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A STUDY OF CFCS REGULATORY IMPACT FOR INDUSTRY IN JAPAN

FINAL REPORT

March,1990

THE JAPAN MACHINERY FEDERATION
ENVIRONMENTAL SCIENCE RESEARCH INSTITUTE INC.

PREFACE

It is nature to be developing technologie in our country where haven't naturally produce things. For that, independent technological development power should be promoted, be reinforced, and the desire for a technological reformation reaching the ceiling be very often put up in the persimmon. However, when an age the last in 80 year is received, energies of the society are maintained in an effective use and an international, economic friction of various energy and the problem of improving the quality of national life further is faced. Especially now, the conversion of the policy of establishment and technological founding a state promotion of an economic security is needed so that our country which is the country of poor resources may overcome the weakness and even a technological founding a state is a large target at which our country should aim.

It is thought that it is necessary to improve a basic, technological level such as the research and development consolidating type industry to establish the consolidating the knowledge such as a new energy developments aviation, space, information processings and baio-technologie type industry and the highly-developed assembly type industry so that our country may promote a technological founding a state in the future at the early stage.

In catching of the tendency in such ages the industrial world in the future, the effect given to the demand structure is the inscrutable one and is thought to become a factor indispensable for the analysis and the elucidation of the up-to-date, technological forecast investigation, the machine engineering project development, and the machine industry upgrading measures in the future by me.

It is an arrival of happiness if the result of the research this report by which "A Studay of CFCs Regulatory Impact for Industry in Japan" is consigned from such backgrounds to the laboratory of a limited company environmental mathematical principle as one of a supplementary business themes such as technological of machine industry development 1989 term promotions and contributing to related all of you's reference.

March, 1990

The Japan Machinery Federation
President *H. Yoshiyama*

Introduction

This report has been prepared by Environmental Science Research Institute Inc. for the Japan Machinery Federation which with the assistance of the Japan Keirin Association through its Machine Industry Promotion Funds.

At first, in UNEP (United Nations Environment Planning), OECD (Organization for Economic Cooperation and Development), etc. the character of this problem was examined from the earth scale which exceeded the border though the investigation, the research, etc. had been executed in the several of the United States and Britain, etc. countries. And, "Vienna agreement for the ozone layer protection" was adopted in March, 1985 and "Montreal protocol concern- ing the material which destroyed the ozone layer" by which a concrete restriction method such as (furon) was provided was adopted based on this agreement in September, 1987. By the way, the evaluation of the restriction measures of a present protocol started be set up the panel of the science, the environment, and the expert of the technology and economy at the the Hague conference in October, 1988 it was provided that the restriction measures would be evaluated according to the latest finding scientific in Article 6 of the protocol and was presented the revision reinforcement idea by the secretariat.

In this investigation and research, it is aimed to evaluate damage to which our country by the restriction level reinforcement of specific flon etc. is assumed because it is aimed to obtain basic material of the best restriction idea examined in the UNEP and the effect on economy and to request the best restriction level. This investigation and research are circumstances by which the one having executed by the guidance everywhere of the restriction measures rooms such as sections of a base the committee the Ministry of International Trade and Industry industry bureau chemical product and CFCs policy office and the corporation Japan machine industry federations and cooperation is recorded and gratitude is sincerely expressed everywhere of these.

March,1990

Environmental Science Reseach Institute Inc.
President *M. Sato*

CONTENTS

1. Investigation and Research technique.

The item is as follows in this investigation and research.

a) Setting of regulatory scenario for specific flon.

b) Calculation of total ozone decrease rate according to regulatory scenario.

c) Extraction of main effect on environment elements which correspond to ozone decrease.

d) Extraction of main effect on economic society according to regulatory scenario.

e) Calculation of effect cost to environment of ozone decrease.

f) Calculation of effect cost to economic society of regulatory scenario.

g) Extraction of the best regulatory by cost-venefit.

h) Summary.

Moreover, the flow of this investigation and research is Figure-1.

