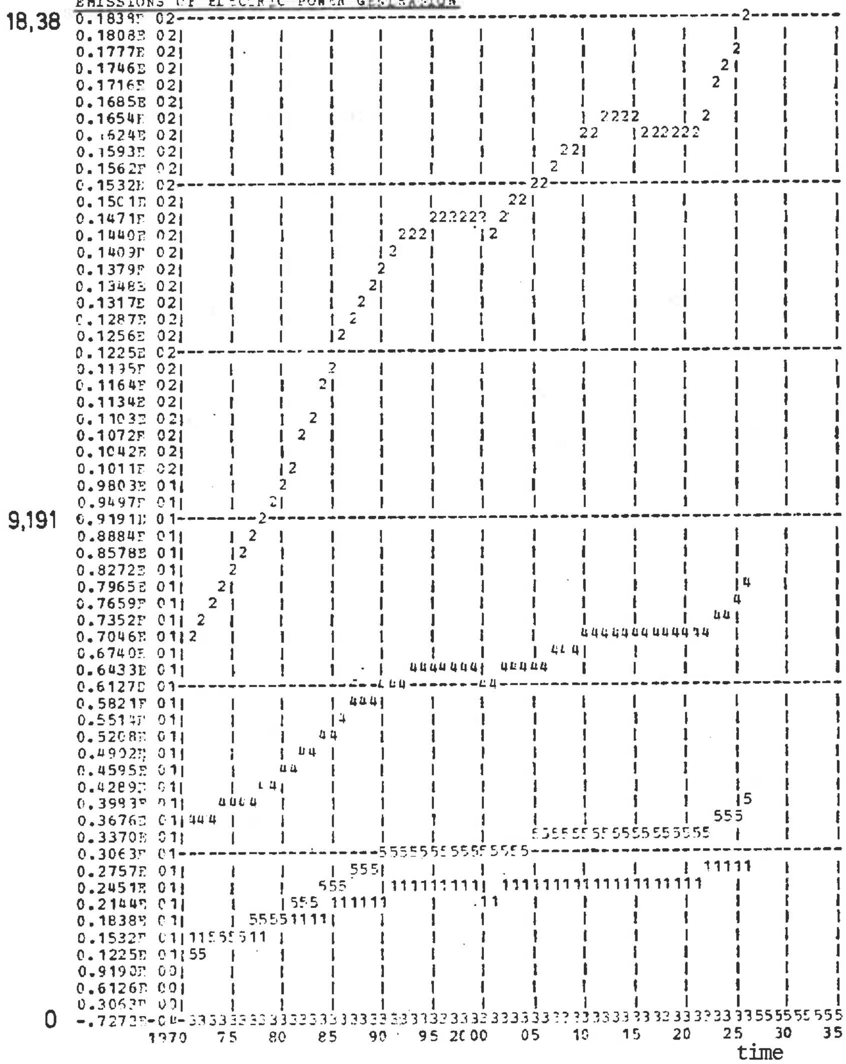
Emissions of Liquid Fuel

UNITED STATES
ADVANCED TECHNOLOGY MIX WITHOUT NUCLEAR POWER (T3,C2)
EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AEO
EMISSIONS OF GASEOUS FUEL



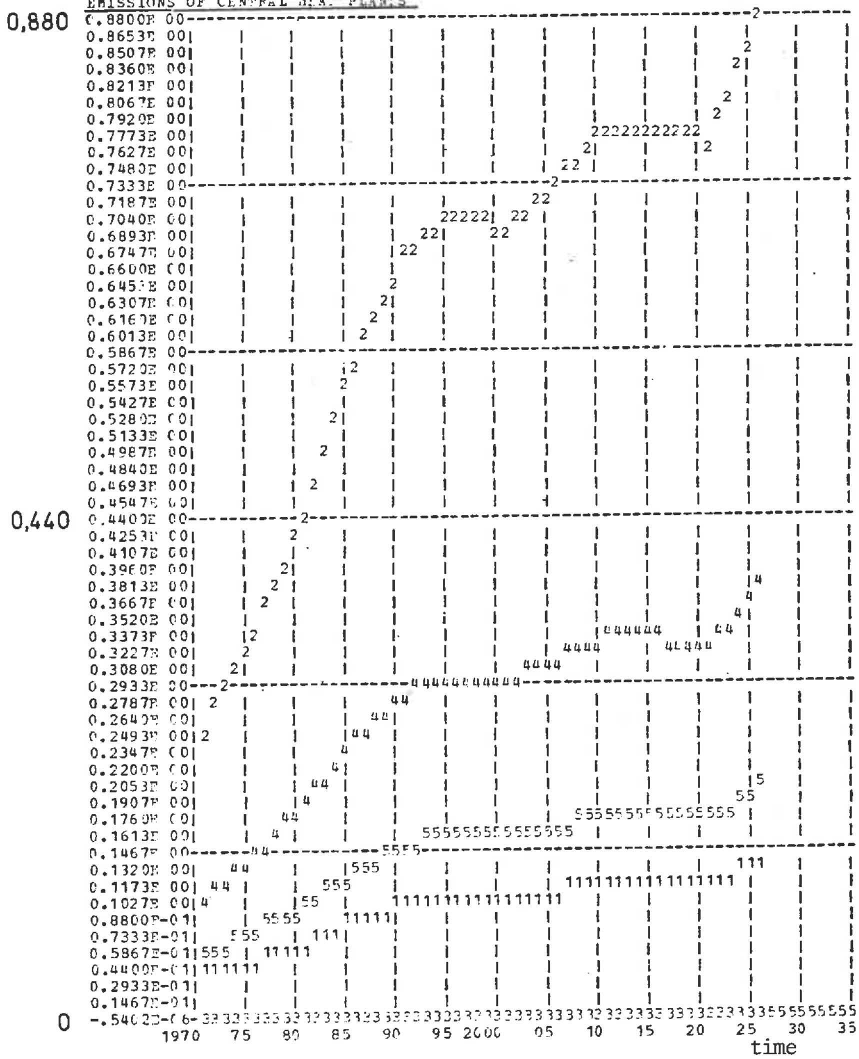
Emissions of Gaseous Fuel

UNITED STATES
ADVANCED TECHNOLOGY MIX WITHOUT NUCLEAR POWER (T3,C2)
EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=APO
EMISSIONS OF ELECTRIC POWER GENERATION



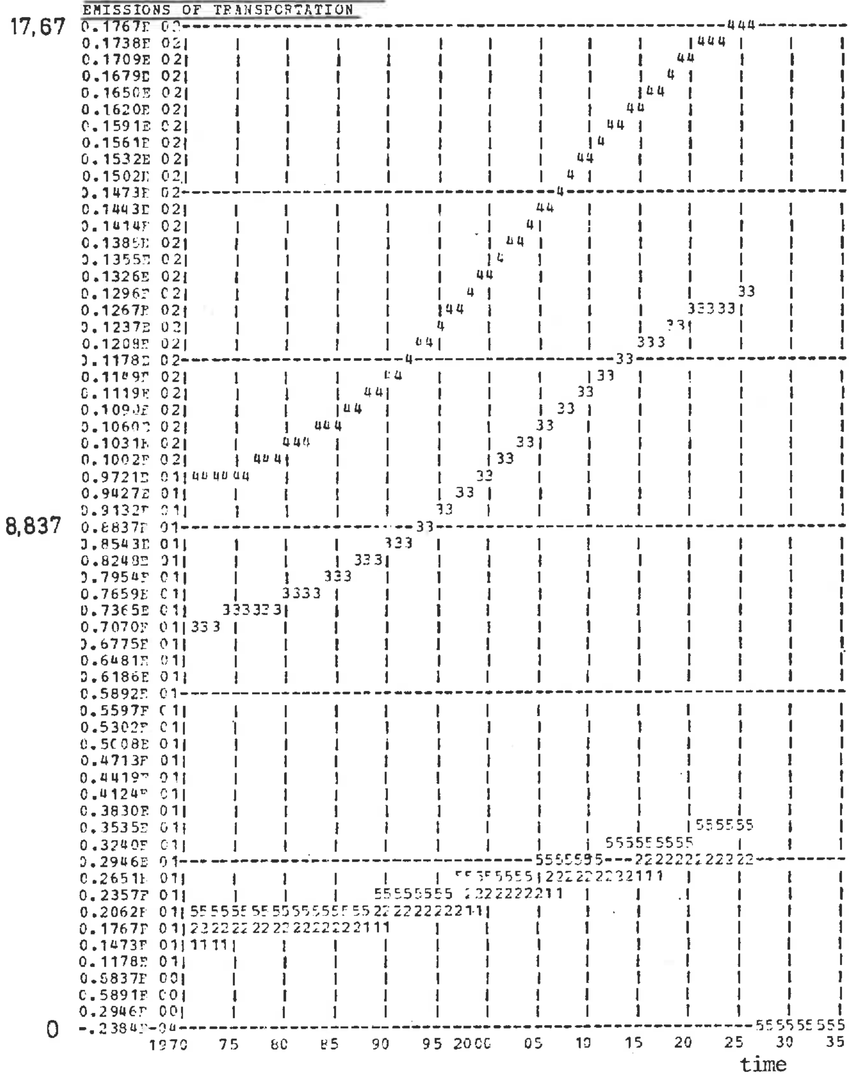
Emissions of Electric Power Generation

UNITED STATES
ADVANCED TECHNOLOGY MIX WITHOUT NUCLEAR POWER (T3,C2)
EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AEO
EMISSIONS OF CENTRAL HEAT PLANTS

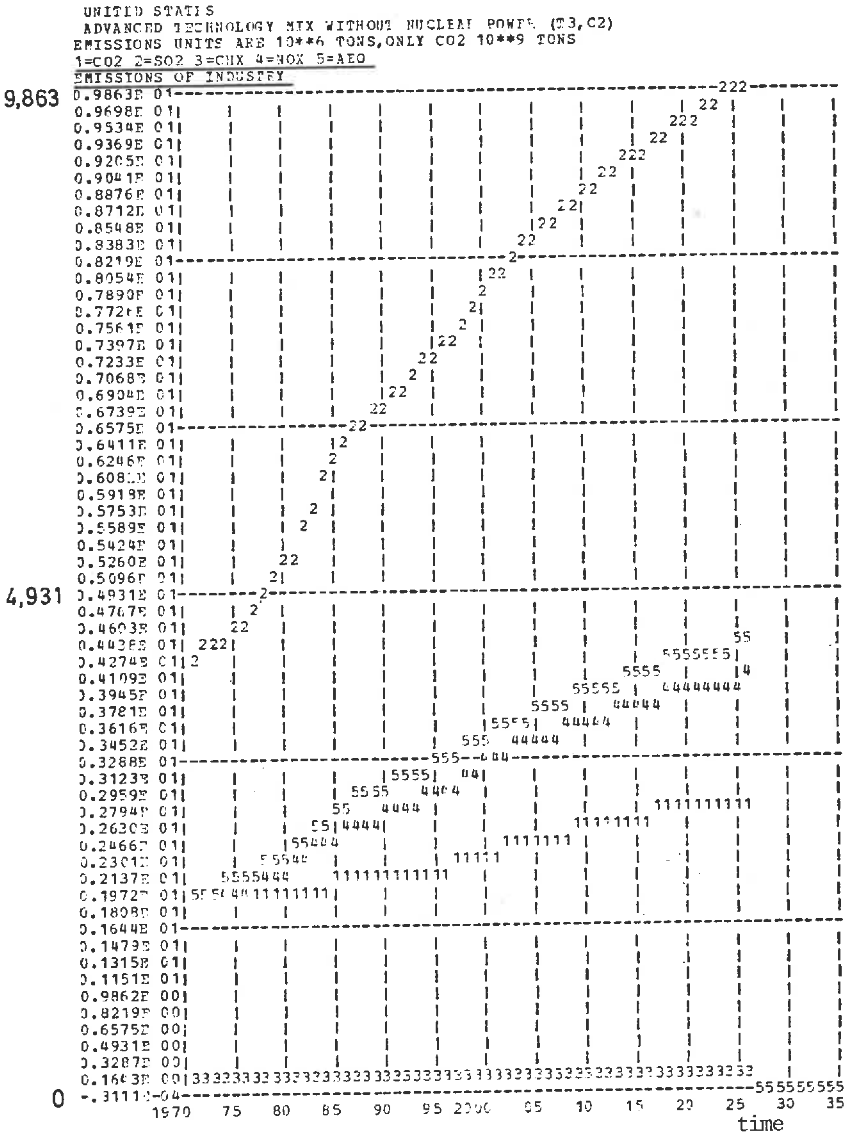


Emissions of Central Heat Plants

UNITED STATES
ADVANCED TECHNOLOGY MIX WITHOUT NUCLEAR POWER (T3,C2)
EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=AFO
EMISSIONS OF TRANSPORTATION

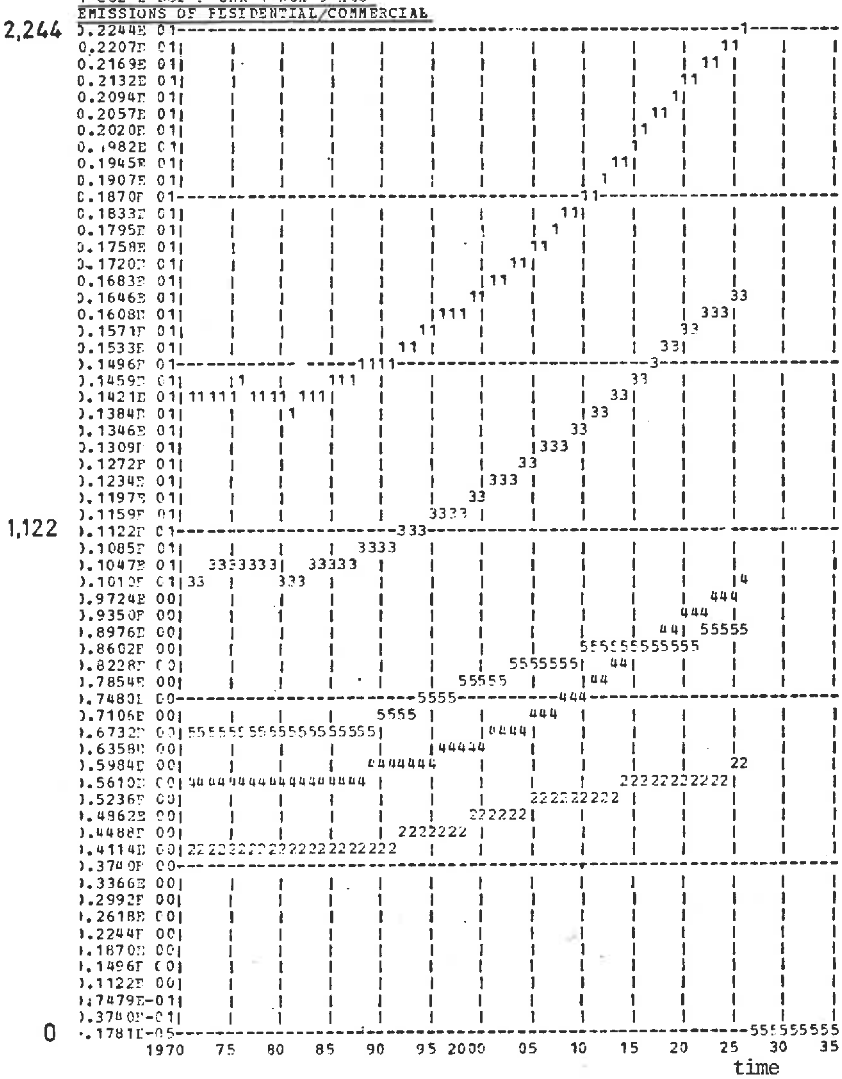


Emissions of Transportation

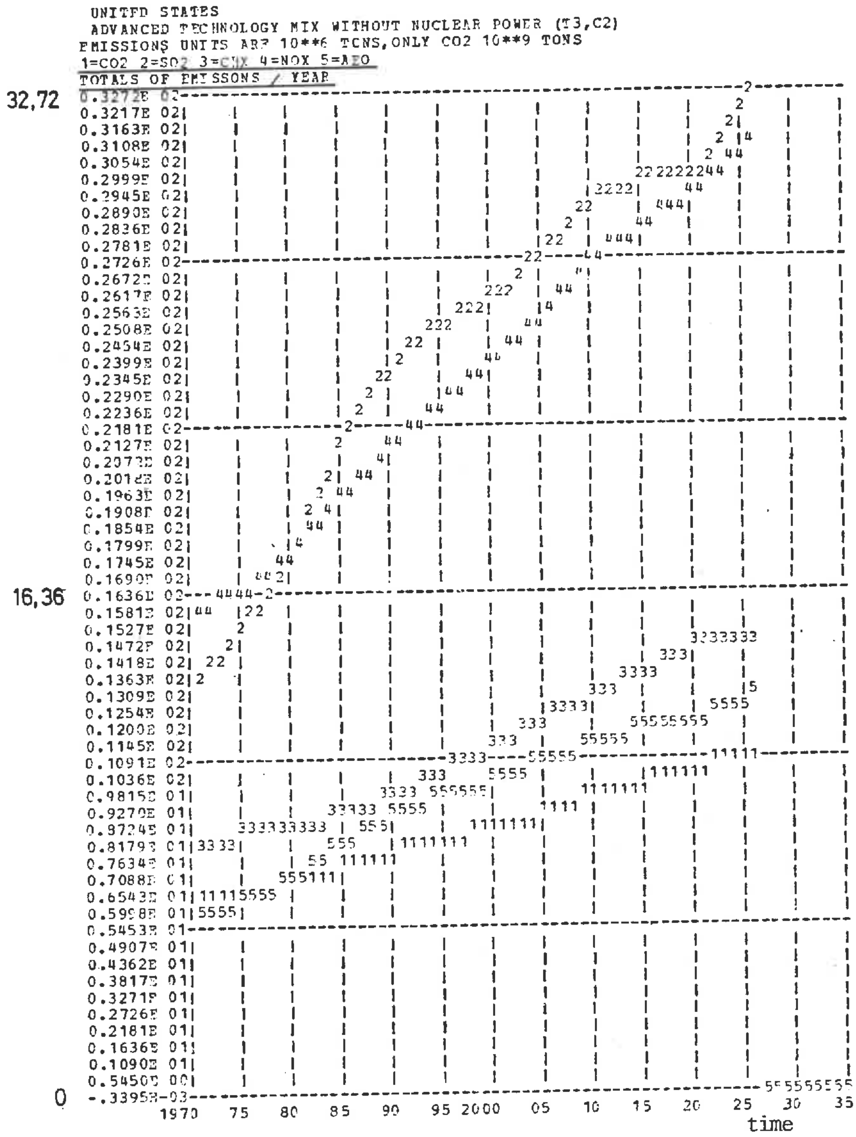


Emissions of Industry

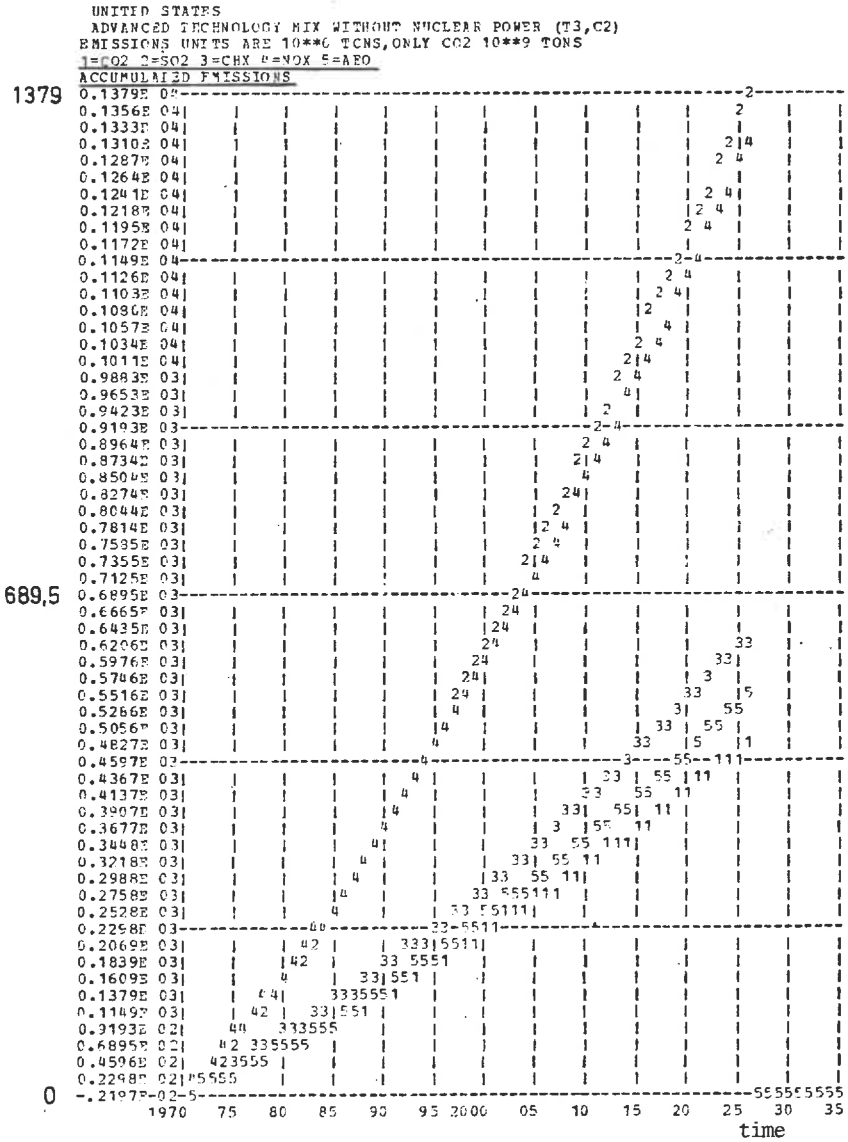
UNITED STATES
ADVANCED TECHNOLOGY MIX WITHOUT NUCLEAR POWER (T3,C2)
EMISSIONS UNITS ARE 10**6 TONS,ONLY CO2 10**9 TONS
1=CO2 2=SO2 3=CHX 4=NOX 5=ASO
EMISSIONS OF RESIDENTIAL/COMMERCIAL



Emissions of Residential/Commercial



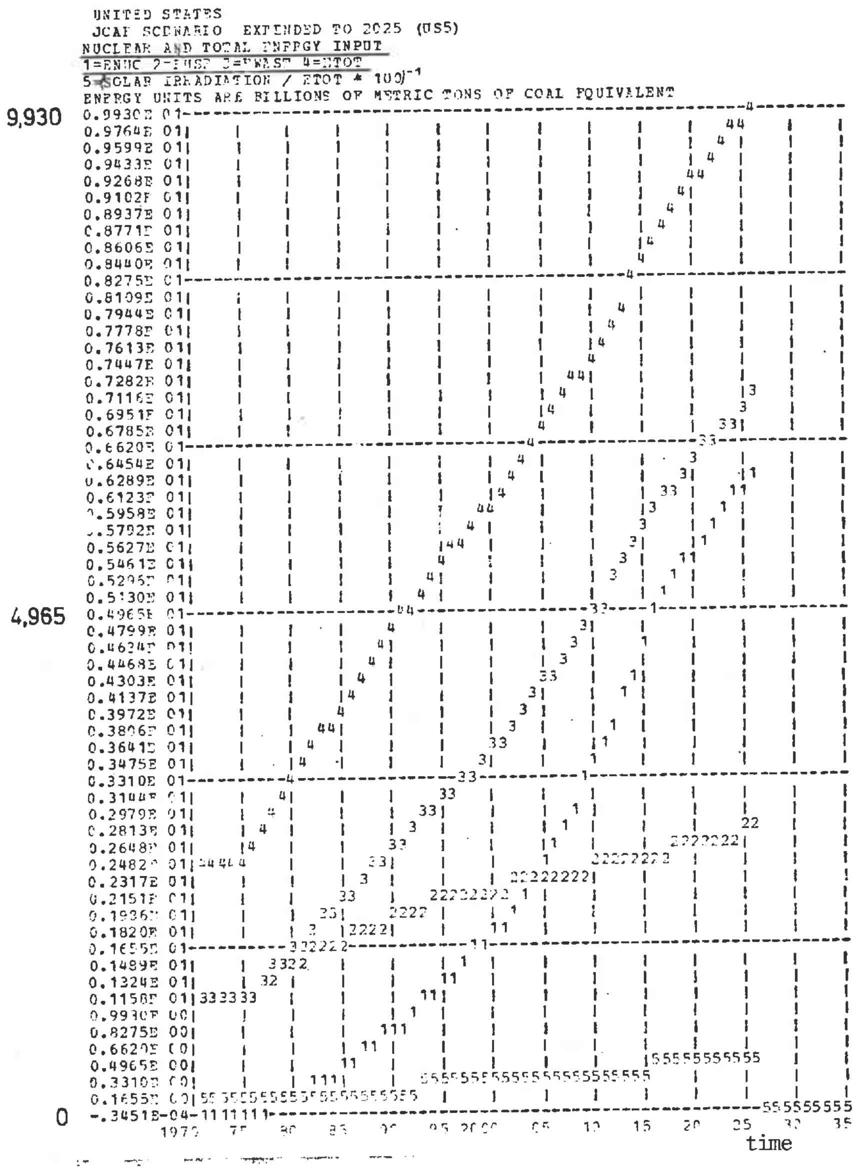
Totals of Emissions/Year



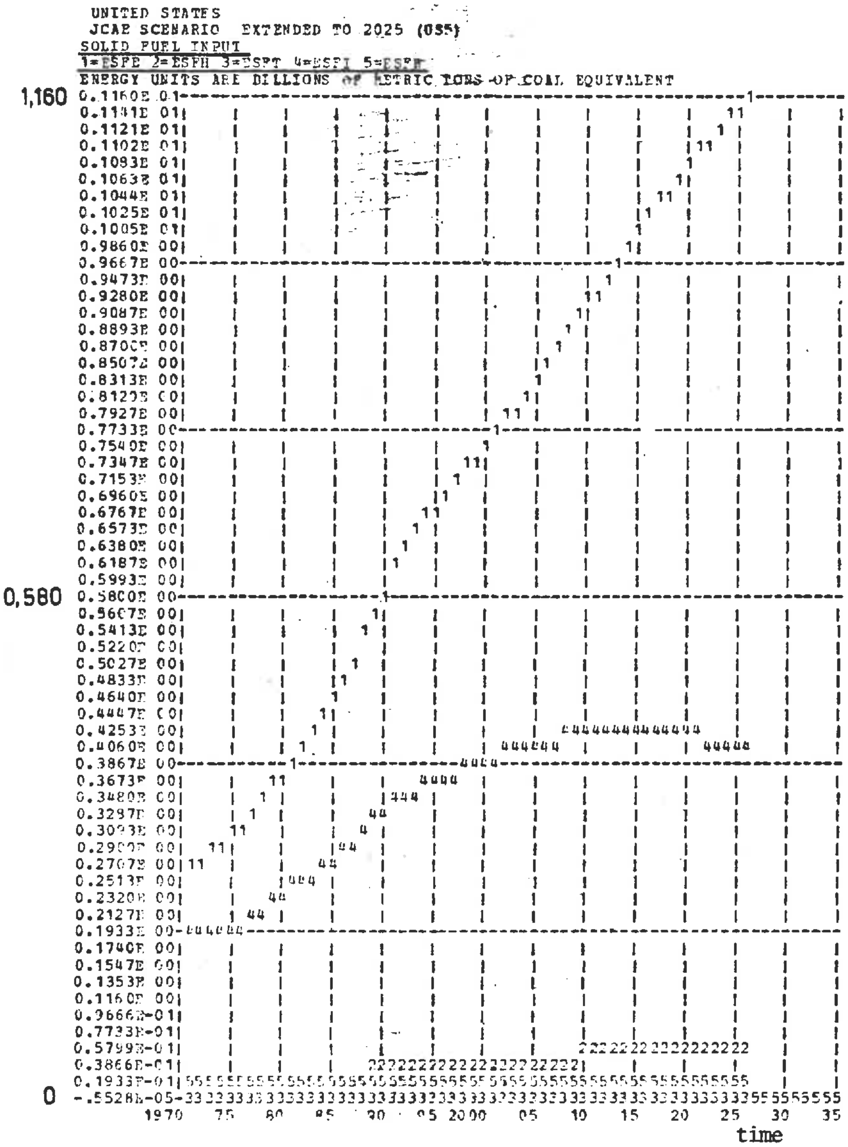
Accumulated Emissions

4. United States

JCAE Scenario Extended to 2025

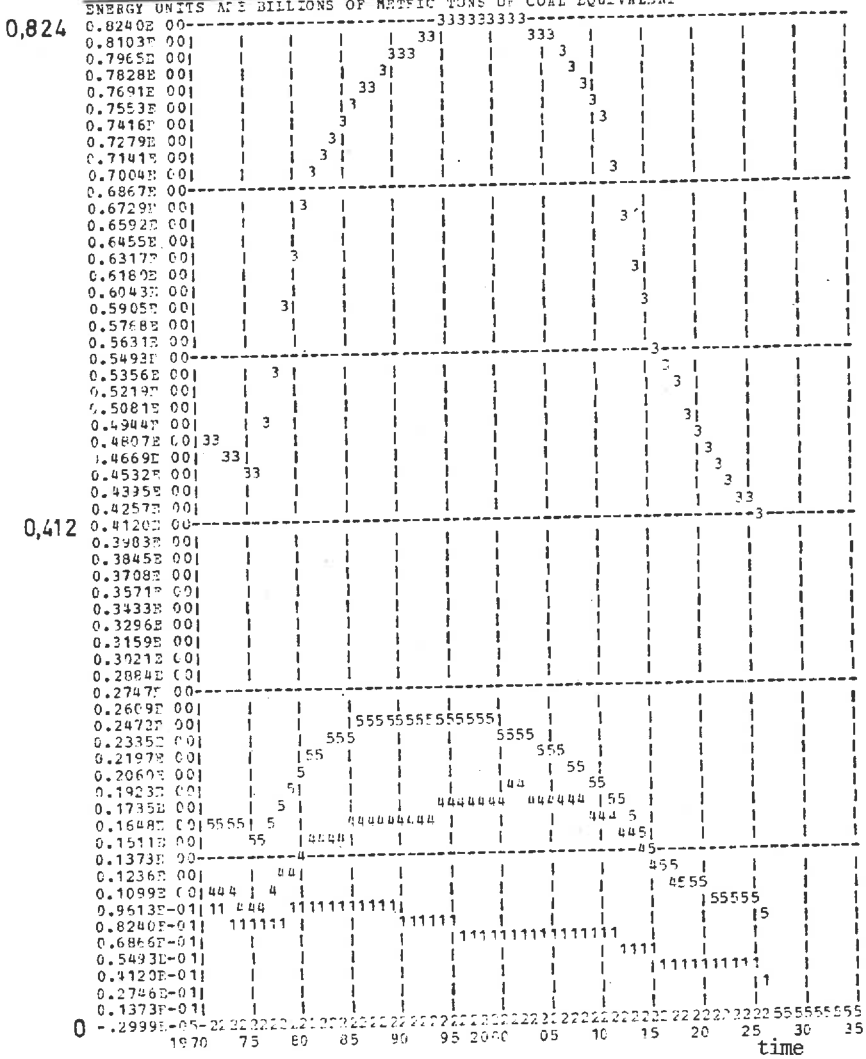


Nuclear and Total Energy Input

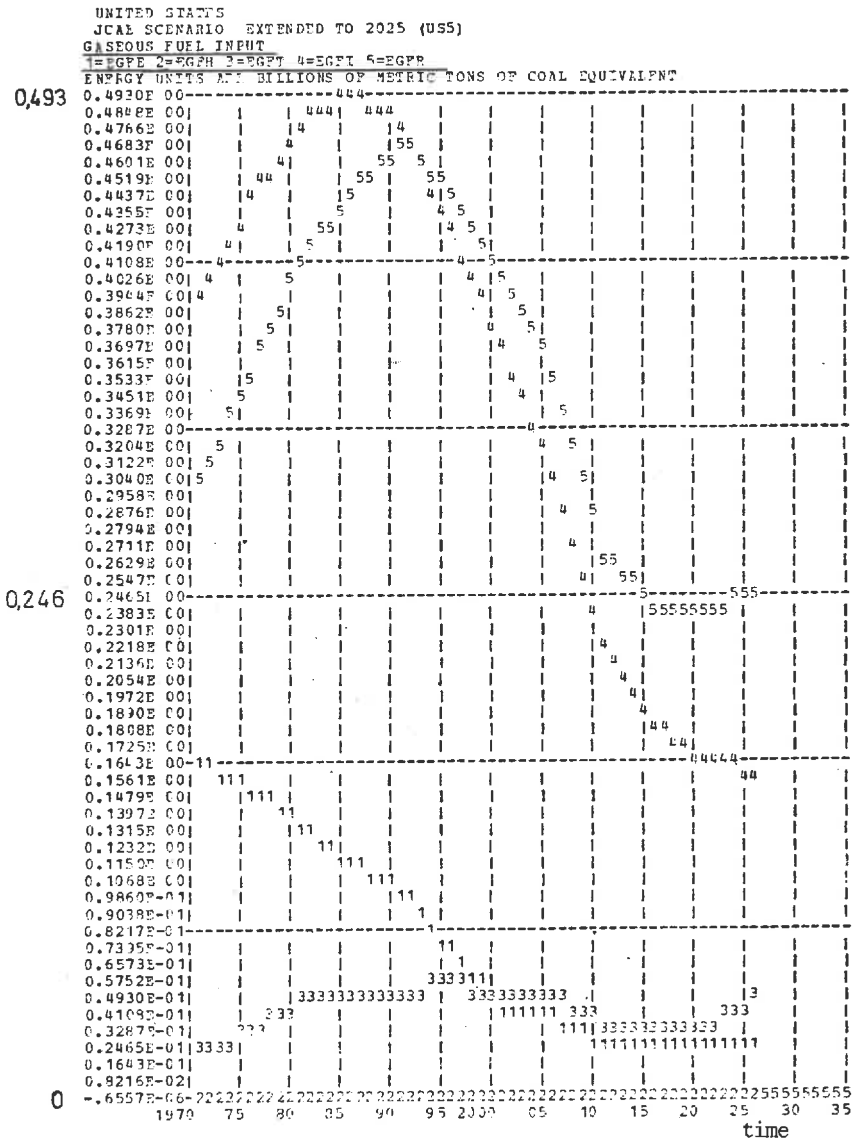


Solid Fuel Input

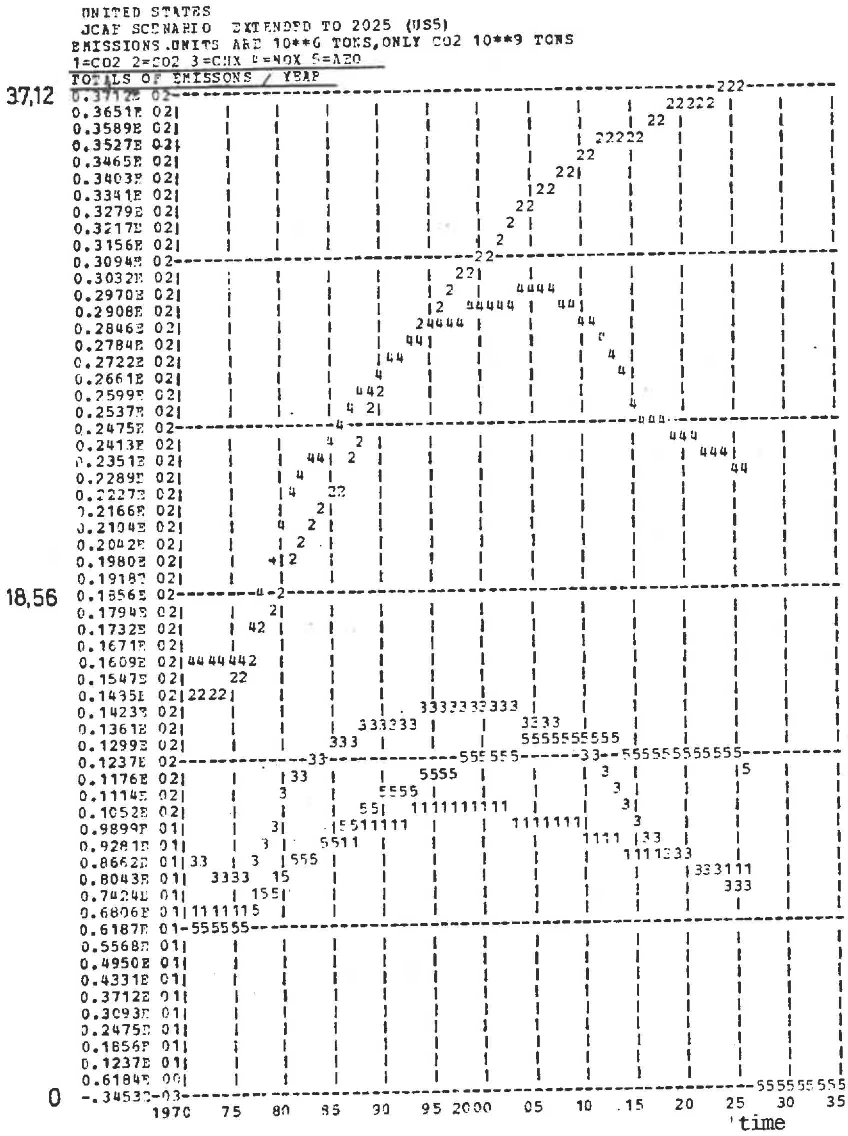
UNITED STATES
JCAE SCENARIO EXTENDED TO 2025 (US5)
LIQIUD FUEL INPUT
1=ELPE 2=ELPH 3=ELPT 4=ELPI 5=ELPP
ENERGY UNITS ARE BILLIONS OF METRIC TONS OF COAL EQUIVALENT



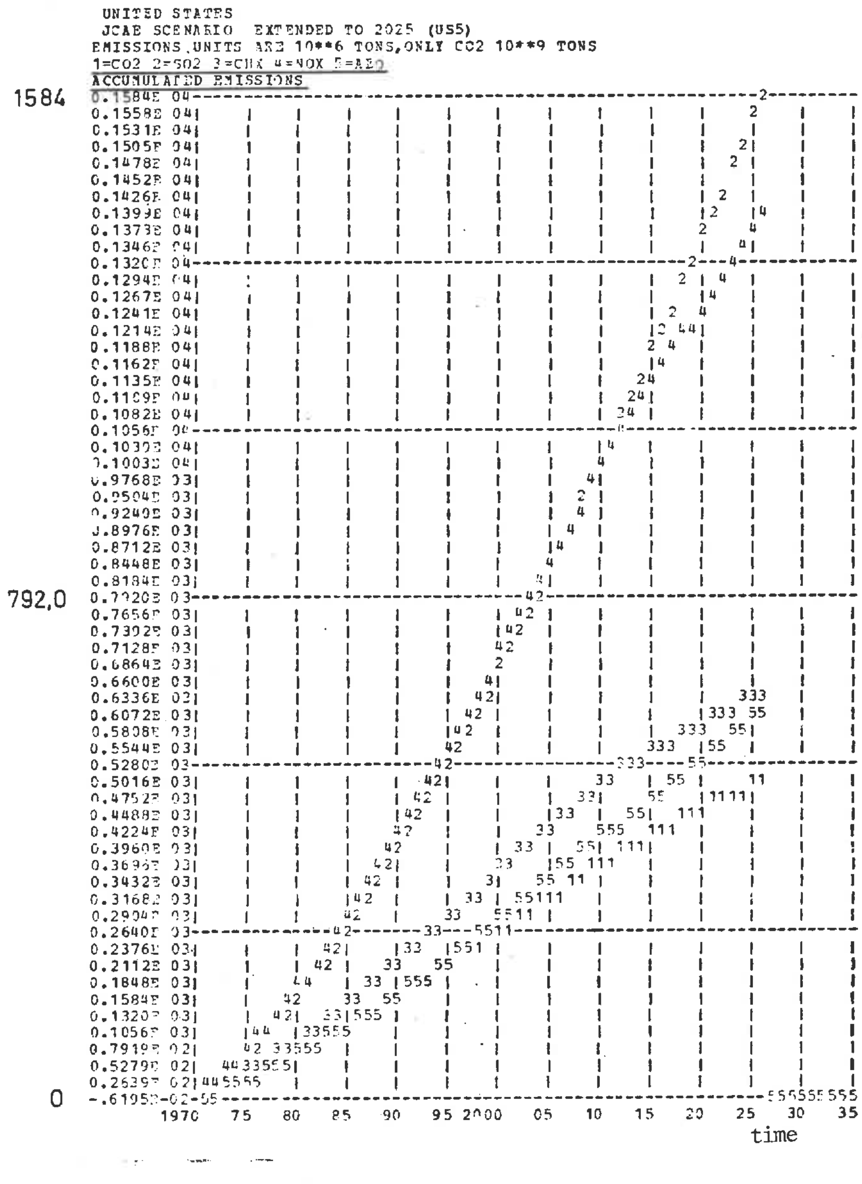
Liquid Fuel Input



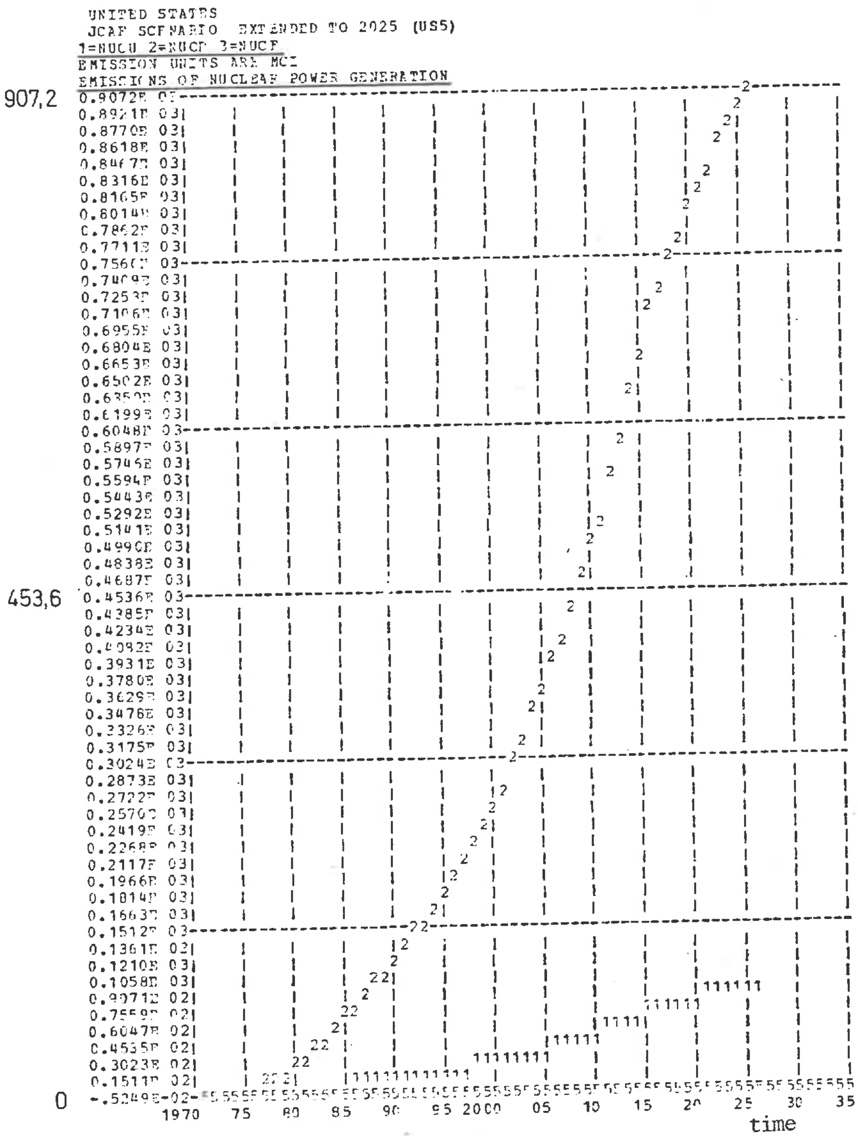
Gaseous Fuel Input



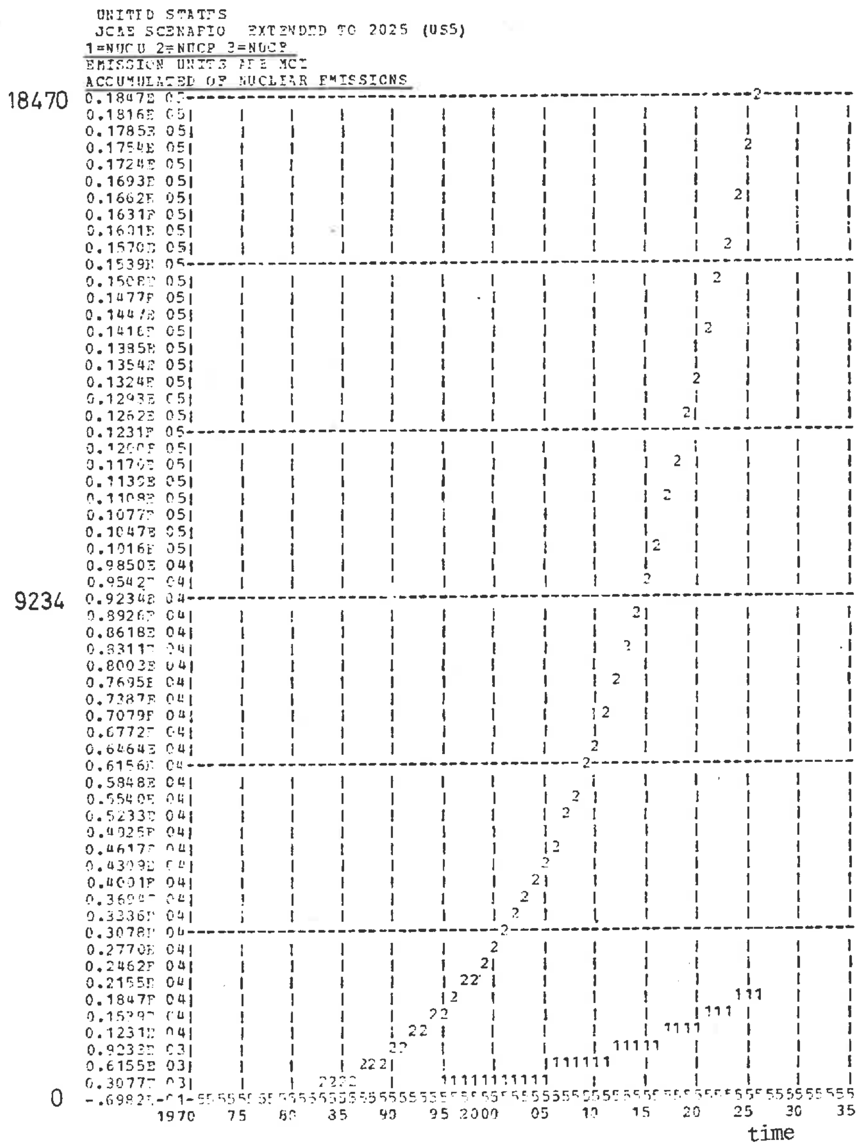
Totals of Emissions/Year



Accumulated Emissions



Emissions of Nuclear Power Generation



Accumulated of Nuclear Emissions

5. DISCUSSION OF APPROACH: LIMITATIONS OF PRESENT ER AND NEXT IMPROVEMENTS

This chapter summarizes the status of the energy emission register ER and the second work phase of the EIA Group in three respects: (i) model structure, (ii) scenarios, (iii) data. Also, some ideas on how we expect to pursue the objectives of the EIA Working Group are presented.