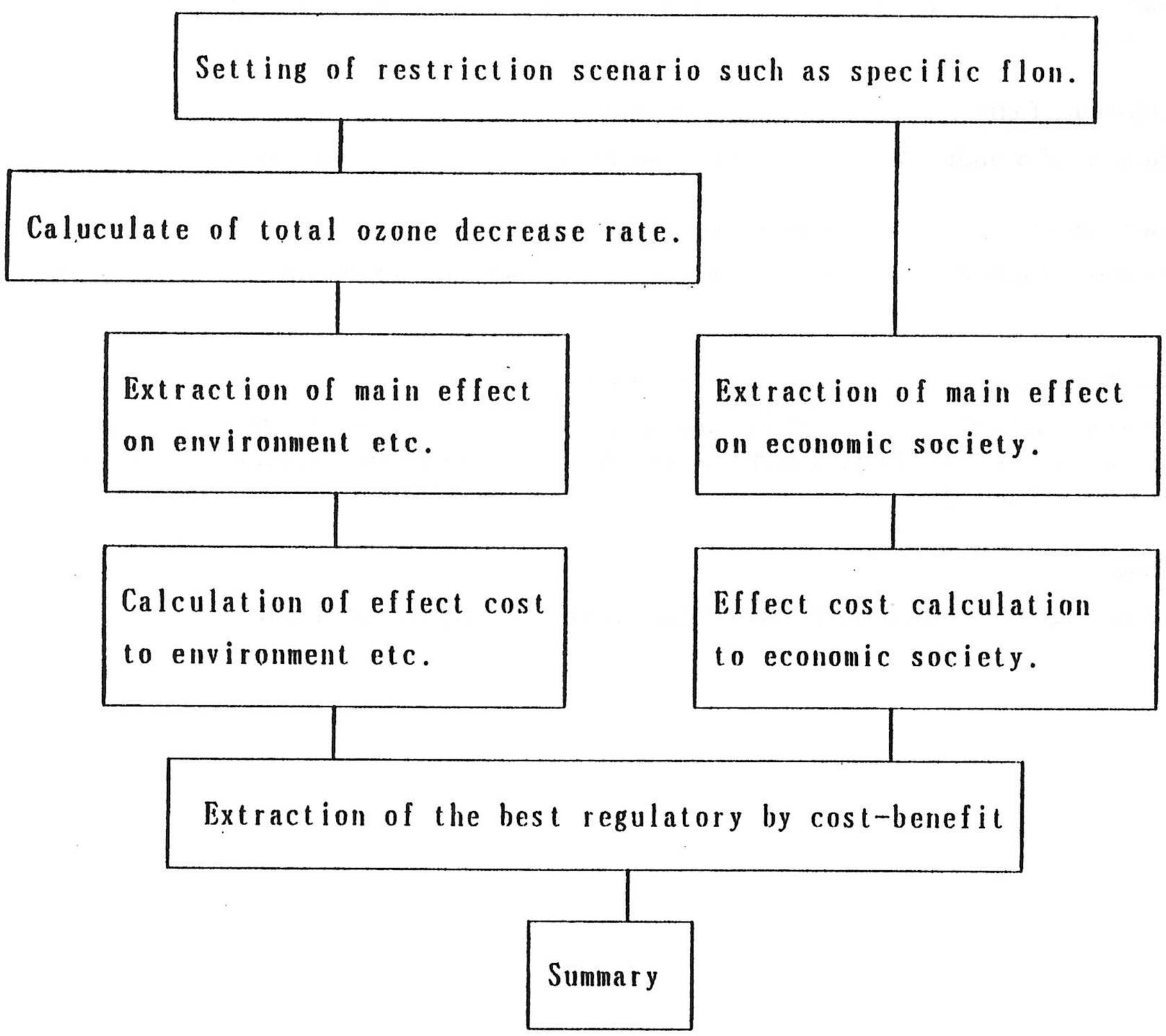

Figure-1 Flow of investigation and research.

The evaluation analysis technique according to the investigation and the research item examined by us is as follows.

(1) Setting of regulatory scenario such as specific flon

We had been setting of regulatory scenario by reference of U.S.A and others

(2) Deriving of total ozone decrease rate according to regulatory scenario

This investigation and research used the presumption value at the ozone decrease rate according to the scenario by research report "Regulatory Impact Analysis; Protection of Stratosphere Ozone,Volume I" of the United States which had referred by (1) without forecasting by "total ozone decrease rate estimate model" which the Ministry of International Trade and Industry had developed in 1981 term because of had completion in a short term and the budget.

(3) Extraction of main effect on environment which correspond to ozone decrease

The effect on a main environment by the stratosphere ozone decrease has been extracted by the thesis researched in the past such as the United States report assumed to be a reference by (1) and (2) and World Weather Organaization (WMO) "Atomospheric Ozone 1985".

(4) Extraction of main effect on economic society according to restriction scenario

The effect on the main economic society affected by the regulatory has been extracted in consideration of special in the United States report assumed to be a reference by (1) and (2) and our country.

(5) Calculation of effect cost to main environment etc.

The cost of a main effect on the environment examined by (3) was calculated.

(6) Calculation of effect cost to main economic society

The cost of a main effect on an economic society which had examined (*O) by (4) was calculated.

(7) Extraction of the best regulatory by cost-benefit

The cost calculated by the profit calculated by (5) accord- ing to the restriction scenario set by (1) and (6) is syn- thesized and the restriction scenario of the maximum profit (minimum cost) has been extracted.

(8) Summary

We arranged for the above-mentioned result and the report was made.

2. Setting of regulatory scenario such as specific flon

2.1 Regulatory scenario of U.S.A. report

The restriction scenario of the United States following reports is set.

Scenario A:

This scenario becomes basic and is a case that flon and halon are not regulatory at all.

Scenario B:

This scenario is a case to freeze the regulatory of flon by the amount of the use of the base in 1986 from 1989.

Scenario C:

This scenario is a case to reduce flon by 20% in 1993 in addition to freezing scenario 2.

Scenario D:

This scenario is a case which is reduced flon by 20% in 1993 in addition to freezing scenario 2 and is further reduced by 50% from 1998 year.

Scenario E:

This scenario is a case which is reduced flon by 20% in 1993 in addition to freezing scenario 2 and is further reduced by 50% from 1998,and reduced by 80% from 2003

Scenario F:

This scenario is near the Montreal Protocol. This scenario is a case which is reduced flon by 20% in 1993 in addition to freezing scenario 2 and is further reduced by 50% from 1998 year. Adding, This scenario is a case to freeze the regulatory of halon by the amount of the use of the base in 1986 from 1992.

Scenario G:

This scenario is a scenario by which it is basically added to see and to reduce (furon) to 80% of the amount of the use in 1986 per 2003 year in the United States though it is the same as scenario 6.

Scenario H:

This scenario is a case when only the United States executes scenario 6.

2.2 Setting our scenario

The scenario of the United States of one includes the restriction measures only of the United States and is improper to set the United States scenario as a res- triction scenario of our country as it is as shown in scenario 7 and scenario 8. Moreover, the investigation of the amount of the halon use of our country etc. cannot set the restriction idea of halon in the insufficiency. Everything from scenario 1 to scenario 5 in the scenario of the United States was set from the above-mentioned as a scenario of our country. The restriction scenario in our country is as follows.

Scenario 1:

This scenario becomes basic and is a case that flon and halon are not regulatory at all.

Scenario 2:

This scenario is a case to freeze the regulatory of flon by the amount of the use of the base in 1986 from 1989.

Scenario 3:

This scenario is a case to reduce flon by 20% in 1993 in addition to freezing scenario 2.

Scenario 4:

This scenario is a case which is reduced flon by 20% in 1993 in addition to freezing scenario 2 and is further reduced by 50% per 1998 year.

Scenario 5:

This scenario is a case which is reduced flon by 20% in 1993 in addition to freezing scenario 2 and is further reduced by 50% from 1998, and reduced by 80% from 2003.

3. Total ozone deplation rate according to each regulatory scenario.

The result of "Total ozone deplation rate estimate model" of the Ministry of International Trade and Industry was added with based on the ozone deplation rate according to the each regulatory scenario calculated by the United States report and the ozone deplation rate was set Figure-2, Figure-3.

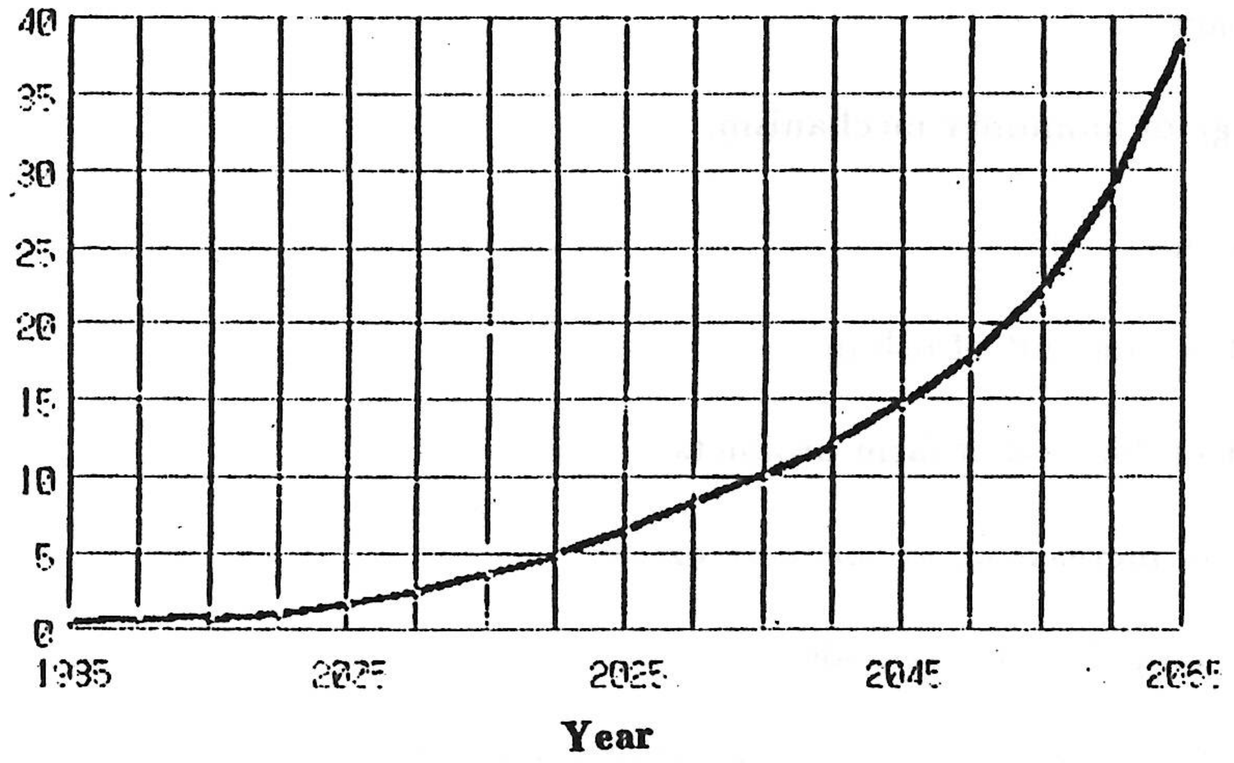

Figure-2 Ozone deplation rate of scenario 1

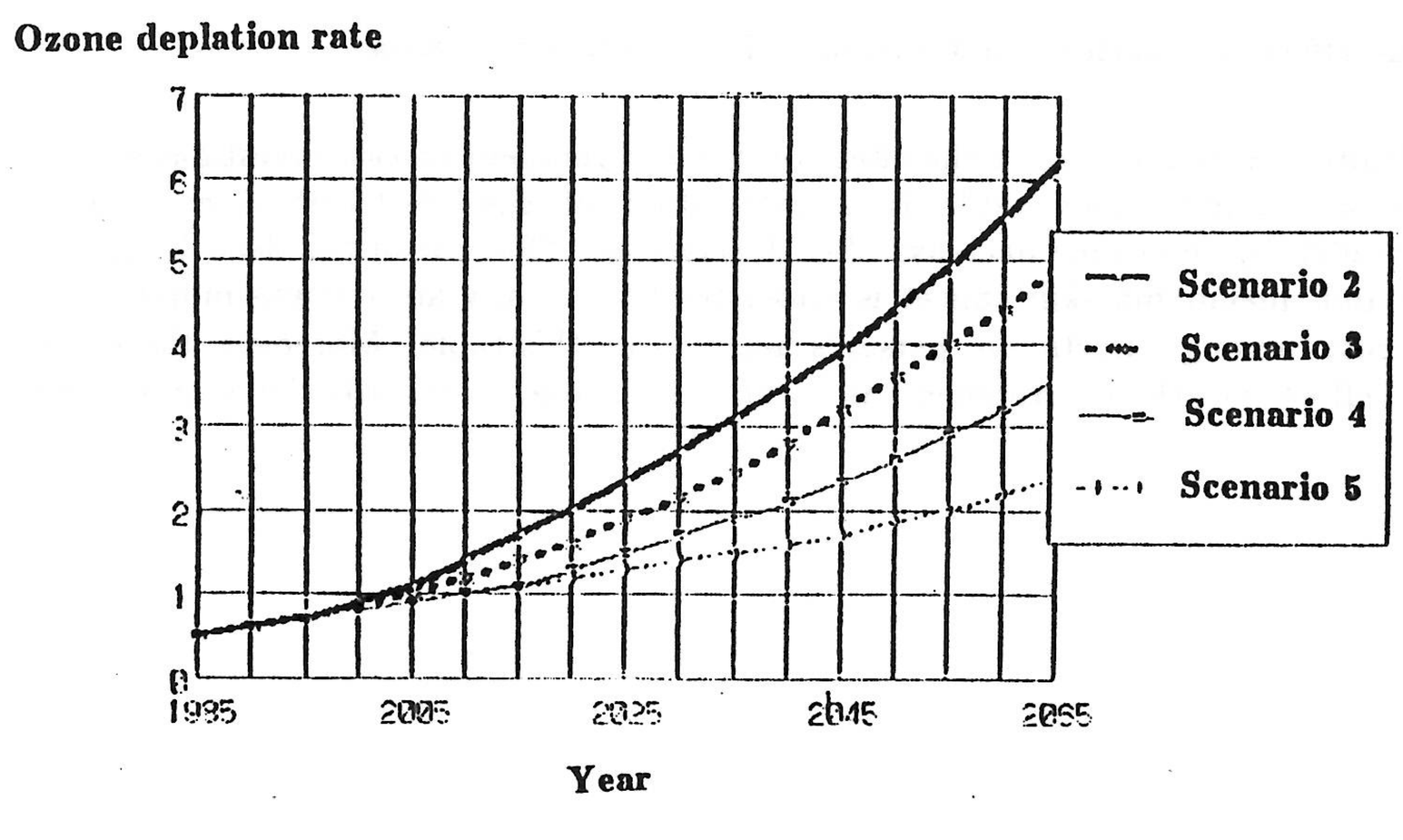

Figure-3 Ozone deplation rate of each scenario

4. Effect on the environment which corresponds to ozone deplation.

4.1 Extraction item of main effect on environment of U.S.A. report.

(1) Effect on person's health

a) Non-melanoma skin cancer.

b) Melanoma skin cancer.

c) Cataract.

d) Change of immunity mechanism.

(2) Effect on environment

a) Effect on amount of fishing.

b) Effect on harvest of farm products.

c) Effect of increase of troposphere ozone.

d) Effect on polymer materials.

e) Effect by sea water level up by Green House Effect.

4.2 The effect cost such as environments of the extraction item

United States report of the effect on the environment of two investigation and the research etc. show Table-1. This table is a calculation of the effect cost such as environments from 1985 to 2075 by the ozone decrease of each scenario. The cost of the dead by non-melanoma skin cancer and melanoma skin cancer is understood to occupy an overwhelmingly high ratio by the effect cost among effects on person's health from this table. Moreover, the error of the item of the effect on the environment is large and Table -1 records the average value.

Table-1 U.S.report of the effect on environment.