(i) Model structure

The ER is an input-throughput-output model with the following properties: It is attached to the energy supply program ESP. Its input, therefore, is limited to time series of energy use as computed in the ESP scenarios. The output is a set of time series of emissions by type generated by the spectrum of primary energy sources used and by the technologies (sectors) where they are consumed. Also, for some abatement technologies the relationship between cost and abatement has been included so that the cost of a given average reduction %-age is obtainable from the output.

There is yet no online feedback to the ESP program or to other submodels. Also, the ER cannot yet be run "in reverse", e.g., using emission threshold time series as inputs and computing maximum energy use in each sector as a function of abatement technology. However, the software model-handling package being developed in Cleveland and in Hannover [70, 76] will make these improvements possible in the second work phase of the EIA Group. Also, the ergonomic improvements of the dialog mode which are being made by the Nijmeegen Group will be incorporated in the structure of our next ER program.

There are two other tasks which we hope to complete before mid-1975: the coupling of the emission register with macro-cycle models and the development of crude emission distribution models.

(ii) Scenarios

Since the ER is only passively attached to the ESP program, we have been limited to scenarios of the environment load generated by different energy policies in 3 regions. Also, cost-benefit analysis of different abatement policies has been done. More work will have to follow though, before we can come out with recommendations for abatement allocation, e.g., whether to invest more heavily into abatement in power plants or into abatement at the various sites of final comsumption. This last example also makes it clear that for the purpose of policy recommendation it will not suffice to look at energy emissions alone. Therefore, we will develop two more ER's in the next work phase: an agriculture emission register and a transport system emission register. These will have the same basic model structure as the energy emission register.

Ultimately, the set of simple emission registers will be increased until the total pollution created by Man can be computed. These emission registers can then be used in combination to compute the environmental load in areas of high industrial concentration or high population density. With such models, policies for saner urban development and industrial infrastructure can be tested, policies of intensive technology vs. extensive technology can be compared, and so on.

Of course, the environment crisis is not just a result of a wrong distribution of pollution. It is also a question of limits. Therefore, work is also being done by other groups in the World Model Project to investigate on a larger scale the global-regional effects of Man's energy consumption on climate. For this task, however, the regionalization will have to be somewhat different from that for economic and political analysis. Perhaps here the "mosaic" approach will prove to be useful, which looks at regions (e.g., the atmosphere, continents, oceans) composed of subregions (e.g. water sheds), subregions composed of landscapes etc. Climate models and macro-cycle models would then provide the coupling between the regions. Work is being done in Hannover on a regionalization routine starting from given regionalization criteria [39] .

Another advantage of this approach is that it can be used for "plug-in" analysis, which focusses on e.g. national problems while retaining the regional and global perspective [9] .

The second work phase of the EIA Group will still be concentrated on the analysis of pollution impact on the physical state of the environment, but some work on the analysis of ecological impact will be started in parallel. A World health model will be developed with which the effects of pollution on health, on life expectancy, on labor etc. can be analysed. Another study will compare different agricultural policies, not only w.r.t. yield but also w.r.t. their ecological soundness.

Finally, we hope to involve more ecologists in our work for identifying powerful indicators of environmental well-being and for developing the necessary ecosystem models.

(iii) Data

The data base for the energy emission register includes specific emission coefficients for each primary energy source by technology and the costs of abatement. The specific emission coefficients for fossile fuels are well documented. For nuclear power our data base is still very weak; only the emissions during operation have been made available to us from the Kernforschungs-Anlage Jülich KFA. The much more critical emissions, however, are generated in the external recycling processes of radioactive and chemically poisonous material. For these we have only a very small and insufficient data base. KFA will give us better data as soon as they have them.

In some cases different fuel qualities are used on the average in different regions; we have accounted for this with region-dependent emission coefficients.

Because abatement technology is very variable and at present under rapid development, the average cost-effectiveness of such technologies cannot be determined very precisely. Therefore we have used the present data bate for sensitivity analysis only. We are compiling a better data base which we will use for the assessment of alternative abatement technologies. The results will be an important input for the evaluation of the energy policies.

Together with ecologists, toxicologists, and industrial engineers our data base will be developed until it can serve as a quantitative basis for the scenarios described in (ii).

BIBLIOGRAPHY

1. Anderson, J.M.: System Simulation to Test Environmental Policy: The Eutrophication of Lakes. Cambridge, 1972.
2. Babcock, L.R.: A Method for Estimation of Emission Control Costs. Environmental Affairs, 1972.
3. Bässler, H.J.: Betrachtungen zur Irrigation - Bewässerungsprobleme am Beispiel Indiens. Report to the World Modeling Project, Heidelberg, 1974.
4. Bauerschmidt, R.; Denton, R., and Maier, H.H.: Energy Model: Resources. Report to IIASA Symposium on Global Modeling, Laxenburg 1974.
5. Bechert, K.: Falsche Informationen und Irreführung der Oeffentlichkeit über die Gefahren friedlicher Kernenergieanwendung. Das Leben - Leben und Umwelt, January 1974.
6. Bolin, B.: The Carbon Cycle. Scientific American, 1970.
7. Bonka, H.: Radioaktive Umweltbelastung durch Kernkraftwerke und Wiederaufarbeitungsanlagen. Lehrstuhl für Reaktortechnik der RWTH Aachen, 1974.
8. Bossel, H.H.: Energy Supply Model. Report to the IIASA Symposium on Global Modeling, Laxenburg, 1974.
9. Bossel, H.H.; Gottwald, M., and Pestel, R.: A Conceptual Foundation for National Policy Analysis and Planning (forthcoming).
10. Bossel, H.H. and Hughes, B.B.: Simulation of Value-Controlled Decision-Making. Karlsruhe/Cleveland, 1973.
11. Budyko, M.I.: The Effect of Solar Radiation Variations on the Climate of the Earth. Tellus, 1969.
12. Cardenas, M. and Huerta, J.M.: Submodel of the Global Water Cycle on a Regional Basis. Report to IIASA Symposium on Global Modeling, Laxenburg, April 1974.
13. Chapman, D.: Electricity Demand Growth and The Energy Crisis. Science, 1972.

14. Clapham, P.: A Model for The Control Requirements of Human Ecosystems. Manuscript CWRU, Cleveland, 1972.

15. Clapham, P.;Gottwald, M., and Pestel, R: A Conceptual Foundation for the Environmental Impact Assessment Study in the Multilevel World Model Project (forthcoming).

16. Cloud, P. and Gibor, A.: The Oxygen Cycle. Scientific American, 1970.

17. Cosby, W.T.: Technische Massnahmen zur Senkung der Luftverschmutzung infolge von Verbrennungsprozessen.
Dt. Uebersetzung aus 'Journal of the Institute of Fuel', 1973.

18. Darmstadter, J.: Energy in the World Economy.
John Hopkins Press, Baltimore, 1971.

19. Darmstadter, J.: Limiting the Demand for Energy: Possible? Probable? Environmental Affairs, 1972.

20. Delwiche, C.C.: The Nitrogen Cycle. Scientific American, 1970.

21. Duffy, P.J.B.: A Review of Environmental Impact Assessment Methods. Ottawa, 1973.

22. Egger, K.: Technologie und Oekologie im Konflikt. Das Leben - Leben und Umwelt, January, 1974.

23. Egger, K. and Glaeser, B.: Die Krise der Menschheit. Universitätsabende der Peterskirche, Heidelberg, 1972.

24. Egger, K.; Glaeser, B., and Reichling, J.: Entwicklung des oekologischen Modellteils. Entwurf, Heidelberg, February, 1973.

25. Ellenberg, H.: Belastung und Belastbarkeit von Oekosystemen. Tagung der Gesellschaft für Oekologie, Giessen, 1972.

26. Flohn, H.: Produzieren wir unser eignes Klima? Meteorologische Rundschau, Heft 6, 1970.

27. Flohn, H.: Globale Energiebilanz und Klimaschwankungen (Manuskript). Bonn, 1973.

28. Flohn, H.:Natürliche und Anthropogene Klimamodifikationen. Annalen der Meteorologie, Neue Folge Nr. 6, 1973.

29. Foerster, S.: Energiesektorales Informationssystem. Berlin, 1973.

30. Fritsch, B.: Data and Models of World Economic Development - An Integrative View. Zuerich, 1973.

31. Fritsch, B.: Wachstumsbegrenzung als Machtinstrument. DVA, Stuttgart, 1974.

32. Gabor, D.: The Proper Priorities of Science and Technology. The 18th Fawley Foundation Lecture, Univ. of Southampton, 1972.

33. Gandhi, S.I.: Address at The Inauguration of The National Committee on Environmental Planning and Coordination. New Delhi, 1972.

34. Gates, D.M.: The Flow of Energy in The Biosphere. Scientific American, 1971.

35. Glaeser, B. and Reichling, J.: System Dynamics: Versuch einer Humanökologischen Methode. Universität Heidelberg, 1973.

36. Goldwater, L.J.: Mercury in the Environment. Scientific American, 1971.

37. DeGolyer, E.L. and McNaughton, L.W.: Twentieth Century Petroleum Statistics 1973. Dallas, 1973.

38. Goodall, D.W.: Problems of Scale and Detail in Ecological Modeling. IIASA, Laxenburg, 1973.

39. Gottwald, M.: Criteria for Regionalization in the Multilevel World Model. Diss. TU Hannover (forthcoming).

40. Hawley, A.H.: Ecology and Population. Science, March, 1973.

41. Heinemann, D.: Viel Gerede um die "Qualitaet des Lebens". Das Leben - Leben und Umwelt. October, 1973.

42. Heinemann, D.: Oekonomie und Oekologie. Das Leben - Leben und Umwelt, November, 1973.

43. Heinemann, D.: Was ist Biologie? Das Leben - Leben und Umwelt. December, 1973.

44. Hill, C.T.: Thermal Pollution and Its Control. Environmental Affairs, 1972.

45. Holling, C.S.: Resilience and Stability of Ecological Systems. IIASA, Laxenburg, 1973.

46. Holling, C.S. et al.: Modeling and Simulation for Environmental Impact Analysis. IIASA Research Memorandum, Laxenburg, 1974.

47. Ishitani, H. and Kaya, Y.: An Integral Study of Regional Systems - MITI Project "Industry and Ecology". Tokyo, 1973.

48. Jaguaribe de Mattos, H.: The World Ecological Equilibrium and The Underdeveloped Nations. Rio de Janeiro, 1971.

49. Jameson, D. and Mesarovic, M.: Prospectus for a Workshop Meeting on the Modeling of Global Ecological Systems. Colorado State University, 1972.

50. Kleeberg, H. and Billib, H.: Globales Wasserkreislauf-Modell auf Regionaler Basis. Region 6: Lateinamerika. TU Hannover, Inst. f. Wasserwirtschaft, Hydrologie und Landwirtsch. Wasserbau, 1974.

51. Knoblauch, K.: Rauchgas ohne Schwefel. Luftreinhaltung, 1973.

52. Koonce, J. and Teraguchi, M.: A Regionalized Model of the Phosphorus and Nitrogen Cycle in the World System. CWRU, Cleveland, 1974.

53. Kuper, A.B.: Solar Energy Prospects:A Report for the Multi-Level World Model Project. Systems Research Center, CWRU, Cleveland, 1973.

54. Macko, D. and Teraguchi, M.: Biomass and Phosporus Dynamics - An Aquatic Ecosystem Submodel. Systems Research Center, CWRU, Cleveland, 1973.

55. Maerkl, H. and Stoll, W.: Rueckfuehrung von Plutonium in Thermische Reaktoren. Atomwirtschaft, 1972.

56. Meadows, D.H.; Meadows, D.L.; Zahn, E.; Milling, P. et al.: Die Grenzen des Wachstums. DVA, Stuttgart, 1972.

57. Meadows, D.L. and Meadows, D.H. (Ed.): Toward Global Equilibrium - Collected Papers. Wright-Allen Press, Cambridge, Mass., 1973.

58. Merian, E.: Umweltforschung. Lecture at the Schweizerische Vereinigung fuer Zukunftsforschung, Zuerich, January, 1974.

59. Mesarovic, M.; Hughes, B. et al: An Interactive Decision Stratum for The Multilevel World Model. Futures, August, 1973.

60. Mesarovic, M. and Pestel, E.: A Goal-Seeking and Regionalized Model for Analysis of Critical World Relationships - The Conceptual Foundation. Kybernetes, 1972.

61. Mesarovic, M. and Pestel, E.: Declining Options for Mankind. A Report to The Club of Rome, 1974.

62. Mesarovic, M.; Takahara, Y. and Macko, D.: Theory of Hierarchical, Multilevel Systems. New York, 1970.

63. Meyer-Abich, K.M.: Die oekologische Grenze des Wirtschaftswachstums. UMSCHAU, 1972.

64. Mottek, H.: Material to the Research Project "Ecological Systems". Presented at IIASA, Laxenburg, 1973.

65. Naill, R.: Conceptualization and Representation of A System Dynamics Model - A Study of Deer Population on the Kaibab Plateau. NATO Workshop on System Dynamics, Hannover, 1972.

66. Newell, R.E.: The Global Circulation of Atmospheric Pollutants. Scientific American, 1971.

67. Peixoto, J.P. and Kettani, M.A.: The Control of the Water Cycle. Scientific American, 1971.

68. Pestel, R.: Eine neue, umfassende Methodologie fuer die Technik - Folgenabschaetzung aufgrund der Theorie der hierarchischen Mehrebenensysteme. Diss. Technical University of Hannover, October, 1973.

69. Randers, J. and Meadows, D.L.: System Simulation to Test Environmental Policy - A Sample Study of DDT Movement in the Environment. MIT, Cambridge, Mass., 1971.

70. Rechenmann, F.:Conversational Use of Multi-Layer Decision Models. April, 1974.

71. Rehbinder, E.:Umweltrelevante Entscheidungsprozesse. Das Leben - Leben und Umwelt, December 1973.

72. Richardson, E.L.: A Report on Measurement of the Quality of Life. U.S. Department of Health, Education, and Welfare, 1973.

73. Saha, G. and Mesarovic, M.: Phosphorus as a Resource. Systems Research Center, CWRU, Cleveland, 1973.

74. Schikarski et al.: Beitrag zum Bericht der Projektgruppe "Umwelt und Energie". Bundesministerium des Inneren, Bonn, 1973.

75. Schwieger, R.G.: Plants Show Progress in Pollution Control. Power, 1971.

76. Shook, T.: Scenario Analysis Package. Report to the IIASA Symposium on Global Modeling, Laxenburg, April 1974.

77. Singer, S.F.: Human Energy Production as a Process in The Biosphere. Scientific American, 1970.

78. Stehfest, H.: Modelltheoretische Untersuchungen zur Selbstreinigung von Fliessgewaessern. Kernforschungszentrum Karlsruhe, 1973.

79. Taschdjian, E.: The Evolution of Ecological Theory. Society for General Systems Research, Washington, D.C., 1973.

80. Taschdjian, E.: Quality of Life - How to Think about It. The Teilhard Review, October, 1973.

81. Thoss, R.: Ein integriertes Optimierungsmodell zur Verbesserung des Umweltschutzes. Universitaet Muenster, 1974.

82. Tinker, J.: Breeders: Risks Man Dare Not Run. New Scientist, 1973.

83. Woodwell, G.M.: The Energy Cycle of The Biosphere. Scientific American, 1970.

84. Zimmermann, C. and Kobus, H.: Waermebelastung und Waermeabfuhrvermoegen eines Flusses. Energie, 1973.

B 1276

V.3. SUBMODEL OF GLOBAL WATER CYCLE ON REGIONAL BASIS

M.A. Cardenas, J.M. Huerta

April 1974

Table of Contents

	Page
1. Introduction	B 1279
2. The Structure of the Model	B 1282
3. Data and Parameter Estimation	B 1301
4. Scenario Specification	B 1313
5. Analysis of Results	B 1327
APPENDIX I: Programming Listing	B 1337
APPENDIX II: Standard Computer Runs	B 1352

1. Introduction

Objective of our efforts is to develop a global but regionalized water cycle model which by proper linkages can be used within the multilevel model of the world system. Consistent with the objectives of the world system model development our concern will be with the long and very long range developments of say 50 or 75 years horizon. This is not so unusual in the water resources area as possibly in some other domains, e.g. economics as such, where the explicit concern traditionally was with much shorter time horizons. After all, change in water resources system requires major physical construction and corresponding substantial investment. It also takes years to build and if the structure is not to become obsolete almost before it is completed and fully in use, a planning horizon measured in decades must be taken.

In the present effort our concern is with the issues much broader than the questions of water resources as such. We are interested in the long range development of the global world system - the effect of growth - population and economic - disparity between various parts of the system, physical limits, their modification and extension, etc. Specifically, our water cycle model should enable our examination of the importance and role which the water cycle - natural and cultural - plays in such development. Three issues, quite naturally, come to mind: Can the water resources be developed - physically and economically - to support the desired development - regional and global? Can these resources be managed in such a manner that the obvious negative consequences of human water use - such as pollution - can be kept under a tolerable level? What is the effect of man-induced changes on the natural cycle, i.e., how the supporting eco-system is changed and is the long range effect of such interference with nature tolerable even if more apparent negative effects, like pollution have been eliminated.

The present report describes the progress made so far. The overall model is based on the regionalization adopted for the total project. The structure of the model and a specific set of equations have been developed and programmed for the use in computer analysis. Parameters are estimated for several regions and the usefulness of the model is assessed by means of a preliminary analysis of alternative scenaria regarding future developments. A pictorial representation of the natural processes involved is shown in Fig. 1.

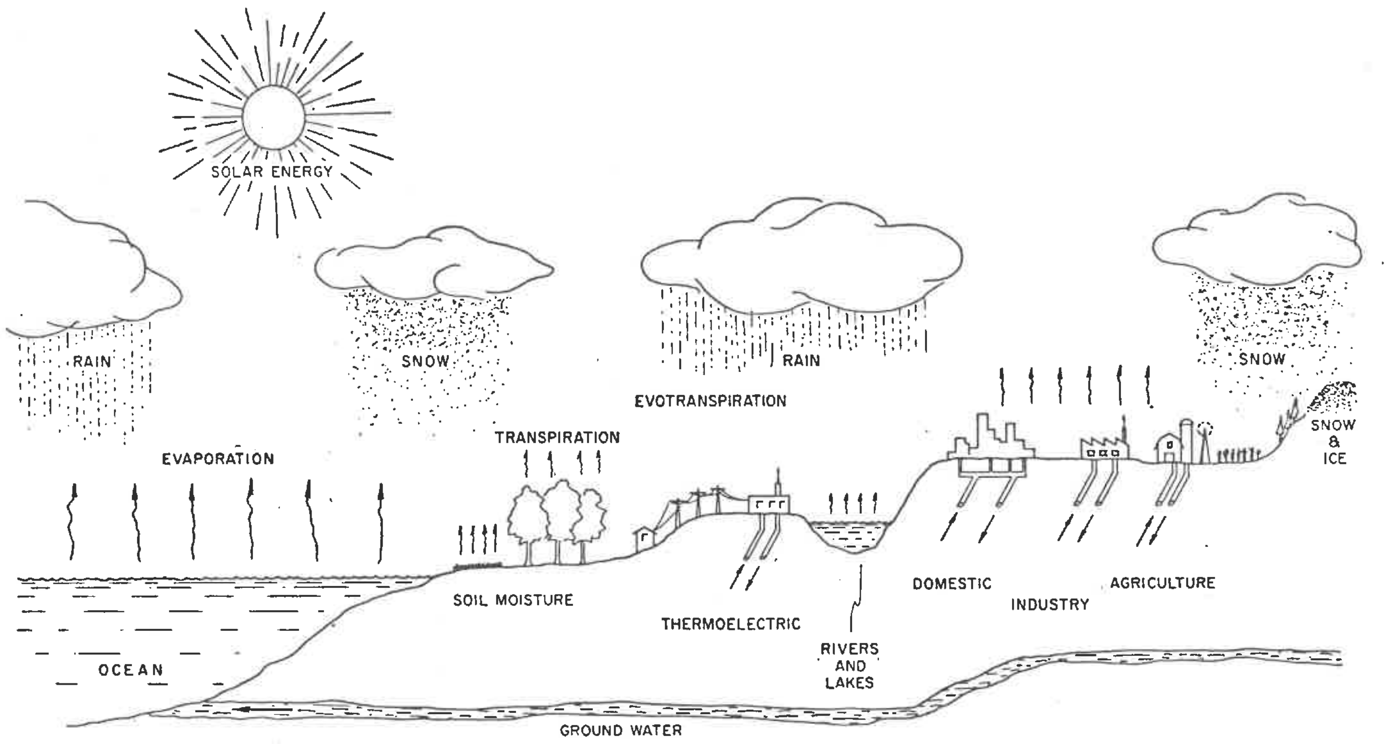

SOLAR ENERGY
RAIN
SNOW
RAIN
SNOW
EVOTRANSPIRATION
TRANSPIRATION
EVAPORATION
SNOW & ICE
SOIL MOISTURE
THERMOELECTRIC
RIVERS AND LAKES
DOMESTIC
INDUSTRY
AGRICULTURE
OCEAN
GROUND WATER

FIGURE 1

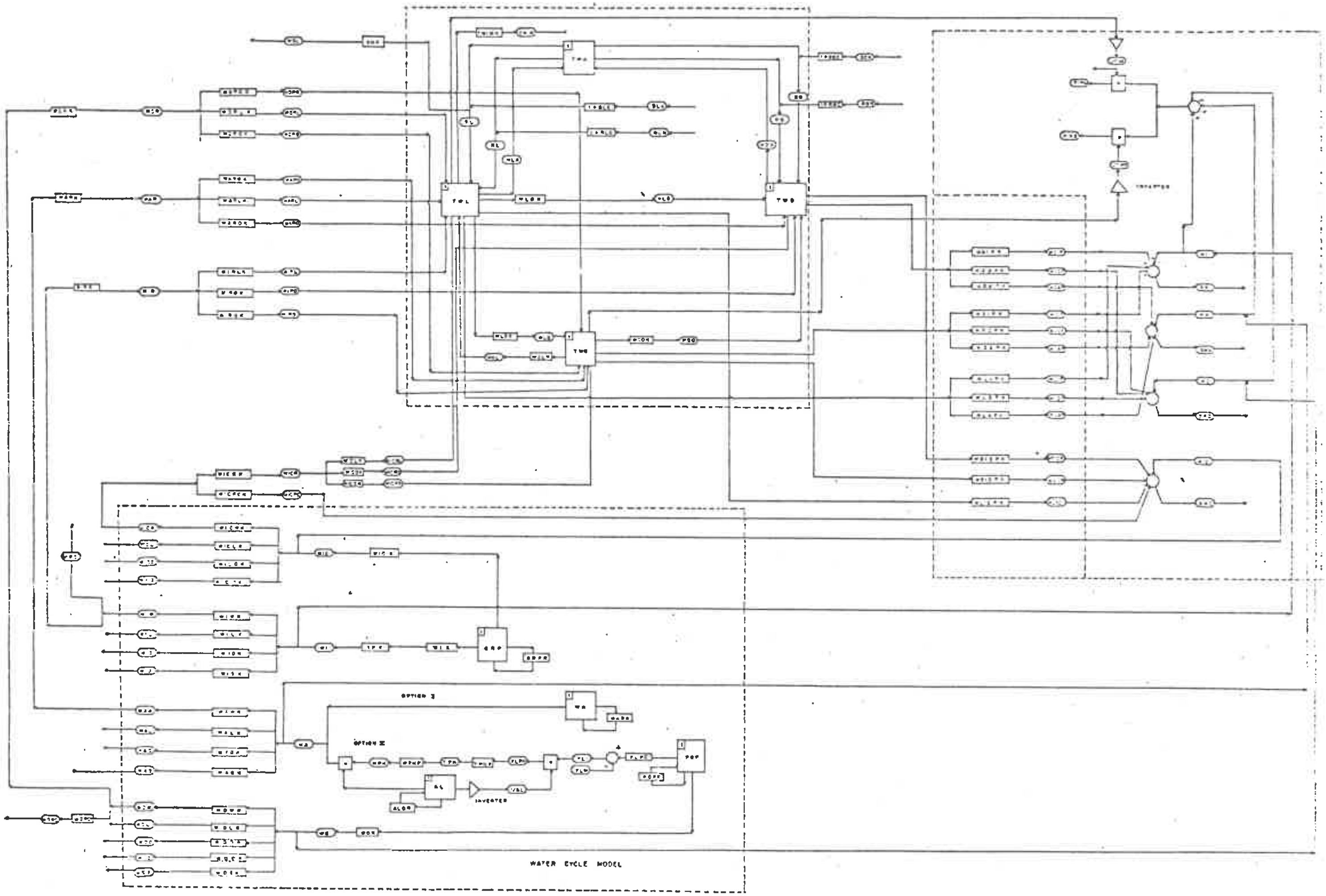
2. Structure of the Model

Two basic assumptions underlie the construction of the water cycle model.

(a) The variables are given in terms of average annual values. Although, for certain other types of problems (flood control, etc.) a seasonal, a monthly, or even daily variation is of interest. For the objectives of our modeling efforts as described in Sec. 1 annual values seem to be satisfactory.

(b) All the processes of the same type within a given region are aggregated into a single process regardless of their actual geographic representation. For example the evapotranspiration from a given region is simply given in terms of total quantity of water; or, the leakage of surface water to groundwater is given in terms of total amount regardless where the ground water is actually located within the region. This is somewhat more constraining assumption but quite a convenient one for the initial effort. Actually the restrictions imposed by their assumption will be relaxed further development of the model by representing some regions in terms of subregions whenever that is required for a proper analysis of the issue concerned.

The overall block diagram of the model is given in Fig. 2. It has essentially demand and supply submodels. The demand part is determined by the economic development, degree of industrialization, type and intensity of agriculture, population and the prevailing customs in use of water etc. The supply side is represented in terms of surface water TWL, ocean and sea water TWO, groundwater TWG and the water in atmosphere, TWA. The relationship

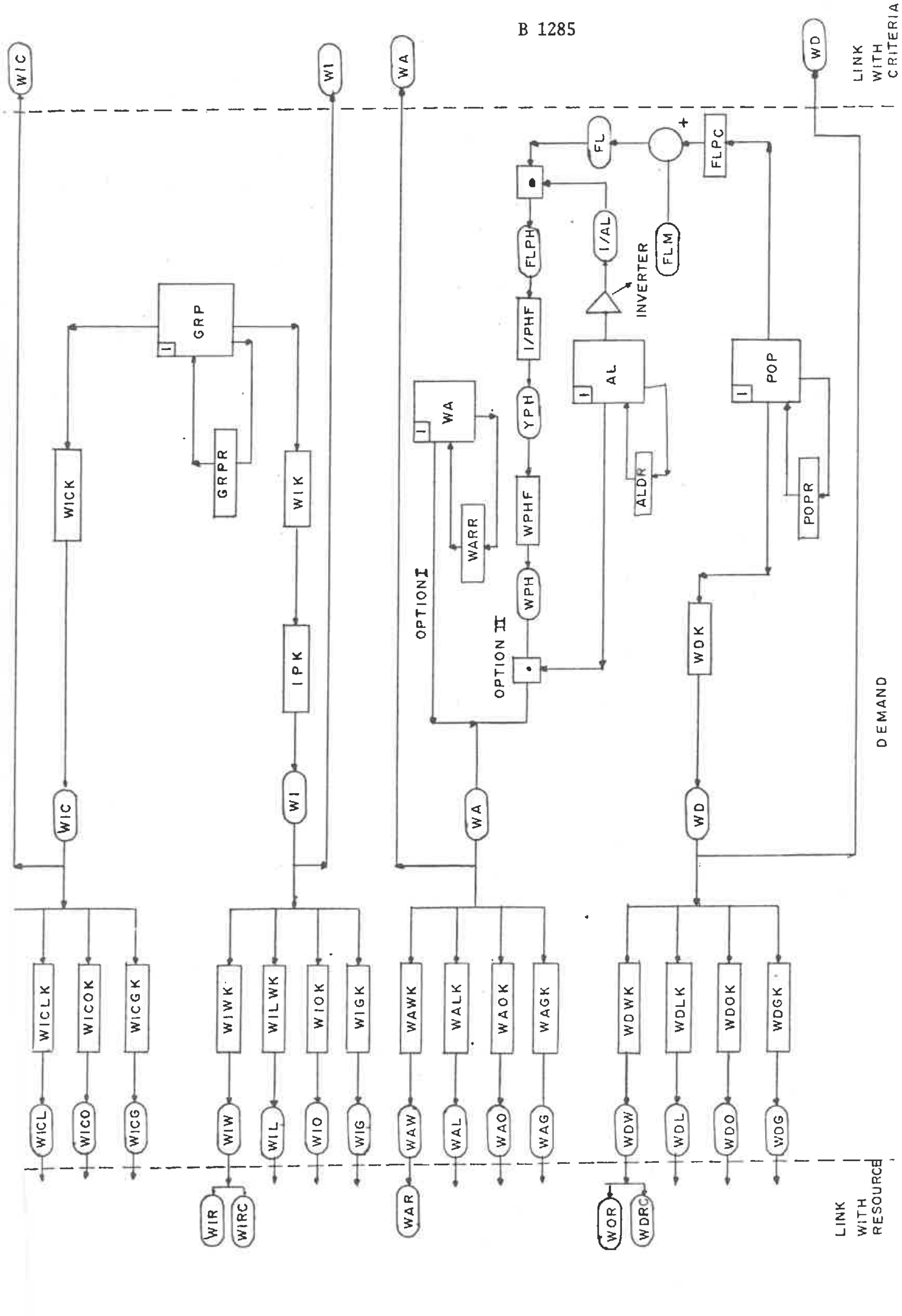

WATER CYCLE MODEL
OPTION I
OPTION II
INVERTER

between key factors is specified by appropriate feedbacks (see Figs. 2a-2d).

A complete set of equations for the system is developed on the basis of the assumptions (a) and (b). For the sake of an easy overview the complete set of these equations is given in Table I with the variables defined in Table II. Additional state equations for any other variables of interest (e.g., surface water impounded, total snow on land, etc.) can be included quite readily. The block diagram for the model using standard notation is given in Fig. 2. The model is programmed for the purpose of computer analysis and the listing of the program is given in App. I while the printout of the standard run is given in App. II. A simplified block diagram is given in Fig. 3.

The model of Figure 2 has general features which can make it useful for analyzing a variety of problems. It is basically a water quantity model (we need to balance the components of the hydrologic water quantity cycle if a macroregional level of aggregation is to be used), although water quality is taken into account implicitly. For example, the coefficients WOIPK (on the supply side) indicates the amount of desalted ocean water available to meet industrial demands and this depends on the treatment infrastructure and water development of the region. If the present model were more disaggregated (e.g., surface water divided into river water and lakes, water deman into sectoral uses, etc.) particular water quality policies would appear more explicit within the structure of the model. The model in its present form provides a framework for the analysis of various specific problems. Any number of modifications

B 1285



LINK WITH CRITERIA
DEMAND
LINK WITH RESOURCE
WIC
WI
WA
WD
GRP
GRPR
WICK
WIK
IPK
WA
WARR
OPTION I
OPTION II
FL
FLPH
I/PHF
YPH
WPHF
WPH
I/AL
INVERTER
AL
ALDR
FLM
FLPC
+
POP
POPR
WDK
WICLK
WICOK
WICGK
WIWK
WILWK
WIOK
WIGK
WAWK
WALK
WAOK
WAGK
WDWK
WDLK
WDOK
WDGK
WICL
WICO
WICG
WIW
WIL
WIO
WIG
WAW
WAL
WAO
WAG
WDW
WDL
WDO
WDG
WIR
WIRC
WAR
WOR
WDRC

Figure 2b

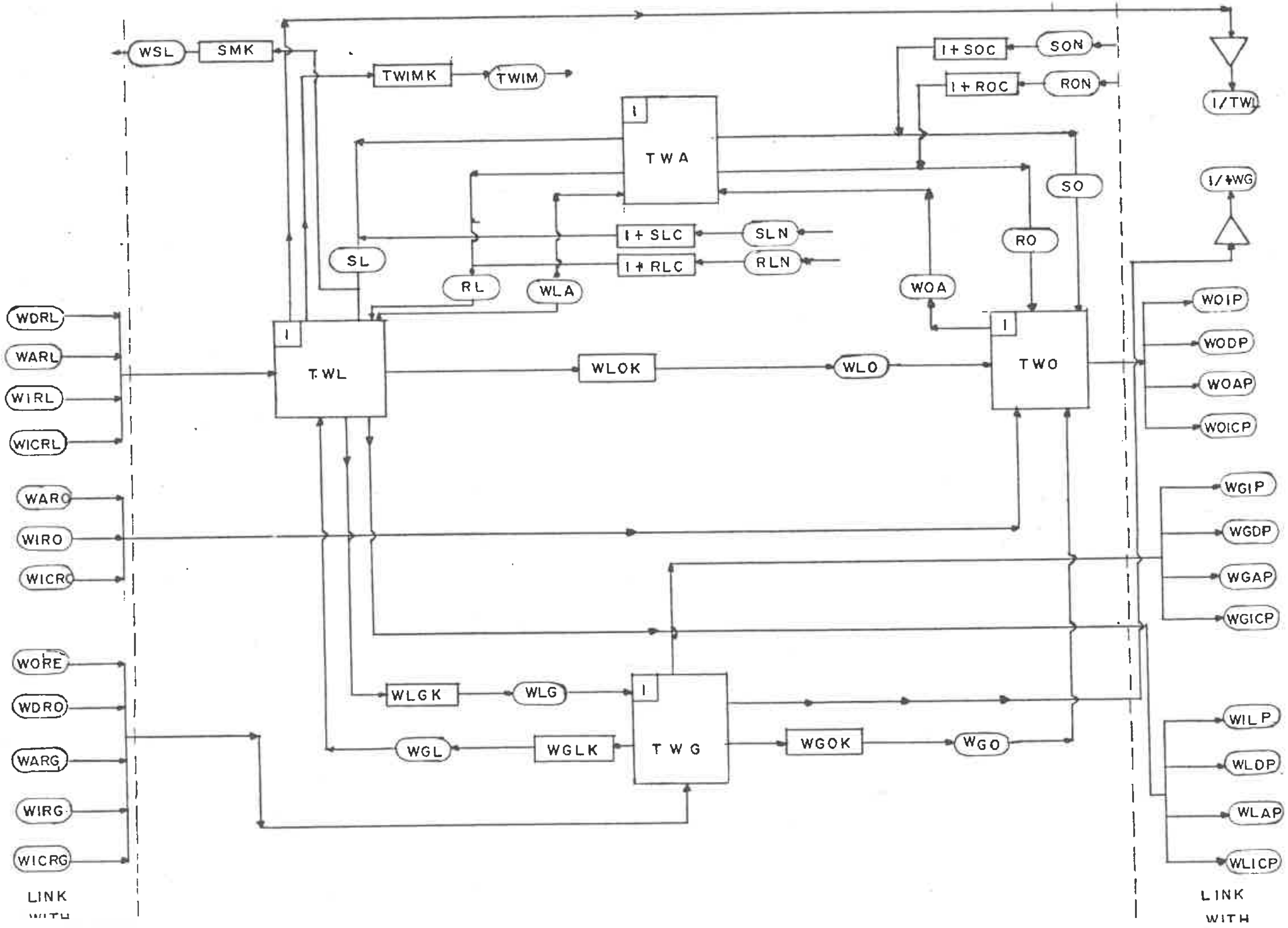
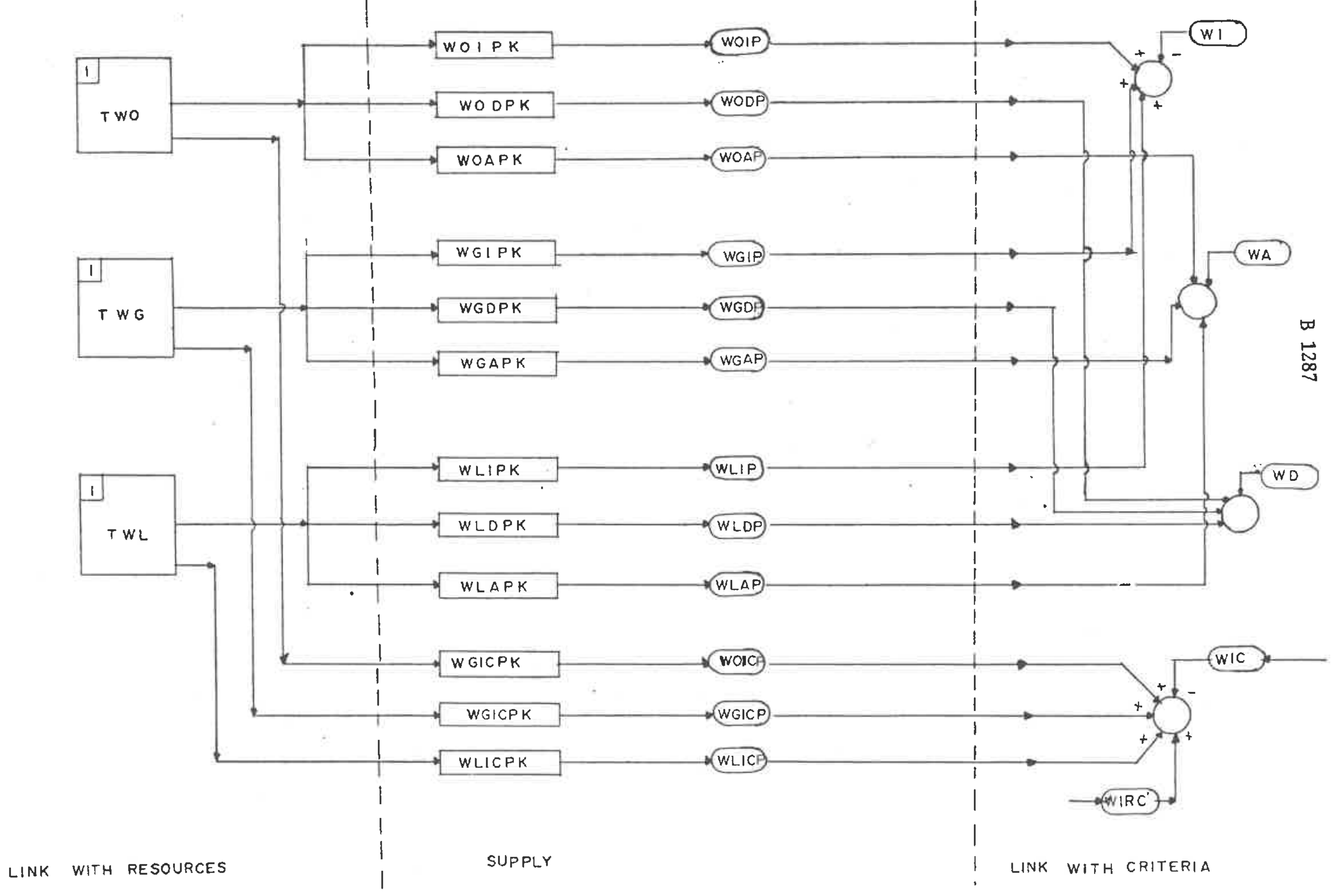