unit:x1000000000 dollas on 1985.

Scinario	Death by non-melanoma	Death by melanoma	Catar-act	fishi-ng	harve-st	pol-ymer	Sea level up
A	3,340	241	3.21	6.72	33.66	5.14	55.1
B	341	44	0.64	0.24	12.28	2.49	51.2
C	273	36	0.52	0.04	10.32	2.07	50.8
D	197	26	0.38	0.00	7.97	1.78	50.2
E	142	20	0.29	0.00	6.31	1.61	49.7

5. Effect on the econommic society according to regulatory scenario.

5.1 Extraction item of effect on economic society of U.S. report.

The following items are extracted as an effect on a main economic society in the United States report.

a) uretan foam

b) ridget foam

c) car air conditioner

d) refrigerator

e) solvent

f) sterilization

The substitute of CFCs according to the regulatory scenario at the producer level of the above-mentioned item is assumed and the effect of the economy of the cost of the substitute and the cost of CFCs from the difference from which the society is calculated.

5.2 EExtraction item of effect on economic society of our report.

The cost effect is assumed to be few though the result of the extraction item United States report of the effect on an economic society of two investigation and the research is converted to the substitute at the product level. However, in the United States report, the item such as decreases of the efficiency of the product produced with the substitute is disregarded. In this investigation and research, the following items have been extracted from the viewpoint which energy cost is more lager than U.S. report.

a) Energy cost of refrigerators.

b) Enargy cost of car air-conditioner.

6. Calculation of effect cost for the environment.

6.1 Calculation method of effect cost for the environment.

Caluculation method of the death by skin cancer is Figure-4.

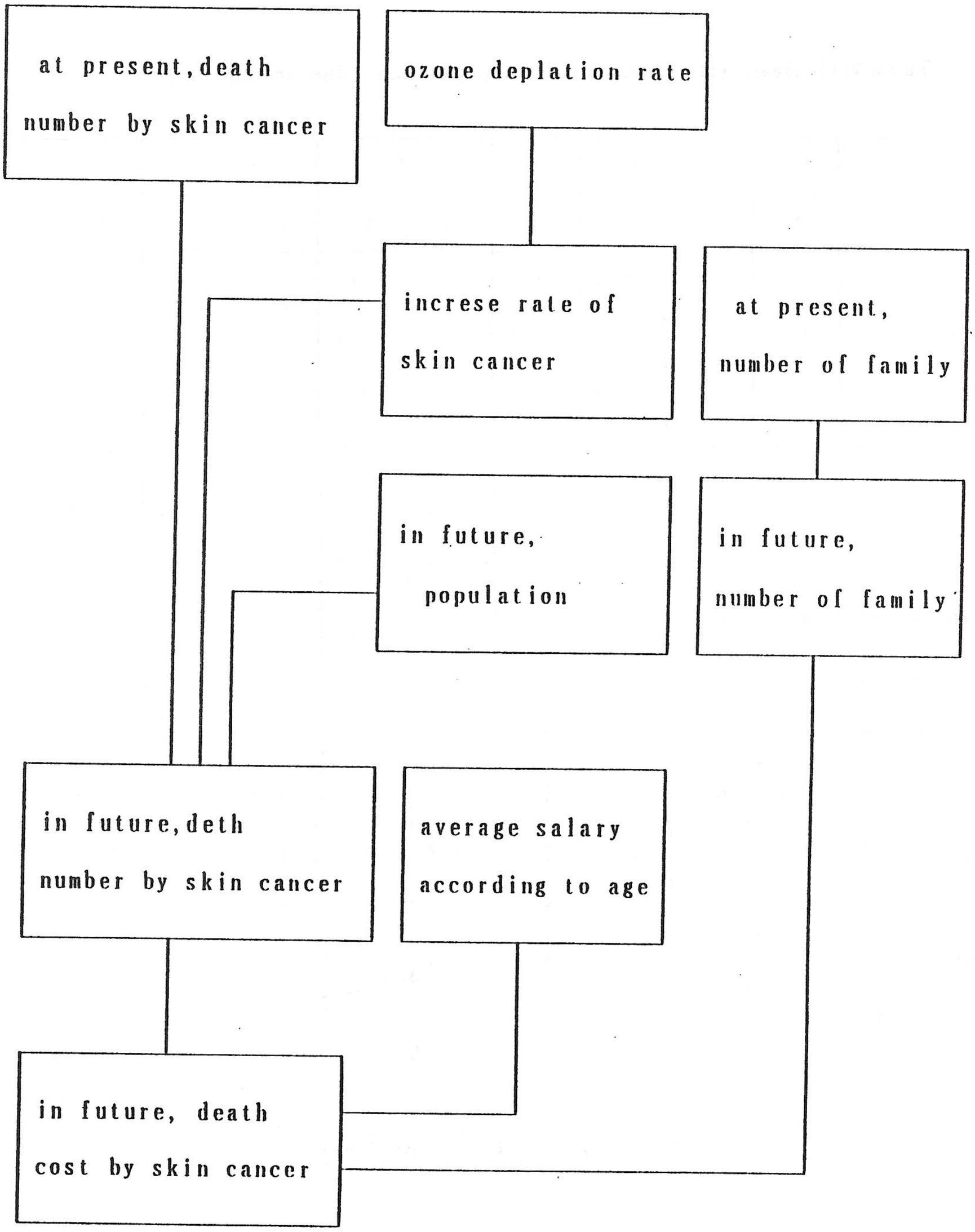

Figure-4 Death cost calculation by skin cancer.

6.1 Setting of death rate according to age of skin cancer at present

As for statistics of the number of the death person due to skin cancer, the number of the death person from 1972 to 1984 according to the sex age class is printed to Statics and Information Department Minster's Secretariat,Minstry of Health and Welfare editing "Mortality Statistics from Malignant Neoplasms 1972-1984,Special Report of Vital Statistics in Japan" (1986). Table-2 is a death rate according to the sex age due to skin cancer. Moreover, Figure-5 shows the transition of the number of the dead of all ages from 1972 to 1984 to 100,000 in population.

Table-2(1) Death rate (100,000 pairs in population) due to skin cancer

ages	1972		1973		1974		1975		1976	
	M	F	M	F	M	F	M	F	M	F
0 ～ 4	0.0	–	0.0	0.0	–	–	–	–	0.0	0.0
5 ～ 9	0.0	–	–	0.0	–	0.0	–	0.0	0.0	–
10 ～ 14	–	0.0	0.0	0.1	–	0.0	–	0.0	–	–
15 ～ 19	0.0	0.0	0.0	0.0	–	0.0	–	0.1	0.0	0.1
20 ～ 24	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.1
25 ～ 29	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
30 ～ 34	0.2	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.1	0.1
35 ～ 39	0.3	0.1	0.2	0.1	0.1	0.2	0.3	0.2	0.2	0.1
40 ～ 44	0.6	0.3	0.3	0.3	0.4	0.3	0.3	0.2	0.3	0.3
45 ～ 49	0.5	0.5	0.8	0.5	0.7	0.5	0.6	0.4	0.9	0.3
50 ～ 54	0.7	0.5	1.1	0.6	0.8	0.5	0.9	0.3	0.9	0.5
55 ～ 59	1.6	0.9	1.9	0.8	1.8	1.2	1.2	0.7	1.6	0.6
60 ～ 64	2.5	1.8	2.3	1.4	2.3	1.3	2.3	1.4	2.8	1.2
65 ～ 69	3.9	1.7	4.1	2.6	2.7	1.8	3.8	2.3	3.4	1.5
70 ～ 74	5.4	2.9	5.0	3.2	4.9	3.0	5.2	3.1	4.9	2.6
75 ～ 79	7.4	5.1	8.0	5.2	9.0	4.4	7.3	6.2	8.1	3.9
80 abave	17.7	14.0	17.8	14.1	17.0	12.8	12.6	10.7	16.1	12.9

M: Male

F: Female

Table-2(2) Death rate (100,000 pairs in population) due to skin cancer

ages	1977		1978		1979		1980		1981	
	M	F	M	F	M	F	M	F	M	F
0 ～ 4	–	–	0.1	0.0	–	–	–	–	–	–
5 ～ 9	–	–	0.0	–	0.0	–	–	–	0.0	–
10 ～ 14	0.0	0.0	–	0.0	–	–	–	0.0	0.1	–
15 ～ 19	0.0	0.1	0.0	–	–	–	–	–	–	0.1
20 ～ 24	0.1	0.0	0.0	–	0.1	0.0	–	–	0.0	0.1
25 ～ 29	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1
30 ～ 34	0.1	0.2	0.1	0.0	0.2	0.1	0.2	0.1	0.2	0.1
35 ～ 39	0.3	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2
40 ～ 44	0.4	0.2	0.3	0.4	0.2	0.1	0.3	0.2	0.3	0.2
45 ～ 49	0.8	0.4	0.3	0.4	0.5	0.3	0.4	0.2	0.3	0.3
50 ～ 54	0.7	0.6	0.9	0.4	1.0	0.4	0.9	0.6	0.6	0.4
55 ～ 59	1.2	1.3	1.2	0.6	1.4	0.4	1.0	0.6	1.3	0.4
60 ～ 64	2.3	1.1	2.2	1.0	1.3	0.8	1.6	0.6	1.4	0.8
65 ～ 69	3.0	1.8	2.5	1.8	2.0	1.5	1.6	1.2	1.9	1.2
70 ～ 74	4.8	2.9	4.3	2.8	3.4	1.9	3.8	2.1	3.4	1.9
75 ～ 79	7.1	4.7	6.3	4.2	5.0	4.6	5.3	3.0	5.6	2.8
80 abave	16.7	12.7	18.8	13.6	13.1	9.0	11.6	10.7	13.3	9.6