WSL
SMK
TWIMK
TWIM
TWA
SL
RL
WLA
1+SLC
1+RLC
SLN
RLN
1+SOC
1+ROC
SON
RON
SO
RO
WOA
1/TWL
1/+WG
WDRL
WARL
WIRL
WICRL
WARO
WIRO
WICRO
WORE
WDRO
WARG
WIRG
WICRG
LINK
WITH
TWL
WLOK
WLO
TWO
WOIP
WODP
WOAP
WOICP
WGIP
WGDP
WGAP
WGICP
WLGK
WLG
TWG
WGL
WGLK
WGOK
WGO
WILP
WLDP
WLAP
WLICP
LINK
WITH

Figure 2c



B 1287

B 1288

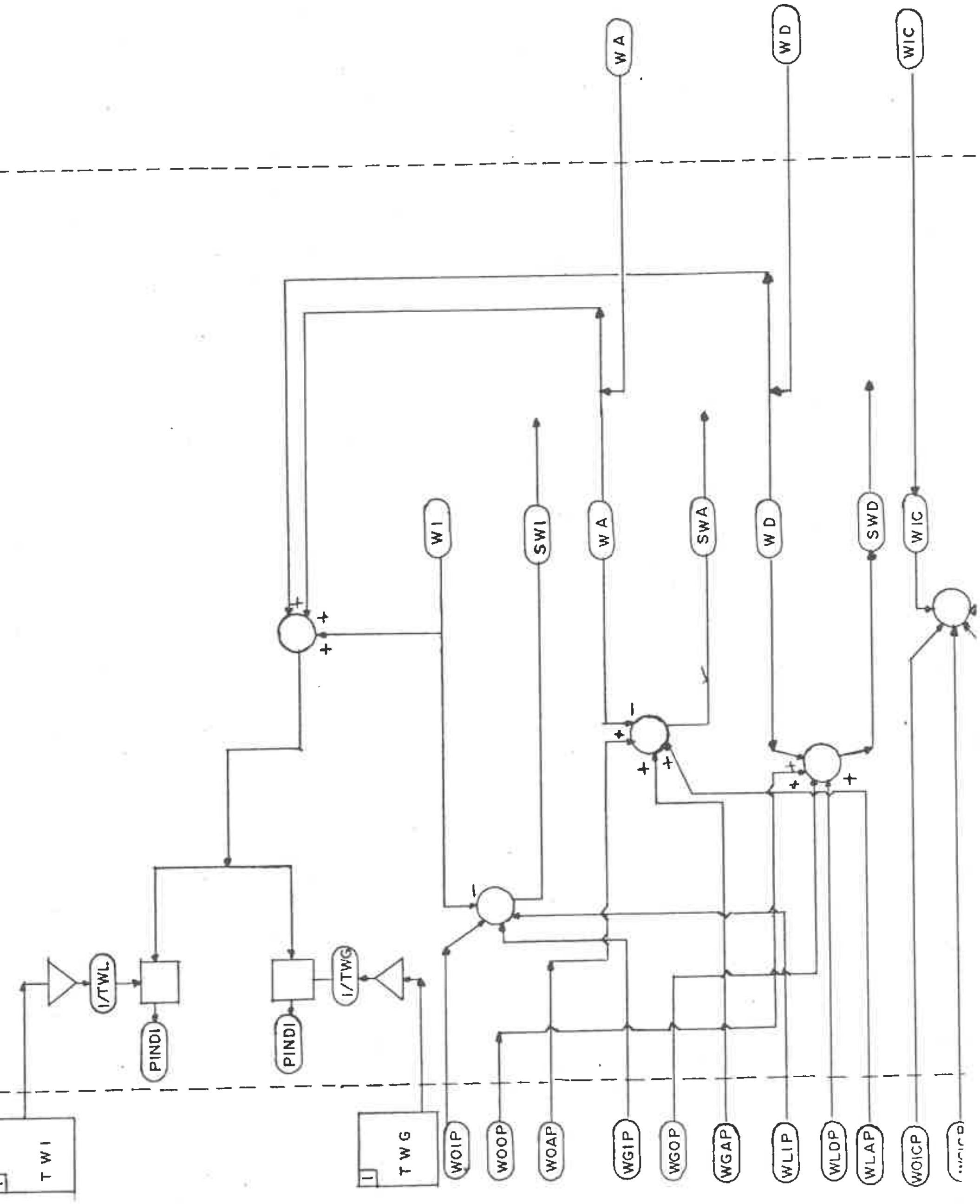
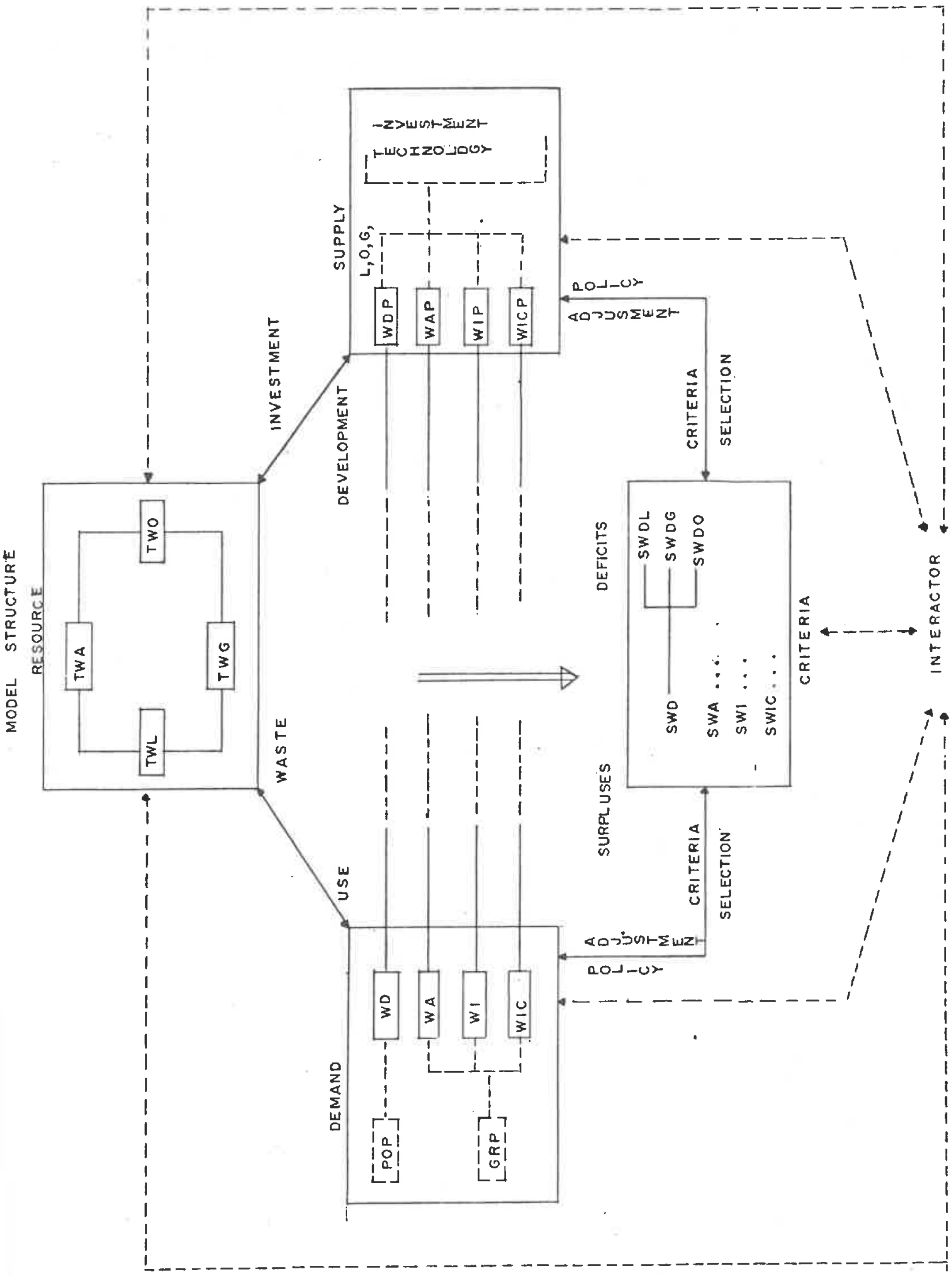


Figure 2d

B 1289



MODEL STRUCTURE
RESOURCE
TWO
TWA
TWG
TWL
INVESTMENT
DEVELOPMENT
WASTE
USE
SUPPLY
L,O,G,
WDP
WAP
WIP
WICP
INVESTMENT
TECHNOLOGY
POLICY
ADJUSMENT
CRITERIA
SELECTION
DEFICITS
SWDL
SWDG
SWDO
SWD
SWA . . .
SWI . . .
SWIC . . .
SURPLUSES
CRITERIA
INTERACTOR
CRITERIA
SELECTION
ADJUSTMENT
POLICY
DEMAND
WD
WA
WI
WIC
POP
GRP

could be made easily to reflect specific analysis interests; for example, to calculate evapotranspiration (WOA) we could explicitly add a cultural parameter (similar to the rainfall augmentation coefficient RLC) if we were interested in seeing the possible future effect of evaporated cooling water on the overall hydrologic cycle. In reference to the great importance of cooling water for thermoelectric power generation in the present model structure the industrial water demand submodel has been divided into WIC (cooling) and WI (normal process water) demands. Additional indicators and auxiliary functions could be also added to the model, such as deficits for industrial water coming from specific sources (surface, ocean, ground) would also be reflected by the parameters WLIPK, WGIPK and WOIPK which would vary with time. More will be said about the advantages and disadvantages of the present model in the chapter on the scenario analysis. The cost on economic component of future water development is implicitly included by estimating the possible investments needed to augment water supply or availability to various levels, i.e., desalination, watershed management, reuse, etc. As the present model is not intended to be used as an optimization tool, at least initially we will not be concerned with recommending any particular water resources policies (such as a minimum cost program for the next 30 years).

TABLE I B 1291

DEMAND

GRP^{t+1}	=	$GRP^{t} (1 + GRPR^{t})$
WIC	=	WICK * GRP
WICW	=	WICWK * WIC
WICRC	=	WICRCK * WICW
WICR	=	WICRK * WICW
WICRL	=	WICRLK * WIC
WICRO	=	WICRLO * WIC
WICRG	=	WICRLG * WIC
WICL	=	WICLK * WIC
WICO	=	WICOK * WIC
WICG	=	WICGK * WIC
WI	=	WIK * IPK * GRP
WIL	=	WILK * WI
WIO	=	WIOK * WI
WIG	=	WIGK * WI
WIW	=	WIWK * WI
WIRC	=	WIRCK * WIW
WIR	=	WIRK * WIW
WIRL	=	WIRLK * WIR
WIRO	=	WIROK * WIR
WIRG	=	WIRGK * WIR
POP^{t}	=	$POP^{t} (1 + POPR^{t})$
WD^{t+1}	=	$WD^{t} * (1 + POPR)$
WD	=	WDK * POP
WDG	=	WDGK * WD

TABLE I (Continued)

WDL	= WDLK * WD
WDO	= WDOK * WD
WDW	= WDWK * WD
WDRC	= WDRCK * WDW
WDR	= WDRK *WDW
WDRL	= WDRLK * WDR
WDRO	= WDROK * WDR
WDRG	= WDR
OPTION I	
AL^{t+1}	$= AL^{t} (1 + ALDR)^{t}$
WA^{t+1}	$= WA^{t} (1 + WARR$
OPTION II	
FL	= FLPC * POP - FLM
FLPH	= FL / AL
YPH	= YPHF (FLPH)
WPH	= WPHF (YPH)
WA	= WPH * AL
WAW	= WAWK * WA
WAO	= WAOK * WA
WAL	= WALK * WA
WAG	= WAGK * WA
WAR	= WARK * WAW
WARG	= WARGK * WAR
WARL	= WARLK * WAR
WARO	= WAROK * WAR

NATURAL RESOURCES

$RL = (1 + RLC) * RLN$

$RO = (1 + ROC) * RON$

$SL = (1 + SLC) * SLN$

$SO = (1 + SOC) * SON$

$WSL = SL * SMK$

$WAL = WALSK * LS$

$WOA = WOASK * OS$

$WSL = SMK * TSL$

$$TWG^{t+1} = TWG^{t} + WLG^{t} - WGL^{t} + WIRG^{t} - WDG^{t} + WDRG^{t} - WAG^{t} + WARG^{t}$$

$WGL = WGLK + TWG$

$$TWL^{t+1} = TWL^{t} + WGL^{t} - WLG^{t} - WIL^{t} + WIRL^{t} - WDL^{t} + WDRL^{t} + RL + WSL^{t} - WLO - WAL^{t} + WARL^{t}$$

$WLG = WLGK * TWL$

$WLO = WLOK * TWL$

$TWIM = TWIMK * TWL$

SUPPLY

$WGIP = WGIPK * TWG$

$WGDP = WGDPK * TWG$

$WGAP = WGAPK * TWG$

$WLDP = WLDPK * TWL$

$WLAP = WLAPK * TWL$

$WOIP = WOIPK * TWO$

$WOAP = WOAPK * TWO$

TABLE I (Continued)

CRITERIA

SE	=	EC * POP - ENH - IEK * EH
SWI	=	WLIP + WGIP + WOIP + WIRC - WI
SWIC	=	WLICP + WGICP + WDICP + WICRC - WIC
SWA	=	WLAP + WGAP + WOAP - WA
SWD	=	WLDP + WGDP + WODP + WDRC - WD
PIND 1	=	(WI + WD + WA) / TWL
PIND 2	=	(WI + WD + WA) TWG

TABLE II

GRP	Gross regional product
GRPR	Gross regional product, rate
WI	Water, industrial
WIK	Water, industrial, coefficient
IPK	Industrial production coefficient
WIW	Water, industrial, waste
WIWK	Water industrial, waste, coefficient
WIL	Water industrial from land
WILK	Water industrial from land, coefficient
WIO	Water industrial from ocean
WIOK	Water industrial from ocean, coefficient
WIG	Water industrial from ground
WIGK	Water industrial from ground, coefficient
WIR	Water industrial, return
WIRK	Water industrial, return, coefficient
WIRL	Water industrial, return to land
WIRLK	Water industrial, return to land, coefficient
WIRO	Water industrial, return to ocean
WIROK	Water industrial, return to ocean, coefficient
WIRG	Water industrial, return to ground
WIRGK	Water industrial, return to ground, coefficient
POP	Population
POPR	Population, rate
WD	Water, domestic
WDK	Water, domestic, coefficient
WDG	Water, domestic, from ground

WDGK	Water, domestic, from ground, coefficient
WDL	Water, domestic, from land
WDLK	Water domestic, from land, coefficient
WDO	Water, domestic, from ocean
WDOK	Water, domestic from ocean, coefficient
WDW	Water, domestic, waste
WDWK	Water, domestic, waste, coefficient
WDR	Water, domestic, return
WDRK	Water, domestic, return, coefficient
WDRG	Water domestic, return to ground
WDRGK	Water domestic, return to ground, coefficient
WDRL	Water domestic, return to land
WDRLK	Water domestic, return to land, coefficient
WDRO	Water domestic, return to ocean
WDROK	Water domestic, return to ocean, coefficient
WA	Water, agriculture
WARR	Water, agriculture, rate
FL	Food from land
FLPC	Food from land per capita
FLM	Food from land imported
FLPH	Food from land, per hectare
AL	Arable land
ALDR	Arable land, development rate
YPH	Yield per hectare
YPHF	Yield per hectare, function

WPH	Water per hectare
WPHF	Water per hectare, function
WAG	Water, agriculture, from ground
WAGK	Water, agriculture, from ground, coefficient
WAL	Water, agriculture, from land
WALK	Water, agriculture, from land, coefficient
WAO	Water, agriculture, from ocean
WAOK	Water, agriculture, from ocean, coefficient
WAW	Water, agriculture, waste
WAWK	Water, agriculture, waste, coefficient
WAR	Water ,agriculture, return
WARK	Water, agriculture, return, coefficient
WARG	Water, agriculture, return to ground
WARGK	Water, agriculture, return to ground, coefficient
WARL	Water, agriculture, return to land
WARLK	Water, agriculture, return to land, coefficient
WARO	Water, agriculture, return to ocean
WAROK	Water, agriculture, return to ocean, coefficient
RL	Rain on land
RLC	Rain on land, cultural
RLN	Rain on land, natural
RO	Rain on oceans
ROC	Rain on oceans, cultural
RON	Rain on oceans, natural
SL	Snow on land
SLC	Snow on land, cultural
SLN	Snow on land, natural

SO	Snow on ocean
SOC	Snow on ocean, cultural
SON	Snow on ocean, natural
TSL	Total snow on land
SMK	Snow melting coefficient
WLA	Water from land to atmosphere
LS	Land surface
WLASK	Water from land to atmosphere per unit surface, coefficient
WOA	Water from ocean to atmosphere
OS	Ocean surface
WOASK	Water from ocean to atmosphere per unit surface, coefficient
WSL	Water from snow on land
TWG	Total water ground
WLG	Water from land to ground
WGL	Water from ground to land
WGLK	Water from ground to land, coefficient
WGIP	Water from ground for industry, planned
WGIPK	Water from ground for industry, planned, coefficient
WGDP	Water from ground for domestic, planned
WGDPK	Water from ground for domestic, planned, coefficient
WAGP	Water from ground for agricultural, planned
WAGPK	Water from ground for agricultural, planned, coefficient
TWL	Total water, land
WLGK	Water from land to ground coefficient
WLO	Water from land to ocean
WLOK	Water from land to ocean, coefficient
TWIM	Water, impounded

TWIMK	Water, impounded, coefficient
WLIP	Water from land for industry, planned
WLIPK	Water from land for industry, planned, coefficient
WLDP	Water from land for domestic, planned
WLDPK	Water from land for domestic, planned, coefficient
WLAP	Water from land for agriculture, planned
WLAPK	Water from land for agriculture, planned, coefficient
WOIP	Water from ocean for industry, planned
WOIPK	Water from ocean for industry, planned, coefficient
WODP	Water from ocean for domestic, planned
WODPK	Water from ocean for domestic, planned, coefficient
WOAP	Water from ocean for agriculture, planned
WOAPK	Water from ocean for agriculture, palnned, coefficient
DWI	Deficit, water for industry; or SWI (surplus)
DWA	Deficit, water for agriculture; SWA (surplus)
DWD	Deficit, water for domestic; or SWD (surplus)
EC	Energy per capita (MW)
ENH	Non-hydro power capacity
EH	Hydroelectric power capacity (installed)
IEK	Ratio of effective to installed hydro capacity
WIRC	Water for industry, recycled
WIRCK	Water for industry, recycled, coefficient
WDRC	Water for domestic, recycled
WDRCK	Water for domestic, recycled, coefficient
WIC	Cooling water demand
WICK	Cooling water demand, coefficient

WIRC	Cooling water returned
WIRCK	Cooling water returned, coefficient
WIRCL	Cooling water returned to land
WIRCLK	Cooling water returned to land, coefficient
WICL	Cooling water demand from land
WICLK	Cooling water demand from land, coefficient
WICO	Cooling water demand from ocean
WICOK	Cooling water demand from ocean, coefficient
WICG	Cooling water demand from ground
WICGK	Cooling water demand from ground, coefficient
WICRC	Cooling water recycled
WICRK	Cooling water recycled, coefficient
WICW	Cooling water waste
WICWK	Cooling water waste, coefficient
WIRCL	Cooling water return to land
WIRCLK	Cooling water return to land, coefficient
WLICP	Cooling water from land, planned
WOICPK	Cooling water from land planned, coefficient
WGICP	Cooling water from ground, planned
WGICP	Cooling water from ground, planned coefficient

3. Data Considerations and Parameter Estimates

According to A. A. Sokolov,* the development of hydrology had four periods:

a) A first period characterized by the need to understand the water stage fluctuations in rivers and lakes

b) A second period where the prime emphasis was in control of runoff and the measurement of water transported by rivers

c) A third period characterized by the transition from the study of streamflow requires to its study as an element of total water balance, and

d) A recent modern period (which has begun only in a few countries) where hydrologists are concerned with the study of the dynamics of the water balance, with the hope of further understanding the phenomena and processes involved without losing perspective of the entire system. The work presented in this report could be categorized as an effort resulting from the latter modern period. Yet, despite the hydrologist's recognition of the need for this type of work, great difficulties are encountered from the lack of appropriate data to identify parameters and validate models on a global or regional scale.

An extensive review of literature has been made by the authors to obtain as much insight as possible as to the relative magnitude of some

---

*"Principal Problems of Modern Hydrology," World Water Balance Symposium Proceedings (July 1970), Vol. 1, page 10.

of the processes and parameters included in the model of Figure 2 on a global as well as on a regional scale. Good reviews of the various estimates made by different scientists for the major parameters of the natural cycle have been presented by Nace (1970), Lvovitch (1970), Baumgartner and Reichel (1970), Budyko (1970) and other investigators listed in the bibliography. Table III synthesizes the results of these and other efforts for the case of the United States, as part of Region I in the Mesarovic-Pestel world model regionalization, and Latin America. Some of the parameters have been calculated from estimates of related variables.(Values shown are for 1975)

Data for other regions is also being collected. The available data base for the model varies; in other words, details reflected in the structure of model are of such nature that all the parameters and variables can be either found in the literature or at least estimated from available approximations of related factors (as this is intended to become eventually a decision-making tool, not an academic mathematical exercise).

TABLE III

UNITED STATES

	PARAMETERS	VALUE	SOURCE
GRPR	Gross regional product, rate	0.034	Bossel's report, Hughes
WIK	Water, industrial, coefficient	0.0632 $km^3/10^9\$$	Calcualted, Geological Survey
IPK	Industrial production coefficient	1.	Mesarovic
WIWK	Water industrial, waste, coefficient	.890	Cardenas
WILK	Water industrial from land, coefficient	.808	Calculated, Geological Survey
WIOK	Water industrial from ocean, coefficient	0.	Cardenas
WIGK	Water industrial from ground, coefficient	.191	Calculated, Geological Survey
WIRK	Water industrial, return, coefficient	.700	Cardenas
WIRLK	Water industrial, return to land, coefficient	.850	Cardenas
WIROK	Water industrial, return to ocean, coefficient	.100	Calculated, Geological Survey
WIRGK	Water industrial, return to ground, coefficient	.050	Calculated, Geological Survey
POPR	Population, rate	.011	Mesarovic, hughes
WDK	Water, domestic, coefficient	$1.72 \times 10^{-7} km^3$/year/capita	Calcualted, Geological Survey
WDGK	Water, domestic, from ground, coefficient	.340	Calcualated, Geological Survey

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WDLK	Water domestic, from land. coefficient	.660	Calculated, Geological Survey
WDOK	Water, domestic from ocean, coefficient	0.	Cardenas
WDWK	Water, domestic, waste, coefficient	.760	Calculated, Geological Survey
WDRK	Water, domestic, return, coefficient	.400	Cardenas
WDRGK	Water domestic, return to ground, coefficient	.050	Cardenas
WDRLK	Water domestic, return to land, coefficient	.800	Cardenas
WDROK	Water domestic, return to ocean, coefficient	.150	Cardenas
WARR	Water, agriculture, rate	.020	Cardenas
WAGK	Water, agriculture, from ground, coefficient	.356	Calculated, Geological Survey
WALK	Water, agriculture, from land, coefficient	.643	Calculated, Geological Survey
WAOK	Water, agriculture, from ocean, coefficient	$1. * 10^{-6}$	Cardenas
WAWK	Water, agriculture, waste, coefficient	.461	Calculated, Geological Survey
WARK	Water, agriculture, return, coefficient	.800	Calculated, Geological Survey

	PARAMETERS	VALUE	SOURCE
WARGK	Water, agriculture, return to ground, coefficient	.400	W.B. Clapham
WARLK	Water, agriculture, return to land, coefficient	.600	Cardenas
WAROK	Water, agriculture, return to ocean, coefficient	0	Cardenas
RLC	Rain on land, cultural	.001	Cardenas
RLN	Rain on land, natural	6600 km^3	Calculated Water Supply
ROC	Rain on oceans, cultural	.01	Cardenas
RON	Rain on oceans, natural	14300 km^3	Budyko, calculated
SLC	Snow on land, cultural	0	Cardenas
SLN	Snow on land, natural	465 km^3	W.B. Clapham
SOC	Snow on ocean, cultural	0	Cardenas
SON	Snow on ocean, natural	1430 km^3	Budyko
SMK	Snow melting coefficient	.070m	W.B. Clapham
LS	Land surface	9.3×10^6 km^2	Atlas
WLASK	Water from land to atmosphere per unit surface, coefficient	.49 m	Water Supply
OS	Ocean surface	14.3×10^6 km^2	Budyko, Calculated
WOASK	Water from ocean to atmosphere per unit surface, coefficient	1.28 m (Avg)	Budyko
WGLK	Water from ground to land, coefficient	0.0076	Calculated, Geological Survey

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WGIPK	Water from ground for industry, planned, coefficient	$6.260 * 10^{-5}$	Calculated, Geological Survey
WGDPK	Water from ground for domestic, planned, coefficient	$6.41 * 10^{-5}$	Calculated, Geological Survey
WGAPK	Water from ground for agricultural, planned, coefficient	$3.23 * 10^{-4}$	Calculated, Geological Survey
WLGK	Water from land to ground coefficient	.012	Calculated, Geological Survey
WLOK	Water from land to ocean, coefficient	.085	Calculated, Geological Survey
TWIMK	Water, impounded, coefficient	.0048	Calculated, Geological Survey
WLIPK	Water from land for industry, planned, coefficient	$1.34 * 10^{-3}$	Calculated, Geological Survey
WLDPK	Water from land for domestic, planned, coefficient	$3.775 * 10^{-6}$	Calculated, Geological Survey
WLAPK	Water from land for agriculture, planned, coefficient	$4.10 * 10^{-6}$	Calculated, Geological Survey
WOIPK	Water from ocean for industry, planned, coefficient	0.	Cardenas
WODPK	Water from ocean for domestic, planned, coefficient	0.	Cardenas
WOAPK	Water from ocean for agriculture, planned, coefficient	0.	Cardenas

B 1306

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WDRCK	Water for domestic recycled, coefficient	.20	Calculated, Geological Survey
EC	Energy per capita (MW)	$.155 \times 10^{-2}$ MW	Cardenas
INH	Non-hydro power capacity (MW)	289.8×10^{3} MW	Geological Survey
EH	Hydroelectric power capacity (installed MW)	55.2×10^{3} MW	Geological Survey
IEK	Ratio of effective to installed hydro capacity	.9	Cardenas
WICK	Water for cooling, coefficient	.22 km^3/million $	Calculated, Geological Survey
WICLK	Water cooling from land, coefficient	.991	Calculated, Geological Survey
WICOK	Water cooling from ocean, coefficient	.0	Cardenas
WICGK	Water cooling from ground, coefficient	.0083	Calculated, Geological Survey
WICWK	Waste water from cooling, coefficient	1.	Cardenas
WIRCLK	Water from cooling returned to land, coefficient	1.	Cardenas
WIRCK	Cooling Water recycled, coefficient	1.	Cardenas
WLICPK	Cooling Water from land, planned, coefficient	5.675×10^{-3}	Calculated, Geological Survey
WOICPK	Cooling water from land, planned, coefficient	0.30	Cardenas
WGICPK	Cooling water from ground planned, coefficient	$2.97 * 10^{-6}$	Cardenas

B 1307

TABLE III (continued)

LATIN AMERICA

	PARAMETERS	VALUE	SOURCE
GRPR	Gross regional product, rate	0.071	SRH - Corehom
WIK	Water, industrial, coefficient	$0.027 km^3/10^9 \$$	Calculated, SHR-Corehum
IPK	Industrial production coefficient	0.6	Huerta
WIWK	Water industrial, waste, coefficient	0.509	SRH-Corehum
WILK	Water industrial from land, coefficient	0.808	Huerta
WIOK	Water industrial from ocean, coefficient	0.	Huerta
WIGK	Water industrial from ground, coefficient	0.191	Huerta
WIRK	Water industrial, return, coefficient	0.7	Cardenas
WIRLK	Water industrial, return to land, coefficient	0.6	SRH-Corehum
WIROK	Water industrial, return to ocean, coefficient	0.2	SRH-Corehum
WIRGK	Water industrial, return to ground, coefficient	0.2	SRH-Corehum
POPR	Population, rate	0.032	FAO
WDK	Water, domestic, coefficient	$3.43 \times 10^{-8} km^3$/year/capita	Calculated, SHR-Corehum
	... ground	0.34	Huerta

B 1308

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WDLK	Water domestic, from land. coefficient	0.66	Huerta
WDOK	Water, domestic from ocean, coefficient	0.	Huerta
WDWK	Water, domestic, waste, coefficient	0.76	Huerta
WDRK	Water, domestic, return, coefficient	0.4	Cardenas
WDRGK	Water domestic, return to ground, coefficient	0.2	Cardenas
WDRLK	Water domestic, return to land, coefficient	0.6	Cardenas
WDROK	Water domestic, return to ocean, coefficient	0.2	Huerta
WARR	Water, agriculture, rate	.025	FAO
WAGK	Water, agriculture, from ground, coefficient	0.356	Huerta
WALK	Water, agriculture, from land, coefficient	0.643	Huerta
WAOK	Water, agriculture, from ocean, coefficient	1.10^{-6}	Cardenas
WAWK	Water, agriculture, waste, coefficient	0.428	SRH-Corehum
WARK	Water, agriculture, return, coefficient	0.8	SRH-Corehum

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WARGK	Water, agriculture, return to ground, coefficient	0.4	Huerta
WARLK	Water, agriculture, return to land, coefficient	0.6	Cardenas
WAROK	Water, agriculture, return to ocean, coefficient	0.	Cardenas
RLC	Rain on land, cultural	0.001	Cardenas
RLN	Rain on land, natural	28509.km^3	Budyko, Calculated
ROC	Rain on oceans, cultural	0.01	Cardenas
RON	Rain on oceans, natural	61769.5km^3	Budyko, Calculated
SLC	Snow on land, cultural	0.	Huerta
SLN	Snow on land, natural	0.	Huerta
SOC	Snow on ocean, cultural	0.	Huerta
SON	Snow on ocean, natural	0.	Huerta
SMK	Snow melting coefficient	0.	Huerta
LS	Land surface	$17.77\times10^6 km^2$	SRH-Corehum
WLASK	Water from land to atmosphere per unit surface, coefficient	0.813×10^{-3}	SRH-Corehum
OS	Ocean surface	$61.7\times10^6 km^2$	Budyko, Calculated
WOASK	Water from ocean to atmosphere per unit surface, coefficient	$1.28\times10^{-3}km$	Budyko
	... land	0.0076	Huerta

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WGIPK	Water from ground for industry, planned, coefficient	2.05×10^{-6}	SRH-Corehum
WGDPK	Water from ground for domestic, planned, coefficient	3.976×10^{-6}	SRH-Corehum
WGAPK	Water from ground for agricultural, planned, coefficient	0.633×10^{-6}	SRH-Corehum
WLGK	Water from land to ground coefficient	0.015	Huerta
WLOK	Water from land to ocean, coefficient	0.085	Huerta
TWIMK	Water, impounded, coefficient	1.539×10^{-3}	Calculated, SRH-Corehum
WLIPK	Water from land for industry, planned, coefficient	2.05×10^{-5}	Calculated, SRH-Corehum
WLDPK	Water from land for domestic, planned, coefficient	1.68×10^{-5}	Calculated, SRH-Corehum
WLAPK	Water from land for agriculture, planned, coefficient	2.808×10^{-3}	Calculated, SRH-Corehum
WOIPK	Water from ocean for industry, planned, coefficient	0.	Cardenas
WODPK	Water from ocean for domestic, planned, coefficient	0.	Cardenas
WOAPK	Water from ocean for agriculture, planned, coefficient	0.	Cardenas
WIRCK	Water for industry recycled, coefficient	0.2	Cardenas

TABLE III (Continued)

	PARAMETERS	VALUE	SOURCE
WDRCK	Water for domestic recycled, coefficient	0.2	Huerta
EC	Energy per capita (MW)	4.612×10^{-5} MW	Calculated, SRH-Corehum
INH	Non-hydro power capacity (MW)	5.66×10^{3} MW	SRH-Corehum
EH	Hydroelectric power capacity (installed MW)	8.49×10^{3} MW	SRH-Corehum
IEK	Ratio of effective to installed hydro capacity	0.6	Cardenas
WICK	Water for cooling, coefficient	0.013 km^3/million $	Calculated, SRH-Corehum
WICLK	Water cooling from land, coefficient	0.991	Huerta
WICOK	Water cooling from ocean, coefficient	0.	Cardenas
WICGK	Water cooling from ground, coefficient	0.083	Huerta
WICWK	Waste water from cooling, coefficient	1.	Cardenas
WIRCLK	Water from cooling returned to land, coefficient	1.	Cardenas
WIRCK	Cooling Water recycled, coefficient	1.	Cardenas
WLICPK	Cooling Water from land, planned, coefficient	1.439×10^{-5}	Huerta
WOICPK	Cooling water from ocean planned, coefficient	6.778×10^{-9}	Huerta
WGICPK	Cooling water from ground planned, coefficient	1.286×10^{-7}	Huerta

4. Scenario Specification

4.1 The United States

The U. S. National Water Commission, in its report to the President and to Congress, suggests that it is impractical (and in fact undesirable) to attempt to forecast precise levels of future water use and development on the basis of past trends. More realistically, a range of "alternative futures" is possible, depending upon population levels and distribution, per capita energy consumption, rate of national income growth, technological development, consumer habits and styles, governmental policies, and others. Some of these variables have been included explicitly in the model presented in Section 2 so as to reflect these interdependencies, while others have been taken into account implicitly. The report of the Natural Water Commission provided the basic motivation for some of the scenarios described below.

1) Water and the Energy Sector

It is expected that the population growth rate of 1.1 percent per annum will assure that the total electrical energy demand keeps growing, even if the per capita energy consumption remains at a constant 1.5 Kw/cap. The projected forecast of future capacity installations in the U.S. is assumed as follows:

(Nominal run)	EH (x1000)	ENH (x1000)
1970	55.2 MW	284.8 MW
1980	95.0 MW	570.0 MW
1990	152.0 MW	1108.0 MW

There is much controversy with regard to the actual plant mix of future electrical systems, especially in reference to whether nuclear or steam plants will be the dominant sources of electricity generation. Whichever is the case, it is agreed that many of these plants will exceed 1000 megawatts in size, which will greatly heighten the potential waste heat problem. This raises the possibility of requiring auxiliary cooling water (or technologies) to support the increased consumptive losses or assimilate the heat. Any policy oriented towards decreasing the rate of expansion in electrical energy would tend to reduce this and other problems (see National Water Commission Report).

In general the installed capacity of hydroelectric plants is different from its usable or "effective" capacity, which depends (among other things) on the availability of water, i.e., the hydrology of the region. The differences between these two "types" of capacities would become larger in cases of drought or reduced flows.

Scenarios	a) EK	b) (Drought in 2020)
1975	.9	.9
2020	.9	.3
2025	.9	.9

2) Increasing the Present Water Supply

In many areas of the U.S., control of the existing supply has been pushed near the physical limit, so that pressures have been developing to consider alternative ways of meeting future water requirements (other than more dams and inter-basin transfers), including those which might come about through technical advances. Three specific strategies (recommended by the National Water Commission) for which research and development is fairly well advanced will be considered here to develop various scenarios: desalting, precipitation augmentation, and land management.

Desalting

It is generally believed that desalination technology will have a significant future role in the United States, especially in areas where other supplies are costly, where existing supplies need to be upgraded or where there are natural supplies of brackish water. The U.S. and its territories had in 1971 a total of 321 plants, each having a capacity of 25,000 gpd, with a total capability of 54.8 m.g.d. The largest operation anywhere in the world today is in Kuwait, with a capacity of 30 m.g.d., and has been operating since 1972. The projected forecast of future desalting activity presented in 1971 by the Office of Saline Water Ref. 1 will be considered in our model. That study showed a wide range in the potential for desalting, depending upon the particular set of assumptions.

Scenario 1 (baseline or nominal)

A capacity of 7.7 bgd by the year 2020 if technology continues to improve, costs continue to decline (_ 30 cents per 1,000 gal. in 2020), and if future water demands are about equal to the projections of the First National Assessment (which are based largely on extensions of past trends) Ref.2 .

TABLE IV. - Projected water use, by purpose, United States'
(Billion gallons per day)

Type of Use	Projected Withdrawals		
	1980	2000	2020
Rural domestic	2.5	2.9	3.3
Municipal (public supplied)	33.6	50.7	74.3
Industrial (self supplied)	75	127.4	210.8
Steam-electric power			
Fresh	134	259.2	410.6
Saline	59.3	211.2	503.5
Agriculture			
Irrigation	135.9	149.8	161
Livestock	2.4	3.4	4.7
U.S. Total	442.6	804.6	1,368.1

U. S. WATER RESOURCES COUNCIL (1968). The Nation's Water Resources. U.S. Government Printing Office, Washington, D.C. Part 1, p. 8.

2) Other Scenarios

A capacity of 1.1 bgd by the year 2020 if costs of desalination remain constant at present levels (approximately $1.00 per 1000 gallons in sea water conversion plants and 50 cents per 1000 gallons in brackish water plants, without considering the additional costs of pumping to the place of use); and alternative water sources (such as importation projects) become available.

3) A capacity of 40 bgd by the year 2020 if no further importation projects are permitted and if costs and technology keep imporving.

4) A number of other projections dependent on different possible factors fall between these two extremes.

Assumed desalting costs in 2020 (cents per 1,000 gallons)	Desalting capacity justified in 2020 (b.g.d.)
42	2.5
36	4.1
30	7.8
24	15.7
16.6	31.8

It is believed that desalting in the future may serve not only as a means of supplying water for municipal and industrial uses. (mostly with small and medium-sized plants, up to 10 mgd, and with probable developments of plants with up to 50 mgd), but also for improving the quality of existing supplies. On the other hand, although forecasts of water costs for plants in the large 50 to 260 mgd size range ($80 to $180 per acre foot) would seem to rule out irrigation use of desalted water, the utility of such desalted water (which is more or less pure) cannot be equated to that of an acre-food of natural water (which usually contains sand and salt). Nevertheless, there are many questions to be answered before significant irrigation use is justified with present or foreseen technology (except for specialized crops and situations).

Precipitation Augmentation

The most common strategy for artifical augmentation of precipiation is through cloud seeding Ref. 3 . The processes and potentials, however, are not totally understood today. Experiments have yielded up to precipitation increases of 200 percent for certain individual storms (mostly from orographic "cloud" systems), but the wide range of results seems inexplicable. Furthermore, increases in average precipitation do not necessarily produce proportional increases in usable water supply (due to the nonlinear relationship between rainfall and runoff). Present estimated costs ranging from $1.00 to $2.30 per acre-food of additonal runoff have been reported by the U.S. Bureau of Reclamation. Ref. 4

Scenario	RLC	
1975	1) .01	2) .01
2005	.01	.10
2025	.01	.10
	(little success)	(success in technology)

Land Management

The National Water Commission suggests that four land management techniques hold potential for increasing the useful supply of water: 1) vegetation management in forest and brush areas, 2) phreatophyte control along river bends, 3) snowpack management in forest and alpine areas, and 4) water harvesting by treatment of soil surface to increase the collection of precipitation.

A recent estimate suggests a potential annual increase in water supply form watershed management as follows: (Ref. 5)

TABLE V. - Potential annual increase in water supply from watershed land management

Area and Source		Potential Annual Increase Under Present Forest Conditions (1,000 acre-feet)		Direct Fin cial Cost Acre-Foot
Northeast (New England, Middle Atlantic Great Lakes, and Central States)				
Commercial forests		2,350		$ 2.18
Southeast (South Atlantic and Gulf States				
Commercial forests		2,750		2.64
Eastern United States	Total	5,100		$ 2.42
Pacific Northwest (Eastern portions of Oregon and Washington)				
Commercial Forests		160		3.17
California (excluding North Coast)				
Commercial forests		130		2.13
Phreatophyte areas		10		10.50
Chaparral		410		20.45
Woodlands-grasses		370		45.00
Northern Rocky Mountains (Idaho,Montana,W.South Dakota, and Wyoming)				
Commercial forests		1,000		.89
Other		40		90.0
Southern Rocky Mountains (Arizona,Colorado,Nevada,New Mexico,and Utah)				
Commercial forests		530		1.0
Phreatophyte areas		900		14.0
Chaparral		290		18.0
Other		300		128.0
Western United States	Total	4,140	Avge.	$ 21.4
48 Continuous United States	Total	9,240		

Source: SOPPER, William E. (1971). Watershed Management, prepared for the National W Commission, Nationa Technical Inf. Service. Springfield, Va. No. PB 206 370, pp.10 After a report by IC. Reigner, RC Maloney & E G Dunford (1969).

The nominal or standard run for the model assumes that the total potential annual increase in water supply is reached by the year 2020.

Groundwater Management and Development

Groundwater represents a most important source because of the vast amounts available and its favorable quality characteristics. It is presently estimated that about one-half of the total global groundwater available (around 7 million square kilometers) is located within half a mile from the surface of the ground. Different rates of growth of groundwater development for the U.S. are possible depending on the investment policies in the next few years. A constant 4% percent growth is taken here as the nominal or standard.

Other Technology

There are other technologies for increasing water supply which, although yet unproven economically, might be potential souces of additional water in the future. These include iceberg towing, undersea aqueducts, artificial ice fields, off-shore reservoirs, and others. Optimistic estimates of future water supply availability could become reality if any of these new technologies is successful.

Wastewater Reuse

It is believed that the prospects for increased reuse of treated municipal and industrial wastewater is considerable. The treatment cost estimates for reuse presented by the Nationa Water Commission are as follows:

TABLE VI.-Approximate costs of secondary and advanced treatment
(June, 1967 Cost Levels)

Capacity of Plant (m.g.d.)	Secondary Treatment		Costs of Advanced Treatment Processes in Addition to Costs of Secondary Treatment: Nutrient removal (including suspended solids)		Removal of nutrients plus nonbiodegradable organics		Removal of nutrients & nonbiodegradable organic plus demineralization	
	Capital Costs ($Million)	Total Unit Treatment Costs (¢/1000 gal)	Capital Costs ($Million)	Total Unit Treatment Costs (¢/1000 gal)	Capital Costs ($Million)	Total Unit Treatment Costs (¢/1000 gal)	Capital Costs ($Million)	Total Unit Treatment Costs (¢/1000 gal)
1	0.54	19	0.43	26.8	0.81	58	-	-
10	3.2	11	1.8	14.0	3.4	24	6.8	36
100	20	6.5	10.9	8.6	26	15.6	-	-

Sources of Cost Data:
1. GAVIS, Jerome (1971. Wastewater Reuse, prepared for the National Water Commission PB 201 535, National Technical Information Service, Springfield, Va.
2. SMITH, Robert & McMICHAEL, Walter F (1969). Cost and Performance Estimates for Tertiary Wastewater Treating Processes, prepared for the Federal Water Pollution Control Administration. Report No. TWRC-9, Robert A. Taft Water Research Center, Cincinnati, O.
3. SMITH R. (Septmeber 1968). Cost of conventional and advanced treatment of wastewater. Journal Water Pollution Control Federation 40(9): 1546-1574

The projections of the Water Resources Council (Ref. 6) for potential industrial and municipal reuse will be taken as the "nominal" values for this model:

A) "To meet projected industrial water withdrawal needs"

	WIRCK	WDRCK	WDW + WIW	
1975	20%	20%	-	(NOMINAL)
1980	20%	20%	73 bgd	
2020	54%	54%	-	

B) "To meet projected industrial and municipal water withdrawal needs" - U.S. Water Resources Council

	WIRCK	WDRCK	WDW + WIW
1975	20%	20%	
1980	34%	34%	73 bgd
2020	87%	87%	

Population and GNP

The U.S. Census Bureau has produced "B, C, and D level" population projections for the year 2000 of 325 million, 300 million, and 280 million, respectively. These and other population projections will be analyzed as scenarios here. "High" and "medium" GNP growth rates of 4.5% and 3.5%, respectively, as well as others, will be tested.

GRP	POP
4.5%, 4.0%, 3.5%, etc.	1%, 2%, 3%, etc.

4.2 Latin America

An attempt has been made to define a "nominal" set of conditions for this region, paving the way for the analysis of a series of possible scenarios. A variety of publication were consulted (see References) in an effort to develop a good data base; wherever possible, model parameter estimates were made on a country-by-country basis:

1) Water and the Energy Sector

The tremendous rate of growth of population (3.2 percent per annum) and the expected increased per capita consumption due to the effects of economic development and social expectations, makes it obvious that electrical energy demand will keep growing. Assuming a doubling rate of at the most 10 years, the nominal value for future demand can be obtained. Table VII presents the electrical power picture for Latinamerica in the year 1968. A similar ratio of hydro to non-hydro production exists today.

2) Increasing Water Supply

It is expected that significant increases in impounded water due to dam construction will augment the amount of available surface water. Watershed land management programs are also being implemented in various countries in an effort to maintain acceptable water quality and to increase the available supply.

a) Reservoir Development:

It is assumed that the rate of growth of impounded water volume will keep increasing at a possible nominal rate of 3 percent annually in order to keep up with increasing industrial, domestic and agricultural demands.

TABLE VII

	Installed Capacity up to 1968 (MW)	Total Generation In GW-Hr	Thermal-electric Generation in GW-Hr
TOTAL →	34,300	95,270	49,601
Mexico	6397	22,875	7091
Brazil	8800	38,700	7740

b) Groundwater development:

It is assumed that groundwater supplies will share with surface water supplies, the future load of agricultural demand, so that a nominal 2 percent growth of ground supplies is taken.

c) Watershed Management:

It is supposed that the average annual potential increase in surface water supplies due to land management (on a per unit surface basis) is comparable to the U.S., although it is clear that the capital investment available for this program in Latin America is much smaller. A nominal value of 5 percent in 1975, increasing up to 7 percent of the annual potential by the year 2020 is taken here.

d) Wastewater reuse:

It is believed that in the industrially advanced Latinamerican countried (e.g., Mexico, Brazil, Venezuela), the reuse of treated municipa; and industrial wastewater will tend to increase to significant levels within the next thirty to forty years:

	WIRCK	WDRCK
1975	3%	2%
1990	5%	5%
2005	10%	10%
2020	20%	20%

5. Analysis of Results

Appendix II presents the nominal or standard scenarios for the U.S. and Latinamerica. These runs indicate that the model is functioning reasonably (e.g., the state variables of the hydrologic cycle, TWL and TWG in particular, remain fairly constant throughout the simulation, the results show the expected relationships between population and gross regional product as generators of the various water demands, etc.); these simulations also give an indication of what might occur in the future if the expected trends of the different variables involved continue. No claim is made here, however, that this will be the case of our future.

Looking at the standard run for Latinamerica, one can note the appearance of a significant deficit of water for industrial processes, cooling and agriculture at around the year 2,000. The domestic water deficit is not too large and might be the result of computer round-off errors. However, this deficit could increase drastically if the demand of water per capita were to rise to levels comparable to those in the U.S. (of the order of 200 cubic meters per annum). This standard run also assumes very optimistic investment policies for electrical energy production, and this is partly the reason for the exaggerated surpluses indicated; the other reason being the assumed constant energy per capita demand (0.156 KW/cap/year). On the supply side, we assume investments in ground and water supply development for industrial processes, with supply growth rates of 4 percent per year; for domestic purposes, 3 percent growth of ground supplies and 2 percent of land supplies. We also suppose here rates of ground and land supply growth for agriculture of the order of 2.5 percent and 2.0 percent, respectively; while for industrial cooling purposes, 4.9 percent growth of land supplies, 3.0 for ocean supplies, and 1.0 for ground.

Analyzing the nominal run for the U.S., we note a significant cooling water deficit within the next ten years. The other uses (industrial, domestic, agriculture) show surpluses at all times (note again the round-off error in the industrial water criterion). A surplus of electrical energy is also indicated because the investment and generation policies assumed, at least keep up with the demand generated by the not too rapidly increasing population. On the whole, desalination technology does not seem to contribute a particularly large amount of the water supply; this is not the case with watershed land management, which reaches in the year 2025 a level of 16.6% of the total water supply (land, ground, ocean). With regard to investments for water supply developments, we assume a zero growth rate for domestic water supply; for agriculture, 1% growth from groundwater supplies and 1% from land(negligible amount is assumed for ocean supply growth rate);for cooling, 1%from land and 2.1%from ocean; and a 1% growth rate for groundwater supplies for industrial uses.

Appendix III presents some of the scenarios that were found interesting.

Latin America

1) Supposing a population control program is implemented to reduce the population growth rate from 3.2 percent to 1.0 percent in the year 2025, the results of the model show that the domestic water deficit remains just about at its negligible values of the nominal run. This indicates that population control is much less important than teaching humans to use water wisely so as to avoid increases in consumption per capita. The energy surplus figures also remain at about the value of the nominal run.

2) Assuming the rate of economic development of Latinamerica increases linearly up to a value of 12 percent annually in the year 2025, the results seem to indicate that the deficit of industrial and cooling water appears about ten years earlier than before, which implies that significant investments in the water sector would be needed to avoid a catastrophe within the next fifteen years. Because energy per capita demand is increased here alos,(linearly per year) up to a value of 2.0 Kw/cap/year, a sudden deficit of electrical energy occurs despite the optimistic investment policies assumed.

3) Supposing a population explotion phenomenon even more drastic than today's were to take the rate of growth from 3.2% to 6.0% (an exaggerated value), results logically indicate that domestic water deficits grow much more

significantly starting at around the year 1990. Despite this growth, however, the energy surplus remains at about the same level of the nominal run (again due to the low per capita demand).

4) Assuming now a very slow or negligible water resources development program in Latinamerica (no watershed management, desalination, groundwater and surface water development, industrial recycling, etc), the model assures disaster and chaos within the next five years due to deficits of water in all categories, except for industrial uses(which accurs at around 1985).

5) Repeating the nominal run, except for allowing no desalination growth or watershed land management programs, the results show slight increases in all the deficits. This indicates that both of these development strategies might be important for augmenting the quantity of available water only in certain localized areas (as in arid zones for the case of desalination). We know, however, that their great value also lies in their conserving water quality in general. This aspect cannot be studied yet with the present structure of the model. A water quality submodel is intended to be built in this connection within the next few months.

6) Assuming energy per capita increases linearly per year from 0.15 in 1975 to 2.0 KW/cap in the year 2025, and supposing the generation of non-hydro electrical energy were to stagnate (in growth) starting in the year 1990, the model results show that the electrical energy deficit grows to its largest vol-yet, and this situation is never remedied under this scenario.

United States

1) Supposing that the total potential annual increase in surface water supply due to land management programs is made available, and assuming no growth in other sources of water, the model results show an immediate cooling water deficit, while an industrial water deficit appears later in the year 1995. The results also indicate a significant deficit of agricultural water supply, starting immediately.

2) Assuming that the actual trend of decreased population growth continues down to zero growth level by the year 2025, the model indicates that the surplus of domestic water is slightly larger than in the nominal run (the other uses still show surpluses as well), which means that this would minimize even more the danger of possible water shortages in the U.S. in the next fifty years.

3) Assuming there is no growth in conventional water supplies, but there is desalination growth up to 0.22 cubic kilometers per year in the year 2025 and land management programs of 11.3 cubic kilometers per year, we see from the model results that almost immediately, a significant industrial cooling deficit (even worse than in the nominal run) and an agricultural deficit appear convincingly. The other criteria remain the same as in the nominal run.

4) Supposing GRPR increases linearly up to a value of 6.0% annually by the year 2025, a dramatic deficit for thermalelectric cooling water appears starting in 1980; and by 1990, a deficit also occurs for industrial process

water. Similarly, a large deficit for electrical energy occurs right-away (you will note that this amount, however, is smaller than in all of the scenarios run for the Latinamerican region due to the latter's larger population). Although the recycle policies (inustrial and domestic) were larger here than in the nominal run, they caused no apparent change in any of the criteria.

REFERENCES

United States

1. Adams, F.D., "The Origin of Springs and Rivers," in The Birth and Development of the Ecological Sciences, New York, Dover, 1954.

2. Carter, D.B., "The Water Balance of the Mediterranean and Black Seas", Publications in Climatology, Vol. IX, No. 3 (Drexel Institute of Technology), 1956.

3. Cluff, CB etal. (July 1972). Development of Economic Water Systems for Increasing Water Supply, Phase II. Research funded by the State of Arizona and the U.S. Office of Water Resources Research. The University of Arizona, Tucson.

4. Finch, V.C. etal., Elements of Geography, McGraw Hill, N.Y. 1957.

5. Fisher, D.G., Water and Man, Rigby Limited, Australia, 1970.

6. Gertilli, J., A Geography of Climate, Univ. of Western Australia Press, Perth, 1958.

7. Hylckama, T.E.A., "The Water Balance of the Earth," Drexel Institute of Technology (Laboratory of Climatology), Vol. IX, No. 2, 1956.

8. Jeffs, D.N. and R.P. Dennis, "Ontario's Water Taking Permit Program", Water Resources Bulletin, A.W.R.A., Vol. 9, No. 1, Feb. 1973.

9. Lackner, Jack D (1971). Based on Precipitation Modification, prepared for the National Water Commission. National Technical Information Service, Springfield, Va., Accession No. PB 201 534 pp. II-16 to II-21.

10. La Rocque, A. (Transl.), "The Admirable Discourses of Bernard Palissy", Univ. of Illinois Press, 1957.

11. Leopold, L.B., Davis, K.S. and Editors of Life, Water, Time Incorporated, New York (1966).

12. McGauhey, P.H., Engineering Management of Water Quality, McGraw-Hill Book Company, 1968.

13. Milway, C.P., Eutrophication in Large Lakes and Impoundments, Synposion D'Uppsala, Sweden, May 1968.

14. Nace, R.L., "Ground Water in Perspective", Water Resources Bulletin, A.W.R.A., Vol. 9, No. 1, Feb. 1973.

15. Needham, J., Science and Civilization in China, Cambridge Univ. Press, 1959.

REFERENCES (Continued)

16. Olson, R.E., A Geography of Water, WM.C. Brown Company Publishers, Dubuque, Iowa.

17. Saha, Gopal C., "Systems Analysis of the Phosphorus As a Resource Problem", M.S. Thesis, Systems Research Center, Case Western Reserve University, January 1973.

18. "Water: Worldwide Use and Misuse," Vol. 86, No. 14, 1965.

19. Tuan Yi-Fu, The Hydrologic Cycle and the Wisdom of God, Univ. of Toronto Press, 1968.

20. UNESCO-IAMS, "Combined Heat, Ice and Water Balances at Selected Glacier Basins", Technical Paper, No. 5, 1973.

21. UNESCO-IAMS, Guide to World Inventory of Sea, Lake and River Ice", Technical Paper No. 9, 1972.

22. U.S. Bureau of Reclamation (1971). Colorado River Basin Pilot Project, Cloud Seeding Research in the San Jean Mountains. Bureau of Reclamation, Denver, Colo. and Aubert EJ etal. (1969). The Utilization of the Atmospheric Water Resources in the Connecticut River Basin: An Essay, TRC Report 7494-352, prepared for the U.S. Bureau of Reclamation, contract 14-06-D-6569. Travelers Research Corporation, Hartford, Conn. p. iii.

23. U.S. Office of Saline Water (June 24, 1971). Briefing Session for the Desalting Industry. U.W. Department of the Interior, Washington, D.C.

24. U.S. Water Resources Council (1968). The Nation's Water Resources. U.S. Government Printing Office, Washington, D.C.

25. Figures are based on U.S. Water Resources Council (1968). The Nation's Water Resources. U.S. Government Printing Office, Washington, D.C. pp 4-1, 4-2-5.

26. Water Policies for the Future, Final Report to the President and to the Congress of the United States by the National Water Commission. Washington, D.C. June 1973.

REFERENCES (Continued)

Latin America

1. Organización de los Estados Americanos. América en Cifras, 1972. Situación Demográfica: Estado y Movimiento de la Población. Instituto Panamericano de Estadística. Washington, D.C. 1972

2. ---------- América en Cifras, 1972. Situación Económica: Agricultura, Ganadería, Silvicultura, Caza y Pesca. Instituto Panamericano de Estadística. Washington, D.C. 1972

3. Food and Agriculture Organization of the United Nations. Water and the Environment. Irrigation and Drainage Paper, 8. Roma. 1971

4. Consejo Económico y Social (ONU). Istmo Centroamericano. Programa de Evaluación de Recursos Hidraúlicos. II. El Salvador. Naciones Unidas. México. 1971

5. --------- Istmo Centroamericano. Programa de Evaluación de Recursos Hidraúlicos. III. Guatemala. Naciones Unidas. México. 1971

6. ---------- Istmo Centroamericano. Programa de Evaluación de Recursos Hidraúlicos. IV. Honduras. Naciones. México. 1970

7. --------- Istmo Centroamericano. Programa de Evaluación de Recursos Hidraúlicos. V. Nicaragua. Naciones Unidas. México. 1970

8. Comisión Económica para América Latina (ONU). Los Recursos Hidraúlicos de América Latina. II Venezuela. Naciones Unidas. Nueva York. 1962

9. ---------- Los Recursos Hidraúlicos de Chile. Naciones Unidas. México. 1960

10. ---------- Los Recursos Hidraúlicos de America Latina. Argentina. Naciones Unidas. Nueva York. 1972

11. ---------- Los Recursos Hidraúlicos de América Latina. III Bolivia y Colombia. Naciones Unidas. Nueva York. 1964

REFERENCES (Continued)

12. FAO - UNESCO. Soil Map of the World. Vol. IV

13. International Association of Agriculture Economics. World of Agriculture. 1970

14. Todd, D.K. The Water Encyclopedia. Water Information Center. New York. 1970

15. Kantor, L. A World Geography of Irrigation. Edinbourgh. 1970

16. Klohn, U. Water Resources Planning in Venezuela. Viena. 1972

17. Kleeberg, H.B. Dr. Eng. (Personal Communication). Technische Universitat, Hannover

18. Plan Nacional Hidraúlico. Información Panorámica. México. 1973

APPENDIX I

B 1338

```
064523 REMOVE,CPLOT,FORTRAN
064527 COMPILE,CPLOT,FORTRAN
          SUBROUTINE CPLOT(A,KOUNT,NVAR,JDATA,NPLOT)                          7CPLOT     2
          DIMENSION A(55,6),IDATA(9),AMAXA(6),DATUS(6),JDATA(9,6 )            7CPLOT    17
          DIMENSION AMINA(6)                                                  7CPLOT    18
          AMAX=1.                                                             7CPLOT    19
          AMIN=0.0                                                            7CPLOT    22
          DO 5 J=1,9                                                          7CPLOT    25
        5 IDATA(J)=JDATA(J,NPLOT)                                             7CPLOT    29
          DO 1 J=1,NVAR                                                       7CPLOT    53
          DO 1 I=1,KOUNT                                                      7CPLOT    57
           AMAX=MAX1F(AMAX,A(I,J))                                            7CPLOT    61
           AMIN=MIN1F(AMIN,A(I,J))                                            7CPLOT    81
        1 CONTINUE                                                            7CPLOT   101
          DO 4 J=1,NVAR                                                       7CPLOT   124
          AMINA(J)=AMIN                                                       7CPLOT   128
        4 AMAXA(J)=AMAX                                                       7CPLOT   132
          CALL PRTYT2(1,IDATA)                                                7CPLOT   147
          CALL PRTYT2(2,AMAXA)                                                7CPLOT   151
          CALL PRTYT2(3,AMINA)                                                7CPLOT   155
          DO 2 I=1,KOUNT                                                      7CPLOT   159
          DO 3 J=1,NVAR                                                       7CPLOT   163
        3 DATOS(J)=A(I,J)                                                     7CPLOT   167
          CALL PRTYT2(4,DATOS)                                                7CPLOT   194
        2 CONTINUE                                                            7CPLOT   195
          CALL PRTYT2(5,DATOS)                                                7CPLOT   210
          RETURN                                                              7CPLOT   214
          END                                                                 7CPLOT   221

      *                                                                       1CPLOT   251

      *PROGRAM END.    0 FORTRAN ERRORS                                       1CPLOT   252
  *00000000  *00000000       END                                              1CPLOT   253

                 *0 ASSEMBLY ERRORS

               000372 PROGRAM OCTAL SIZE

               000000 FOL TABLE OCTAL SIZE

064558 REMOVE,HYDROL,PERMANENT
064559 COMPILE,HYDROL,PERMANENT
      C      HYDROLOGICAL MODEL                                               7HYDROL    2
      C    SYSTEMS RESEARCH CENTER ***CASE WESTERN RESERVE UNIVERSITY         7HYDROL    3
      C   EQUATION FOR POPULATION **POP = POP*(1+ POPR)                       7HYDROL    4
      C    EQUATION FOR GIP **GIP = GIP*(1 +GIPR)                             7HYDROL    5
      C   ARRAYS PROVIDE ROOM FOR 50 CYCLES OF SIMULATION                     7HYDROL    6
      C    INITIAL PARAMETERS                                                 7HYDROL    7
           DIMENSION            WIC( 55), WARG(55), WAG(55) , TWG(55)         7HYDROL    8
           DIMENSION                  WIG(55),WIRG(55), WDG(55),WDRG(55)      7HYDROL    9
           DIMENSION WIL(55), WIRL(55), WDL(55), WDRL(55), WAL(55),           7HYDROL   10
          Z          WARL(55)                                                 7HYDROL   11
           DIMENSION  GRP (55), WI(55),          POP(55), WD(55),             7HYDROL   12
          Z  WA(55 ),                   TWL(55),WAR(55)                       7HYDROL   13
           DIMENSION WAP(55), WIP(55), WICP(55)                               7HYDROL   14
```

B 1339


```
      DIMENSION WDP(55)                                          7HYDROL  15
      DIMENSION A(55,6), JDATA(9, 6), IYEARP(11)                 7HYDROL  16
      DIMENSION TINH(6), TIEH(6)                                 7HYDROL  17
      DIMENSION TWS(55 ) , XWLM(55)                              7HYDROL  18
      REAL      LS  ,        IPK                                 7HYDROL  19
      EQUIVALENCE (WIL,WIP),(WAL,WAP),(WDL,WDP),(WICL,WICP)      7HYDROL  20
  106 FORMAT ( 1H1  , 20X ,$           $)                        7HYDROL  21
  112 FORMAT (112 , 114 , 112)                                   7HYDROL  31
  115 FORMAT (7F5.0)                                             7HYDROL  36
  116 FORMAT (6E10.3)                                            7HYDROL  39
  891 FORMAT (1H ,I5, 5X,6 (1X, E10.3, 2X) )                     7HYDROL  42
  892 FORMAT (1H ,I5, 5X,5 (1X, E10.3, 2X) )                     7HYDROL  53
  893 FORMAT (1H ,I5, 5X,3 (1X, E10.3, 2X) )                     7HYDROL  64
  900 FORMAT ( /1X , 15X, $GRP$ ,10X,$WI$ , 10X,$WIL $ , 10X ,   7HYDROL  75
     Z  $WIG$, 10X , $WIO$ )                                     7HYDROL  76
 901  FORMAT ( /1X , 15X ,$WIW$,10X,$WIR $,10X,  $WIRL$ ,  7X ,  7HYDROL  95
     Z  $ WIRO$ , 8X , $WIRG$ )                                  7HYDROL  96
  902 FORMAT ( /1X , 13X, $ POP$ ,10X , $ WD$ ,10X, $WDG$, 10X,  7HYDROL 116
     X      $ WDL$ ,10X , $ WDO$ )                               7HYDROL 117
  903 FORMAT ( /1X , 15X,$WDW $ , 8X, $ WDR$, 8X,$ WDRG$ ,10X ,  7HYDROL 136
     Z  $WDRL$ , 10X, $WDRO$  )                                  7HYDROL 137
  904 FORMAT ( /1X , 13X, $AL$ ,12X , $ WA$,11X,$WAG$      ,     7HYDROL 157
     Z  10X, $WAL $ , 8X, $WAO$  )                               7HYDROL 158
  905 FORMAT ( /1X , 13X, $ WPM $ ,8X , $WA$,8X, $WAG$,8X,$WAL$, 7HYDROL 177
     Z 8X ,$WAO$)                                                7HYDROL 178
  906 FORMAT  ( /1X , 15X, $WAW$,10X, $WAR$, 10X, $WARG$, 10X ,  7HYDROL 198
     Z$WARL $, 7X, $WARO$  )                                     7HYDROL 199
  907 FORMAT ( /1X , 15X, $HL$, 10X, $RO$, 10X,$ SL$, 12X,       7HYDROL 219
     Z  $SO$,  11X, $TSL$)                                       7HYDROL 220
  908 FORMAT( /1X , 15X , $ WIC $ , 10X, $WICL$,  8X ,           7HYDROL 239
     Z $WICG$ , 8X ,$WICO$  )                                    7HYDROL 240
  909 FORMAT ( /1X , 15X, $WICW$, 10X, $WIRC$ , 10X, $WICRL$  )  7HYDROL 257
  910 FORMAT ( /1X , 15X, $WLA$ ,10X,$WOA$, 10X,$WSL$)           7HYDROL 271
  911 FORMAT ( /1X , 15X, $TWG$ ,10X,$WGL$,10X,$TWLM$,           7HYDROL 284
     X 10X,$WLO$,11X,$WLG$)                                      7HYDROL 285
  912 FORMAT ( /1X , 15X, $TWL$ ,10X,$TWIM$)                     7HYDROL 304
  913 FORMAT ( /1X , 15X, $WLDP$,10X,$WODP$,10X,$WGDP$ ,  7X ,   7HYDROL 314
     X  $WODP$, 10X, $WLMDP$ )                                   7HYDROL 315
  914 FORMAT ( /1X , 15X, $FACT$,10X,$PIND1$ ,  6X , $ PIND2$ )  7HYDROL 335
  915 FORMAT ( / 1X , 15X , $WLAP$ , 10X ,$WOAP $ ,  7X , $WGAP$ , 7HYDROL 350
     Z 8X, $WOSAP$,8X, $WLMAP$ )                                 7HYDROL 351
  916 FORMAT( / 1X,15X,$TWS$,11X          ,$FNH$,11X,$FH$,11X,$SF$)7HYDROL 373
  917 FORMAT ( /1X , 15X, $ WLICP$,  7X,  $WOICP$, 8X, $WGICP$,  7HYDROL 389
     X 8X, $WOSICP$, 8X, $WLMICP$)                               7HYDROL 390
  918 FORMAT ( /1X, 15X, $SWI$, 10X, $SWD$ , 10X,$SWA$,          7HYDROL 414
     * 10X , $SWIC$ )                                            7HYDROL 415
  920 FORMAT (/1X, 15X, $WLIP$, 10X, $WOIP$, 10X, $WGIP$,        7HYDROL 431
     V  8X, $WOSIP$ ,8X, $WLMIP$)                                7HYDROL 432
  925 FORMAT (/1X, 15X, $WIP$, 10X, $WDP$,10X, $WAP$,10X, $WICP$) 7HYDROL 453
  981 FORMAT(1X ,16X,$+$,12X,$*$,13X,$@$,11X,$0$,11X,$>$)        7HYDROL 469
  982 FORMAT(1X ,16X,$+$,12X,$*$,13X,$@$,11X,$0$)                7HYDROL 487
  983 FORMAT(1X ,16X,$+$,12X,$*$,13X,$@$)                        7HYDROL 502
  986 FORMAT(1X ,16X,$+$,12X,$*$,13X,$@$,11X,$0$,11X,$>$,12X, $X$) 7HYDROL 514
  991 FORMAT(1X,8I10,3I10)                                       7HYDROL 535
```

```
  992 FORMAT (1X, 10X , 6( E10.3 , 3X )  )                           7HYDROL 540
  993 FORMAT (1X, 10X , 4( E10.3 , 3X )           )                  7HYDROL 548
  994 FORMAT (1X, 10X , 3( E10.3., 3X )      )                       7HYDROL 556
  999 FORMAT (// 1X,$P A R A M E T E R S$,I5,6(2X,E12.5))            7HYDROL 564
 8000 FORMAT (4I2,5A1)                                               7HYDROL 580
CC***********************************************                    7HYDROL 584
C    *****  CONSTANTS                                                7HYDROL 585
C                                                                    7HYDROL 586
C                                                                    7HYDROL 587
      UMILLU   = 1.E6                                                7HYDROL 588
      CIENML = 1.E5                                                  7HYDROL 591
      DIZML  = 1.E4                                                  7HYDROL 594
      UMIL  = 1.E3                                                   7HYDROL 597
      CIEN = 1.E2                                                    7HYDROL 600
      DIEZ = 10.                                                     7HYDROL 603
      UNO = 1.                                                       7HYDROL 606
      UDCM  = 1./10.                                                 7HYDROL 609
      UCTSM  = 1./ 100.                                              7HYDROL 613
      UMLSM  = 1./ 1.E3                                              7HYDROL 617
      UDMLSM   = 1./ 1.E4                                            7HYDROL 621
      UCMLS = 1./ 1.E5                                               7HYDROL 625
      UMLLS = 1./ 1.E6                                               7HYDROL 629
      GRPR  = 0.0342                                                 7HYDROL 633
      PIK = 0.06322                                                  7HYDROL 636
      IPK = 1.                                                       7HYDROL 639
      WIKK= 0.89                                                     7HYDROL 642
      WILK  = .806                                                   7HYDROL 645
      WIOK = 2.63E-4                                                 7HYDROL 648
      WICUK = 0.                                                     7HYDROL 651
      WIGK  = 0.191                                                  7HYDROL 654
      WIRK  = .7                                                     7HYDROL 657
      WIRLK  =  .85                                                  7HYDROL 660
      WIROK   =  .10                                                 7HYDROL 663
      WIRGK  = .05                                                   7HYDROL 666
      POPR  = .011                                                   7HYDROL 669
      WOK  = 1.72E-7                                                 7HYDROL 672
      WDGK  = .34                                                    7HYDROL 675
      WDLK  = .66                                                    7HYDROL 678
      WDOK = 7.87E-5                                                 7HYDROL 681
      WDWK  = .76                                                    7HYDROL 684
      WDRK  =  .4                                                    7HYDROL 687
      WDRGK   = .05                                                  7HYDROL 690
      WDRLK  = .80                                                   7HYDROL 693
      WDROK   = .15                                                  7HYDROL 696
      WARH  = .02                                                    7HYDROL 699
      WAGK   = .356                                                  7HYDROL 702
      WALK  = .643                                                   7HYDROL 705
      WAUK = 1.97 E-4                                                7HYDROL 708
      WAWK    = .4615                                                7HYDROL 711
      KARK  =  .8                                                    7HYDROL 714
      WARGK  = .4                                                    7HYDROL 717
      WARLK  = .60                                                   7HYDROL 720
      WAROK   = .0                                                   7HYDROL 723
      RLC  = .001                                                    7HYDROL 726
```

B 1340

B 1341


```
      RLN    = 6600.                                            7HYDROL 729
      RUC    = .01                                              7HYDROL 732
      RON    = 14300.                                           7HYDROL 735
      SLC    = 0.                                               7HYDROL 738
      SLN   = 465.                                              7HYDROL 741
      SUC   = 0.                                                7HYDROL 744
      SON    = 1430.                                            7HYDROL 747
      SMK    = .07                                              7HYDROL 750
      LS = 9.3E6                                                7HYDROL 753
      WLASK  = 0.49E-3                                          7HYDROL 756
      OS    = 14.3E6                                            7HYDROL 759
      WOASK    =     1.28E-3                                    7HYDROL 762
      WGLK = .00202                                             7HYDROL 765
      WGIPK    = 6.26E-5                                        7HYDROL 768
      WGDPK     =   6.41E-5                                     7HYDROL 771
      WGAPK = 3.136E-4                                          7HYDROL 774
      WLGK = .0125                                              7HYDROL 777
      WLOK = 5.8E-2                                             7HYDROL 780
      TWINK   = 4.8E-3                                          7HYDROL 783
      WOIPK = 0.                                                7HYDROL 786
      WODPK = 0.                                                7HYDROL 789
      WOAPK = 0.                                                7HYDROL 792
      WLICPK   = 5.675E-3                                       7HYDROL 795
      WIRCK   = .20                                             7HYDROL 798
      WDRCK   = .20                                             7HYDROL 801
      EC = 1.56E-3                                              7HYDROL 804
      ENH    = 298.8E3                                          7HYDROL 807
      EH   = 55.2E3                                             7HYDROL 810
       EK = .9                                                  7HYDROL 813
      WICK = .22                                                7HYDROL 816
      WICLK   = .9916                                           7HYDROL 819
      WICHK = 1.                                                7HYDROL 822
      WIPCLK     = 1.                                           7HYDROL 825
      WICGK   =   .0083                                         7HYDROL 828
      WIRCK   = 1.                                              7HYDROL 831
      ALDR = 0.02                                               7HYDROL 834
      WLIPK =   1.312E-3                                        7HYDROL 837
      WLDPK   = 6.37E-4                                         7HYDROL 840
      WLAPK   =   2.875E-3                                      7HYDROL 843
      WOICPK = 0.                                               7HYDROL 846
      WGICPK    = 2.97E-5                                       7HYDROL 849
      WLICPK = 5.584E-3                                         7HYDROL 852
C   ***** SCENARIOS SPECIFICATIONS                              7HYDROL 855
C                                                               7HYDROL 856
C                                                               7HYDROL 857
      GIRL = 11.38                                              7HYDROL 858
      GRWD   = 1.3915                                           7HYDROL 861
      GRWI   = 4.554                                            7HYDROL 864
      GRWIC   = 24.145                                          7HYDROL 867
      GRWA    = .9185                                           7HYDROL 870
      WI ( 1) = 86.62                                           7HYDROL 873
      WLMIK = .129                                              7HYDROL 876
      WLMDK = .075                                              7HYDROL 879
      WLMAK = .349                                              7HYDROL 882
```

B 1342

```
      WLMICK = .447                                                     7HYDROL 885
      WOSIK = .4                                                        7HYDROL 886
      WOSDK = .6                                                        7HYDROL 891
      WOSAK = 0.                                                        7HYDROL 894
      WOSICK  = 0.                                                      7HYDROL 897
C*********************                                                  7HYDROL 900
C*********************                                                  7HYDROL 901
C*********************                                                  7HYDROL 902
C                                                                       7HYDROL 903
C                                                                       7HYDROL 904
C   INITIAL STATE VALUES                                                7HYDROL 905
      POP(1)  = 224.3E6                                                 7HYDROL 906
      GRP( 1 ) = 1028.09                                                7HYDROL 909
      WIW    = 57.67                                                    7HYDROL 912
      WIRC    = 227.03                                                  7HYDROL 915
      WD(1) = 38.578                                                    7HYDROL 918
      WA(1 ) = 179.361                                                  7HYDROL 921
      AL    = .922E6                                                    7HYDROL 924
      TSL      = 465.                                                   7HYDROL 927
      TWG( 1 ) = 198.E3                                                 7HYDROL 930
      TWL( 1 ) = 40.E3                                                  7HYDROL 933
      TWSWL=14.3E6                                                      7HYDROL 936
      TWS1=0.076                                                        7HYDROL 939
      WIC(1)= .226E3                                                    7HYDROL 942
      XWLM(1) =0.                                                       7HYDROL 945
C     GIWL = INCREMENT OF WATER DUE TO LAND MANAGEMENT                  7HYDROL 948
C     GIWS = INCREMENT OF WATER DUE TO DESALTING                        7HYDROL 949
C                                                                       7HYDROL 950
C                                                                       7HYDROL 951
C                                                                       7HYDROL 952
      READ  112 , KOUNT,IYEAR  ,ISWC1                                   7HYDROL 953
C     TIEH  = INCREMENT IN HIDROELECTRIC ENERGY                         7HYDROL 964
C     TINH  = INCREMENT IN NO-HIDROELECTRIC ENERGY PRODUCTION           7HYDROL 965
      READ 116, GIWL, GIWS, EC, RLC                                     7HYDROL 966
      READ 115, (TINH(I),I=1,6)                                         7HYDROL 979
      READ 115, (TIEH(I),I=1,6)                                         7HYDROL 998
      READ 116, GRPH, POPH                                              7HYDROL1017
      READ 116, WIOK,  WDOK, WAOK, WICOK, WICGK                         7HYDROL1026
      READ 116, WGIPK, WGDPK, WGAPK, WGICPK                             7HYDROL1041
      READ 116, WLIPK , WLDPK , WLAPK                                   7HYDROL1054
C     READING OF PARAMETERS FOR SUBROUTINE CPLOT FOR PLOTTING           7HYDROL1065
      READ 8000,((JDATA(I,J),I=1,9),J=1,6 )                             7HYDROL1066
      IEAR = IYEAR                                                      7HYDROL1100
      DO 9000 J=1,11                                                    7HYDROL1103
 9000 IYEARP(J)=IYEAR + 5 * (J - 1)                                     7HYDROL1107
      PRINT 106                                                         7HYDROL1123
      PRINT 999, ISWC1, GIWL, GIWS, EC, TINH(1), TIEH(1)                7HYDROL1126
      PRINT 106                                                         7HYDROL1145
      PRINT 900                                                         7HYDROL1150
      DO 1000  IT = 1 , KOUNT                                           7HYDROL1155
      GRP (IT + 1) = GRP(IT)  * (1. + GRPR )                            7HYDROL1159
      IF ( ISWC1 - 1 ) 4305 , 4306 , 4305                               7HYDROL1165
 4306 WI (IT + 1 ) = WI (IT) + GRWI                                     7HYDROL1173
      GO TO 4316                                                        7HYDROL1178
```

```
4305 WI (IT) = WIK * IPK  * GRP (IT)                                   7HYDROL1180
4316 CONTINUE                                                          7HYDROL1186
     WIL (IT)= WILK * WI(IT)                                           7HYDROL1188
     WIO = WICK  * WI(IT)                                              7HYDROL1193
     WIG(IT)=WICK* WI(  IT)                                            7HYDROL1197
     PRINT 891, IEAR , GRP(IT), WI(IT) , WIL(IT) , WIG(IT),WIO         7HYDROL1201
     A(IT,1)=GRP(IT) * UCTSM                                           7HYDROL1226
     A(IT,2)=WI(IT)                                                    7HYDROL1230
     A(IT,3)=WIL(IT)                                                   7HYDROL1233
     A(IT,4)=WIG(IT)                                                   7HYDROL1236
     A(IT,5)=WIO                                                       7HYDROL1239
     IEAR = IEAR +1                                                    7HYDROL1242
1000 CONTINUE                                                          7HYDROL1246
     PRINT 106                                                         7HYDROL1254
     PRINT 900                                                         7HYDROL1259
     PRINT 981                                                         7HYDROL1264
     PRINT  992 , UCTSM , UNO, UNO , UNO, UNO                          7HYDROL1269
     CALL CPLOT(A,KOUNT,5,JDATA,5)                                     7HYDROL1284
     PRINT 991, IYEARP                                                 7HYDROL1291
     IEAR  =IYEAR                                                      7HYDROL1309
     PRINT 106                                                         7HYDROL1312
     PRINT 901                                                         7HYDROL1317
     DO 1200  IT = 1 , KOUNT                                           7HYDROL1322
     WIW       = WIWK * WI( IT)                                        7HYDROL1326
     WIR   = WIRK  * WIW                                               7HYDROL1331
     WIRL(IT) = WIRLK * WIR                                            7HYDROL1335
     WIRO  =  WIROK * WIR                                              7HYDROL1339
     WIRG(IT) = WIRGK * WIR                                            7HYDROL1343
     PRINT 891, IEAR , WIW     , WIR , WIRL(IT),WIRO , WIRG(IT)        7HYDROL1347
     A(IT,1)=WIW                                                       7HYDROL1368
     A(IT,2)=WIR                                                       7HYDROL1371
     A(IT,3)=WIRL(IT)                                                  7HYDROL1374
     A(IT,4)=WIRO*DIEZ                                                 7HYDROL1377
     A(IT,5)=WIRG(IT)*DIEZ                                             7HYDROL1381
     IEAR     = IEAR + 1                                               7HYDROL1385
1200 CONTINUE                                                          7HYDROL1389
     PRINT 106                                                         7HYDROL1397
     PRINT 901                                                         7HYDROL1402
     PRINT 981                                                         7HYDROL1407
     PRINT  992 , UNO, UNO , UNO, DIEZ, DIEZ                           7HYDROL1412
     CALL CPLOT(A,KOUNT,5,JDATA,5)                                     7HYDROL1427
     PRINT 991, IYEARP                                                 7HYDROL1434
     PRINT 106                                                         7HYDROL1452
     PRINT 902                                                         7HYDROL1457
     IEAR  =IYEAR                                                      7HYDROL1462
     DO 1400 IT = 1 , KOUNT                                            7HYDROL1465
     POP (IT + 1 ) = POP(IT  )  * ( 1.+ POPR)                          7HYDROL1469
     IF( ISWC1 - 1 ) 1405 , 1410 , 1405                                7HYDROL1475
1410 WD (IT + 1) = WD(IT) + GRWD                                       7HYDROL1483
     GO TO 1415                                                        7HYDROL1488
1405 WD( IT + 1 ) =  WD(IT) * (1. + POPR )                             7HYDROL1490
1415 CONTINUE                                                          7HYDROL1496
     WDG(IT) = WDGK * WD(IT)                                           7HYDROL1498
     WDL(IT) = WDLK * WD(IT)                                           7HYDROL1503
```

```
      WDO  = WDOK * WD(IT)                                             7HYDROL1507
      PRINT 891, IEAR , PUP (IT) , WD(IT), WDG(IT),WDL(IT),WDO         7HYDROL1511
      A(IT,1)=PUP(IT) *UMLLS                                           7HYDROL1536
      A(IT,2)=WD(IT)                                                   7HYDROL1540
      A(IT,3)=WDG(IT)                                                  7HYDROL1543
      A(IT,4)=WDL(IT)                                                  7HYDROL1546
      A(IT,5)=WDO                                                      7HYDROL1549
      IEAR  = IEAR + 1                                                 7HYDROL1552
 1400 CONTINUE                                                         7HYDROL1556
      PRINT 106                                                        7HYDROL1564
      PRINT 902                                                        7HYDROL1569
      PRINT 961                                                        7HYDROL1574
      PRINT 992 , UMLLS, UNO , UNO, UNO, UNO                           7HYDROL1579
      CALL CPLOT(A,KOUNT,5,JDATA,5)                                    7HYDROL1594
      PRINT 991, IYEARP                                                7HYDROL1601
      PRINT 106                                                        7HYDROL1619
      PRINT 903                                                        7HYDROL1624
      IEAR =  IYEAR                                                    7HYDROL1629
      DO 1600  IT = 1, KOUNT                                           7HYDROL1632
      WDW        =  WDWK  *WD(IT )                                     7HYDROL1636
      WDR =  WDRK * WDW                                                7HYDROL1641
      WDRG(IT)  = WDRGK * WDR                                          7HYDROL1645
      WDRL(IT) = WDRLK * WDR                                           7HYDROL1649
      WDRO  = WDROK * WDR                                              7HYDROL1653
      PRINT 891 , IEAR, WDW  ,   WDR, WDRG(IT) ,WDRL(IT), WDRO         7HYDROL1657
      A(IT,1)=WDW                                                      7HYDROL1678
      A(IT,2)=WDR                                                      7HYDROL1681
      A(IT,3)=WDRG(IT)*DIEZ                                            7HYDROL1684
      A(IT,4)=WDRL(IT)                                                 7HYDROL1688
      A(IT,5)=WDRO*DIEZ                                                7HYDROL1691
      IEAR  = IEAR + 1                                                 7HYDROL1695
 1600 CONTINUE                                                         7HYDROL1699
      PRINT 106                                                        7HYDROL1707
      PRINT 903                                                        7HYDROL1712
      PRINT 981                                                        7HYDROL1717
      PRINT 992 , UNO , UNO , DIEZ , UNO , DIEZ                        7HYDROL1722
      CALL CPLOT(A,KOUNT,5,JDATA,5)                                    7HYDROL1737
      PRINT 991, IYEARP                                                7HYDROL1744
      PRINT 106                                                        7HYDROL1762
      PRINT 904                                                        7HYDROL1767
      IEAR  = IYEAR                                                    7HYDROL1772
      DO 1800  IT = 1, KOUNT                                           7HYDROL1775
      IF ( ISWC1 - 1 ) 1805 , 1810, 1805                               7HYDROL1779
 1810 WA(IT + 1 ) = WA (IT) + GRWA                                     7HYDROL1787
      GO TO 1815                                                       7HYDROL1792
 1805 WA(IT + 1)= WA (IT) * (1. + ALDR)                                7HYDROL1794
 1815 CONTINUE                                                         7HYDROL1800
      WAW       = WAWK * WA(IT)                                        7HYDROL1802
      WAR (IT)  = WARK * WAW                                           7HYDROL1807
      WAG(IT)= WAGK * WA(IT)                                           7HYDROL1811
      WAL(IT) = WALK * WA(IT)                                          7HYDROL1815
      WAO  = WAOK * WA(IT)                                             7HYDROL1819
      AL = AL *( 1. + ALDH)                                            7HYDROL1823
      PRINT 891 , IEAR,  AL  ,   WA(IT), WAG(IT) , WAL(IT) , WAO       7HYDROL1828
```

```
      A(IT,1)=AL      * UDMLSM                                            7HYDROL1851
      A(IT,2)=WA(IT)                                                      7HYDROL1855
      A(IT,3)= WAG(IT)                                                    7HYDROL1858
      A(IT,4)= WAL(IT)                                                    7HYDROL1861
      A(IT,5)= WAO * DIZML                                                7HYDROL1864
      IEAR  = IEAR + 1                                                    7HYDROL1868
 1800 CONTINUE                                                            7HYDROL1872
      PRINT 106                                                           7HYDROL1880
      PRINT 904                                                           7HYDROL1885
      PRINT 981                                                           7HYDROL1890
      PRINT 992 , UDMLSM, UNO , UNO , UNO , DIZML                         7HYDROL1895
      CALL CPLOT(A,KOUNT,5,JDATA,5)                                       7HYDROL1910
      PRINT 991, IYEARP                                                   7HYDROL1917
      IEAR  = IYEAR                                                       7HYDROL1935
      DO 2000  IT = 1, KOUNT                                              7HYDROL1938
      IEAR  = IEAR + 1                                                    7HYDROL1942
 2000 CONTINUE                                                            7HYDROL1946
      IEAR = IYEAR                                                        7HYDROL1954
      PRINT 106                                                           7HYDROL1957
      PRINT 906                                                           7HYDROL1962
      DO 2200  IT = 1, KOUNT                                              7HYDROL1967
      WAW = WAWK * WA(IT)                                                 7HYDROL1971
      WARG(IT) = WARGK * WAR(IT)                                          7HYDROL1976
      WARL(IT) = WARLK*WAR(IT)                                            7HYDROL1980
      WARO = WAROK *WAR(IT)                                               7HYDROL1984
      PRINT 891 , IEAR , WAW,      WAR(IT), WARG(IT), WARL(IT), WARO      7HYDROL1988
      A(IT,1)=WAW                                                         7HYDROL2011
      A(IT,2)=WAR(IT)                                                     7HYDROL2014
      A(IT,3)=WARG(IT)                                                    7HYDROL2017
      A(IT,4)=WARL(IT)                                                    7HYDROL2020
      A(IT,5)=WARO                                                        7HYDROL2023
      IEAR = IEAR + 1                                                     7HYDROL2026
 2200 CONTINUE                                                            7HYDROL2030
      PRINT 106                                                           7HYDROL2038
      PRINT 906                                                           7HYDROL2043
      PRINT 981                                                           7HYDROL2048
      PRINT 992, UNO, UNO , UNO , UNO , UNO                               7HYDROL2053
      CALL CPLOT(A,KOUNT,5,JDATA,5)                                       7HYDROL2068
      PRINT 991, IYEARP                                                   7HYDROL2075
      IEAR = IYEAR                                                        7HYDROL2093
      PRINT 106                                                           7HYDROL2096
      PRINT   908                                                         7HYDROL2101
      DO 2600    IT = 1, KOUNT                                            7HYDROL2106
      IF(ISWC1- 1)2605,2610,2605                                          7HYDROL2110
 2610  WIC (IT + 1) = WIC (IT) + GRWIC                                    7HYDROL2118
      GO TO 2615                                                          7HYDROL2123
 2605 WIC (IT) = WICK * GHP (IT)                                          7HYDROL2125
 2615 CONTINUE                                                            7HYDROL2130
      WICL  =  WICLK  * WIC( IT)                                          7HYDROL2132
      WICO = WICOK * WIC (IT)                                             7HYDROL2137
      WICG  = WICGK  * WIC(IT)                                            7HYDROL2141
      PRINT 892 ,  IEAR, WIC (IT)  , WICL, WICG    , WICO                 7HYDROL2145
      A(IT,1)=WIC(IT)                                                     7HYDROL2162
      A(IT,2)=WICL                                                        7HYDROL2165
```