M: Male

F: Female

Table-2(3) Death rate (100,000 pairs in population) due to skin cancer

ages	1982		1983		1984	
	M	F	M	F	M	F
0 ～ 4	-	-	-	-	-	0.0
5 ～ 9	-	0.0	-	-	-	-
10 ～ 14	0.0	0.0	-	-	-	-
15 ～ 19	0.0	-	-	-	0.1	-
20 ～ 24	0.0	-	-	0.1	0.0	0.0
25 ～ 29	0.0	0.1	0.0	0.1	0.1	0.1
30 ～ 34	0.1	0.0	0.2	0.1	0.2	0.1
35 ～ 39	0.2	0.2	0.1	0.2	0.2	0.2
40 ～ 44	0.2	0.2	0.2	0.1	0.2	0.3
45 ～ 49	0.4	0.2	0.7	0.2	0.4	0.1
50 ～ 54	0.5	0.5	0.9	0.3	0.7	0.4
55 ～ 59	1.0	0.7	0.8	0.5	1.0	0.3
60 ～ 64	1.6	0.7	1.4	0.6	1.5	1.0
65 ～ 69	2.3	1.2	2.0	1.2	2.0	1.1
70 ～ 74	3.6	1.9	2.4	1.6	3.0	2.0
75 ～ 79	5.7	2.5	4.2	2.8	5.4	2.7
80 abave	11.4	7.8	10.7	7.2	11.0	7.3

M: Male

F: Female

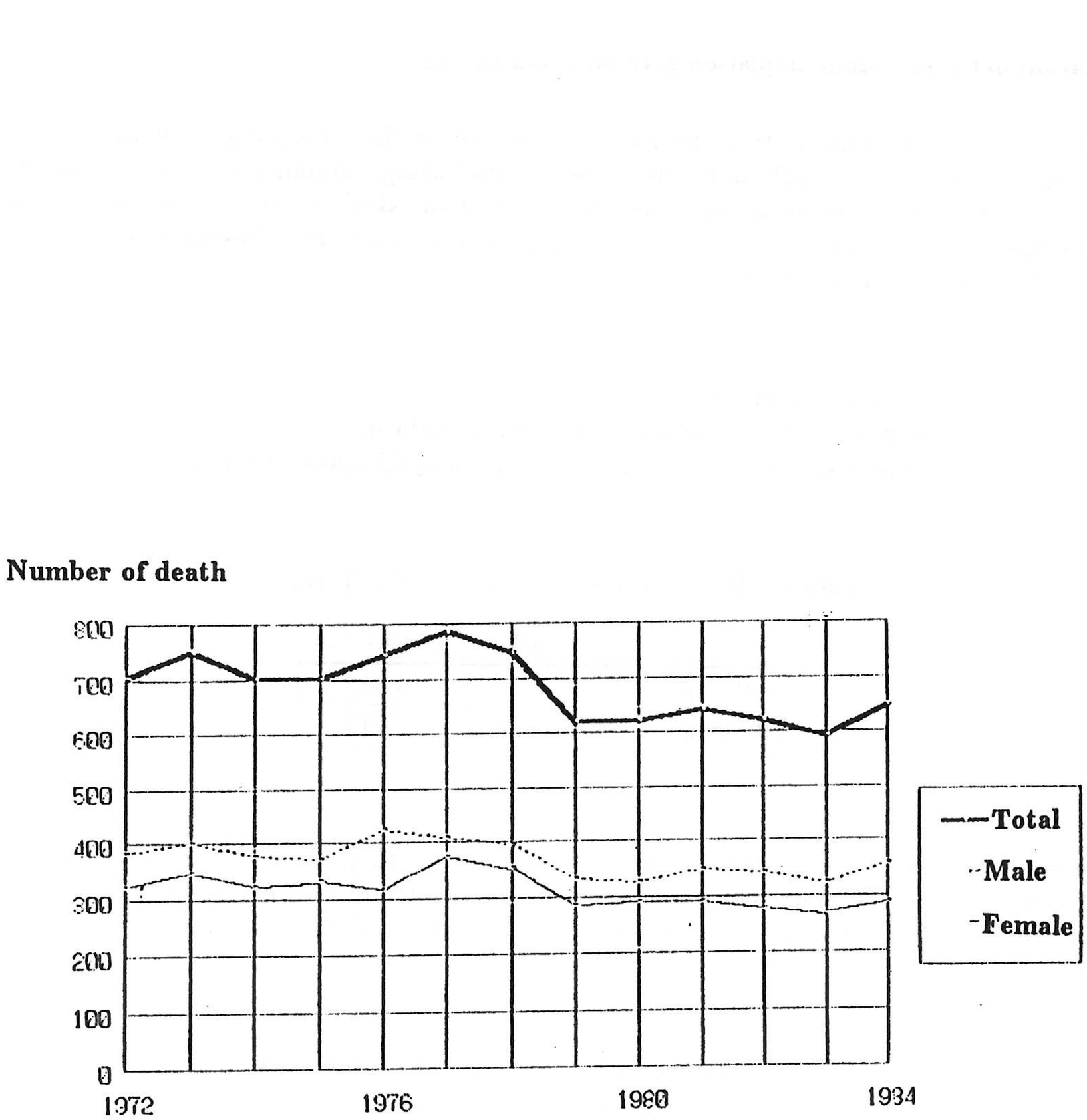

Figure-5 Age Transition of death rate of skin cancer.