B 1345

```
      A(IT,3)=WICG     *CIEN                                     7HYDROL2168
      A(IT,4)=WICO*CIEN                                          7HYDROL2172
      IEAR  = IEAR + 1                                           7HYDROL2176
 2600 CONTINUE                                                   7HYDROL2180
      PRINT 106                                                  7HYDROL2189
      PRINT 908                                                  7HYDROL2193
      PRINT 962                                                  7HYDROL2198
      PRINT 993 , UNO , UNO , CIEN , CIEN                        7HYDROL2203
      CALL CPLOT(A,KOUNT,4,JDATA,4)                              7HYDROL2216
      PRINT 991, IYEARP                                          7HYDROL2223
C                                                                7HYDROL2241
C                                                                7HYDROL2242
      IEAR  = IYEAR                                              7HYDROL2243
      PRINT 106                                                  7HYDROL2246
      PRINT 909                                                  7HYDROL2251
      DO  2800   IT = 1, KOUNT                                   7HYDROL2256
      WICW  =  WICWK  * WIC(IT)                                  7HYDROL2260
      WICRL  = WIRCLK * WICW                                     7HYDROL2265
      WIRC    = WIRCK * WIC(IT)                                  7HYDROL2269
      PRINT 893,  IEAR, WICW , WIRC        , WICRL               7HYDROL2273
      A(IT,1)=WICW                                               7HYDROL2286
      A(IT,2)=WIRC                                               7HYDROL2289
      A(IT,3)=WICRL                                              7HYDROL2292
      IEAR   = IEAR  + 1                                         7HYDROL2295
 2800 CONTINUE                                                   7HYDROL2299
      PRINT 106                                                  7HYDROL2307
      PRINT 909                                                  7HYDROL2312
      PRINT 983                                                  7HYDROL2317
      PRINT 994, UNO, UNO, UNO                                   7HYDROL2322
      CALL CPLOT(A,KOUNT,3,JDATA,3)                              7HYDROL2333
      PRINT 991, IYEARP                                          7HYDROL2340
      IEAR = IYEAR                                               7HYDROL2358
      PRINT 106                                                  7HYDROL2361
      PRINT  907                                                 7HYDROL2366
      RL     = (1.  +  RLC)  * RLN                               7HYDROL2371
      RO    = (1. + ROC)  *RON                                   7HYDROL2376
      SL     = (1.  +  SLC ) *SLN                                7HYDROL2381
      SO      =  (1. + SOC ) *SON                                7HYDROL2386
      TSL = SL *(1. - SMK)                                       7HYDROL2391
      PRINT 891 , IEAR , RL ,   RO, SL      , SO, TSL            7HYDROL2396
C                                                                7HYDROL2411
C                                                                7HYDROL2412
      PRINT 106                                                  7HYDROL2413
      PRINT 910                                                  7HYDROL2418
      WLA  =  WLASK * LS                                         7HYDROL2423
      WOA  = WOASK  * OS                                         7HYDROL2427
      WSL      = SMK * TSL                                       7HYDROL2431
      PRINT 893 , IEAR , WLA , WOA , WSL                         7HYDROL2435
      PRINT 106                                                  7HYDROL2448
      PRINT 911                                                  7HYDROL2453
      TWS(1) = TWSI                                              7HYDROL2458
      DO 3200   IT = 1, KOUNT                                    7HYDROL2461
      XWLM(IT +1 ) = XWLM(IT) + GIWL                             7HYDROL2465
      TWS( IT + 1 ) = TWS(IT) + GIWS                             7HYDROL2470
```

```
      WICG = WICGK * WIC (IT)                                           7HYDROL2474
      WGL     = WGLK  * TWG(IT)                                         7HYDROL2478
      WLG      = WLGK * TWL(IT).                                        7HYDROL2482
      TWG(IT + 1 ) = TWG(IT) + WLG        - WGL       - WIG(IT) +       7HYDROL2486
     Z WIRG (IT) - WDG (IT) + WDRG (IT) - WAG (IT) + WARG(IT)-          7HYDROL2487
     ZWICG                                                              7HYDROL2488
C**********                                                             7HYDROL2500
C**********                                                             7HYDROL2501
C**********                                                             7HYDROL2502
      WLO     = WLOK * TWL(IT)                                          7HYDROL2503
      TWL(IT + 1 ) =  TWL(IT) + WGL      - WLG      - WIL(IT) +         7HYDROL2507
     Z  WIRL(IT) -WDL(IT) + WDRL(IT) - WAL(IT) + WARL(IT)               7HYDROL2508
     X + RL      + TSL      - WLO       - WLA                           7HYDROL2509
      PRINT 891,IEAR, TWG(IT), WGL, XWLM(IT),WLO, WLG                   7HYDROL2524
      A(IT,1)=TWG(IT)* UMLSM                                            7HYDROL2545
      A(IT,2)=WGL      * UDCM                                           7HYDROL2549
      A(IT,3)=XWLM(IT)                                                  7HYDROL2553
      A(IT,4)=WLO                                                       7HYDROL2556
      A(IT,5)=WLG                                                       7HYDROL2559
      IEAR = IEAR + 1                                                   7HYDROL2562
 3200 CONTINUE                                                          7HYDROL2566
      PRINT 106                                                         7HYDROL2574
      PRINT 911                                                         7HYDROL2579
      PRINT 981                                                         7HYDROL2584
      PRINT 992 , UMLSM , UDCM, UNO, UNO UNO                            7HYDROL2589
      CALL CPLOT(A,KOUNT,5,JDATA,5 )                                    7HYDROL2602
      PRINT 991, IYEARP                                                 7HYDROL2609
      IEAR = IYEAR                                                      7HYDROL2627
      PRINT 106                                                         7HYDROL2630
      PRINT 912                                                         7HYDROL2635
C**********                                                             7HYDROL2640
C**********                                                             7HYDROL2641
      DO 3400    IT = 1 , KOUNT                                         7HYDROL2642
      TWIM   =  TWIMK * TWL(IT)                                         7HYDROL2646
      PRINT 891 , IEAR , TWL(IT) , TWIM                                 7HYDROL2651
      A(IT,1)=TWL(IT)/10.                                               7HYDROL2664
      A(IT,2)=TWIM                                                      7HYDROL2668
      IEAR = IEAR + 1                                                   7HYDROL2671
 3400 CONTINUE                                                          7HYDROL2675
      PRINT 106                                                         7HYDROL2683
      PRINT 912                                                         7HYDROL2688
      PRINT 983                                                         7HYDROL2693
      PRINT 992 , UDCM , UNO                                            7HYDROL2698
      CALL CPLOT(A,KOUNT,2,JDATA,2)                                     7HYDROL2707
      PRINT 991, IYEARP                                                 7HYDROL2714
      IEAR = IYEAR                                                      7HYDROL2732
      PRINT 106                                                         7HYDROL2735
      PRINT 920                                                         7HYDROL2740
      DO 3450    IT = 1 , KOUNT                                         7HYDROL2745
      WLIP    = WLIFK * TWL(IT)                                         7HYDROL2749
      WOIP = WOPIK * TWSWL                                              7HYDROL2754
      WGIP = WGIPK * TWG( IT)                                           7HYDROL2758
      WOSIP = WOISK * TWS (IT)                                          7HYDROL2762
      WLMIP  = WLMIK * XWLM(IT)                                         7HYDROL2766
```

B 1348

```
      WIP(IT) = WLIP + WOIP + WGIP + WOSIP + WLMIP                     7HYDROL2770
      PRINT 891 , IEAR, WLIP , WOIP , WGIP , WOSIP , WLMIP             7HYDROL2777
      A(IT, 1 ) = WLIP                                                 7HYDROL2794
      A(IT, 2 ) = WOIP                                                 7HYDROL2797
      A(IT, 3 ) = WGIP                                                 7HYDROL2800
      A(IT, 4 ) = WOSIP                                                7HYDROL2803
      A(IT, 5 ) = WLMIP                                                7HYDROL2806
      IEAR = IEAR + 1                                                  7HYDROL2809
 3450 CONTINUE                                                         7HYDROL2813
      PRINT 106                                                        7HYDROL2821
      PRINT 920                                                        7HYDROL2826
      PRINT 981                                                        7HYDROL2831
      PRINT 992 ,UNO ,UNO, UNO, UNO, UNO                               7HYDROL2836
      CALL CPLOT (A, KOUNT, 5 , JDATA, 5 )                             7HYDROL2851
      PRINT 991 , IYEARP                                               7HYDROL2858
      IEAR = IYEAR                                                     7HYDROL2876
      PRINT 106                                                        7HYDROL2879
      PRINT 913                                                        7HYDROL2884
      DO  3600   IT = 1 , KOUNT                                        7HYDROL2889
      WLDP = WLDPK * TWL(IT)                                           7HYDROL2893
      WODP = WODPK * TWSWL                                             7HYDROL2898
      WGDP = WGDPK * TWG (IT)                                          7HYDROL2902
      WOSDP = WOSDK * TWS(IT)                                          7HYDROL2906
      WLMDP = WLMDK * XWLM(IT)                                         7HYDROL2910
      WDP(IT) = WLDP + WODP + WGDP + WOSDP + WLMDP                     7HYDROL2914
      PRINT 891 , IEAR , WLDP , WODP , WGDP , WOSDP , WLMDP            7HYDROL2921
      A (IT , 1 ) = WLDP                                               7HYDROL2938
      A (IT , 2 ) = WODP                                               7HYDROL2941
      A (IT , 3 ) = WGDP                                               7HYDROL2944
      A (IT , 4 ) = WOSDP                                              7HYDROL2947
      A (IT , 5 ) = WLMDP                                              7HYDROL2950
      IEAR = IEAR + 1                                                  7HYDROL2953
 3600 CONTINUE                                                         7HYDROL2957
      PRINT 106                                                        7HYDROL2965
      PRINT 913                                                        7HYDROL2970
      PRINT 981                                                        7HYDROL2975
      PRINT 992 , UNO , UNO , UNO ,   UNO  , UNO                       7HYDROL2980
      CALL CPLOT(A, KOUNT , 5 , JDATA , 5 )                            7HYDROL2995
      PRINT 991, IYEARP                                                7HYDROL3002
      IEAR = IYEAR                                                     7HYDROL3020
      PRINT 106                                                        7HYDROL3023
      PRINT 915                                                        7HYDROL3028
      DO 3650  IT = 1 , KOUNT                                          7HYDROL3033
      WLAP = WLAPK * TWL(IT)                                           7HYDROL3037
      WOAP = WOAPK * TWSWL                                             7HYDROL3042
      WGAP = WGAPK * TWG(IT)                                           7HYDROL3046
      WOSAP = WOSAK * TWS(IT)                                          7HYDROL3050
      WLMAP = WLMAK * XWLM(IT)                                         7HYDROL3054
      WAP(IT) = WLAP  + WOAP + WGAP + WOSAP + WLMAP                    7HYDROL3058
      PRINT 891 , IEAR, WLAP , WOAP , WGAP, WOSAP,WLMAP                7HYDROL3065
      A(IT, 1 )= WLAP                                                  7HYDROL3082
      A(IT, 2 )= WOAP                                                  7HYDROL3085
      A(IT, 3 )= WGAP                                                  7HYDROL3088
      A(IT, 4 )= WOSAP                                                 7HYDROL3091
```

```
      A(IT, 5 )= WLMAP                                              7HYDROL3094
      IEAR = IEAR + 1                                               7HYDROL3097
 3650 CONTINUE                                                      7HYDROL3101
      PRINT 106                                                     7HYDROL3109
      PRINT 915                                                     7HYDROL3114
      PRINT 981                                                     7HYDROL3119
      PRINT 992, UNO, UNO, UNO, UNO,UNO                             7HYDROL3124
      CALL CPLOT ( A , KOUNT , 5 , JDATA, 5 )                       7HYDROL3139
      PRINT 991, IYEARP                                             7HYDROL3146
      IEAR = IYEAR                                                  7HYDROL3164
      PRINT 106                                                     7HYDROL3167
      PRINT 917                                                     7HYDROL3172
      DO 3700  IT = 1 , KOUNT                                       7HYDROL3177
      WLICP = WLICPK * TWL(IT)                                      7HYDROL3181
      WOICP = WOICPK * TWSWL                                        7HYDROL3186
      WGICP = WGICPK * TWG(IT)                                      7HYDROL3190
      WOSIP = WOSIK * TWS(IT)                                       7HYDROL3194
      WLMICP = WLMICK * XWLM(IT)                                    7HYDROL3198
      WICP(IT)= WLICP + WOICP + WGICP + WOSICP+WLMICP               7HYDROL3202
      PRINT 891  , IEAR, WLICP,WOICP,WGICP, WOSICP,WLMICP           7HYDROL3209
      A(IT, 1 ) = WLICP                                             7HYDROL3226
      A(IT, 2 ) = WOICP                                             7HYDROL3229
      A(IT, 3 ) = WGICP                                             7HYDROL3232
      A(IT, 4 ) =WOSICP                                             7HYDROL3235
      A(IT, 5 ) = WLMICP                                            7HYDROL3238
      IEAR = IEAR + 1                                               7HYDROL3241
 3700 CONTINUE                                                      7HYDROL3245
      PRINT 106                                                     7HYDROL3253
      PRINT 917                                                     7HYDROL3258
      PRINT 981                                                     7HYDROL3263
      PRINT 992 ,UNO, UNO, UNO, UNO, UNO                            7HYDROL3268
      CALL CPLOT ( A, KOUNT , 5 , JDATA, 5 )                        7HYDROL3283
      PRINT 991, IYEARP                                             7HYDROL3290
      IEAR = IYEAR                                                  7HYDROL3308
      PRINT 106                                                     7HYDROL3311
      PRINT 925                                                     7HYDROL3316
      DO 3725 IT = 1 , KOUNT                                        7HYDROL3321
      PRINT 891 , IEAR , WIP(IT),WOP(IT) , WAP(IT),WICP(IT)         7HYDROL3325
      A(IT , 1 ) = WIP(IT)                                          7HYDROL3349
      A(IT , 2 ) = WOP(IT)                                          7HYDROL3352
      A(IT , 3 ) = WAP(IT)                                          7HYDROL3355
      A(IT , 4 ) = WICP(IT)                                         7HYDROL3358
      IEAR = IEAR + 1                                               7HYDROL3361
 3725 CONTINUE                                                      7HYDROL3365
      PRINT 106                                                     7HYDROL3373
      PRINT 925                                                     7HYDROL3376
      PRINT 982                                                     7HYDROL3383
      PRINT 992 , UNO,UNO,UNO,UNO                                   7HYDROL3388
      CALL CPLOT( A, KOUNT, 4, JDATA, 4 )                           7HYDROL3401
      PRINT 991, IYEARP                                             7HYDROL3408
      IEAR = IYEAR                                                  7HYDROL3426
      PRINT 106                                                     7HYDROL3429
      PRINT 918                                                     7HYDROL3434
      DO 3750  IT = 1, KOUNT                                        7HYDROL3439
```

B 1349

B 1350

```
      SWI = WIP(IT) - WI(IT)                                            7HYDROL3443
      SWD = WDP(IT) - WD(IT)                                            7HYDROL3448
      SWA = WAP(IT) - WA(IT)                                            7HYDROL3452
      SWIC = WICP (IT) - WIC (IT)                                       7HYDROL3456
      PRINT 891, IEAR, SWI, SWD, SWA, SWIC                              7HYDROL3460
      A(IT, 1 ) = SWI                                                   7HYDROL3475
      A(IT, 2 ) = SWD                                                   7HYDROL3478
      A(IT, 3 ) = SWA                                                   7HYDROL3481
      A(IT, 4 ) = SWIC                                                  7HYDROL3484
      IEAR = IEAR + 1                                                   7HYDROL3487
 3750 CONTINUE                                                          7HYDROL3491
      PRINT 106                                                         7HYDROL3499
      PRINT 918                                                         7HYDROL3504
      PRINT 982                                                         7HYDROL3509
      PRINT 992,UNO, UNO, UNO, UNO                                      7HYDROL3514
      CALL CPLOT ( A, KOUNT , 4 , JDATA, 4 )                            7HYDROL3527
      PRINT 991 , IYEARP                                                7HYDROL3534
      IEAR = IYEAR                                                      7HYDROL3552
      PRINT 106                                                         7HYDROL3555
      PRINT  916                                                        7HYDROL3560
      DO 3850 IT = 1, KOUNT                                             7HYDROL3565
      KK = (IT + 3) / 10 + 1                                            7HYDROL3569
      ENH = ENH + TINH(KK) * 1.E3                                       7HYDROL3577
      EH = EH + TIEH (KK)     * 1.E3                                    7HYDROL3583
      SE  =-FC * PCP(IT) +(ENH +  EK * EH  )                            7HYDROL3588
      PRINT  892, IEAR, TWS(IT)          ,ENH, EH, SE                   7HYDROL3598
      A(IT,1)= TWS(IT) * UIE7                                           7HYDROL3615
      A(IT,2)= ENH * 1.E-7                                              7HYDROL3619
      A(IT,3)= EH * 1.E-2                                               7HYDROL3623
      A(IT,4)=SE/1000.                                                  7HYDROL3627
      IEAR=IEAR + 1                                                     7HYDROL3631
 3850 CONTINUE                                                          7HYDROL3635
      PRINT 106                                                         7HYDROL3643
      PRINT  916                                                        7HYDROL3648
      PRINT 981                                                         7HYDROL3653
      PRINT 992, UIE7,        UNO,  UCTMS, UMLSM                        7HYDROL3658
      CALL CPLOT(A,KOUNT,4,JDATA,4)                                     7HYDROL3671
      PRINT 991, IYEARP                                                 7HYDROL3678
C   PRINT OUT INDICATORS                                                7HYDROL3696
      IEAR  = IYEAR                                                     7HYDROL3697
      PRINT 106                                                         7HYDROL3700
      PRINT 914                                                         7HYDROL3705
      DO  3800     IT =  1 , KOUNT                                      7HYDROL3710
      FACT =  WI(IT) + WD (IT) + WA(IT)                                 7HYDROL3714
      PIND1 = FACT / TWL(IT)                                            7HYDROL3720
      PIND2 =  FACT / TWG(IT)                                           7HYDROL3724
      PRINT 891, IEAR, FACT, PIND1, PIND2                               7HYDROL3728
      A(IT,1)=FACT                                                      7HYDROL3741
      A(IT,2)=PIND1*1.E05                                               7HYDROL3744
      A(IT,3)=PIND2*1.E06                                               7HYDROL3748
      IEAR = IEAR + 1                                                   7HYDROL3752
 3800 CONTINUE                                                          7HYDROL3756
      PRINT 106                                                         7HYDROL3764
      PRINT 914                                                         7HYDROL3769
```

```
      PRINT 981                                              7HYDROL3774
      PRINT 993 , UNO , CIENML , UMILLO                      7HYDROL3779
      CALL CPLOT(A,KOUNT,3,JDATA,3 )                         7HYDROL3790
      PRINT 991, IYEARP                                      7HYDROL3797
      STOP                                                   7HYDROL3815
      END                                                    7HYDROL3818
*                                                            1HYDROL4128
*PROGRAM END.    0 FORTRAN ERRORS                            1HYDROL4129
*U0000000  *00000000      END                                1HYDROL4130

                 0 ASSEMBLY ERRORS

            014076 PROGRAM OCTAL SIZE

            001744 EQL TABLE OCTAL SIZE

065500 FIN
```

B 1351

B 1352

APPENDIX II

Units:

The data listed in Appendices II and III is given in cubic kilometers; only the following variable are given in terms of other units: GRP, billions of dollars; POP, inhabitants; AL, square kilometers; ENH, megawatts; EH, megawatts.

B 1354

LATIN AMERICA

NOMINAL RUN

	GRP	WI	WIL	WIG	WIO
1975	0.335E 03	0.542E 01	0.438E 01	0.104E 01	0.000E 00
1976	0.359E 03	0.581E 01	0.469E 01	0.111E 01	0.000E 00
1977	0.384E 03	0.622E 01	0.503E 01	0.119E 01	0.000E 00
1978	0.411E 03	0.666E 01	0.538E 01	0.127E 01	0.000E 00
1979	0.441E 03	0.714E 01	0.577E 01	0.136E 01	0.000E 00
1980	0.472E 03	0.764E 01	0.618E 01	0.146E 01	0.000E 00
1981	0.505E 03	0.819E 01	0.661E 01	0.156E 01	0.000E 00
1982	0.541E 03	0.877E 01	0.708E 01	0.167E 01	0.000E 00
1983	0.580E 03	0.939E 01	0.759E 01	0.179E 01	0.000E 00
1984	0.621E 03	0.101E 02	0.813E 01	0.192E 01	0.000E 00
1985	0.665E 03	0.108E 02	0.870E 01	0.206E 01	0.000E 00
1986	0.712E 03	0.115E 02	0.932E 01	0.220E 01	0.000E 00
1987	0.763E 03	0.124E 02	0.998E 01	0.236E 01	0.000E 00
1988	0.817E 03	0.132E 02	0.107E 02	0.253E 01	0.000E 00
1989	0.875E 03	0.142E 02	0.114E 02	0.271E 01	0.000E 00
1990	0.937E 03	0.152E 02	0.123E 02	0.290E 01	0.000E 00
1991	0.100E 04	0.163E 02	0.131E 02	0.310E 01	0.000E 00
1992	0.107E 04	0.174E 02	0.141E 02	0.332E 01	0.000E 00
1993	0.115E 04	0.186E 02	0.151E 02	0.356E 01	0.000E 00
1994	0.123E 04	0.200E 02	0.161E 02	0.381E 01	0.000E 00
1995	0.132E 04	0.214E 02	0.173E 02	0.408E 01	0.000E 00
1996	0.141E 04	0.229E 02	0.185E 02	0.437E 01	0.000E 00
1997	0.151E 04	0.245E 02	0.198E 02	0.468E 01	0.000E 00
1998	0.162E 04	0.263E 02	0.212E 02	0.502E 01	0.000E 00
1999	0.174E 04	0.281E 02	0.227E 02	0.537E 01	0.000E 00
2000	0.186E 04	0.301E 02	0.243E 02	0.575E 01	0.000E 00
2001	0.199E 04	0.323E 02	0.261E 02	0.616E 01	0.000E 00
2002	0.213E 04	0.346E 02	0.279E 02	0.660E 01	0.000E 00
2003	0.228E 04	0.370E 02	0.299E 02	0.707E 01	0.000E 00
2004	0.245E 04	0.396E 02	0.320E 02	0.757E 01	0.000E 00
2005	0.262E 04	0.425E 02	0.343E 02	0.811E 01	0.000E 00
2006	0.281E 04	0.455E 02	0.367E 02	0.868E 01	0.000E 00
2007	0.301E 04	0.487E 02	0.393E 02	0.930E 01	0.000E 00
2008	0.322E 04	0.521E 02	0.421E 02	0.996E 01	0.000E 00
2009	0.345E 04	0.559E 02	0.451E 02	0.107E 02	0.000E 00
2010	0.369E 04	0.598E 02	0.483E 02	0.114E 02	0.000E 00
2011	0.395E 04	0.641E 02	0.518E 02	0.122E 02	0.000E 00
2012	0.424E 04	0.686E 02	0.554E 02	0.131E 02	0.000E 00
2013	0.454E 04	0.735E 02	0.594E 02	0.140E 02	0.000E 00
2014	0.486E 04	0.787E 02	0.636E 02	0.150E 02	0.000E 00
2015	0.520E 04	0.843E 02	0.681E 02	0.161E 02	0.000E 00
2016	0.557E 04	0.903E 02	0.729E 02	0.172E 02	0.000E 00
2017	0.597E 04	0.967E 02	0.781E 02	0.185E 02	0.000E 00
2018	0.639E 04	0.104E 03	0.837E 02	0.198E 02	0.000E 00
2019	0.685E 04	0.111E 03	0.896E 02	0.212E 02	0.000E 00
2020	0.733E 04	0.119E 03	0.960E 02	0.227E 02	0.000E 00
2021	0.785E 04	0.127E 03	0.103E 03	0.243E 02	0.000E 00
2022	0.841E 04	0.136E 03	0.110E 03	0.260E 02	0.000E 00
2023	0.901E 04	0.146E 03	0.118E 03	0.279E 02	0.000E 00
2024	0.964E 04	0.156E 03	0.126E 03	0.298E 02	0.000E 00
2025	0.103E 05	0.167E 03	0.135E 03	0.320E 02	0.000E 00

	WIW	WIR	WIRL	WIRD	WIRG
1975	0.276E 01	0.193E 01	0.116E 01	0.386E 00	0.386E 00
1976	0.295E 01	0.207E 01	0.124E 01	0.413E 00	0.413E 00
1977	0.316E 01	0.221E 01	0.133E 01	0.443E 00	0.443E 00
1978	0.339E 01	0.237E 01	0.142E 01	0.474E 00	0.474E 00
1979	0.363E 01	0.254E 01	0.152E 01	0.508E 00	0.508E 00
1980	0.388E 01	0.272E 01	0.163E 01	0.544E 00	0.544E 00
1981	0.416E 01	0.291E 01	0.175E 01	0.582E 00	0.582E 00
1982	0.445E 01	0.312E 01	0.187E 01	0.624E 00	0.624E 00
1983	0.477E 01	0.334E 01	0.200E 01	0.668E 00	0.668E 00
1984	0.511E 01	0.358E 01	0.215E 01	0.715E 00	0.715E 00
1985	0.547E 01	0.383E 01	0.230E 01	0.766E 00	0.766E 00
1986	0.586E 01	0.410E 01	0.246E 01	0.820E 00	0.820E 00
1987	0.628E 01	0.439E 01	0.264E 01	0.879E 00	0.879E 00
1988	0.672E 01	0.470E 01	0.282E 01	0.941E 00	0.941E 00
1989	0.720E 01	0.504E 01	0.302E 01	0.101E 01	0.101E 01
1990	0.771E 01	0.540E 01	0.324E 01	0.108E 01	0.108E 01
1991	0.826E 01	0.578E 01	0.347E 01	0.116E 01	0.116E 01
1992	0.884E 01	0.619E 01	0.371E 01	0.124E 01	0.124E 01
1993	0.947E 01	0.663E 01	0.398E 01	0.133E 01	0.133E 01
1994	0.101E 02	0.710E 01	0.426E 01	0.142E 01	0.142E 01
1995	0.109E 02	0.760E 01	0.456E 01	0.152E 01	0.152E 01
1996	0.116E 02	0.814E 01	0.489E 01	0.163E 01	0.163E 01
1997	0.125E 02	0.872E 01	0.523E 01	0.174E 01	0.174E 01
1998	0.133E 02	0.934E 01	0.560E 01	0.187E 01	0.187E 01
1999	0.143E 02	0.100E 02	0.600E 01	0.200E 01	0.200E 01
2000	0.153E 02	0.107E 02	0.643E 01	0.214E 01	0.214E 01
2001	0.164E 02	0.115E 02	0.688E 01	0.229E 01	0.229E 01
2002	0.176E 02	0.123E 02	0.737E 01	0.246E 01	0.246E 01
2003	0.188E 02	0.132E 02	0.790E 01	0.263E 01	0.263E 01
2004	0.201E 02	0.141E 02	0.846E 01	0.282E 01	0.282E 01
2005	0.216E 02	0.151E 02	0.906E 01	0.302E 01	0.302E 01
2006	0.231E 02	0.162E 02	0.970E 01	0.323E 01	0.323E 01
2007	0.247E 02	0.173E 02	0.104E 02	0.346E 01	0.346E 01
2008	0.265E 02	0.185E 02	0.111E 02	0.371E 01	0.371E 01
2009	0.284E 02	0.199E 02	0.119E 02	0.397E 01	0.397E 01
2010	0.304E 02	0.213E 02	0.128E 02	0.425E 01	0.425E 01
2011	0.325E 02	0.228E 02	0.137E 02	0.456E 01	0.456E 01
2012	0.349E 02	0.244E 02	0.146E 02	0.488E 01	0.488E 01
2013	0.373E 02	0.261E 02	0.157E 02	0.523E 01	0.523E 01
2014	0.400E 02	0.280E 02	0.168E 02	0.560E 01	0.560E 01
2015	0.428E 02	0.300E 02	0.180E 02	0.599E 01	0.599E 01
2016	0.459E 02	0.321E 02	0.193E 02	0.642E 01	0.642E 01
2017	0.491E 02	0.344E 02	0.206E 02	0.688E 01	0.688E 01
2018	0.526E 02	0.368E 02	0.221E 02	0.736E 01	0.736E 01
2019	0.563E 02	0.394E 02	0.237E 02	0.789E 01	0.789E 01
2020	0.603E 02	0.422E 02	0.253E 02	0.845E 01	0.845E 01
2021	0.646E 02	0.452E 02	0.271E 02	0.905E 01	0.905E 01
2022	0.692E 02	0.484E 02	0.291E 02	0.969E 01	0.969E 01
2023	0.741E 02	0.519E 02	0.311E 02	0.104E 02	0.104E 02
2024	0.794E 02	0.556E 02	0.333E 02	0.111E 02	0.111E 02
2025	0.850E 02	0.595E 02	0.357E 02	0.119E 02	0.119E 02

	POP	WD	WDG	WDL	WDO
1975	0.307E 09	0.105E 02	0.358E 01	0.695E 01	0.000E 00
1976	0.317E 09	0.109E 02	0.369E 01	0.717E 01	0.000E 00
1977	0.327E 09	0.112E 02	0.381E 01	0.740E 01	0.000E 00
1978	0.337E 09	0.116E 02	0.393E 01	0.764E 01	0.000E 00
1979	0.348E 09	0.119E 02	0.406E 01	0.788E 01	0.000E 00
1980	0.359E 09	0.123E 02	0.419E 01	0.813E 01	0.000E 00
1981	0.371E 09	0.127E 02	0.432E 01	0.840E 01	0.000E 00
1982	0.383E 09	0.131E 02	0.446E 01	0.866E 01	0.000E 00
1983	0.395E 09	0.135E 02	0.461E 01	0.894E 01	0.000E 00
1984	0.407E 09	0.140E 02	0.475E 01	0.923E 01	0.000E 00
1985	0.420E 09	0.144E 02	0.491E 01	0.952E 01	0.000E 00
1986	0.434E 09	0.149E 02	0.506E 01	0.983E 01	0.000E 00
1987	0.448E 09	0.154E 02	0.522E 01	0.101E 02	0.000E 00
1988	0.462E 09	0.159E 02	0.539E 01	0.105E 02	0.000E 00
1989	0.477E 09	0.164E 02	0.556E 01	0.108E 02	0.000E 00
1990	0.492E 09	0.169E 02	0.574E 01	0.111E 02	0.000E 00
1991	0.508E 09	0.174E 02	0.593E 01	0.115E 02	0.000E 00
1992	0.524E 09	0.180E 02	0.611E 01	0.119E 02	0.000E 00
1993	0.541E 09	0.186E 02	0.631E 01	0.122E 02	0.000E 00
1994	0.558E 09	0.192E 02	0.651E 01	0.126E 02	0.000E 00
1995	0.576E 09	0.198E 02	0.672E 01	0.130E 02	0.000E 00
1996	0.595E 09	0.204E 02	0.694E 01	0.135E 02	0.000E 00
1997	0.614E 09	0.211E 02	0.716E 01	0.139E 02	0.000E 00
1998	0.633E 09	0.217E 02	0.739E 01	0.143E 02	0.000E 00
1999	0.653E 09	0.224E 02	0.762E 01	0.148E 02	0.000E 00
2000	0.674E 09	0.231E 02	0.787E 01	0.153E 02	0.000E 00
2001	0.696E 09	0.239E 02	0.812E 01	0.158E 02	0.000E 00
2002	0.718E 09	0.246E 02	0.838E 01	0.163E 02	0.000E 00
2003	0.741E 09	0.254E 02	0.865E 01	0.168E 02	0.000E 00
2004	0.765E 09	0.262E 02	0.892E 01	0.173E 02	0.000E 00
2005	0.789E 09	0.271E 02	0.921E 01	0.179E 02	0.000E 00
2006	0.815E 09	0.279E 02	0.950E 01	0.184E 02	0.000E 00
2007	0.841E 09	0.288E 02	0.981E 01	0.190E 02	0.000E 00
2008	0.867E 09	0.298E 02	0.101E 02	0.196E 02	0.000E 00
2009	0.895E 09	0.307E 02	0.104E 02	0.203E 02	0.000E 00
2010	0.924E 09	0.317E 02	0.108E 02	0.209E 02	0.000E 00
2011	0.953E 09	0.327E 02	0.111E 02	0.216E 02	0.000E 00
2012	0.984E 09	0.338E 02	0.115E 02	0.223E 02	0.000E 00
2013	0.102E 10	0.348E 02	0.118E 02	0.230E 02	0.000E 00
2014	0.105E 10	0.360E 02	0.122E 02	0.237E 02	0.000E 00
2015	0.108E 10	0.371E 02	0.126E 02	0.245E 02	0.000E 00
2016	0.112E 10	0.383E 02	0.130E 02	0.253E 02	0.000E 00
2017	0.115E 10	0.395E 02	0.134E 02	0.261E 02	0.000E 00
2018	0.119E 10	0.408E 02	0.139E 02	0.269E 02	0.000E 00
2019	0.123E 10	0.421E 02	0.143E 02	0.278E 02	0.000E 00
2020	0.127E 10	0.434E 02	0.148E 02	0.287E 02	0.000E 00
2021	0.131E 10	0.448E 02	0.152E 02	0.296E 02	0.000E 00
2022	0.135E 10	0.463E 02	0.157E 02	0.305E 02	0.000E 00
2023	0.139E 10	0.477E 02	0.162E 02	0.315E 02	0.000E 00
2024	0.144E 10	0.493E 02	0.167E 02	0.325E 02	0.000E 00
2025	0.148E 10	0.508E 02	0.173E 02	0.336E 02	0.000E 00

	WDW	WDR	WDRG	WDRL	WDRO
1975	0.800E 01	0.320E 01	0.640E 00	0.192E 01	0.640E 00
1976	0.826E 01	0.330E 01	0.661E 00	0.198E 01	0.661E 00
1977	0.852E 01	0.341E 01	0.682E 00	0.205E 01	0.682E 00
1978	0.880E 01	0.352E 01	0.704E 00	0.211E 01	0.704E 00
1979	0.908E 01	0.363E 01	0.726E 00	0.218E 01	0.726E 00
1980	0.937E 01	0.375E 01	0.749E 00	0.225E 01	0.749E 00
1981	0.967E 01	0.387E 01	0.773E 00	0.232E 01	0.773E 00
1982	0.998E 01	0.399E 01	0.798E 00	0.239E 01	0.798E 00
1983	0.103E 02	0.412E 01	0.824E 00	0.247E 01	0.824E 00
1984	0.106E 02	0.425E 01	0.850E 00	0.255E 01	0.850E 00
1985	0.110E 02	0.439E 01	0.877E 00	0.263E 01	0.877E 00
1986	0.113E 02	0.453E 01	0.905E 00	0.272E 01	0.905E 00
1987	0.117E 02	0.467E 01	0.934E 00	0.280E 01	0.934E 00
1988	0.121E 02	0.482E 01	0.964E 00	0.289E 01	0.964E 00
1989	0.124E 02	0.497E 01	0.995E 00	0.298E 01	0.995E 00
1990	0.128E 02	0.513E 01	0.103E 01	0.308E 01	0.103E 01
1991	0.132E 02	0.530E 01	0.106E 01	0.318E 01	0.106E 01
1992	0.137E 02	0.547E 01	0.109E 01	0.328E 01	0.109E 01
1993	0.141E 02	0.564E 01	0.113E 01	0.339E 01	0.113E 01
1994	0.146E 02	0.582E 01	0.116E 01	0.349E 01	0.116E 01
1995	0.150E 02	0.601E 01	0.120E 01	0.361E 01	0.120E 01
1996	0.155E 02	0.620E 01	0.124E 01	0.372E 01	0.124E 01
1997	0.160E 02	0.640E 01	0.128E 01	0.384E 01	0.128E 01
1998	0.165E 02	0.660E 01	0.132E 01	0.396E 01	0.132E 01
1999	0.170E 02	0.682E 01	0.136E 01	0.409E 01	0.136E 01
2000	0.176E 02	0.703E 01	0.141E 01	0.422E 01	0.141E 01
2001	0.181E 02	0.726E 01	0.145E 01	0.436E 01	0.145E 01
2002	0.187E 02	0.749E 01	0.150E 01	0.449E 01	0.150E 01
2003	0.193E 02	0.773E 01	0.155E 01	0.464E 01	0.155E 01
2004	0.199E 02	0.798E 01	0.160E 01	0.479E 01	0.160E 01
2005	0.206E 02	0.823E 01	0.165E 01	0.494E 01	0.165E 01
2006	0.212E 02	0.850E 01	0.170E 01	0.510E 01	0.170E 01
2007	0.219E 02	0.877E 01	0.175E 01	0.526E 01	0.175E 01
2008	0.226E 02	0.905E 01	0.181E 01	0.543E 01	0.181E 01
2009	0.233E 02	0.934E 01	0.187E 01	0.560E 01	0.187E 01
2010	0.241E 02	0.964E 01	0.193E 01	0.578E 01	0.193E 01
2011	0.249E 02	0.994E 01	0.199E 01	0.597E 01	0.199E 01
2012	0.257E 02	0.103E 02	0.205E 01	0.616E 01	0.205E 01
2013	0.265E 02	0.106E 02	0.212E 01	0.635E 01	0.212E 01
2014	0.273E 02	0.109E 02	0.219E 01	0.656E 01	0.219E 01
2015	0.282E 02	0.113E 02	0.226E 01	0.677E 01	0.226E 01
2016	0.291E 02	0.116E 02	0.233E 01	0.698E 01	0.233E 01
2017	0.300E 02	0.120E 02	0.240E 01	0.721E 01	0.240E 01
2018	0.310E 02	0.124E 02	0.248E 01	0.744E 01	0.248E 01
2019	0.320E 02	0.128E 02	0.256E 01	0.768E 01	0.256E 01
2020	0.330E 02	0.132E 02	0.264E 01	0.792E 01	0.264E 01
2021	0.341E 02	0.136E 02	0.273E 01	0.817E 01	0.273E 01
2022	0.352E 02	0.141E 02	0.281E 01	0.844E 01	0.281E 01
2023	0.363E 02	0.145E 02	0.290E 01	0.871E 01	0.290E 01
2024	0.374E 02	0.150E 02	0.299E 01	0.898E 01	0.299E 01
2025	0.386E 02	0.155E 02	0.309E 01	0.927E 01	0.309E 01

	AL	WA	WAG	WAL	WAO
1975	0.918E 06	0.156E 04	0.554E 03	0.100E 04	0.156E-02
1976	0.941E 06	0.159E 04	0.568E 03	0.103E 04	0.159E-02
1977	0.965E 06	0.163E 04	0.582E 03	0.105E 04	0.163E-02
1978	0.989E 06	0.168E 04	0.596E 03	0.108E 04	0.168E-02
1979	0.101E 07	0.172E 04	0.611E 03	0.110E 04	0.172E-02
1980	0.104E 07	0.176E 04	0.627E 03	0.113E 04	0.176E-02
1981	0.106E 07	0.180E 04	0.642E 03	0.116E 04	0.180E-02
1982	0.109E 07	0.185E 04	0.658E 03	0.119E 04	0.185E-02
1983	0.112E 07	0.190E 04	0.675E 03	0.122E 04	0.190E-02
1984	0.115E 07	0.194E 04	0.692E 03	0.125E 04	0.194E-02
1985	0.118E 07	0.199E 04	0.709E 03	0.128E 04	0.199E-02
1986	0.120E 07	0.204E 04	0.727E 03	0.131E 04	0.204E-02
1987	0.123E 07	0.209E 04	0.745E 03	0.135E 04	0.209E-02
1988	0.127E 07	0.214E 04	0.763E 03	0.138E 04	0.214E-02
1989	0.130E 07	0.220E 04	0.783E 03	0.141E 04	0.220E-02
1990	0.133E 07	0.225E 04	0.802E 03	0.145E 04	0.225E-02
1991	0.136E 07	0.231E 04	0.822E 03	0.148E 04	0.231E-02
1992	0.140E 07	0.237E 04	0.843E 03	0.152E 04	0.237E-02
1993	0.143E 07	0.243E 04	0.864E 03	0.156E 04	0.243E-02
1994	0.147E 07	0.249E 04	0.885E 03	0.160E 04	0.249E-02
1995	0.150E 07	0.255E 04	0.907E 03	0.164E 04	0.255E-02
1996	0.154E 07	0.261E 04	0.930E 03	0.168E 04	0.261E-02
1997	0.158E 07	0.268E 04	0.953E 03	0.172E 04	0.268E-02
1998	0.162E 07	0.274E 04	0.977E 03	0.176E 04	0.274E-02
1999	0.166E 07	0.281E 04	0.100E 04	0.181E 04	0.281E-02
2000	0.170E 07	0.288E 04	0.103E 04	0.185E 04	0.288E-02
2001	0.174E 07	0.296E 04	0.105E 04	0.190E 04	0.296E-02
2002	0.179E 07	0.303E 04	0.108E 04	0.195E 04	0.303E-02
2003	0.183E 07	0.311E 04	0.111E 04	0.200E 04	0.311E-02
2004	0.188E 07	0.318E 04	0.113E 04	0.205E 04	0.318E-02
2005	0.193E 07	0.326E 04	0.116E 04	0.210E 04	0.326E-02
2006	0.197E 07	0.334E 04	0.119E 04	0.215E 04	0.334E-02
2007	0.202E 07	0.343E 04	0.122E 04	0.220E 04	0.343E-02
2008	0.207E 07	0.351E 04	0.125E 04	0.226E 04	0.351E-02
2009	0.213E 07	0.360E 04	0.128E 04	0.232E 04	0.360E-02
2010	0.218E 07	0.369E 04	0.131E 04	0.237E 04	0.369E-02
2011	0.223E 07	0.378E 04	0.135E 04	0.243E 04	0.378E-02
2012	0.229E 07	0.388E 04	0.138E 04	0.249E 04	0.388E-02
2013	0.235E 07	0.397E 04	0.141E 04	0.256E 04	0.397E-02
2014	0.240E 07	0.407E 04	0.145E 04	0.262E 04	0.407E-02
2015	0.246E 07	0.418E 04	0.149E 04	0.268E 04	0.418E-02
2016	0.253E 07	0.428E 04	0.152E 04	0.275E 04	0.428E-02
2017	0.259E 07	0.439E 04	0.156E 04	0.282E 04	0.439E-02
2018	0.265E 07	0.450E 04	0.160E 04	0.289E 04	0.450E-02
2019	0.272E 07	0.461E 04	0.164E 04	0.296E 04	0.461E-02
2020	0.279E 07	0.472E 04	0.168E 04	0.304E 04	0.472E-02
2021	0.286E 07	0.484E 04	0.172E 04	0.311E 04	0.484E-02
2022	0.293E 07	0.496E 04	0.177E 04	0.319E 04	0.496E-02
2023	0.300E 07	0.509E 04	0.181E 04	0.327E 04	0.509E-02
2024	0.308E 07	0.521E 04	0.186E 04	0.335E 04	0.521E-02
2025	0.315E 07	0.534E 04	0.190E 04	0.344E 04	0.534E-02