6.2 Relation between ozone deplation rate and skin cancer.

The decrease of ozone is thought for the skin cancer for a harmful ultraviolet rays to arrive at the surface of the earth and to increase by irradiating human body the ultraviolet rays about every day. The increase of the generation rate of the skin cancer is presumed by the following expressions in United States report). Table-3 is set as a DoseRespone coefficient of the white by the United States report.

$$D = (I+1)^b$$

D : Increace death rate.
I : Increace rate of ultora-violet rays in surface.
b : Doseresponse coefficient (biological amplification coefficient)

Table-3 DoseResponse coefficient of U.S. report

sex	non-melanoma	melanoma
male	2.03	0.512
female	2.22	0.611

However, non-melanoma and melanoma cannot be distinguished by the statistical data of our country and are set more safely (direction where getting cancer increases and the cost rises) on the side. Table-4 is a DoseResponse coefficient adopted by this investigation and research.

Table-4 DoseResponse coefficient of this work

sex	skin cancer
male	2.03
female	2.22

6.3 Population composition according to ages

From "Population Projection for Japan:1985-2085"(Institute Population Problems,Ministry of Health and Welfare editings,Dec.,1986) , the population composition according to the sex age in the future from 1985 to 2075 was used. Table-5 is a population composition according to the sex age used by this work. And,Figure-5 is a transition of population in the future.

Table-5(1) The population composition according to the sex age in the future

(unit:1,000 person)

ages	1985			1990		
	Total	Male	Female	Total	Male	Female
0 - 4	7,462	3,821	3,641	7,159	3,674	3,486
5 - 9	8,535	4,375	4,160	7,441	3,809	3,632
10 - 14	10,046	5,149	4,896	8,532	4,373	4,159
15 - 19	8,983	4,603	4,381	10,036	5,143	4,893
20 - 24	8,203	4,168	4,035	8,950	4,579	4,371
25 - 29	7,826	3,950	3,876	8,170	4,146	4,024
30 - 34	9,057	4,560	4,497	7,798	3,934	3,864
35 - 39	10,742	5,401	4,341	9,022	4,539	4,483
40 - 44	9,138	4,554	4,584	10,679	5,361	5,318
45 - 49	8,239	4,094	4,145	9,046	4,495	4,551
50 - 54	7,936	3,928	4,007	8,100	4,002	4,098
55 - 59	7,002	3,411	3,591	7,733	3,791	3,943
60 - 64	5,407	2,381	3,026	6,740	3,238	3,502
65 - 69	4,195	1,782	2,413	5,100	2,196	2,904
70 - 74	3,565	1,504	2,060	3,801	1,555	2,246
75 - 79	2,494	1,018	1,476	2,987	1,185	1,802
80abave	2,219	798	1,420	2,930	1,035	1,896
Total	121,049	59,497	61,552	124,225	61,054	63,171

Table-5(2) The population composition according to the sex age in the future
(unit:1,000 person)

ages	1995			2000		
	Total	Male	Female	Total	Male	Female
0 - 4	7,809	4,007	3,802	8,665	4,446	4,219
5 - 9	7,140	3,663	3,477	7,788	3,996	3,792
10 - 14	7,439	3,808	3,631	7,138	3,662	3,476
15 - 19	8,525	4,369	4,156	7,433	3,804	3,629
20 - 24	10,000	5,118	4,882	8,495	4,348	4,147
25 - 29	8,915	4,557	4,358	9,963	5,094	4,869
30 - 34	8,142	4,130	4,012	8,885	4,539	4,346
35 - 39	7,769	3,916	3,853	8,113	4,113	4,001
40 - 44	8,971	4,506	4,465	7,728	3,890	3,838
45 - 49	10,581	5,298	5,283	8,890	4,455	4,436
50 - 54	8,901	4,399	4,502	10,422	5,192	5,230
55 - 59	7,905	3,869	4,036	8,696	4,259	4,437
60 - 64	7,460	3,608	3,852	7,637	3,690	3,948
65 - 69	6,368	2,997	3,370	7,064	3,350	3,715
70 - 74	4,655	1,936	2,719	5,821	2,653	3,168
75 - 79	3,234	1,244	1,990	4,003	1,573	2,430
80abave	3,752	1,291	2,461	4,450	1,480	2,968
Total	127,565	62,716	64,849	131,192	64,543	66,649

Table-5(3) The population composition according to the sex age in the future
(unit:1,000 person)

ages	2005			2010		
	Total	Male	Female	Total	Male	Female
0 - 4	8,735	4,482	4,253	7,946	4,077	3,869
5 - 9	8,643	4,434	4,208	8,714	4,471	4,243
10 - 14	7,787	3,995	3,792	8,641	4,433	4,208
15 - 19	7,133	3,659	3,474	7,781	3,992	3,790
20 - 24	7,408	3,787	3,621	7,110	3,643	3,467
25 - 29	8,465	4,329	4,136	7,382	3,770	3,612
30 - 34	9,931	5,076	4,855	8,438	4,313	4,125
35 - 39	8,855	4,521	4,334	9,898	5,055	4,842
40 - 44	8,072	4,086	3,986	8,812	4,493	4.319
45 - 49	7,661	3,847	3,814	8,005	4,043	3,962
50 - 54	8,758	4,366	4,392	7,552	3,774	3,778
55 - 59	10,193	5,034	5,159	8,567	4,234	4,333
60 - 64	8,411	4,067	4,344	9,873	4,817	5,056
65 - 69	7,245	3,432	3,813	7,988	3,789	4,200
70 - 74	6,479	2,976	3,502	6,659	3,058	3,602
75 - 79	5,016	2,167	2,848	5,608	2,445	3,163
80abave	5,456	1,825	3,630	6,848	2,455	4,394
Total	134,247	66,084	68,163	135,823	66,861	68,962