B 1360

	WAW	WAR	WARG	WARL	WARO
1975	0.666E 03	0.533E 03	0.213E 03	0.320E 03	0.000E 00
1976	0.683E 03	0.546E 03	0.218E 03	0.328E 03	0.000E 00
1977	0.700E 03	0.560E 03	0.224E 03	0.336E 03	0.000E 00
1978	0.717E 03	0.574E 03	0.229E 03	0.344E 03	0.000E 00
1979	0.735E 03	0.588E 03	0.235E 03	0.353E 03	0.000E 00
1980	0.753E 03	0.603E 03	0.241E 03	0.362E 03	0.000E 00
1981	0.772E 03	0.618E 03	0.247E 03	0.371E 03	0.000E 00
1982	0.792E 03	0.633E 03	0.253E 03	0.380E 03	0.000E 00
1983	0.811E 03	0.649E 03	0.260E 03	0.389E 03	0.000E 00
1984	0.832E 03	0.665E 03	0.266E 03	0.399E 03	0.000E 00
1985	0.852E 03	0.682E 03	0.273E 03	0.409E 03	0.000E 00
1986	0.874E 03	0.699E 03	0.280E 03	0.419E 03	0.000E 00
1987	0.895E 03	0.716E 03	0.287E 03	0.430E 03	0.000E 00
1988	0.918E 03	0.734E 03	0.294E 03	0.441E 03	0.000E 00
1989	0.941E 03	0.753E 03	0.301E 03	0.452E 03	0.000E 00
1990	0.964E 03	0.771E 03	0.309E 03	0.463E 03	0.000E 00
1991	0.988E 03	0.791E 03	0.316E 03	0.474E 03	0.000E 00
1992	0.101E 04	0.810E 03	0.324E 03	0.486E 03	0.000E 00
1993	0.104E 04	0.831E 03	0.332E 03	0.498E 03	0.000E 00
1994	0.106E 04	0.851E 03	0.341E 03	0.511E 03	0.000E 00
1995	0.109E 04	0.873E 03	0.349E 03	0.524E 03	0.000E 00
1996	0.112E 04	0.895E 03	0.358E 03	0.537E 03	0.000E 00
1997	0.115E 04	0.917E 03	0.367E 03	0.550E 03	0.000E 00
1998	0.117E 04	0.940E 03	0.376E 03	0.564E 03	0.000E 00
1999	0.120E 04	0.963E 03	0.385E 03	0.578E 03	0.000E 00
2000	0.123E 04	0.987E 03	0.395E 03	0.592E 03	0.000E 00
2001	0.127E 04	0.101E 04	0.405E 03	0.607E 03	0.000E 00
2002	0.130E 04	0.104E 04	0.415E 03	0.622E 03	0.000E 00
2003	0.133E 04	0.106E 04	0.425E 03	0.638E 03	0.000E 00
2004	0.136E 04	0.109E 04	0.436E 03	0.654E 03	0.000E 00
2005	0.140E 04	0.112E 04	0.447E 03	0.670E 03	0.000E 00
2006	0.143E 04	0.114E 04	0.458E 03	0.687E 03	0.000E 00
2007	0.147E 04	0.117E 04	0.469E 03	0.704E 03	0.000E 00
2008	0.150E 04	0.120E 04	0.481E 03	0.722E 03	0.000E 00
2009	0.154E 04	0.123E 04	0.493E 03	0.740E 03	0.000E 00
2010	0.158E 04	0.126E 04	0.505E 03	0.758E 03	0.000E 00
2011	0.162E 04	0.130E 04	0.518E 03	0.777E 03	0.000E 00
2012	0.166E 04	0.133E 04	0.531E 03	0.797E 03	0.000E 00
2013	0.170E 04	0.136E 04	0.544E 03	0.816E 03	0.000E 00
2014	0.174E 04	0.139E 04	0.558E 03	0.837E 03	0.000E 00
2015	0.179E 04	0.143E 04	0.572E 03	0.858E 03	0.000E 00
2016	0.183E 04	0.147E 04	0.586E 03	0.879E 03	0.000E 00
2017	0.188E 04	0.150E 04	0.601E 03	0.901E 03	0.000E 00
2018	0.192E 04	0.154E 04	0.616E 03	0.924E 03	0.000E 00
2019	0.197E 04	0.158E 04	0.631E 03	0.947E 03	0.000E 00
2020	0.202E 04	0.162E 04	0.647E 03	0.970E 03	0.000E 00
2021	0.207E 04	0.166E 04	0.663E 03	0.995E 03	0.000E 00
2022	0.212E 04	0.170E 04	0.680E 03	0.102E 04	0.000E 00
2023	0.218E 04	0.174E 04	0.697E 03	0.104E 04	0.000E 00
2024	0.223E 04	0.179E 04	0.714E 03	0.107E 04	0.000E 00
2025	0.229E 04	0.183E 04	0.732E 03	0.110E 04	0.000E 00

	WIC	WICL	WICG	WICO
1975	0.435E 01	0.432E 01	0.361E-01	0.000E 00
1976	0.466E 01	0.462E 01	0.387E-01	0.000E 00
1977	0.499E 01	0.495E 01	0.414E-01	0.000E 00
1978	0.535E 01	0.530E 01	0.444E-01	0.000E 00
1979	0.573E 01	0.568E 01	0.475E-01	0.000E 00
1980	0.613E 01	0.608E 01	0.509E-01	0.000E 00
1981	0.657E 01	0.651E 01	0.545E-01	0.000E 00
1982	0.704E 01	0.698E 01	0.584E-01	0.000E 00
1983	0.754E 01	0.747E 01	0.625E-01	0.000E 00
1984	0.807E 01	0.800E 01	0.670E-01	0.000E 00
1985	0.864E 01	0.857E 01	0.717E-01	0.000E 00
1986	0.926E 01	0.918E 01	0.768E-01	0.000E 00
1987	0.991E 01	0.983E 01	0.823E-01	0.000E 00
1988	0.106E 02	0.105E 02	0.881E-01	0.000E 00
1989	0.114E 02	0.113E 02	0.944E-01	0.000E 00
1990	0.122E 02	0.121E 02	0.101E 00	0.000E 00
1991	0.130E 02	0.129E 02	0.108E 00	0.000E 00
1992	0.140E 02	0.139E 02	0.116E 00	0.000E 00
1993	0.150E 02	0.148E 02	0.124E 00	0.000E 00
1994	0.160E 02	0.159E 02	0.133E 00	0.000E 00
1995	0.172E 02	0.170E 02	0.142E 00	0.000E 00
1996	0.184E 02	0.182E 02	0.153E 00	0.000E 00
1997	0.197E 02	0.195E 02	0.163E 00	0.000E 00
1998	0.211E 02	0.209E 02	0.175E 00	0.000E 00
1999	0.226E 02	0.224E 02	0.187E 00	0.000E 00
2000	0.242E 02	0.240E 02	0.201E 00	0.000E 00
2001	0.259E 02	0.257E 02	0.215E 00	0.000E 00
2002	0.277E 02	0.275E 02	0.230E 00	0.000E 00
2003	0.297E 02	0.295E 02	0.247E 00	0.000E 00
2004	0.318E 02	0.315E 02	0.264E 00	0.000E 00
2005	0.341E 02	0.338E 02	0.283E 00	0.000E 00
2006	0.365E 02	0.362E 02	0.303E 00	0.000E 00
2007	0.391E 02	0.387E 02	0.324E 00	0.000E 00
2008	0.418E 02	0.415E 02	0.347E 00	0.000E 00
2009	0.448E 02	0.444E 02	0.372E 00	0.000E 00
2010	0.480E 02	0.476E 02	0.398E 00	0.000E 00
2011	0.514E 02	0.510E 02	0.427E 00	0.000E 00
2012	0.551E 02	0.546E 02	0.457E 00	0.000E 00
2013	0.590E 02	0.585E 02	0.489E 00	0.000E 00
2014	0.632E 02	0.626E 02	0.524E 00	0.000E 00
2015	0.676E 02	0.671E 02	0.561E 00	0.000E 00
2016	0.724E 02	0.718E 02	0.601E 00	0.000E 00
2017	0.776E 02	0.769E 02	0.644E 00	0.000E 00
2018	0.831E 02	0.824E 02	0.690E 00	0.000E 00
2019	0.890E 02	0.882E 02	0.739E 00	0.000E 00
2020	0.953E 02	0.945E 02	0.791E 00	0.000E 00
2021	0.102E 03	0.101E 03	0.847E 00	0.000E 00
2022	0.109E 03	0.108E 03	0.907E 00	0.000E 00
2023	0.117E 03	0.116E 03	0.972E 00	0.000E 00
2024	0.125E 03	0.124E 03	0.104E 01	0.000E 00
2025	0.134E 03	0.133E 03	0.111E 01	0.000E 00

	WICW	WIRC	WICRL
1975	0.435E 01	0.435E 01	0.435E 01
1976	0.466E 01	0.466E 01	0.466E 01
1977	0.499E 01	0.499E 01	0.499E 01
1978	0.535E 01	0.535E 01	0.535E 01
1979	0.573E 01	0.573E 01	0.573E 01
1980	0.613E 01	0.613E 01	0.613E 01
1981	0.657E 01	0.657E 01	0.657E 01
1982	0.704E 01	0.704E 01	0.704E 01
1983	0.754E 01	0.754E 01	0.754E 01
1984	0.807E 01	0.807E 01	0.807E 01
1985	0.864E 01	0.864E 01	0.864E 01
1986	0.926E 01	0.926E 01	0.926E 01
1987	0.991E 01	0.991E 01	0.991E 01
1988	0.106E 02	0.106E 02	0.106E 02
1989	0.114E 02	0.114E 02	0.114E 02
1990	0.122E 02	0.122E 02	0.122E 02
1991	0.130E 02	0.130E 02	0.130E 02
1992	0.140E 02	0.140E 02	0.140E 02
1993	0.150E 02	0.150E 02	0.150E 02
1994	0.160E 02	0.160E 02	0.160E 02
1995	0.172E 02	0.172E 02	0.172E 02
1996	0.184E 02	0.184E 02	0.184E 02
1997	0.197E 02	0.197E 02	0.197E 02
1998	0.211E 02	0.211E 02	0.211E 02
1999	0.226E 02	0.226E 02	0.226E 02
2000	0.242E 02	0.242E 02	0.242E 02
2001	0.259E 02	0.259E 02	0.259E 02
2002	0.277E 02	0.277E 02	0.277E 02
2003	0.297E 02	0.297E 02	0.297E 02
2004	0.318E 02	0.318E 02	0.318E 02
2005	0.341E 02	0.341E 02	0.341E 02
2006	0.365E 02	0.365E 02	0.365E 02
2007	0.391E 02	0.391E 02	0.391E 02
2008	0.418E 02	0.418E 02	0.418E 02
2009	0.448E 02	0.448E 02	0.448E 02
2010	0.480E 02	0.480E 02	0.480E 02
2011	0.514E 02	0.514E 02	0.514E 02
2012	0.551E 02	0.551E 02	0.551E 02
2013	0.590E 02	0.590E 02	0.590E 02
2014	0.632E 02	0.632E 02	0.632E 02
2015	0.676E 02	0.676E 02	0.676E 02
2016	0.724E 02	0.724E 02	0.724E 02
2017	0.776E 02	0.776E 02	0.776E 02
2018	0.831E 02	0.831E 02	0.831E 02
2019	0.890E 02	0.890E 02	0.890E 02
2020	0.953E 02	0.953E 02	0.953E 02
2021	0.102E 03	0.102E 03	0.102E 03
2022	0.109E 03	0.109E 03	0.109E 03
2023	0.117E 03	0.117E 03	0.117E 03
2024	0.125E 03	0.125E 03	0.125E 03
2025	0.134E 03	0.134E 03	0.134E 03

	TWG	WGL	TWLM	WLO	WLG
1975	0.855E 06	0.650E 04	0.000E 00	0.181E 05	0.686E 04
1976	0.855E 06	0.650E 04	0.151E 00	0.181E 05	0.689E 04
1977	0.855E 06	0.650E 04	0.302E 00	0.182E 05	0.692E 04
1978	0.855E 06	0.650E 04	0.453E 00	0.183E 05	0.694E 04
1979	0.855E 06	0.650E 04	0.604E 00	0.183E 05	0.696E 04
1980	0.855E 06	0.650E 04	0.755E 00	0.184E 05	0.698E 04
1981	0.856E 06	0.650E 04	0.906E 00	0.184E 05	0.700E 04
1982	0.856E 06	0.650E 04	0.106E 01	0.185E 05	0.701E 04
1983	0.856E 06	0.650E 04	0.121E 01	0.185E 05	0.703E 04
1984	0.856E 06	0.650E 04	0.136E 01	0.185E 05	0.704E 04
1985	0.856E 06	0.651E 04	0.151E 01	0.186E 05	0.705E 04
1986	0.856E 06	0.651E 04	0.166E 01	0.186E 05	0.706E 04
1987	0.856E 06	0.651E 04	0.181E 01	0.186E 05	0.707E 04
1988	0.856E 06	0.651E 04	0.196E 01	0.186E 05	0.708E 04
1989	0.856E 06	0.651E 04	0.211E 01	0.187E 05	0.709E 04
1990	0.857E 06	0.651E 04	0.226E 01	0.187E 05	0.710E 04
1991	0.857E 06	0.651E 04	0.242E 01	0.187E 05	0.710E 04
1992	0.857E 06	0.651E 04	0.257E 01	0.187E 05	0.711E 04
1993	0.857E 06	0.651E 04	0.272E 01	0.187E 05	0.711E 04
1994	0.857E 06	0.651E 04	0.287E 01	0.187E 05	0.711E 04
1995	0.857E 06	0.651E 04	0.302E 01	0.187E 05	0.711E 04
1996	0.857E 06	0.651E 04	0.317E 01	0.187E 05	0.712E 04
1997	0.857E 06	0.651E 04	0.332E 01	0.187E 05	0.712E 04
1998	0.857E 06	0.651E 04	0.347E 01	0.187E 05	0.712E 04
1999	0.857E 06	0.651E 04	0.362E 01	0.187E 05	0.712E 04
2000	0.857E 06	0.651E 04	0.377E 01	0.187E 05	0.712E 04
2001	0.857E 06	0.651E 04	0.393E 01	0.187E 05	0.712E 04
2002	0.857E 06	0.651E 04	0.408E 01	0.187E 05	0.711E 04
2003	0.857E 06	0.651E 04	0.423E 01	0.187E 05	0.711E 04
2004	0.857E 06	0.651E 04	0.438E 01	0.187E 05	0.711E 04
2005	0.857E 06	0.651E 04	0.453E 01	0.187E 05	0.711E 04
2006	0.856E 06	0.651E 04	0.468E 01	0.187E 05	0.710E 04
2007	0.856E 06	0.651E 04	0.483E 01	0.187E 05	0.710E 04
2008	0.856E 06	0.651E 04	0.498E 01	0.187E 05	0.709E 04
2009	0.856E 06	0.651E 04	0.513E 01	0.186E 05	0.709E 04
2010	0.856E 06	0.650E 04	0.528E 01	0.186E 05	0.708E 04
2011	0.855E 06	0.650E 04	0.543E 01	0.186E 05	0.707E 04
2012	0.855E 06	0.650E 04	0.559E 01	0.186E 05	0.707E 04
2013	0.855E 06	0.650E 04	0.574E 01	0.186E 05	0.706E 04
2014	0.855E 06	0.649E 04	0.589E 01	0.186E 05	0.705E 04
2015	0.854E 06	0.649E 04	0.604E 01	0.185E 05	0.705E 04
2016	0.854E 06	0.649E 04	0.619E 01	0.185E 05	0.704E 04
2017	0.853E 06	0.649E 04	0.634E 01	0.185E 05	0.703E 04
2018	0.853E 06	0.648E 04	0.649E 01	0.185E 05	0.702E 04
2019	0.853E 06	0.648E 04	0.664E 01	0.184E 05	0.701E 04
2020	0.852E 06	0.648E 04	0.679E 01	0.184E 05	0.700E 04
2021	0.851E 06	0.647E 04	0.694E 01	0.184E 05	0.699E 04
2022	0.851E 06	0.647E 04	0.710E 01	0.184E 05	0.698E 04
2023	0.850E 06	0.646E 04	0.725E 01	0.183E 05	0.697E 04
2024	0.850E 06	0.646E 04	0.740E 01	0.183E 05	0.696E 04
2025	0.849E 06	0.645E 04	0.755E 01	0.183E 05	0.694E 04

	TWL	TWIM
1975	0.361E 06	0.556E 03
1976	0.363E 06	0.558E 03
1977	0.364E 06	0.560E 03
1978	0.365E 06	0.562E 03
1979	0.366E 06	0.564E 03
1980	0.367E 06	0.565E 03
1981	0.368E 06	0.567E 03
1982	0.369E 06	0.568E 03
1983	0.370E 06	0.569E 03
1984	0.371E 06	0.570E 03
1985	0.371E 06	0.571E 03
1986	0.372E 06	0.572E 03
1987	0.372E 06	0.573E 03
1988	0.373E 06	0.574E 03
1989	0.373E 06	0.574E 03
1990	0.373E 06	0.575E 03
1991	0.374E 06	0.575E 03
1992	0.374E 06	0.576E 03
1993	0.374E 06	0.576E 03
1994	0.374E 06	0.576E 03
1995	0.374E 06	0.576E 03
1996	0.375E 06	0.576E 03
1997	0.375E 06	0.577E 03
1998	0.375E 06	0.577E 03
1999	0.375E 06	0.577E 03
2000	0.375E 06	0.576E 03
2001	0.375E 06	0.576E 03
2002	0.374E 06	0.576E 03
2003	0.374E 06	0.576E 03
2004	0.374E 06	0.576E 03
2005	0.374E 06	0.576E 03
2006	0.374E 06	0.575E 03
2007	0.374E 06	0.575E 03
2008	0.373E 06	0.574E 03
2009	0.373E 06	0.574E 03
2010	0.373E 06	0.574E 03
2011	0.372E 06	0.573E 03
2012	0.372E 06	0.573E 03
2013	0.372E 06	0.572E 03
2014	0.371E 06	0.571E 03
2015	0.371E 06	0.571E 03
2016	0.370E 06	0.570E 03
2017	0.370E 06	0.569E 03
2018	0.369E 06	0.569E 03
2019	0.369E 06	0.568E 03
2020	0.368E 06	0.567E 03
2021	0.368E 06	0.566E 03
2022	0.367E 06	0.565E 03
2023	0.367E 06	0.564E 03
2024	0.366E 06	0.563E 03
2025	0.365E 06	0.562E 03

	WLIP	WOIP	WGIP	WOSIP	WLMIP
1975	0.770E 01	0.000E 00	0.182E 01	0.000E 00	0.000E 00
1976	0.804E 01	0.000E 00	0.190E 01	0.863E-03	0.195E-01
1977	0.839E 01	0.000E 00	0.197E 01	0.259E-02	0.390E-01
1978	0.876E 01	0.000E 00	0.205E 01	0.518E-02	0.584E-01
1979	0.914E 01	0.000E 00	0.213E 01	0.863E-02	0.779E-01
1980	0.953E 01	0.000E 00	0.222E 01	0.129E-01	0.974E-01
1981	0.993E 01	0.000E 00	0.231E 01	0.181E-01	0.117E 00
1982	0.104E 02	0.000E 00	0.240E 01	0.242E-01	0.136E 00
1983	0.108E 02	0.000E 00	0.250E 01	0.311E-01	0.156E 00
1984	0.112E 02	0.000E 00	0.260E 01	0.388E-01	0.175E 00
1985	0.117E 02	0.000E 00	0.270E 01	0.475E-01	0.195E 00
1986	0.122E 02	0.000E 00	0.281E 01	0.569E-01	0.214E 00
1987	0.127E 02	0.000E 00	0.292E 01	0.673E-01	0.234E 00
1988	0.132E 02	0.000E 00	0.304E 01	0.785E-01	0.253E 00
1989	0.138E 02	0.000E 00	0.316E 01	0.906E-01	0.273E 00
1990	0.143E 02	0.000E 00	0.329E 01	0.104E 00	0.292E 00
1991	0.149E 02	0.000E 00	0.342E 01	0.117E 00	0.312E 00
1992	0.155E 02	0.000E 00	0.356E 01	0.132E 00	0.331E 00
1993	0.162E 02	0.000E 00	0.370E 01	0.148E 00	0.351E 00
1994	0.168E 02	0.000E 00	0.385E 01	0.164E 00	0.370E 00
1995	0.175E 02	0.000E 00	0.400E 01	0.181E 00	0.390E 00
1996	0.182E 02	0.000E 00	0.416E 01	0.199E 00	0.409E 00
1997	0.189E 02	0.000E 00	0.433E 01	0.218E 00	0.428E 00
1998	0.197E 02	0.000E 00	0.450E 01	0.238E 00	0.448E 00
1999	0.205E 02	0.000E 00	0.468E 01	0.259E 00	0.467E 00
2000	0.213E 02	0.000E 00	0.487E 01	0.280E 00	0.487E 00
2001	0.221E 02	0.000E 00	0.506E 01	0.303E 00	0.506E 00
2002	0.230E 02	0.000E 00	0.527E 01	0.326E 00	0.526E 00
2003	0.239E 02	0.000E 00	0.548E 01	0.350E 00	0.545E 00
2004	0.249E 02	0.000E 00	0.569E 01	0.375E 00	0.565E 00
2005	0.258E 02	0.000E 00	0.592E 01	0.401E 00	0.584E 00
2006	0.269E 02	0.000E 00	0.616E 01	0.428E 00	0.604E 00
2007	0.279E 02	0.000E 00	0.640E 01	0.456E 00	0.623E 00
2008	0.290E 02	0.000E 00	0.666E 01	0.484E 00	0.643E 00
2009	0.302E 02	0.000E 00	0.692E 01	0.513E 00	0.662E 00
2010	0.313E 02	0.000E 00	0.720E 01	0.544E 00	0.682E 00
2011	0.326E 02	0.000E 00	0.748E 01	0.575E 00	0.701E 00
2012	0.338E 02	0.000E 00	0.778E 01	0.607E 00	0.721E 00
2013	0.351E 02	0.000E 00	0.809E 01	0.639E 00	0.740E 00
2014	0.365E 02	0.000E 00	0.841E 01	0.673E 00	0.760E 00
2015	0.379E 02	0.000E 00	0.874E 01	0.707E 00	0.779E 00
2016	0.394E 02	0.000E 00	0.908E 01	0.743E 00	0.798E 00
2017	0.409E 02	0.000E 00	0.944E 01	0.779E 00	0.818E 00
2018	0.425E 02	0.000E 00	0.981E 01	0.816E 00	0.837E 00
2019	0.441E 02	0.000E 00	0.102E 02	0.854E 00	0.857E 00
2020	0.458E 02	0.000E 00	0.106E 02	0.893E 00	0.876E 00
2021	0.476E 02	0.000E 00	0.110E 02	0.933E 00	0.896E 00
2022	0.494E 02	0.000E 00	0.115E 02	0.973E 00	0.915E 00
2023	0.513E 02	0.000E 00	0.119E 02	0.101E 01	0.935E 00
2024	0.533E 02	0.000E 00	0.124E 02	0.106E 01	0.954E 00
2025	0.553E 02	0.000E 00	0.129E 02	0.110E 01	0.974E 00

	WLDP	WODP	WGDP	WOSDP	WLMDP
1975	0.619E 01	0.000E 00	0.350E 01	0.000E 00	0.000E 00
1976	0.634E 01	0.000E 00	0.361E 01	0.129E-02	0.113E-01
1977	0.649E 01	0.000E 00	0.372E 01	0.388E-02	0.226E-01
1978	0.664E 01	0.000E 00	0.383E 01	0.776E-02	0.340E-01
1979	0.679E 01	0.000E 00	0.394E 01	0.129E-01	0.453E-01
1980	0.695E 01	0.000E 00	0.406E 01	0.194E-01	0.566E-01
1981	0.711E 01	0.000E 00	0.418E 01	0.272E-01	0.679E-01
1982	0.727E 01	0.000E 00	0.431E 01	0.362E-01	0.793E-01
1983	0.743E 01	0.000E 00	0.444E 01	0.466E-01	0.906E-01
1984	0.759E 01	0.000E 00	0.457E 01	0.582E-01	0.102E 00
1985	0.775E 01	0.000E 00	0.471E 01	0.712E-01	0.113E 00
1986	0.792E 01	0.000E 00	0.485E 01	0.854E-01	0.125E 00
1987	0.809E 01	0.000E 00	0.500E 01	0.101E 00	0.136E 00
1988	0.826E 01	0.000E 00	0.515E 01	0.118E 00	0.147E 00
1989	0.843E 01	0.000E 00	0.530E 01	0.136E 00	0.159E 00
1990	0.861E 01	0.000E 00	0.546E 01	0.155E 00	0.170E 00
1991	0.879E 01	0.000E 00	0.563E 01	0.176E 00	0.181E 00
1992	0.897E 01	0.000E 00	0.580E 01	0.198E 00	0.193E 00
1993	0.915E 01	0.000E 00	0.597E 01	0.221E 00	0.204E 00
1994	0.934E 01	0.000E 00	0.615E 01	0.246E 00	0.215E 00
1995	0.953E 01	0.000E 00	0.634E 01	0.272E 00	0.226E 00
1996	0.972E 01	0.000E 00	0.653E 01	0.299E 00	0.238E 00
1997	0.992E 01	0.000E 00	0.672E 01	0.327E 00	0.249E 00
1998	0.101E 02	0.000E 00	0.692E 01	0.357E 00	0.260E 00
1999	0.103E 02	0.000E 00	0.713E 01	0.388E 00	0.272E 00
2000	0.105E 02	0.000E 00	0.735E 01	0.421E 00	0.283E 00
2001	0.107E 02	0.000E 00	0.757E 01	0.454E 00	0.294E 00
2002	0.109E 02	0.000E 00	0.779E 01	0.489E 00	0.306E 00
2003	0.112E 02	0.000E 00	0.803E 01	0.525E 00	0.317E 00
2004	0.114E 02	0.000E 00	0.827E 01	0.563E 00	0.328E 00
2005	0.116E 02	0.000E 00	0.851E 01	0.602E 00	0.340E 00
2006	0.118E 02	0.000E 00	0.877E 01	0.642E 00	0.351E 00
2007	0.121E 02	0.000E 00	0.903E 01	0.683E 00	0.362E 00
2008	0.123E 02	0.000E 00	0.930E 01	0.726E 00	0.374E 00
2009	0.125E 02	0.000E 00	0.957E 01	0.770E 00	0.385E 00
2010	0.128E 02	0.000E 00	0.986E 01	0.815E 00	0.396E 00
2011	0.130E 02	0.000E 00	0.101E 02	0.862E 00	0.408E 00
2012	0.133E 02	0.000E 00	0.105E 02	0.910E 00	0.419E 00
2013	0.135E 02	0.000E 00	0.108E 02	0.959E 00	0.430E 00
2014	0.138E 02	0.000E 00	0.111E 02	0.101E 01	0.442E 00
2015	0.140E 02	0.000E 00	0.114E 02	0.106E 01	0.453E 00
2016	0.143E 02	0.000E 00	0.117E 02	0.111E 01	0.464E 00
2017	0.145E 02	0.000E 00	0.121E 02	0.117E 01	0.476E 00
2018	0.148E 02	0.000E 00	0.124E 02	0.122E 01	0.487E 00
2019	0.151E 02	0.000E 00	0.128E 02	0.128E 01	0.498E 00
2020	0.154E 02	0.000E 00	0.132E 02	0.134E 01	0.509E 00
2021	0.157E 02	0.000E 00	0.136E 02	0.140E 01	0.521E 00
2022	0.159E 02	0.000E 00	0.140E 02	0.146E 01	0.532E 00
2023	0.162E 02	0.000E 00	0.144E 02	0.152E 01	0.543E 00
2024	0.165E 02	0.000E 00	0.148E 02	0.159E 01	0.555E 00
2025	0.168E 02	0.000E 00	0.152E 02	0.165E 01	0.566E 00

	WLAP	WOAP	WGAP	WOSAP	WLMAP
1975	0.104E 04	0.000E 00	0.552E 03	0.000E 00	0.000E 00
1976	0.107E 04	0.000E 00	0.563E 03	0.000E 00	0.527E-01
1977	0.110E 04	0.000E 00	0.574E 03	0.000E 00	0.105E 00
1978	0.113E 04	0.000E 00	0.586E 03	0.000E 00	0.158E 00
1979	0.116E 04	0.000E 00	0.598E 03	0.000E 00	0.211E 00
1980	0.120E 04	0.000E 00	0.610E 03	0.000E 00	0.263E 00
1981	0.123E 04	0.000E 00	0.622E 03	0.000E 00	0.316E 00
1982	0.126E 04	0.000E 00	0.635E 03	0.000E 00	0.369E 00
1983	0.130E 04	0.000E 00	0.647E 03	0.000E 00	0.422E 00
1984	0.133E 04	0.000E 00	0.660E 03	0.000E 00	0.474E 00
1985	0.137E 04	0.000E 00	0.674E 03	0.000E 00	0.527E 00
1986	0.140E 04	0.000E 00	0.687E 03	0.000E 00	0.580E 00
1987	0.144E 04	0.000E 00	0.701E 03	0.000E 00	0.632E 00
1988	0.148E 04	0.000E 00	0.715E 03	0.000E 00	0.685E 00
1989	0.152E 04	0.000E 00	0.729E 03	0.000E 00	0.738E 00
1990	0.156E 04	0.000E 00	0.744E 03	0.000E 00	0.790E 00
1991	0.160E 04	0.000E 00	0.759E 03	0.000E 00	0.843E 00
1992	0.164E 04	0.000E 00	0.774E 03	0.000E 00	0.896E 00
1993	0.168E 04	0.000E 00	0.790E 03	0.000E 00	0.948E 00
1994	0.172E 04	0.000E 00	0.806E 03	0.000E 00	0.100E 01
1995	0.177E 04	0.000E 00	0.822E 03	0.000E 00	0.105E 01
1996	0.181E 04	0.000E 00	0.838E 03	0.000E 00	0.111E 01
1997	0.186E 04	0.000E 00	0.855E 03	0.000E 00	0.116E 01
1998	0.190E 04	0.000E 00	0.872E 03	0.000E 00	0.121E 01
1999	0.195E 04	0.000E 00	0.890E 03	0.000E 00	0.126E 01
2000	0.200E 04	0.000E 00	0.907E 03	0.000E 00	0.132E 01
2001	0.205E 04	0.000E 00	0.925E 03	0.000E 00	0.137E 01
2002	0.210E 04	0.000E 00	0.944E 03	0.000E 00	0.142E 01
2003	0.215E 04	0.000E 00	0.963E 03	0.000E 00	0.148E 01
2004	0.220E 04	0.000E 00	0.982E 03	0.000E 00	0.153E 01
2005	0.226E 04	0.000E 00	0.100E 04	0.000E 00	0.158E 01
2006	0.231E 04	0.000E 00	0.102E 04	0.000E 00	0.163E 01
2007	0.237E 04	0.000E 00	0.104E 04	0.000E 00	0.169E 01
2008	0.243E 04	0.000E 00	0.106E 04	0.000E 00	0.174E 01
2009	0.248E 04	0.000E 00	0.108E 04	0.000E 00	0.179E 01
2010	0.254E 04	0.000E 00	0.110E 04	0.000E 00	0.184E 01
2011	0.261E 04	0.000E 00	0.113E 04	0.000E 00	0.190E 01
2012	0.267E 04	0.000E 00	0.115E 04	0.000E 00	0.195E 01
2013	0.273E 04	0.000E 00	0.117E 04	0.000E 00	0.200E 01
2014	0.280E 04	0.000E 00	0.119E 04	0.000E 00	0.205E 01
2015	0.286E 04	0.000E 00	0.122E 04	0.000E 00	0.211E 01
2016	0.293E 04	0.000E 00	0.124E 04	0.000E 00	0.216E 01
2017	0.300E 04	0.000E 00	0.126E 04	0.000E 00	0.221E 01
2018	0.307E 04	0.000E 00	0.129E 04	0.000E 00	0.227E 01
2019	0.315E 04	0.000E 00	0.131E 04	0.000E 00	0.232E 01
2020	0.322E 04	0.000E 00	0.134E 04	0.000E 00	0.237E 01
2021	0.329E 04	0.000E 00	0.137E 04	0.000E 00	0.242E 01
2022	0.337E 04	0.000E 00	0.139E 04	0.000E 00	0.248E 01
2023	0.345E 04	0.000E 00	0.142E 04	0.000E 00	0.253E 01
2024	0.353E 04	0.000E 00	0.145E 04	0.000E 00	0.258E 01
2025	0.361E 04	0.000E 00	0.147E 04	0.000E 00	0.263E 01

	WLICP	WOICP	WGICP	WOSICP	WLMICP
1975	0.545E 01	0.431E 00	0.111E 00	0.000E 00	0.000E 00
1976	0.574E 01	0.444E 00	0.112E 00	0.000E 00	0.675E-01
1977	0.605E 01	0.457E 00	0.113E 00	0.000E 00	0.135E 00
1978	0.636E 01	0.471E 00	0.114E 00	0.000E 00	0.202E 00
1979	0.670E 01	0.485E 00	0.116E 00	0.000E 00	0.270E 00
1980	0.704E 01	0.500E 00	0.117E 00	0.000E 00	0.337E 00
1981	0.741E 01	0.515E 00	0.118E 00	0.000E 00	0.405E 00
1982	0.779E 01	0.530E 00	0.119E 00	0.000E 00	0.472E 00
1983	0.819E 01	0.546E 00	0.120E 00	0.000E 00	0.540E 00
1984	0.860E 01	0.563E 00	0.122E 00	0.000E 00	0.607E 00
1985	0.904E 01	0.579E 00	0.123E 00	0.000E 00	0.675E 00
1986	0.950E 01	0.597E 00	0.124E 00	0.000E 00	0.742E 00
1987	0.998E 01	0.615E 00	0.125E 00	0.000E 00	0.810E 00
1988	0.105E 02	0.633E 00	0.127E 00	0.000E 00	0.877E 00
1989	0.110E 02	0.652E 00	0.128E 00	0.000E 00	0.945E 00
1990	0.116E 02	0.672E 00	0.129E 00	0.000E 00	0.101E 01
1991	0.121E 02	0.692E 00	0.130E 00	0.000E 00	0.108E 01
1992	0.127E 02	0.713E 00	0.132E 00	0.000E 00	0.115E 01
1993	0.134E 02	0.734E 00	0.133E 00	0.000E 00	0.121E 01
1994	0.140E 02	0.756E 00	0.134E 00	0.000E 00	0.128E 01
1995	0.147E 02	0.779E 00	0.136E 00	0.000E 00	0.135E 01
1996	0.154E 02	0.802E 00	0.137E 00	0.000E 00	0.142E 01
1997	0.162E 02	0.826E 00	0.138E 00	0.000E 00	0.148E 01
1998	0.170E 02	0.851E 00	0.140E 00	0.000E 00	0.155E 01
1999	0.178E 02	0.876E 00	0.141E 00	0.000E 00	0.162E 01
2000	0.187E 02	0.903E 00	0.143E 00	0.000E 00	0.169E 01
2001	0.196E 02	0.930E 00	0.144E 00	0.000E 00	0.175E 01
2002	0.206E 02	0.958E 00	0.146E 00	0.000E 00	0.182E 01
2003	0.216E 02	0.986E 00	0.147E 00	0.000E 00	0.189E 01
2004	0.226E 02	0.102E 01	0.148E 00	0.000E 00	0.196E 01
2005	0.237E 02	0.105E 01	0.150E 00	0.000E 00	0.202E 01
2006	0.248E 02	0.108E 01	0.151E 00	0.000E 00	0.209E 01
2007	0.260E 02	0.111E 01	0.153E 00	0.000E 00	0.216E 01
2008	0.273E 02	0.114E 01	0.154E 00	0.000E 00	0.223E 01
2009	0.286E 02	0.118E 01	0.156E 00	0.000E 00	0.229E 01
2010	0.300E 02	0.121E 01	0.157E 00	0.000E 00	0.236E 01
2011	0.314E 02	0.125E 01	0.159E 00	0.000E 00	0.243E 01
2012	0.330E 02	0.129E 01	0.160E 00	0.000E 00	0.250E 01
2013	0.345E 02	0.133E 01	0.162E 00	0.000E 00	0.256E 01
2014	0.362E 02	0.136E 01	0.164E 00	0.000E 00	0.263E 01
2015	0.379E 02	0.141E 01	0.165E 00	0.000E 00	0.270E 01
2016	0.397E 02	0.145E 01	0.167E 00	0.000E 00	0.277E 01
2017	0.416E 02	0.149E 01	0.168E 00	0.000E 00	0.283E 01
2018	0.436E 02	0.154E 01	0.170E 00	0.000E 00	0.290E 01
2019	0.457E 02	0.158E 01	0.171E 00	0.000E 00	0.297E 01
2020	0.478E 02	0.163E 01	0.173E 00	0.000E 00	0.304E 01
2021	0.501E 02	0.168E 01	0.175E 00	0.000E 00	0.310E 01
2022	0.525E 02	0.173E 01	0.176E 00	0.000E 00	0.317E 01
2023	0.550E 02	0.178E 01	0.178E 00	0.000E 00	0.324E 01
2024	0.576E 02	0.183E 01	0.180E 00	0.000E 00	0.331E 01
2025	0.603E 02	0.189E 01	0.181E 00	0.000E 00	0.337E 01

	WIP	WDP	WAP	WICP
1975	0.961E 01	0.985E 01	0.159E 04	0.600E 01
1976	0.100E 02	0.101E 02	0.163E 04	0.637E 01
1977	0.105E 02	0.104E 02	0.168E 04	0.675E 01
1978	0.110E 02	0.107E 02	0.172E 04	0.715E 01
1979	0.115E 02	0.110E 02	0.176E 04	0.757E 01
1980	0.120E 02	0.113E 02	0.181E 04	0.800E 01
1981	0.126E 02	0.119E 02	0.185E 04	0.844E 01
1982	0.131E 02	0.122E 02	0.190E 04	0.891E 01
1983	0.137E 02	0.125E 02	0.194E 04	0.939E 01
1984	0.143E 02	0.129E 02	0.199E 04	0.989E 01
1985	0.149E 02	0.132E 02	0.204E 04	0.104E 02
1986	0.156E 02	0.135E 02	0.209E 04	0.110E 02
1987	0.162E 02	0.139E 02	0.214E 04	0.115E 02
1988	0.169E 02	0.143E 02	0.219E 04	0.121E 02
1989	0.177E 02	0.147E 02	0.225E 04	0.127E 02
1990	0.184E 02	0.150E 02	0.230E 04	0.134E 02
1991	0.195E 02	0.159E 02	0.236E 04	0.140E 02
1992	0.203E 02	0.164E 02	0.241E 04	0.147E 02
1993	0.212E 02	0.168E 02	0.247E 04	0.154E 02
1994	0.221E 02	0.172E 02	0.253E 04	0.162E 02
1995	0.230E 02	0.177E 02	0.259E 04	0.170E 02
1996	0.240E 02	0.181E 02	0.265E 04	0.178E 02
1997	0.250E 02	0.186E 02	0.271E 04	0.186E 02
1998	0.260E 02	0.191E 02	0.278E 04	0.195E 02
1999	0.271E 02	0.196E 02	0.284E 04	0.205E 02
2000	0.283E 02	0.201E 02	0.291E 04	0.214E 02
2001	0.300E 02	0.213E 02	0.297E 04	0.224E 02
2002	0.313E 02	0.219E 02	0.304E 04	0.235E 02
2003	0.326E 02	0.224E 02	0.311E 04	0.246E 02
2004	0.340E 02	0.230E 02	0.319E 04	0.257E 02
2005	0.354E 02	0.236E 02	0.326E 04	0.269E 02
2006	0.369E 02	0.242E 02	0.333E 04	0.282E 02
2007	0.385E 02	0.249E 02	0.341E 04	0.295E 02
2008	0.401E 02	0.255E 02	0.349E 04	0.308E 02
2009	0.418E 02	0.262E 02	0.357E 04	0.322E 02
2010	0.436E 02	0.268E 02	0.365E 04	0.337E 02
2011	0.466E 02	0.285E 02	0.373E 04	0.353E 02
2012	0.486E 02	0.292E 02	0.382E 04	0.369E 02
2013	0.507E 02	0.300E 02	0.390E 04	0.386E 02
2014	0.528E 02	0.307E 02	0.399E 04	0.403E 02
2015	0.551E 02	0.315E 02	0.408E 04	0.422E 02
2016	0.575E 02	0.323E 02	0.417E 04	0.441E 02
2017	0.599E 02	0.332E 02	0.427E 04	0.461E 02
2018	0.625E 02	0.340E 02	0.436E 04	0.482E 02
2019	0.652E 02	0.349E 02	0.446E 04	0.504E 02
2020	0.680E 02	0.358E 02	0.456E 04	0.527E 02
2021	0.734E 02	0.380E 02	0.466E 04	0.551E 02
2022	0.766E 02	0.389E 02	0.477E 04	0.576E 02
2023	0.800E 02	0.399E 02	0.487E 04	0.602E 02
2024	0.835E 02	0.410E 02	0.498E 04	0.629E 02
2025	0.872E 02	0.420E 02	0.509E 04	0.657E 02

B 1370

	SWI	SWD	SWA	SWIC
1975	0.418E 01	-0.677E 00	0.360E 02	0.164E 01
1976	0.424E 01	-0.742E 00	0.384E 02	0.171E 01
1977	0.428E 01	-0.812E 00	0.406E 02	0.176E 01
1978	0.431E 01	-0.887E 00	0.426E 02	0.180E 01
1979	0.433E 01	-0.966E 00	0.444E 02	0.184E 01
1980	0.433E 01	-0.105E 01	0.459E 02	0.186E 01
1981	0.440E 01	-0.852E 00	0.472E 02	0.188E 01
1982	0.437E 01	-0.938E 00	0.483E 02	0.187E 01
1983	0.432E 01	-0.103E 01	0.491E 02	0.186E 01
1984	0.425E 01	-0.113E 01	0.497E 02	0.182E 01
1985	0.416E 01	-0.123E 01	0.500E 02	0.177E 01
1986	0.404E 01	-0.134E 01	0.501E 02	0.170E 01
1987	0.389E 01	-0.146E 01	0.500E 02	0.161E 01
1988	0.370E 01	-0.158E 01	0.496E 02	0.150E 01
1989	0.349E 01	-0.171E 01	0.490E 02	0.136E 01
1990	0.323E 01	-0.185E 01	0.481E 02	0.119E 01
1991	0.324E 01	-0.149E 01	0.469E 02	0.985E 00
1992	0.291E 01	-0.163E 01	0.455E 02	0.751E 00
1993	0.254E 01	-0.177E 01	0.437E 02	0.481E 00
1994	0.211E 01	-0.193E 01	0.417E 02	0.170E 00
1995	0.163E 01	-0.209E 01	0.393E 02	-0.185E 00
1996	0.108E 01	-0.226E 01	0.367E 02	-0.586E 00
1997	0.460E 00	-0.243E 01	0.338E 02	-0.104E 01
1998	-0.233E 00	-0.262E 01	0.305E 02	-0.155E 01
1999	-0.101E 01	-0.282E 01	0.268E 02	-0.212E 01
2000	-0.187E 01	-0.302E 01	0.229E 02	-0.276E 01
2001	-0.222E 01	-0.256E 01	0.185E 02	-0.346E 01
2002	-0.324E 01	-0.277E 01	0.138E 02	-0.425E 01
2003	-0.437E 01	-0.299E 01	0.866E 01	-0.512E 01
2004	-0.562E 01	-0.321E 01	0.306E 01	-0.608E 01
2005	-0.701E 01	-0.346E 01	-0.294E 01	-0.715E 01
2006	-0.853E 01	-0.371E 01	-0.944E 01	-0.832E 01
2007	-0.102E 02	-0.398E 01	-0.165E 02	-0.960E 01
2008	-0.120E 02	-0.425E 01	-0.239E 02	-0.110E 02
2009	-0.141E 02	-0.455E 01	-0.319E 02	-0.126E 02
2010	-0.163E 02	-0.486E 01	-0.404E 02	-0.143E 02
2011	-0.175E 02	-0.425E 01	-0.496E 02	-0.161E 02
2012	-0.200E 02	-0.456E 01	-0.592E 02	-0.182E 02
2013	-0.228E 02	-0.488E 01	-0.696E 02	-0.204E 02
2014	-0.258E 02	-0.523E 01	-0.806E 02	-0.228E 02
2015	-0.292E 02	-0.558E 01	-0.922E 02	-0.255E 02
2016	-0.328E 02	-0.596E 01	-0.105E 03	-0.283E 02
2017	-0.367E 02	-0.635E 01	-0.118E 03	-0.315E 02
2018	-0.410E 02	-0.677E 01	-0.132E 03	-0.349E 02
2019	-0.457E 02	-0.720E 01	-0.147E 03	-0.386E 02
2020	-0.507E 02	-0.765E 01	-0.163E 03	-0.426E 02
2021	-0.538E 02	-0.685E 01	-0.179E 03	-0.470E 02
2022	-0.596E 02	-0.731E 01	-0.197E 03	-0.518E 02
2023	-0.659E 02	-0.779E 01	-0.215E 03	-0.569E 02
2024	-0.727E 02	-0.829E 01	-0.235E 03	-0.625E 02
2025	-0.801E 02	-0.882E 01	-0.256E 03	-0.686E 02

	TWS	ENH	EH	SE
1975	0.000E 00	0.155E 05	0.356E 05	-0.283E 03
1976	0.216E-02	0.166E 05	0.381E 05	0.152E 04
1977	0.647E-02	0.178E 05	0.408E 05	0.350E 04
1978	0.129E-01	0.190E 05	0.437E 05	0.568E 04
1979	0.216E-01	0.203E 05	0.467E 05	0.808E 04
1980	0.324E-01	0.218E 05	0.500E 05	0.107E 05
1981	0.453E-01	0.233E 05	0.535E 05	0.136E 05
1982	0.604E-01	0.249E 05	0.572E 05	0.167E 05
1983	0.777E-01	0.267E 05	0.612E 05	0.202E 05
1984	0.971E-01	0.285E 05	0.655E 05	0.239E 05
1985	0.119E 00	0.305E 05	0.701E 05	0.280E 05
1986	0.142E 00	0.326E 05	0.750E 05	0.325E 05
1987	0.168E 00	0.349E 05	0.803E 05	0.373E 05
1988	0.196E 00	0.374E 05	0.859E 05	0.426E 05
1989	0.226E 00	0.400E 05	0.919E 05	0.483E 05
1990	0.259E 00	0.428E 05	0.983E 05	0.545E 05
1991	0.293E 00	0.458E 05	0.105E 06	0.612E 05
1992	0.330E 00	0.490E 05	0.113E 06	0.685E 05
1993	0.369E 00	0.524E 05	0.120E 06	0.764E 05
1994	0.410E 00	0.561E 05	0.129E 06	0.850E 05
1995	0.453E 00	0.600E 05	0.138E 06	0.942E 05
1996	0.498E 00	0.642E 05	0.148E 06	0.104E 06
1997	0.546E 00	0.687E 05	0.158E 06	0.115E 06
1998	0.595E 00	0.735E 05	0.169E 06	0.127E 06
1999	0.647E 00	0.787E 05	0.181E 06	0.139E 06
2000	0.701E 00	0.842E 05	0.193E 06	0.153E 06
2001	0.757E 00	0.901E 05	0.207E 06	0.168E 06
2002	0.815E 00	0.964E 05	0.221E 06	0.184E 06
2003	0.876E 00	0.103E 06	0.237E 06	0.201E 06
2004	0.938E 00	0.110E 06	0.253E 06	0.219E 06
2005	0.100E 01	0.118E 06	0.271E 06	0.239E 06
2006	0.107E 01	0.126E 06	0.290E 06	0.260E 06
2007	0.114E 01	0.135E 06	0.310E 06	0.283E 06
2008	0.121E 01	0.145E 06	0.332E 06	0.308E 06
2009	0.128E 01	0.155E 06	0.355E 06	0.335E 06
2010	0.136E 01	0.166E 06	0.380E 06	0.364E 06
2011	0.144E 01	0.177E 06	0.407E 06	0.395E 06
2012	0.152E 01	0.190E 06	0.435E 06	0.428E 06
2013	0.160E 01	0.203E 06	0.466E 06	0.464E 06
2014	0.168E 01	0.217E 06	0.498E 06	0.502E 06
2015	0.177E 01	0.232E 06	0.533E 06	0.543E 06
2016	0.186E 01	0.248E 06	0.571E 06	0.588E 06
2017	0.195E 01	0.266E 06	0.611E 06	0.636E 06
2018	0.204E 01	0.284E 06	0.653E 06	0.687E 06
2019	0.214E 01	0.304E 06	0.699E 06	0.742E 06
2020	0.223E 01	0.326E 06	0.748E 06	0.801E 06
2021	0.233E 01	0.348E 06	0.800E 06	0.865E 06
2022	0.243E 01	0.373E 06	0.856E 06	0.933E 06
2023	0.254E 01	0.399E 06	0.916E 06	0.101E 07
2024	0.264E 01	0.427E 06	0.980E 06	0.109E 07
2025	0.275E 01	0.457E 06	0.105E 07	0.117E 07

	FACT	PIND1	PIND2
1975	0.158E 04	0.436E-02	0.184E-02
1976	0.162E 04	0.446E-02	0.189E-02
1977	0.166E 04	0.455E-02	0.194E-02
1978	0.170E 04	0.465E-02	0.199E-02
1979	0.174E 04	0.476E-02	0.204E-02
1980	0.179E 04	0.486E-02	0.209E-02
1981	0.183E 04	0.497E-02	0.214E-02
1982	0.188E 04	0.509E-02	0.220E-02
1983	0.193E 04	0.521E-02	0.225E-02
1984	0.198E 04	0.533E-02	0.231E-02
1985	0.203E 04	0.546E-02	0.237E-02
1986	0.208E 04	0.559E-02	0.243E-02
1987	0.213E 04	0.572E-02	0.249E-02
1988	0.218E 04	0.586E-02	0.255E-02
1989	0.224E 04	0.600E-02	0.262E-02
1990	0.230E 04	0.615E-02	0.268E-02
1991	0.236E 04	0.630E-02	0.275E-02
1992	0.242E 04	0.646E-02	0.282E-02
1993	0.248E 04	0.662E-02	0.289E-02
1994	0.254E 04	0.679E-02	0.297E-02
1995	0.261E 04	0.696E-02	0.304E-02
1996	0.267E 04	0.714E-02	0.312E-02
1997	0.274E 04	0.732E-02	0.320E-02
1998	0.281E 04	0.751E-02	0.328E-02
1999	0.289E 04	0.770E-02	0.337E-02
2000	0.296E 04	0.790E-02	0.346E-02
2001	0.304E 04	0.811E-02	0.354E-02
2002	0.312E 04	0.832E-02	0.364E-02
2003	0.320E 04	0.854E-02	0.373E-02
2004	0.328E 04	0.877E-02	0.383E-02
2005	0.337E 04	0.900E-02	0.393E-02
2006	0.345E 04	0.924E-02	0.403E-02
2007	0.354E 04	0.949E-02	0.414E-02
2008	0.364E 04	0.974E-02	0.425E-02
2009	0.373E 04	0.100E-01	0.436E-02
2010	0.383E 04	0.103E-01	0.448E-02
2011	0.393E 04	0.106E-01	0.460E-02
2012	0.403E 04	0.108E-01	0.472E-02
2013	0.414E 04	0.111E-01	0.484E-02
2014	0.425E 04	0.115E-01	0.497E-02
2015	0.436E 04	0.118E-01	0.511E-02
2016	0.448E 04	0.121E-01	0.525E-02
2017	0.460E 04	0.124E-01	0.539E-02
2018	0.472E 04	0.128E-01	0.554E-02
2019	0.485E 04	0.131E-01	0.569E-02
2020	0.498E 04	0.135E-01	0.585E-02
2021	0.512E 04	0.139E-01	0.601E-02
2022	0.525E 04	0.143E-01	0.617E-02
2023	0.540E 04	0.147E-01	0.635E-02
2024	0.554E 04	0.151E-01	0.653E-02
2025	0.570E 04	0.156E-01	0.671E-02

B 1373

NOMINAL

United States

B 1374

	GRP	WI	WIL	WIG	WIO
1975	0.103E 04	0.650E 02	0.525E 02	0.124E 02	0.171E-01
1976	0.106E 04	0.672E 02	0.543E 02	0.128E 02	0.177E-01
1977	0.110E 04	0.695E 02	0.562E 02	0.133E 02	0.183E-01
1978	0.114E 04	0.719E 02	0.581E 02	0.137E 02	0.189E-01
1979	0.118E 04	0.743E 02	0.601E 02	0.142E 02	0.196E-01
1980	0.122E 04	0.769E 02	0.621E 02	0.147E 02	0.202E-01
1981	0.126E 04	0.795E 02	0.642E 02	0.152E 02	0.209E-01
1982	0.130E 04	0.822E 02	0.664E 02	0.157E 02	0.216E-01
1983	0.135E 04	0.850E 02	0.687E 02	0.162E 02	0.224E-01
1984	0.139E 04	0.880E 02	0.711E 02	0.168E 02	0.231E-01
1985	0.144E 04	0.910E 02	0.735E 02	0.174E 02	0.239E-01
1986	0.149E 04	0.941E 02	0.760E 02	0.180E 02	0.247E-01
1987	0.154E 04	0.973E 02	0.786E 02	0.186E 02	0.256E-01
1988	0.159E 04	0.101E 03	0.813E 02	0.192E 02	0.265E-01
1989	0.165E 04	0.104E 03	0.841E 02	0.199E 02	0.274E-01
1990	0.170E 04	0.108E 03	0.869E 02	0.206E 02	0.283E-01
1991	0.176E 04	0.111E 03	0.899E 02	0.213E 02	0.293E-01
1992	0.182E 04	0.115E 03	0.930E 02	0.220E 02	0.303E-01
1993	0.188E 04	0.119E 03	0.962E 02	0.227E 02	0.313E-01
1994	0.195E 04	0.123E 03	0.995E 02	0.235E 02	0.324E-01
1995	0.201E 04	0.127E 03	0.103E 03	0.243E 02	0.335E-01
1996	0.208E 04	0.132E 03	0.106E 03	0.251E 02	0.346E-01
1997	0.215E 04	0.136E 03	0.110E 03	0.260E 02	0.358E-01
1998	0.223E 04	0.141E 03	0.114E 03	0.269E 02	0.370E-01
1999	0.230E 04	0.146E 03	0.118E 03	0.278E 02	0.383E-01
2000	0.238E 04	0.151E 03	0.122E 03	0.288E 02	0.396E-01
2001	0.246E 04	0.156E 03	0.126E 03	0.297E 02	0.410E-01
2002	0.255E 04	0.161E 03	0.130E 03	0.308E 02	0.424E-01
2003	0.263E 04	0.167E 03	0.135E 03	0.318E 02	0.438E-01
2004	0.272E 04	0.172E 03	0.139E 03	0.329E 02	0.453E-01
2005	0.282E 04	0.178E 03	0.144E 03	0.340E 02	0.469E-01
2006	0.291E 04	0.184E 03	0.149E 03	0.352E 02	0.485E-01
2007	0.301E 04	0.191E 03	0.154E 03	0.364E 02	0.501E-01
2008	0.312E 04	0.197E 03	0.159E 03	0.376E 02	0.518E-01
2009	0.322E 04	0.204E 03	0.165E 03	0.389E 02	0.536E-01
2010	0.333E 04	0.211E 03	0.170E 03	0.403E 02	0.554E-01
2011	0.345E 04	0.218E 03	0.176E 03	0.416E 02	0.573E-01
2012	0.357E 04	0.225E 03	0.182E 03	0.431E 02	0.593E-01
2013	0.369E 04	0.233E 03	0.188E 03	0.445E 02	0.613E-01
2014	0.381E 04	0.241E 03	0.195E 03	0.460E 02	0.634E-01
2015	0.394E 04	0.249E 03	0.201E 03	0.476E 02	0.656E-01
2016	0.408E 04	0.258E 03	0.208E 03	0.492E 02	0.678E-01
2017	0.422E 04	0.267E 03	0.215E 03	0.509E 02	0.701E-01
2018	0.436E 04	0.276E 03	0.223E 03	0.527E 02	0.725E-01
2019	0.451E 04	0.285E 03	0.230E 03	0.545E 02	0.750E-01
2020	0.467E 04	0.295E 03	0.238E 03	0.563E 02	0.776E-01
2021	0.483E 04	0.305E 03	0.246E 03	0.583E 02	0.802E-01
2022	0.499E 04	0.315E 03	0.255E 03	0.603E 02	0.830E-01
2023	0.516E 04	0.326E 03	0.264E 03	0.623E 02	0.858E-01
2024	0.534E 04	0.337E 03	0.273E 03	0.644E 02	0.887E-01
2025	0.552E 04	0.349E 03	0.282E 03	0.666E 02	0.918E-01

	WIW	WIR	WIRL	WIRO	WIRG
1975	0.578E 02	0.405E 02	0.344E 02	0.405E 01	0.202E 01
1976	0.598E 02	0.419E 02	0.356E 02	0.419E 01	0.209E 01
1977	0.619E 02	0.433E 02	0.368E 02	0.433E 01	0.217E 01
1978	0.640E 02	0.448E 02	0.381E 02	0.448E 01	0.224E 01
1979	0.662E 02	0.463E 02	0.394E 02	0.463E 01	0.232E 01
1980	0.684E 02	0.479E 02	0.407E 02	0.479E 01	0.239E 01
1981	0.708E 02	0.495E 02	0.421E 02	0.495E 01	0.248E 01
1982	0.732E 02	0.512E 02	0.435E 02	0.512E 01	0.256E 01
1983	0.757E 02	0.530E 02	0.450E 02	0.530E 01	0.265E 01
1984	0.783E 02	0.548E 02	0.466E 02	0.548E 01	0.274E 01
1985	0.810E 02	0.567E 02	0.482E 02	0.567E 01	0.283E 01
1986	0.837E 02	0.586E 02	0.498E 02	0.586E 01	0.293E 01
1987	0.866E 02	0.606E 02	0.515E 02	0.606E 01	0.303E 01
1988	0.895E 02	0.627E 02	0.533E 02	0.627E 01	0.313E 01
1989	0.926E 02	0.648E 02	0.551E 02	0.648E 01	0.324E 01
1990	0.958E 02	0.670E 02	0.570E 02	0.670E 01	0.335E 01
1991	0.990E 02	0.693E 02	0.589E 02	0.693E 01	0.347E 01
1992	0.102E 03	0.717E 02	0.609E 02	0.717E 01	0.359E 01
1993	0.106E 03	0.742E 02	0.630E 02	0.742E 01	0.371E 01
1994	0.110E 03	0.767E 02	0.652E 02	0.767E 01	0.383E 01
1995	0.113E 03	0.793E 02	0.674E 02	0.793E 01	0.397E 01
1996	0.117E 03	0.820E 02	0.697E 02	0.820E 01	0.410E 01
1997	0.121E 03	0.848E 02	0.721E 02	0.848E 01	0.424E 01
1998	0.125E 03	0.877E 02	0.746E 02	0.877E 01	0.439E 01
1999	0.130E 03	0.907E 02	0.771E 02	0.907E 01	0.454E 01
2000	0.134E 03	0.938E 02	0.797E 02	0.938E 01	0.469E 01
2001	0.139E 03	0.970E 02	0.825E 02	0.970E 01	0.485E 01
2002	0.143E 03	0.100E 03	0.853E 02	0.100E 02	0.502E 01
2003	0.148E 03	0.104E 03	0.882E 02	0.104E 02	0.519E 01
2004	0.153E 03	0.107E 03	0.912E 02	0.107E 02	0.537E 01
2005	0.159E 03	0.111E 03	0.943E 02	0.111E 02	0.555E 01
2006	0.164E 03	0.115E 03	0.976E 02	0.115E 02	0.574E 01
2007	0.170E 03	0.119E 03	0.101E 03	0.119E 02	0.594E 01
2008	0.175E 03	0.123E 03	0.104E 03	0.123E 02	0.614E 01
2009	0.181E 03	0.127E 03	0.108E 03	0.127E 02	0.635E 01
2010	0.188E 03	0.131E 03	0.112E 03	0.131E 02	0.657E 01
2011	0.194E 03	0.136E 03	0.115E 03	0.136E 02	0.679E 01
2012	0.201E 03	0.140E 03	0.119E 03	0.140E 02	0.702E 01
2013	0.207E 03	0.145E 03	0.123E 03	0.145E 02	0.726E 01
2014	0.215E 03	0.150E 03	0.128E 03	0.150E 02	0.751E 01
2015	0.222E 03	0.155E 03	0.132E 03	0.155E 02	0.777E 01
2016	0.229E 03	0.161E 03	0.137E 03	0.161E 02	0.803E 01
2017	0.237E 03	0.166E 03	0.141E 03	0.166E 02	0.831E 01
2018	0.245E 03	0.172E 03	0.146E 03	0.172E 02	0.859E 01
2019	0.254E 03	0.178E 03	0.151E 03	0.178E 02	0.888E 01
2020	0.263E 03	0.184E 03	0.156E 03	0.184E 02	0.919E 01
2021	0.271E 03	0.190E 03	0.162E 03	0.190E 02	0.950E 01
2022	0.281E 03	0.197E 03	0.167E 03	0.197E 02	0.983E 01
2023	0.290E 03	0.203E 03	0.173E 03	0.203E 02	0.102E 02
2024	0.300E 03	0.210E 03	0.179E 03	0.210E 02	0.105E 02
2025	0.311E 03	0.217E 03	0.185E 03	0.217E 02	0.109E 02

	POP	WD	WDG	WDL	WDO
1975	0.224E 09	0.386E 02	0.000E 00	0.000E 00	0.304E-02
1976	0.227E 09	0.390E 02	0.000E 00	0.000E 00	0.307E-02
1977	0.229E 09	0.394E 02	0.000E 00	0.000E 00	0.310E-02
1978	0.232E 09	0.399E 02	0.000E 00	0.000E 00	0.314E-02
1979	0.234E 09	0.403E 02	0.000E 00	0.000E 00	0.317E-02
1980	0.237E 09	0.407E 02	0.000E 00	0.000E 00	0.321E-02
1981	0.239E 09	0.412E 02	0.000E 00	0.000E 00	0.324E-02
1982	0.242E 09	0.416E 02	0.000E 00	0.000E 00	0.328E-02
1983	0.245E 09	0.421E 02	0.000E 00	0.000E 00	0.331E-02
1984	0.247E 09	0.426E 02	0.000E 00	0.000E 00	0.335E-02
1985	0.250E 09	0.430E 02	0.000E 00	0.000E 00	0.339E-02
1986	0.253E 09	0.435E 02	0.000E 00	0.000E 00	0.342E-02
1987	0.256E 09	0.440E 02	0.000E 00	0.000E 00	0.346E-02
1988	0.259E 09	0.445E 02	0.000E 00	0.000E 00	0.350E-02
1989	0.261E 09	0.449E 02	0.000E 00	0.000E 00	0.354E-02
1990	0.264E 09	0.454E 02	0.000E 00	0.000E 00	0.358E-02
1991	0.267E 09	0.459E 02	0.000E 00	0.000E 00	0.362E-02
1992	0.270E 09	0.464E 02	0.000E 00	0.000E 00	0.366E-02
1993	0.273E 09	0.470E 02	0.000E 00	0.000E 00	0.370E-02
1994	0.276E 09	0.475E 02	0.000E 00	0.000E 00	0.374E-02
1995	0.279E 09	0.480E 02	0.000E 00	0.000E 00	0.378E-02
1996	0.282E 09	0.485E 02	0.000E 00	0.000E 00	0.382E-02
1997	0.285E 09	0.490E 02	0.000E 00	0.000E 00	0.386E-02
1998	0.288E 09	0.496E 02	0.000E 00	0.000E 00	0.390E-02
1999	0.291E 09	0.501E 02	0.000E 00	0.000E 00	0.395E-02
2000	0.295E 09	0.507E 02	0.000E 00	0.000E 00	0.399E-02
2001	0.298E 09	0.512E 02	0.000E 00	0.000E 00	0.403E-02
2002	0.301E 09	0.518E 02	0.000E 00	0.000E 00	0.408E-02
2003	0.304E 09	0.524E 02	0.000E 00	0.000E 00	0.412E-02
2004	0.308E 09	0.529E 02	0.000E 00	0.000E 00	0.417E-02
2005	0.311E 09	0.535E 02	0.000E 00	0.000E 00	0.421E-02
2006	0.315E 09	0.541E 02	0.000E 00	0.000E 00	0.426E-02
2007	0.318E 09	0.547E 02	0.000E 00	0.000E 00	0.431E-02
2008	0.322E 09	0.553E 02	0.000E 00	0.000E 00	0.435E-02
2009	0.325E 09	0.559E 02	0.000E 00	0.000E 00	0.440E-02
2010	0.329E 09	0.565E 02	0.000E 00	0.000E 00	0.445E-02
2011	0.332E 09	0.571E 02	0.000E 00	0.000E 00	0.450E-02
2012	0.336E 09	0.578E 02	0.000E 00	0.000E 00	0.455E-02
2013	0.340E 09	0.584E 02	0.000E 00	0.000E 00	0.460E-02
2014	0.343E 09	0.591E 02	0.000E 00	0.000E 00	0.465E-02
2015	0.347E 09	0.597E 02	0.000E 00	0.000E 00	0.470E-02
2016	0.351E 09	0.604E 02	0.000E 00	0.000E 00	0.475E-02
2017	0.355E 09	0.610E 02	0.000E 00	0.000E 00	0.480E-02
2018	0.359E 09	0.617E 02	0.000E 00	0.000E 00	0.485E-02
2019	0.363E 09	0.624E 02	0.000E 00	0.000E 00	0.491E-02
2020	0.367E 09	0.630E 02	0.000E 00	0.000E 00	0.496E-02
2021	0.371E 09	0.637E 02	0.000E 00	0.000E 00	0.502E-02
2022	0.375E 09	0.644E 02	0.000E 00	0.000E 00	0.507E-02
2023	0.379E 09	0.651E 02	0.000E 00	0.000E 00	0.513E-02
2024	0.383E 09	0.659E 02	0.000E 00	0.000E 00	0.518E-02
2025	0.387E 09	0.666E 02	0.000E 00	0.000E 00	0.524E-02

	WDW	WDR	WDRG	WDRL	WDRO
1975	0.293E 02	0.117E 02	0.586E 00	0.938E 01	0.176E 01
1976	0.296E 02	0.119E 02	0.593E 00	0.949E 01	0.178E 01
1977	0.300E 02	0.120E 02	0.599E 00	0.959E 01	0.180E 01
1978	0.303E 02	0.121E 02	0.606E 00	0.969E 01	0.182E 01
1979	0.306E 02	0.123E 02	0.613E 00	0.980E 01	0.184E 01
1980	0.310E 02	0.124E 02	0.619E 00	0.991E 01	0.186E 01
1981	0.313E 02	0.125E 02	0.626E 00	0.100E 02	0.188E 01
1982	0.316E 02	0.127E 02	0.633E 00	0.101E 02	0.190E 01
1983	0.320E 02	0.128E 02	0.640E 00	0.102E 02	0.192E 01
1984	0.323E 02	0.129E 02	0.647E 00	0.104E 02	0.194E 01
1985	0.327E 02	0.131E 02	0.654E 00	0.105E 02	0.196E 01
1986	0.331E 02	0.132E 02	0.661E 00	0.106E 02	0.198E 01
1987	0.334E 02	0.134E 02	0.668E 00	0.107E 02	0.201E 01
1988	0.338E 02	0.135E 02	0.676E 00	0.108E 02	0.203E 01
1989	0.342E 02	0.137E 02	0.683E 00	0.109E 02	0.205E 01
1990	0.345E 02	0.138E 02	0.691E 00	0.111E 02	0.207E 01
1991	0.349E 02	0.140E 02	0.698E 00	0.112E 02	0.209E 01
1992	0.353E 02	0.141E 02	0.706E 00	0.113E 02	0.212E 01
1993	0.357E 02	0.143E 02	0.714E 00	0.114E 02	0.214E 01
1994	0.361E 02	0.144E 02	0.722E 00	0.115E 02	0.216E 01
1995	0.365E 02	0.146E 02	0.729E 00	0.117E 02	0.219E 01
1996	0.369E 02	0.147E 02	0.737E 00	0.118E 02	0.221E 01
1997	0.373E 02	0.149E 02	0.746E 00	0.119E 02	0.224E 01
1998	0.377E 02	0.151E 02	0.754E 00	0.121E 02	0.226E 01
1999	0.381E 02	0.152E 02	0.762E 00	0.122E 02	0.229E 01
2000	0.385E 02	0.154E 02	0.770E 00	0.123E 02	0.231E 01
2001	0.389E 02	0.156E 02	0.779E 00	0.125E 02	0.234E 01
2002	0.394E 02	0.157E 02	0.787E 00	0.126E 02	0.236E 01
2003	0.398E 02	0.159E 02	0.796E 00	0.127E 02	0.239E 01
2004	0.402E 02	0.161E 02	0.805E 00	0.129E 02	0.241E 01
2005	0.407E 02	0.163E 02	0.814E 00	0.130E 02	0.244E 01
2006	0.411E 02	0.165E 02	0.823E 00	0.132E 02	0.247E 01
2007	0.416E 02	0.166E 02	0.832E 00	0.133E 02	0.249E 01
2008	0.420E 02	0.168E 02	0.841E 00	0.135E 02	0.252E 01
2009	0.425E 02	0.170E 02	0.850E 00	0.136E 02	0.255E 01
2010	0.430E 02	0.172E 02	0.859E 00	0.137E 02	0.258E 01
2011	0.434E 02	0.174E 02	0.869E 00	0.139E 02	0.261E 01
2012	0.439E 02	0.176E 02	0.878E 00	0.141E 02	0.263E 01
2013	0.444E 02	0.178E 02	0.888E 00	0.142E 02	0.266E 01
2014	0.449E 02	0.180E 02	0.898E 00	0.144E 02	0.269E 01
2015	0.454E 02	0.181E 02	0.907E 00	0.145E 02	0.272E 01
2016	0.459E 02	0.183E 02	0.917E 00	0.147E 02	0.275E 01
2017	0.464E 02	0.185E 02	0.927E 00	0.148E 02	0.278E 01
2018	0.469E 02	0.188E 02	0.938E 00	0.150E 02	0.281E 01
2019	0.474E 02	0.190E 02	0.948E 00	0.152E 02	0.284E 01
2020	0.479E 02	0.192E 02	0.958E 00	0.153E 02	0.287E 01
2021	0.484E 02	0.194E 02	0.969E 00	0.155E 02	0.291E 01
2022	0.490E 02	0.196E 02	0.980E 00	0.157E 02	0.294E 01
2023	0.495E 02	0.198E 02	0.990E 00	0.158E 02	0.297E 01
2024	0.501E 02	0.200E 02	0.100E 01	0.160E 02	0.300E 01
2025	0.506E 02	0.202E 02	0.101E 01	0.162E 02	0.304E 01

	AL	WA	WAG	WAL	WAO
1975	0.936E 06	0.179E 03	0.639E 02	0.115E 03	0.353E-01
1976	0.950E 06	0.182E 03	0.648E 02	0.117E 03	0.359E-01
1977	0.964E 06	0.185E 03	0.658E 02	0.119E 03	0.364E-01
1978	0.979E 06	0.188E 03	0.668E 02	0.121E 03	0.369E-01
1979	0.993E 06	0.190E 03	0.678E 02	0.122E 03	0.375E-01
1980	0.101E 07	0.193E 03	0.688E 02	0.124E 03	0.381E-01
1981	0.102E 07	0.196E 03	0.698E 02	0.126E 03	0.386E-01
1982	0.104E 07	0.199E 03	0.709E 02	0.128E 03	0.392E-01
1983	0.105E 07	0.202E 03	0.719E 02	0.130E 03	0.398E-01
1984	0.107E 07	0.205E 03	0.730E 02	0.132E 03	0.404E-01
1985	0.109E 07	0.208E 03	0.741E 02	0.134E 03	0.410E-01
1986	0.110E 07	0.211E 03	0.752E 02	0.136E 03	0.416E-01
1987	0.112E 07	0.214E 03	0.763E 02	0.138E 03	0.422E-01
1988	0.114E 07	0.218E 03	0.775E 02	0.140E 03	0.429E-01
1989	0.115E 07	0.221E 03	0.786E 02	0.142E 03	0.435E-01
1990	0.117E 07	0.224E 03	0.798E 02	0.144E 03	0.442E-01
1991	0.119E 07	0.228E 03	0.810E 02	0.146E 03	0.448E-01
1992	0.121E 07	0.231E 03	0.822E 02	0.149E 03	0.455E-01
1993	0.122E 07	0.234E 03	0.835E 02	0.151E 03	0.462E-01
1994	0.124E 07	0.238E 03	0.847E 02	0.153E 03	0.469E-01
1995	0.126E 07	0.242E 03	0.860E 02	0.155E 03	0.476E-01
1996	0.128E 07	0.245E 03	0.873E 02	0.158E 03	0.483E-01
1997	0.130E 07	0.249E 03	0.886E 02	0.160E 03	0.490E-01
1998	0.132E 07	0.253E 03	0.899E 02	0.162E 03	0.498E-01
1999	0.134E 07	0.256E 03	0.913E 02	0.165E 03	0.505E-01
2000	0.136E 07	0.260E 03	0.926E 02	0.167E 03	0.513E-01
2001	0.138E 07	0.264E 03	0.940E 02	0.170E 03	0.520E-01
2002	0.140E 07	0.268E 03	0.954E 02	0.172E 03	0.528E-01
2003	0.142E 07	0.272E 03	0.968E 02	0.175E 03	0.536E-01
2004	0.144E 07	0.276E 03	0.983E 02	0.178E 03	0.544E-01
2005	0.146E 07	0.280E 03	0.998E 02	0.180E 03	0.552E-01
2006	0.148E 07	0.284E 03	0.101E 03	0.183E 03	0.560E-01
2007	0.151E 07	0.289E 03	0.103E 03	0.186E 03	0.569E-01
2008	0.153E 07	0.293E 03	0.104E 03	0.188E 03	0.577E-01
2009	0.155E 07	0.297E 03	0.106E 03	0.191E 03	0.586E-01
2010	0.158E 07	0.302E 03	0.107E 03	0.194E 03	0.595E-01
2011	0.160E 07	0.306E 03	0.109E 03	0.197E 03	0.604E-01
2012	0.162E 07	0.311E 03	0.111E 03	0.200E 03	0.613E-01
2013	0.165E 07	0.316E 03	0.112E 03	0.203E 03	0.622E-01
2014	0.167E 07	0.320E 03	0.114E 03	0.206E 03	0.631E-01
2015	0.170E 07	0.325E 03	0.116E 03	0.209E 03	0.641E-01
2016	0.172E 07	0.330E 03	0.118E 03	0.212E 03	0.650E-01
2017	0.175E 07	0.335E 03	0.119E 03	0.215E 03	0.660E-01
2018	0.177E 07	0.340E 03	0.121E 03	0.219E 03	0.670E-01
2019	0.180E 07	0.345E 03	0.123E 03	0.222E 03	0.680E-01
2020	0.183E 07	0.350E 03	0.125E 03	0.225E 03	0.690E-01
2021	0.186E 07	0.356E 03	0.127E 03	0.229E 03	0.701E-01
2022	0.188E 07	0.361E 03	0.128E 03	0.232E 03	0.711E-01
2023	0.191E 07	0.366E 03	0.130E 03	0.236E 03	0.722E-01
2024	0.194E 07	0.372E 03	0.132E 03	0.239E 03	0.732E-01
2025	0.197E 07	0.377E 03	0.134E 03	0.243E 03	0.743E-01

	WAW	WAR	WARG	WARL	WARO
1975	0.828E 02	0.662E 02	0.265E 02	0.397E 02	0.000E 00
1976	0.840E 02	0.672E 02	0.269E 02	0.403E 02	0.000E 00
1977	0.853E 02	0.682E 02	0.273E 02	0.409E 02	0.000E 00
1978	0.866E 02	0.692E 02	0.277E 02	0.415E 02	0.000E 00
1979	0.879E 02	0.703E 02	0.281E 02	0.422E 02	0.000E 00
1980	0.892E 02	0.713E 02	0.285E 02	0.428E 02	0.000E 00
1981	0.905E 02	0.724E 02	0.290E 02	0.434E 02	0.000E 00
1982	0.919E 02	0.735E 02	0.294E 02	0.441E 02	0.000E 00
1983	0.932E 02	0.746E 02	0.298E 02	0.448E 02	0.000E 00
1984	0.946E 02	0.757E 02	0.303E 02	0.454E 02	0.000E 00
1985	0.961E 02	0.768E 02	0.307E 02	0.461E 02	0.000E 00
1986	0.975E 02	0.780E 02	0.312E 02	0.468E 02	0.000E 00
1987	0.990E 02	0.792E 02	0.317E 02	0.475E 02	0.000E 00
1988	0.100E 03	0.804E 02	0.321E 02	0.482E 02	0.000E 00
1989	0.102E 03	0.816E 02	0.326E 02	0.489E 02	0.000E 00
1990	0.103E 03	0.828E 02	0.331E 02	0.497E 02	0.000E 00
1991	0.105E 03	0.840E 02	0.336E 02	0.504E 02	0.000E 00
1992	0.107E 03	0.853E 02	0.341E 02	0.512E 02	0.000E 00
1993	0.108E 03	0.866E 02	0.346E 02	0.519E 02	0.000E 00
1994	0.110E 03	0.879E 02	0.351E 02	0.527E 02	0.000E 00
1995	0.111E 03	0.892E 02	0.357E 02	0.535E 02	0.000E 00
1996	0.113E 03	0.905E 02	0.362E 02	0.543E 02	0.000E 00
1997	0.115E 03	0.919E 02	0.367E 02	0.551E 02	0.000E 00
1998	0.117E 03	0.932E 02	0.373E 02	0.559E 02	0.000E 00
1999	0.118E 03	0.946E 02	0.379E 02	0.568E 02	0.000E 00
2000	0.120E 03	0.961E 02	0.384E 02	0.576E 02	0.000E 00
2001	0.122E 03	0.975E 02	0.390E 02	0.585E 02	0.000E 00
2002	0.124E 03	0.990E 02	0.396E 02	0.594E 02	0.000E 00
2003	0.126E 03	0.100E 03	0.402E 02	0.603E 02	0.000E 00
2004	0.127E 03	0.102E 03	0.408E 02	0.612E 02	0.000E 00
2005	0.129E 03	0.103E 03	0.414E 02	0.621E 02	0.000E 00
2006	0.131E 03	0.105E 03	0.420E 02	0.630E 02	0.000E 00
2007	0.133E 03	0.107E 03	0.426E 02	0.640E 02	0.000E 00
2008	0.135E 03	0.108E 03	0.433E 02	0.649E 02	0.000E 00
2009	0.137E 03	0.110E 03	0.439E 02	0.659E 02	0.000E 00
2010	0.139E 03	0.111E 03	0.446E 02	0.669E 02	0.000E 00
2011	0.141E 03	0.113E 03	0.453E 02	0.679E 02	0.000E 00
2012	0.144E 03	0.115E 03	0.459E 02	0.689E 02	0.000E 00
2013	0.146E 03	0.117E 03	0.466E 02	0.699E 02	0.000E 00
2014	0.148E 03	0.118E 03	0.473E 02	0.710E 02	0.000E 00
2015	0.150E 03	0.120E 03	0.480E 02	0.720E 02	0.000E 00
2016	0.152E 03	0.122E 03	0.488E 02	0.731E 02	0.000E 00
2017	0.155E 03	0.124E 03	0.495E 02	0.742E 02	0.000E 00
2018	0.157E 03	0.126E 03	0.502E 02	0.753E 02	0.000E 00
2019	0.159E 03	0.127E 03	0.510E 02	0.765E 02	0.000E 00
2020	0.162E 03	0.129E 03	0.517E 02	0.776E 02	0.000E 00
2021	0.164E 03	0.131E 03	0.525E 02	0.788E 02	0.000E 00
2022	0.167E 03	0.133E 03	0.533E 02	0.800E 02	0.000E 00
2023	0.169E 03	0.135E 03	0.541E 02	0.811E 02	0.000E 00
2024	0.172E 03	0.137E 03	0.549E 02	0.824E 02	0.000E 00
2025	0.174E 03	0.139E 03	0.557E 02	0.836E 02	0.000E 00

	WIC	WICL	WICG	WICO
1975	0.226E 03	0.158E 03	0.188E 01	0.679E 02
1976	0.234E 03	0.164E 03	0.194E 01	0.702E 02
1977	0.242E 03	0.169E 03	0.201E 01	0.726E 02
1978	0.250E 03	0.175E 03	0.208E 01	0.751E 02
1979	0.259E 03	0.181E 03	0.215E 01	0.776E 02
1980	0.268E 03	0.187E 03	0.222E 01	0.803E 02
1981	0.277E 03	0.194E 03	0.230E 01	0.830E 02
1982	0.286E 03	0.200E 03	0.238E 01	0.858E 02
1983	0.296E 03	0.207E 03	0.246E 01	0.888E 02
1984	0.306E 03	0.214E 03	0.254E 01	0.918E 02
1985	0.317E 03	0.222E 03	0.263E 01	0.950E 02
1986	0.327E 03	0.229E 03	0.272E 01	0.982E 02
1987	0.339E 03	0.237E 03	0.281E 01	0.102E 03
1988	0.350E 03	0.245E 03	0.291E 01	0.105E 03
1989	0.362E 03	0.253E 03	0.301E 01	0.109E 03
1990	0.374E 03	0.262E 03	0.311E 01	0.112E 03
1991	0.387E 03	0.271E 03	0.321E 01	0.116E 03
1992	0.401E 03	0.280E 03	0.332E 01	0.120E 03
1993	0.414E 03	0.290E 03	0.344E 01	0.124E 03
1994	0.428E 03	0.300E 03	0.356E 01	0.129E 03
1995	0.443E 03	0.310E 03	0.368E 01	0.133E 03
1996	0.458E 03	0.321E 03	0.380E 01	0.137E 03
1997	0.474E 03	0.332E 03	0.393E 01	0.142E 03
1998	0.490E 03	0.343E 03	0.407E 01	0.147E 03
1999	0.507E 03	0.355E 03	0.421E 01	0.152E 03
2000	0.524E 03	0.367E 03	0.435E 01	0.157E 03
2001	0.542E 03	0.379E 03	0.450E 01	0.163E 03
2002	0.561E 03	0.392E 03	0.465E 01	0.168E 03
2003	0.580E 03	0.406E 03	0.481E 01	0.174E 03
2004	0.599E 03	0.420E 03	0.498E 01	0.180E 03
2005	0.620E 03	0.434E 03	0.515E 01	0.186E 03
2006	0.641E 03	0.449E 03	0.532E 01	0.192E 03
2007	0.663E 03	0.464E 03	0.550E 01	0.199E 03
2008	0.686E 03	0.480E 03	0.569E 01	0.206E 03
2009	0.709E 03	0.496E 03	0.589E 01	0.213E 03
2010	0.733E 03	0.513E 03	0.609E 01	0.220E 03
2011	0.758E 03	0.531E 03	0.630E 01	0.228E 03
2012	0.784E 03	0.549E 03	0.651E 01	0.235E 03
2013	0.811E 03	0.568E 03	0.673E 01	0.243E 03
2014	0.839E 03	0.587E 03	0.696E 01	0.252E 03
2015	0.868E 03	0.607E 03	0.720E 01	0.260E 03
2016	0.897E 03	0.628E 03	0.745E 01	0.269E 03
2017	0.928E 03	0.650E 03	0.770E 01	0.278E 03
2018	0.960E 03	0.672E 03	0.797E 01	0.288E 03
2019	0.993E 03	0.695E 03	0.824E 01	0.298E 03
2020	0.103E 04	0.718E 03	0.852E 01	0.308E 03
2021	0.106E 04	0.743E 03	0.881E 01	0.318E 03
2022	0.110E 04	0.768E 03	0.911E 01	0.329E 03
2023	0.114E 04	0.795E 03	0.942E 01	0.341E 03
2024	0.117E 04	0.822E 03	0.975E 01	0.352E 03
2025	0.121E 04	0.850E 03	0.101E 02	0.364E 03

	WICW	WIRC	WICRL
1975	0.226E 03	0.226E 03	0.226E 03
1976	0.234E 03	0.234E 03	0.234E 03
1977	0.242E 03	0.242E 03	0.242E 03
1978	0.250E 03	0.250E 03	0.250E 03
1979	0.259E 03	0.259E 03	0.259E 03
1980	0.268E 03	0.268E 03	0.268E 03
1981	0.277E 03	0.277E 03	0.277E 03
1982	0.286E 03	0.286E 03	0.286E 03
1983	0.296E 03	0.296E 03	0.296E 03
1984	0.306E 03	0.306E 03	0.306E 03
1985	0.317E 03	0.317E 03	0.317E 03
1986	0.327E 03	0.327E 03	0.327E 03
1987	0.339E 03	0.339E 03	0.339E 03
1988	0.350E 03	0.350E 03	0.350E 03
1989	0.362E 03	0.362E 03	0.362E 03
1990	0.374E 03	0.374E 03	0.374E 03
1991	0.387E 03	0.387E 03	0.387E 03
1992	0.401E 03	0.401E 03	0.401E 03
1993	0.414E 03	0.414E 03	0.414E 03
1994	0.428E 03	0.428E 03	0.428E 03
1995	0.443E 03	0.443E 03	0.443E 03
1996	0.458E 03	0.458E 03	0.458E 03
1997	0.474E 03	0.474E 03	0.474E 03
1998	0.490E 03	0.490E 03	0.490E 03
1999	0.507E 03	0.507E 03	0.507E 03
2000	0.524E 03	0.524E 03	0.524E 03
2001	0.542E 03	0.542E 03	0.542E 03
2002	0.561E 03	0.561E 03	0.561E 03
2003	0.580E 03	0.580E 03	0.580E 03
2004	0.599E 03	0.599E 03	0.599E 03
2005	0.620E 03	0.620E 03	0.620E 03
2006	0.641E 03	0.641E 03	0.641E 03
2007	0.663E 03	0.663E 03	0.663E 03
2008	0.686E 03	0.686E 03	0.686E 03
2009	0.709E 03	0.709E 03	0.709E 03
2010	0.733E 03	0.733E 03	0.733E 03
2011	0.758E 03	0.758E 03	0.758E 03
2012	0.784E 03	0.784E 03	0.784E 03
2013	0.811E 03	0.811E 03	0.811E 03
2014	0.839E 03	0.839E 03	0.839E 03
2015	0.868E 03	0.868E 03	0.868E 03
2016	0.897E 03	0.897E 03	0.897E 03
2017	0.928E 03	0.928E 03	0.928E 03
2018	0.960E 03	0.960E 03	0.960E 03
2019	0.993E 03	0.993E 03	0.993E 03
2020	0.103E 04	0.103E 04	0.103E 04
2021	0.106E 04	0.106E 04	0.106E 04
2022	0.110E 04	0.110E 04	0.110E 04
2023	0.114E 04	0.114E 04	0.114E 04
2024	0.117E 04	0.117E 04	0.117E 04
2025	0.121E 04	0.121E 04	0.121E 04

B 1382

	TWG	WGL	TWLM	WLO	WLG
1975	0.198E 06	0.400E 03	0.000E 00	0.232E 04	0.480E 03
1976	0.198E 06	0.400E 03	0.500E 01	0.232E 04	0.480E 03
1977	0.198E 06	0.400E 03	0.100E 02	0.232E 04	0.481E 03
1978	0.198E 06	0.400E 03	0.150E 02	0.232E 04	0.481E 03
1979	0.198E 06	0.400E 03	0.200E 02	0.232E 04	0.481E 03
1980	0.198E 06	0.400E 03	0.250E 02	0.232E 04	0.481E 03
1981	0.198E 06	0.400E 03	0.300E 02	0.233E 04	0.481E 03
1982	0.198E 06	0.400E 03	0.350E 02	0.233E 04	0.481E 03
1983	0.198E 06	0.400E 03	0.400E 02	0.233E 04	0.481E 03
1984	0.198E 06	0.400E 03	0.450E 02	0.233E 04	0.481E 03
1985	0.198E 06	0.401E 03	0.500E 02	0.233E 04	0.481E 03
1986	0.198E 06	0.401E 03	0.550E 02	0.233E 04	0.481E 03
1987	0.198E 06	0.401E 03	0.600E 02	0.233E 04	0.481E 03
1988	0.198E 06	0.401E 03	0.650E 02	0.233E 04	0.481E 03
1989	0.198E 06	0.401E 03	0.700E 02	0.233E 04	0.481E 03
1990	0.198E 06	0.401E 03	0.750E 02	0.232E 04	0.481E 03
1991	0.198E 06	0.401E 03	0.800E 02	0.232E 04	0.481E 03
1992	0.198E 06	0.401E 03	0.850E 02	0.232E 04	0.481E 03
1993	0.198E 06	0.401E 03	0.900E 02	0.232E 04	0.480E 03
1994	0.198E 06	0.401E 03	0.950E 02	0.232E 04	0.480E 03
1995	0.198E 06	0.401E 03	0.100E 03	0.232E 04	0.480E 03
1996	0.198E 06	0.401E 03	0.105E 03	0.232E 04	0.480E 03
1997	0.198E 06	0.401E 03	0.110E 03	0.232E 04	0.480E 03
1998	0.198E 06	0.401E 03	0.115E 03	0.232E 04	0.479E 03
1999	0.198E 06	0.401E 03	0.120E 03	0.232E 04	0.479E 03
2000	0.198E 06	0.401E 03	0.125E 03	0.231E 04	0.479E 03
2001	0.198E 06	0.401E 03	0.130E 03	0.231E 04	0.479E 03
2002	0.198E 06	0.401E 03	0.135E 03	0.231E 04	0.478E 03
2003	0.198E 06	0.401E 03	0.140E 03	0.231E 04	0.478E 03
2004	0.198E 06	0.401E 03	0.145E 03	0.231E 04	0.478E 03
2005	0.198E 06	0.401E 03	0.150E 03	0.231E 04	0.477E 03
2006	0.198E 06	0.401E 03	0.155E 03	0.231E 04	0.477E 03
2007	0.198E 06	0.401E 03	0.160E 03	0.230E 04	0.477E 03
2008	0.198E 06	0.401E 03	0.165E 03	0.230E 04	0.476E 03
2009	0.198E 06	0.401E 03	0.170E 03	0.230E 04	0.476E 03
2010	0.198E 06	0.401E 03	0.175E 03	0.230E 04	0.475E 03
2011	0.198E 06	0.400E 03	0.180E 03	0.230E 04	0.475E 03
2012	0.198E 06	0.400E 03	0.185E 03	0.229E 04	0.474E 03
2013	0.198E 06	0.400E 03	0.190E 03	0.229E 04	0.474E 03
2014	0.198E 06	0.400E 03	0.195E 03	0.229E 04	0.473E 03
2015	0.198E 06	0.400E 03	0.200E 03	0.229E 04	0.473E 03
2016	0.198E 06	0.400E 03	0.205E 03	0.228E 04	0.472E 03
2017	0.198E 06	0.400E 03	0.210E 03	0.228E 04	0.472E 03
2018	0.198E 06	0.400E 03	0.215E 03	0.228E 04	0.471E 03
2019	0.198E 06	0.400E 03	0.220E 03	0.228E 04	0.471E 03
2020	0.198E 06	0.400E 03	0.225E 03	0.227E 04	0.470E 03
2021	0.198E 06	0.400E 03	0.230E 03	0.227E 04	0.470E 03
2022	0.198E 06	0.399E 03	0.235E 03	0.227E 04	0.469E 03
2023	0.198E 06	0.399E 03	0.240E 03	0.226E 04	0.468E 03
2024	0.198E 06	0.399E 03	0.245E 03	0.226E 04	0.468E 03
2025	0.198E 06	0.399E 03	0.250E 03	0.226E 04	0.467E 03

	TWL	TWIM
1975	0.400E 05	0.192E 03
1976	0.400E 05	0.192E 03
1977	0.400E 05	0.192E 03
1978	0.401E 05	0.192E 03
1979	0.401E 05	0.192E 03
1980	0.401E 05	0.192E 03
1981	0.401E 05	0.192E 03
1982	0.401E 05	0.192E 03
1983	0.401E 05	0.193E 03
1984	0.401E 05	0.193E 03
1985	0.401E 05	0.193E 03
1986	0.401E 05	0.193E 03
1987	0.401E 05	0.192E 03
1988	0.401E 05	0.192E 03
1989	0.401E 05	0.192E 03
1990	0.401E 05	0.192E 03
1991	0.401E 05	0.192E 03
1992	0.401E 05	0.192E 03
1993	0.400E 05	0.192E 03
1994	0.400E 05	0.192E 03
1995	0.400E 05	0.192E 03
1996	0.400E 05	0.192E 03
1997	0.400E 05	0.192E 03
1998	0.400E 05	0.192E 03
1999	0.399E 05	0.192E 03
2000	0.399E 05	0.192E 03
2001	0.399E 05	0.191E 03
2002	0.399E 05	0.191E 03
2003	0.398E 05	0.191E 03
2004	0.398E 05	0.191E 03
2005	0.398E 05	0.191E 03
2006	0.397E 05	0.191E 03
2007	0.397E 05	0.191E 03
2008	0.397E 05	0.190E 03
2009	0.396E 05	0.190E 03
2010	0.396E 05	0.190E 03
2011	0.396E 05	0.190E 03
2012	0.395E 05	0.190E 03
2013	0.395E 05	0.190E 03
2014	0.395E 05	0.189E 03
2015	0.394E 05	0.189E 03
2016	0.394E 05	0.189E 03
2017	0.393E 05	0.189E 03
2018	0.393E 05	0.189E 03
2019	0.392E 05	0.188E 03
2020	0.392E 05	0.188E 03
2021	0.391E 05	0.188E 03
2022	0.391E 05	0.188E 03
2023	0.390E 05	0.187E 03
2024	0.390E 05	0.187E 03
2025	0.389E 05	0.187E 03

	WLIP	WOIP	WGIP	WOSIP	WLMIP
1975	0.530E 02	0.000E 00	0.124E 02	0.304E-01	0.000E 00
1976	0.536E 02	0.000E 00	0.124E 02	0.315E-01	0.645E 00
1977	0.541E 02	0.000E 00	0.124E 02	0.338E-01	0.129E 01
1978	0.547E 02	0.000E 00	0.124E 02	0.371E-01	0.193E 01
1979	0.553E 02	0.000E 00	0.124E 02	0.416E-01	0.258E 01
1980	0.558E 02	0.000E 00	0.124E 02	0.472E-01	0.322E 01
1981	0.564E 02	0.000E 00	0.124E 02	0.539E-01	0.387E 01
1982	0.570E 02	0.000E 00	0.124E 02	0.618E-01	0.451E 01
1983	0.575E 02	0.000E 00	0.124E 02	0.707E-01	0.516E 01
1984	0.581E 02	0.000E 00	0.124E 02	0.808E-01	0.580E 01
1985	0.587E 02	0.000E 00	0.124E 02	0.920E-01	0.645E 01
1986	0.593E 02	0.000E 00	0.124E 02	0.104E 00	0.709E 01
1987	0.599E 02	0.000E 00	0.124E 02	0.118E 00	0.774E 01
1988	0.605E 02	0.000E 00	0.124E 02	0.132E 00	0.838E 01
1989	0.610E 02	0.000E 00	0.124E 02	0.148E 00	0.903E 01
1990	0.616E 02	0.000E 00	0.124E 02	0.165E 00	0.967E 01
1991	0.622E 02	0.000E 00	0.124E 02	0.183E 00	0.103E 02
1992	0.628E 02	0.000E 00	0.124E 02	0.202E 00	0.110E 02
1993	0.634E 02	0.000E 00	0.124E 02	0.222E 00	0.116E 02
1994	0.641E 02	0.000E 00	0.124E 02	0.243E 00	0.123E 02
1995	0.647E 02	0.000E 00	0.124E 02	0.266E 00	0.129E 02
1996	0.653E 02	0.000E 00	0.124E 02	0.289E 00	0.135E 02
1997	0.659E 02	0.000E 00	0.124E 02	0.314E 00	0.142E 02
1998	0.665E 02	0.000E 00	0.124E 02	0.340E 00	0.148E 02
1999	0.672E 02	0.000E 00	0.124E 02	0.366E 00	0.155E 02
2000	0.678E 02	0.000E 00	0.124E 02	0.394E 00	0.161E 02
2001	0.684E 02	0.000E 00	0.124E 02	0.424E 00	0.168E 02
2002	0.691E 02	0.000E 00	0.124E 02	0.454E 00	0.174E 02
2003	0.697E 02	0.000E 00	0.124E 02	0.485E 00	0.181E 02
2004	0.704E 02	0.000E 00	0.124E 02	0.518E 00	0.187E 02
2005	0.710E 02	0.000E 00	0.124E 02	0.551E 00	0.193E 02
2006	0.717E 02	0.000E 00	0.124E 02	0.586E 00	0.200E 02
2007	0.723E 02	0.000E 00	0.124E 02	0.622E 00	0.206E 02
2008	0.730E 02	0.000E 00	0.124E 02	0.659E 00	0.213E 02
2009	0.736E 02	0.000E 00	0.124E 02	0.697E 00	0.219E 02
2010	0.743E 02	0.000E 00	0.124E 02	0.736E 00	0.226E 02
2011	0.750E 02	0.000E 00	0.124E 02	0.776E 00	0.232E 02
2012	0.757E 02	0.000E 00	0.124E 02	0.818E 00	0.239E 02
2013	0.763E 02	0.000E 00	0.124E 02	0.860E 00	0.245E 02
2014	0.770E 02	0.000E 00	0.124E 02	0.904E 00	0.252E 02
2015	0.777E 02	0.000E 00	0.124E 02	0.949E 00	0.258E 02
2016	0.784E 02	0.000E 00	0.124E 02	0.995E 00	0.264E 02
2017	0.791E 02	0.000E 00	0.124E 02	0.104E 01	0.271E 02
2018	0.798E 02	0.000E 00	0.124E 02	0.109E 01	0.277E 02
2019	0.805E 02	0.000E 00	0.124E 02	0.114E 01	0.284E 02
2020	0.812E 02	0.000E 00	0.124E 02	0.119E 01	0.290E 02
2021	0.819E 02	0.000E 00	0.124E 02	0.124E 01	0.297E 02
2022	0.826E 02	0.000E 00	0.124E 02	0.129E 01	0.303E 02
2023	0.833E 02	0.000E 00	0.124E 02	0.135E 01	0.310E 02
2024	0.840E 02	0.000E 00	0.124E 02	0.140E 01	0.316E 02
2025	0.847E 02	0.000E 00	0.124E 02	0.146E 01	0.322E 02

B 1385

	WLDP	WODP	WGDP	WOSDP	WLMDP
1975	0.254E 02	0.000E 00	0.127E 02	0.456E-01	0.000E 00
1976	0.254E 02	0.000E 00	0.127E 02	0.473E-01	0.375E 00
1977	0.254E 02	0.000E 00	0.127E 02	0.506E-01	0.750E 00
1978	0.254E 02	0.000E 00	0.127E 02	0.557E-01	0.112E 01
1979	0.254E 02	0.000E 00	0.127E 02	0.624E-01	0.150E 01
1980	0.255E 02	0.000E 00	0.127E 02	0.708E-01	0.187E 01
1981	0.255E 02	0.000E 00	0.127E 02	0.809E-01	0.225E 01
1982	0.255E 02	0.000E 00	0.127E 02	0.926E-01	0.262E 01
1983	0.255E 02	0.000E 00	0.127E 02	0.106E 00	0.300E 01
1984	0.255E 02	0.000E 00	0.127E 02	0.121E 00	0.337E 01
1985	0.255E 02	0.000E 00	0.127E 02	0.138E 00	0.375E 01
1986	0.255E 02	0.000E 00	0.127E 02	0.156E 00	0.412E 01
1987	0.255E 02	0.000E 00	0.127E 02	0.177E 00	0.450E 01
1988	0.255E 02	0.000E 00	0.127E 02	0.198E 00	0.487E 01
1989	0.255E 02	0.000E 00	0.127E 02	0.222E 00	0.525E 01
1990	0.254E 02	0.000E 00	0.127E 02	0.247E 00	0.562E 01
1991	0.254E 02	0.000E 00	0.127E 02	0.274E 00	0.600E 01
1992	0.254E 02	0.000E 00	0.127E 02	0.303E 00	0.637E 01
1993	0.254E 02	0.000E 00	0.127E 02	0.333E 00	0.675E 01
1994	0.254E 02	0.000E 00	0.127E 02	0.365E 00	0.712E 01
1995	0.254E 02	0.000E 00	0.127E 02	0.398E 00	0.750E 01
1996	0.254E 02	0.000E 00	0.127E 02	0.434E 00	0.787E 01
1997	0.254E 02	0.000E 00	0.127E 02	0.471E 00	0.825E 01
1998	0.254E 02	0.000E 00	0.127E 02	0.509E 00	0.862E 01
1999	0.254E 02	0.000E 00	0.127E 02	0.550E 00	0.900E 01
2000	0.253E 02	0.000E 00	0.127E 02	0.592E 00	0.937E 01
2001	0.253E 02	0.000E 00	0.127E 02	0.635E 00	0.975E 01
2002	0.253E 02	0.000E 00	0.127E 02	0.681E 00	0.101E 02
2003	0.253E 02	0.000E 00	0.127E 02	0.728E 00	0.105E 02
2004	0.253E 02	0.000E 00	0.127E 02	0.776E 00	0.109E 02
2005	0.253E 02	0.000E 00	0.127E 02	0.827E 00	0.112E 02
2006	0.252E 02	0.000E 00	0.127E 02	0.879E 00	0.116E 02
2007	0.252E 02	0.000E 00	0.127E 02	0.933E 00	0.120E 02
2008	0.252E 02	0.000E 00	0.127E 02	0.988E 00	0.124E 02
2009	0.252E 02	0.000E 00	0.127E 02	0.105E 01	0.127E 02
2010	0.252E 02	0.000E 00	0.127E 02	0.110E 01	0.131E 02
2011	0.251E 02	0.000E 00	0.127E 02	0.116E 01	0.135E 02
2012	0.251E 02	0.000E 00	0.127E 02	0.123E 01	0.139E 02
2013	0.251E 02	0.000E 00	0.127E 02	0.129E 01	0.142E 02
2014	0.251E 02	0.000E 00	0.127E 02	0.136E 01	0.146E 02
2015	0.250E 02	0.000E 00	0.127E 02	0.142E 01	0.150E 02
2016	0.250E 02	0.000E 00	0.127E 02	0.149E 01	0.154E 02
2017	0.250E 02	0.000E 00	0.127E 02	0.156E 01	0.157E 02
2018	0.249E 02	0.000E 00	0.127E 02	0.163E 01	0.161E 02
2019	0.249E 02	0.000E 00	0.127E 02	0.171E 01	0.165E 02
2020	0.249E 02	0.000E 00	0.127E 02	0.178E 01	0.169E 02
2021	0.249E 02	0.000E 00	0.127E 02	0.186E 01	0.172E 02
2022	0.248E 02	0.000E 00	0.127E 02	0.194E 01	0.176E 02
2023	0.248E 02	0.000E 00	0.127E 02	0.202E 01	0.180E 02
2024	0.247E 02	0.000E 00	0.127E 02	0.210E 01	0.184E 02
2025	0.247E 02	0.000E 00	0.127E 02	0.219E 01	0.187E 02

B 1386

	WLAP	WOAP	WGAP	WOSAP	WLMAP
					0.000E 00
1975	0.116E 03	0.000E 00	0.627E 02	0.000E 00	0.174E 01
1976	0.117E 03	0.000E 00	0.633E 02	0.000E 00	0.349E 01
1977	0.119E 03	0.000E 00	0.640E 02	0.000E 00	0.523E 01
1978	0.120E 03	0.000E 00	0.646E 02	0.000E 00	0.698E 01
1979	0.121E 03	0.000E 00	0.653E 02	0.000E 00	0.872E 01
1980	0.122E 03	0.000E 00	0.660E 02	0.000E 00	0.105E 02
1981	0.124E 03	0.000E 00	0.666E 02	0.000E 00	0.122E 02
1982	0.125E 03	0.000E 00	0.673E 02	0.000E 00	0.140E 02
1983	0.126E 03	0.000E 00	0.680E 02	0.000E 00	0.157E 02
1984	0.127E 03	0.000E 00	0.687E 02	0.000E 00	0.174E 02
1985	0.129E 03	0.000E 00	0.694E 02	0.000E 00	0.192E 02
1986	0.130E 03	0.000E 00	0.701E 02	0.000E 00	0.209E 02
1987	0.131E 03	0.000E 00	0.708E 02	0.000E 00	0.227E 02
1988	0.132E 03	0.000E 00	0.715E 02	0.000E 00	0.244E 02
1989	0.134E 03	0.000E 00	0.722E 02	0.000E 00	0.262E 02
1990	0.135E 03	0.000E 00	0.729E 02	0.000E 00	0.279E 02
1991	0.136E 03	0.000E 00	0.737E 02	0.000E 00	0.297E 02
1992	0.138E 03	0.000E 00	0.744E 02	0.000E 00	0.314E 02
1993	0.139E 03	0.000E 00	0.751E 02	0.000E 00	0.332E 02
1994	0.140E 03	0.000E 00	0.759E 02	0.000E 00	0.349E 02
1995	0.142E 03	0.000E 00	0.767E 02	0.000E 00	0.366E 02
1996	0.143E 03	0.000E 00	0.774E 02	0.000E 00	0.384E 02
1997	0.144E 03	0.000E 00	0.782E 02	0.000E 00	0.401E 02
1998	0.146E 03	0.000E 00	0.790E 02	0.000E 00	0.419E 02
1999	0.147E 03	0.000E 00	0.798E 02	0.000E 00	0.436E 02
2000	0.149E 03	0.000E 00	0.806E 02	0.000E 00	0.454E 02
2001	0.150E 03	0.000E 00	0.814E 02	0.000E 00	0.471E 02
2002	0.151E 03	0.000E 00	0.822E 02	0.000E 00	0.489E 02
2003	0.153E 03	0.000E 00	0.830E 02	0.000E 00	0.506E 02
2004	0.154E 03	0.000E 00	0.838E 02	0.000E 00	0.523E 02
2005	0.156E 03	0.000E 00	0.847E 02	0.000E 00	0.541E 02
2006	0.157E 03	0.000E 00	0.855E 02	0.000E 00	0.558E 02
2007	0.158E 03	0.000E 00	0.863E 02	0.000E 00	0.576E 02
2008	0.160E 03	0.000E 00	0.872E 02	0.000E 00	0.593E 02
2009	0.161E 03	0.000E 00	0.881E 02	0.000E 00	0.611E 02
2010	0.163E 03	0.000E 00	0.889E 02	0.000E 00	0.628E 02
2011	0.164E 03	0.000E 00	0.898E 02	0.000E 00	0.646E 02
2012	0.166E 03	0.000E 00	0.907E 02	0.000E 00	0.663E 02
2013	0.167E 03	0.000E 00	0.916E 02	0.000E 00	0.681E 02
2014	0.169E 03	0.000E 00	0.925E 02	0.000E 00	0.698E 02
2015	0.170E 03	0.000E 00	0.934E 02	0.000E 00	0.715E 02
2016	0.172E 03	0.000E 00	0.943E 02	0.000E 00	0.733E 02
2017	0.173E 03	0.000E 00	0.952E 02	0.000E 00	0.750E 02
2018	0.175E 03	0.000E 00	0.961E 02	0.000E 00	0.768E 02
2019	0.176E 03	0.000E 00	0.971E 02	0.000E 00	0.785E 02
2020	0.178E 03	0.000E 00	0.980E 02	0.000E 00	0.803E 02
2021	0.179E 03	0.000E 00	0.990E 02	0.000E 00	0.820E 02
2022	0.181E 03	0.000E 00	0.999E 02	0.000E 00	0.838E 02
2023	0.183E 03	0.000E 00	0.101E 03	0.000E 00	0.855E 02
2024	0.184E 03	0.000E 00	0.102E 03	0.000E 00	0.872E 02
2025	0.186E 03	0.000E 00	0.103E 03	0.000E 00	

	WLICP	WOICP	WGICP	WOSICP	WLMICP
1975	0.683E 02	0.161E 03	0.588E 01	0.000E 00	0.000E 00
1976	0.690E 02	0.165E 03	0.588E 01	0.000E 00	0.223E 01
1977	0.697E 02	0.168E 03	0.588E 01	0.000E 00	0.447E 01
1978	0.704E 02	0.172E 03	0.588E 01	0.000E 00	0.670E 01
1979	0.712E 02	0.175E 03	0.588E 01	0.000E 00	0.894E 01
1980	0.719E 02	0.179E 03	0.589E 01	0.000E 00	0.112E 02
1981	0.726E 02	0.183E 03	0.589E 01	0.000E 00	0.134E 02
1982	0.734E 02	0.187E 03	0.589E 01	0.000E 00	0.156E 02
1983	0.741E 02	0.191E 03	0.589E 01	0.000E 00	0.179E 02
1984	0.749E 02	0.195E 03	0.589E 01	0.000E 00	0.201E 02
1985	0.756E 02	0.199E 03	0.589E 01	0.000E 00	0.223E 02
1986	0.764E 02	0.203E 03	0.589E 01	0.000E 00	0.246E 02
1987	0.771E 02	0.207E 03	0.589E 01	0.000E 00	0.268E 02
1988	0.779E 02	0.212E 03	0.589E 01	0.000E 00	0.291E 02
1989	0.786E 02	0.216E 03	0.589E 01	0.000E 00	0.313E 02
1990	0.794E 02	0.220E 03	0.589E 01	0.000E 00	0.335E 02
1991	0.802E 02	0.225E 03	0.589E 01	0.000E 00	0.358E 02
1992	0.809E 02	0.230E 03	0.589E 01	0.000E 00	0.380E 02
1993	0.817E 02	0.235E 03	0.589E 01	0.000E 00	0.402E 02
1994	0.825E 02	0.240E 03	0.589E 01	0.000E 00	0.425E 02
1995	0.833E 02	0.245E 03	0.589E 01	0.000E 00	0.447E 02
1996	0.841E 02	0.250E 03	0.589E 01	0.000E 00	0.469E 02
1997	0.849E 02	0.255E 03	0.589E 01	0.000E 00	0.492E 02
1998	0.857E 02	0.260E 03	0.589E 01	0.000E 00	0.514E 02
1999	0.865E 02	0.266E 03	0.589E 01	0.000E 00	0.536E 02
2000	0.873E 02	0.271E 03	0.589E 01	0.000E 00	0.559E 02
2001	0.881E 02	0.277E 03	0.589E 01	0.000E 00	0.581E 02
2002	0.890E 02	0.283E 03	0.589E 01	0.000E 00	0.603E 02
2003	0.898E 02	0.289E 03	0.589E 01	0.000E 00	0.626E 02
2004	0.906E 02	0.295E 03	0.589E 01	0.000E 00	0.648E 02
2005	0.914E 02	0.301E 03	0.589E 01	0.000E 00	0.670E 02
2006	0.923E 02	0.307E 03	0.589E 01	0.000E 00	0.693E 02
2007	0.931E 02	0.314E 03	0.589E 01	0.000E 00	0.715E 02
2008	0.940E 02	0.320E 03	0.589E 01	0.000E 00	0.738E 02
2009	0.948E 02	0.327E 03	0.589E 01	0.000E 00	0.760E 02
2010	0.957E 02	0.334E 03	0.589E 01	0.000E 00	0.782E 02
2011	0.966E 02	0.341E 03	0.589E 01	0.000E 00	0.805E 02
2012	0.974E 02	0.348E 03	0.589E 01	0.000E 00	0.827E 02
2013	0.983E 02	0.355E 03	0.589E 01	0.000E 00	0.849E 02
2014	0.992E 02	0.363E 03	0.589E 01	0.000E 00	0.872E 02
2015	0.100E 03	0.371E 03	0.588E 01	0.000E 00	0.894E 02
2016	0.101E 03	0.378E 03	0.588E 01	0.000E 00	0.916E 02
2017	0.102E 03	0.386E 03	0.588E 01	0.000E 00	0.939E 02
2018	0.103E 03	0.394E 03	0.588E 01	0.000E 00	0.961E 02
2019	0.104E 03	0.403E 03	0.588E 01	0.000E 00	0.983E 02
2020	0.105E 03	0.411E 03	0.588E 01	0.000E 00	0.101E 03
2021	0.105E 03	0.420E 03	0.588E 01	0.000E 00	0.103E 03
2022	0.106E 03	0.429E 03	0.587E 01	0.000E 00	0.105E 03
2023	0.107E 03	0.438E 03	0.587E 01	0.000E 00	0.107E 03
2024	0.108E 03	0.447E 03	0.587E 01	0.000E 00	0.110E 03
2025	0.109E 03	0.456E 03	0.587E 01	0.000E 00	0.112E 03

	WIP	WDP	WAP	WICP
1975	0.770E 02	0.440E 02	0.179E 03	0.236E 03
1976	0.786E 02	0.445E 02	0.182E 03	0.242E 03
1977	0.802E 02	0.449E 02	0.186E 03	0.248E 03
1978	0.819E 02	0.454E 02	0.190E 03	0.255E 03
1979	0.835E 02	0.458E 02	0.193E 03	0.261E 03
1980	0.852E 02	0.463E 02	0.197E 03	0.268E 03
1981	0.918E 02	0.489E 02	0.201E 03	0.275E 03
1982	0.937E 02	0.494E 02	0.204E 03	0.282E 03
1983	0.956E 02	0.499E 02	0.208E 03	0.289E 03
1984	0.975E 02	0.504E 02	0.212E 03	0.296E 03
1985	0.995E 02	0.509E 02	0.215E 03	0.303E 03
1986	0.101E 03	0.514E 02	0.219E 03	0.310E 03
1987	0.104E 03	0.519E 02	0.223E 03	0.317E 03
1988	0.106E 03	0.524E 02	0.227E 03	0.324E 03
1989	0.108E 03	0.529E 02	0.230E 03	0.332E 03
1990	0.110E 03	0.534E 02	0.234E 03	0.339E 03
1991	0.119E 03	0.563E 02	0.238E 03	0.347E 03
1992	0.121E 03	0.568E 02	0.242E 03	0.355E 03
1993	0.124E 03	0.574E 02	0.246E 03	0.363E 03
1994	0.126E 03	0.579E 02	0.249E 03	0.370E 03
1995	0.129E 03	0.584E 02	0.253E 03	0.379E 03
1996	0.131E 03	0.590E 02	0.257E 03	0.387E 03
1997	0.134E 03	0.595E 02	0.261E 03	0.395E 03
1998	0.137E 03	0.600E 02	0.265E 03	0.403E 03
1999	0.139E 03	0.606E 02	0.269E 03	0.412E 03
2000	0.142E 03	0.611E 02	0.273E 03	0.420E 03
2001	0.169E 03	0.683E 02	0.277E 03	0.429E 03
2002	0.172E 03	0.689E 02	0.281E 03	0.438E 03
2003	0.176E 03	0.695E 02	0.285E 03	0.447E 03
2004	0.180E 03	0.702E 02	0.289E 03	0.456E 03
2005	0.184E 03	0.708E 02	0.293E 03	0.465E 03
2006	0.188E 03	0.714E 02	0.297E 03	0.475E 03
2007	0.192E 03	0.721E 02	0.301E 03	0.484E 03
2008	0.197E 03	0.727E 02	0.305E 03	0.494E 03
2009	0.201E 03	0.734E 02	0.309E 03	0.504E 03
2010	0.206E 03	0.740E 02	0.313E 03	0.514E 03
2011	0.245E 03	0.825E 02	0.317E 03	0.524E 03
2012	0.251E 03	0.832E 02	0.321E 03	0.534E 03
2013	0.257E 03	0.840E 02	0.325E 03	0.545E 03
2014	0.264E 03	0.847E 02	0.329E 03	0.555E 03
2015	0.270E 03	0.855E 02	0.333E 03	0.566E 03
2016	0.277E 03	0.862E 02	0.338E 03	0.577E 03
2017	0.283E 03	0.870E 02	0.342E 03	0.588E 03
2018	0.290E 03	0.877E 02	0.346E 03	0.599E 03
2019	0.298E 03	0.885E 02	0.350E 03	0.611E 03
2020	0.305E 03	0.893E 02	0.354E 03	0.622E 03
2021	0.359E 03	0.983E 02	0.359E 03	0.634E 03
2022	0.368E 03	0.992E 02	0.363E 03	0.646E 03
2023	0.378E 03	0.100E 03	0.367E 03	0.658E 03
2024	0.388E 03	0.101E 03	0.371E 03	0.670E 03
2025	0.398E 03	0.102E 03	0.376E 03	0.683E 03

	SWI	SWD	SWA	SWIC
1975	0.120E 02	0.542E 01	-0.504E 00	0.945E 01
1976	0.114E 02	0.546E 01	0.412E 00	0.807E 01
1977	0.107E 02	0.549E 01	0.130E 01	0.649E 01
1978	0.997E 01	0.551E 01	0.216E 01	0.471E 01
1979	0.916E 01	0.553E 01	0.299E 01	0.273E 01
1980	0.829E 01	0.555E 01	0.379E 01	0.539E 00
1981	0.123E 02	0.775E 01	0.455E 01	-0.188E 01
1982	0.115E 02	0.779E 01	0.528E 01	-0.452E 01
1983	0.106E 02	0.782E 01	0.598E 01	-0.741E 01
1984	0.959E 01	0.784E 01	0.665E 01	-0.105E 02
1985	0.855E 01	0.787E 01	0.729E 01	-0.139E 02
1986	0.743E 01	0.788E 01	0.789E 01	-0.176E 02
1987	0.623E 01	0.790E 01	0.846E 01	-0.216E 02
1988	0.495E 01	0.791E 01	0.899E 01	-0.258E 02
1989	0.359E 01	0.792E 01	0.950E 01	-0.303E 02
1990	0.215E 01	0.792E 01	0.996E 01	-0.352E 02
1991	0.755E 01	0.104E 02	0.104E 02	-0.403E 02
1992	0.616E 01	0.104E 02	0.108E 02	-0.458E 02
1993	0.469E 01	0.104E 02	0.111E 02	-0.517E 02
1994	0.313E 01	0.104E 02	0.115E 02	-0.579E 02
1995	0.147E 01	0.104E 02	0.117E 02	-0.645E 02
1996	-0.275E 00	0.104E 02	0.120E 02	-0.715E 02
1997	-0.212E 01	0.104E 02	0.122E 02	-0.789E 02
1998	-0.408E 01	0.104E 02	0.124E 02	-0.867E 02
1999	-0.613E 01	0.104E 02	0.125E 02	-0.949E 02
2000	-0.830E 01	0.104E 02	0.126E 02	-0.104E 03
2001	0.130E 02	0.170E 02	0.126E 02	-0.113E 03
2002	0.114E 02	0.171E 02	0.126E 02	-0.122E 03
2003	0.970E 01	0.172E 02	0.125E 02	-0.133E 03
2004	0.791E 01	0.172E 02	0.125E 02	-0.143E 03
2005	0.603E 01	0.173E 02	0.123E 02	-0.155E 03
2006	0.404E 01	0.173E 02	0.121E 02	-0.166E 03
2007	0.194E 01	0.174E 02	0.119E 02	-0.179E 03
2008	-0.283E 00	0.174E 02	0.116E 02	-0.192E 03
2009	-0.262E 01	0.174E 02	0.113E 02	-0.205E 03
2010	-0.507E 01	0.175E 02	0.109E 02	-0.220E 03
2011	0.273E 02	0.253E 02	0.105E 02	-0.235E 03
2012	0.258E 02	0.254E 02	0.998E 01	-0.250E 03
2013	0.241E 02	0.255E 02	0.944E 01	-0.267E 03
2014	0.224E 02	0.256E 02	0.885E 01	-0.284E 03
2015	0.206E 02	0.258E 02	0.819E 01	-0.302E 03
2016	0.187E 02	0.259E 02	0.750E 01	-0.320E 03
2017	0.167E 02	0.260E 02	0.674E 01	-0.340E 03
2018	0.146E 02	0.261E 02	0.591E 01	-0.361E 03
2019	0.123E 02	0.261E 02	0.504E 01	-0.382E 03
2020	0.996E 01	0.262E 02	0.409E 01	-0.404E 03
2021	0.536E 02	0.346E 02	0.308E 01	-0.428E 03
2022	0.526E 02	0.347E 02	0.201E 01	-0.452E 03
2023	0.515E 02	0.349E 02	0.867E 00	-0.477E 03
2024	0.502E 02	0.351E 02	-0.336E 00	-0.504E 03
2025	0.489E 02	0.352E 02	-0.162E 01	-0.531E 03

	TWS	ENH	EH	SE
1975	0.760E-01	0.320E 06	0.591E 05	-0.585E 04
1976	0.788E-01	0.343E 06	0.633E 05	0.165E 05
1977	0.844E-01	0.367E 06	0.678E 05	0.406E 05
1978	0.928E-01	0.393E 06	0.726E 05	0.668E 05
1979	0.104E 00	0.421E 06	0.778E 05	0.950E 05
1980	0.118E 00	0.451E 06	0.833E 05	0.126E 06
1981	0.135E 00	0.483E 06	0.892E 05	0.158E 06
1982	0.154E 00	0.517E 06	0.955E 05	0.194E 06
1983	0.177E 00	0.554E 06	0.102E 06	0.232E 06
1984	0.202E 00	0.593E 06	0.110E 06	0.274E 06
1985	0.230E 00	0.635E 06	0.117E 06	0.318E 06
1986	0.261E 00	0.680E 06	0.126E 06	0.366E 06
1987	0.294E 00	0.729E 06	0.135E 06	0.418E 06
1988	0.331E 00	0.780E 06	0.144E 06	0.473E 06
1989	0.370E 00	0.836E 06	0.154E 06	0.533E 06
1990	0.412E 00	0.895E 06	0.165E 06	0.598E 06
1991	0.457E 00	0.959E 06	0.177E 06	0.667E 06
1992	0.504E 00	0.103E 07	0.190E 06	0.741E 06
1993	0.555E 00	0.110E 07	0.203E 06	0.821E 06
1994	0.608E 00	0.118E 07	0.218E 06	0.907E 06
1995	0.664E 00	0.126E 07	0.233E 06	0.100E 07
1996	0.723E 00	0.135E 07	0.250E 06	0.110E 07
1997	0.784E 00	0.145E 07	0.267E 06	0.121E 07
1998	0.849E 00	0.155E 07	0.286E 06	0.132E 07
1999	0.916E 00	0.166E 07	0.307E 06	0.144E 07
2000	0.986E 00	0.178E 07	0.328E 06	0.157E 07
2001	0.106E 01	0.190E 07	0.352E 06	0.172E 07
2002	0.113E 01	0.204E 07	0.377E 06	0.187E 07
2003	0.121E 01	0.218E 07	0.403E 06	0.203E 07
2004	0.129E 01	0.234E 07	0.432E 06	0.221E 07
2005	0.138E 01	0.250E 07	0.463E 06	0.239E 07
2006	0.146E 01	0.268E 07	0.496E 06	0.260E 07
2007	0.155E 01	0.287E 07	0.531E 06	0.281E 07
2008	0.165E 01	0.308E 07	0.568E 06	0.304E 07
2009	0.174E 01	0.330E 07	0.609E 06	0.329E 07
2010	0.184E 01	0.353E 07	0.652E 06	0.356E 07
2011	0.194E 01	0.378E 07	0.698E 06	0.385E 07
2012	0.204E 01	0.405E 07	0.748E 06	0.415E 07
2013	0.215E 01	0.434E 07	0.801E 06	0.448E 07
2014	0.226E 01	0.464E 07	0.858E 06	0.483E 07
2015	0.237E 01	0.497E 07	0.919E 06	0.521E 07
2016	0.249E 01	0.533E 07	0.984E 06	0.562E 07
2017	0.260E 01	0.570E 07	0.105E 07	0.605E 07
2018	0.272E 01	0.611E 07	0.113E 07	0.652E 07
2019	0.285E 01	0.654E 07	0.121E 07	0.702E 07
2020	0.297E 01	0.701E 07	0.129E 07	0.755E 07
2021	0.310E 01	0.750E 07	0.139E 07	0.813E 07
2022	0.323E 01	0.804E 07	0.148E 07	0.874E 07
2023	0.337E 01	0.861E 07	0.159E 07	0.940E 07
2024	0.351E 01	0.922E 07	0.170E 07	0.101E 08
2025	0.365E 01	0.987E 07	0.182E 07	0.109E 08

	FACT	PIND1	PIND2
1975	0.509E 03	0.127E-01	0.257E-02
1976	0.522E 03	0.130E-01	0.264E-02
1977	0.536E 03	0.134E-01	0.270E-02
1978	0.549E 03	0.137E-01	0.277E-02
1979	0.564E 03	0.141E-01	0.285E-02
1980	0.578E 03	0.144E-01	0.292E-02
1981	0.594E 03	0.148E-01	0.299E-02
1982	0.609E 03	0.152E-01	0.307E-02
1983	0.625E 03	0.156E-01	0.315E-02
1984	0.642E 03	0.160E-01	0.324E-02
1985	0.659E 03	0.164E-01	0.332E-02
1986	0.676E 03	0.169E-01	0.341E-02
1987	0.694E 03	0.173E-01	0.350E-02
1988	0.713E 03	0.178E-01	0.359E-02
1989	0.732E 03	0.183E-01	0.369E-02
1990	0.752E 03	0.188E-01	0.379E-02
1991	0.772E 03	0.193E-01	0.389E-02
1992	0.793E 03	0.198E-01	0.400E-02
1993	0.815E 03	0.203E-01	0.411E-02
1994	0.837E 03	0.209E-01	0.422E-02
1995	0.860E 03	0.215E-01	0.433E-02
1996	0.883E 03	0.221E-01	0.445E-02
1997	0.908E 03	0.227E-01	0.458E-02
1998	0.933E 03	0.234E-01	0.470E-02
1999	0.959E 03	0.240E-01	0.483E-02
2000	0.986E 03	0.247E-01	0.497E-02
2001	0.101E 04	0.254E-01	0.511E-02
2002	0.104E 04	0.261E-01	0.525E-02
2003	0.107E 04	0.269E-01	0.540E-02
2004	0.110E 04	0.277E-01	0.555E-02
2005	0.113E 04	0.285E-01	0.571E-02
2006	0.116E 04	0.293E-01	0.587E-02
2007	0.120E 04	0.301E-01	0.603E-02
2008	0.123E 04	0.310E-01	0.621E-02
2009	0.127E 04	0.319E-01	0.639E-02
2010	0.130E 04	0.329E-01	0.657E-02
2011	0.134E 04	0.339E-01	0.676E-02
2012	0.138E 04	0.349E-01	0.695E-02
2013	0.142E 04	0.359E-01	0.716E-02
2014	0.146E 04	0.370E-01	0.737E-02
2015	0.150E 04	0.381E-01	0.758E-02
2016	0.155E 04	0.393E-01	0.780E-02
2017	0.159E 04	0.405E-01	0.803E-02
2018	0.164E 04	0.417E-01	0.827E-02
2019	0.169E 04	0.430E-01	0.851E-02
2020	0.173E 04	0.443E-01	0.877E-02
2021	0.179E 04	0.456E-01	0.903E-02
2022	0.184E 04	0.470E-01	0.930E-02
2023	0.189E 04	0.485E-01	0.958E-02
2024	0.195E 04	0.500E-01	0.986E-02
2025	0.201E 04	0.516E-01	0.102E-01