Table-5(4) The population composition according to the sex age in the future
(unit:1,000 person)

ages	2015			2020		
	Total	Male	Female	Total	Male	Female
0 - 4	7,236	3,713	3,523	7,182	3,685	3,497
5 - 9	7,927	4,067	3,860	7,219	3,704	3,515
10 - 14	8,713	4,470	4,243	7,926	4,067	3,859
15 - 19	8,636	4,430	4,206	8,707	4,467	4,240
20 - 24	7,757	3,975	3,782	8,609	4,411	4,197
25 - 29	7,085	3,627	3,458	7,730	3,958	3,772
30 - 34	7,359	3,757	3,602	7,064	3,615	3,449
35 - 39	8,410	4,296	4,114	7,336	3,743	3,593
40 - 44	9,850	5,025	4,825	8,370	4,270	4,100
45 - 49	8,740	4,447	4,293	9,770	4,973	4,797
50 - 54	7,893	3,968	3,925	8,620	4,366	4,254
55 - 59	7,391	3,662	3,729	7,729	3,853	3,876
60 - 64	8,297	4,050	4,247	7,163	3,507	3,656
65 - 69	9,396	4,500	4,896	7,892	3,781	4,111
70 - 74	7,353	3,381	3,973	8,675	4,032	4,643
75 - 79	5,783	2,521	3,262	6,399	2,794	3,605
80abave	8,110	3,000	5,111	8,913	3,318	5,596
Total	135,938	66,889	69,049	135,304	66,543	68,762

Table-5(5) The population composition according to the sex age in the future
(unit:1,000 person)

ages	2025			2030		
	Total	Male	Female	Total	Male	Female
0 - 4	7,692	3,947	3,745	8,171	4,193	3,978
5 - 9	7,165	3,676	3,489	7,673	3,937	3,736
10 - 14	7,218	3,704	3,515	7,164	3,676	3,488
15 - 19	7,921	4,064	3,875	7,214	3,701	3,513
20 - 24	8,680	4,448	4,232	7,896	4,047	3,850
25 - 29	8,579	4,393	4,187	8,651	4,430	4,221
30 - 34	7,707	3,944	3,762	8,554	4,378	4,176
35 - 39	7,041	3,601	3,440	7,682	3,929	3,753
40 - 44	7,301	3,720	3,581	7,008	3,580	3,428
45 - 49	8,302	4,227	4,076	7,242	3,683	3,560
50 - 54	9,635	4,882	4,754	8,188	4,149	4,039
55 - 59	8,442	4,241	4,201	9,435	4,741	4,694
60 - 64	7,493	3,692	3,802	8,187	4,065	4,122
65 - 69	6,820	3,278	3,543	7,138	3,453	3,685
70 - 74	7,278	3,382	3,896	6,297	2,936	3,360
75 - 79	7,586	3,354	4,232	6,345	2,802	3,543
80abave	9,782	3,656	6,126	11,222	4,251	6,971
Total	134,642	66,207	68,436	134,067	65,950	68,117

Table-5(6) The population composition according to the sex age in the future
(unit:1,000 person)

ages	2035			2040		
	Total	Male	Female	Total	Male	Female
0 - 4	8,090	4,151	3,939	7,576	3,887	3,688
5 - 9	8,152	4,183	3,969	8,071	4,141	3,930
10 - 14	7,673	3,937	3,736	8,151	4,182	3,969
15 - 19	7,160	3,673	3,487	7,668	3,934	3,734
20 - 24	7,191	3,685	3,506	7,138	3,658	3,480
25 - 29	7,870	4,030	3,840	7,167	3,670	3,497
30 - 34	8,625	4,415	4,210	7,846	4,016	3,830
35 - 39	8,526	4,362	4,165	8,597	4,398	4,199
40 - 44	7,646	3,906	3,740	8,487	4,336	4,151
45 - 49	6,952	3,544	3,409	7,586	3,867	3,719
50 - 54	7,143	3,615	3,528	6,857	3,479	3,378
55 - 59	8,017	4,029	3,988	6,995	3,511	3,484
60 - 64	9,147	4,542	4,605	7,771	3,859	3,911
65 - 69	7,799	3,803	3,996	8,708	4,246	4,462
70 - 74	6,593	3,096	3,497	7,204	3,411	3,793
75 - 79	5,497	2,438	3,059	5,760	2,574	3,186
80abave	11,053	4,154	6,899	10,066	3,762	6,304
Total	133,133	65,562	67,571	131,646	64,933	66,713

Table-5(7) The population composition according to the sex age in the future

(unit:1,000 person)

ages	2045			2050		
	Total	Male	Female	Total	Male	Female
0 - 4	7,181	3,685	3,496	7,245	3,718	3,527
5 - 9	7,558	3,878	3,680	7,164	3,676	3,488
10 - 14	8,070	4,141	3,929	7,557	3,878	3,680
15 - 19	8,146	4,179	3,967	8,065	4,138	3,927
20 - 24	7,644	3,918	3,727	8,121	4,162	3,959
25 - 29	7,113	3,643	3,471	7,618	3,901	3,717
30 - 34	7,145	3,658	3,488	7,092	3,630	3,462
35 - 39	7,821	4,001	3,820	7,123	3,644	3,479
40 - 44	8,557	4,372	4,185	7,784	3,977	3,807
45 - 49	8,419	4,292	4,127	8,488	4,327	4,161
50 - 54	7,482	3,797	3,685	8,304	4,214	4,090
55 - 59	6,715	3,379	3,336	7,327	3,688	3,639
60 - 64	6,780	3,363	3,417	6,510	3,238	3,272
65 - 69	7,396	3,606	3,790	6,455	3,144	3,311
70 - 74	8,036	3,804	4,232	6,821	3,228	3,593
75 - 79	6,295	2,838	3,457	7,010	3,157	3,853
80abave	9,656	3,650	6,005	9,995	3,836	6,159
Total	130,017	64,204	65,812	128,681	63,557	65,124

Table-5(8) The population composition according to the sex age in the future
(unit:1,000 person)

ages	2055			2060		
	Total	Male	Female	Total	Male	Female
0 - 4	7,626	3,913	3,713	7,893	4,050	3,843
5 - 9	7,228	3,709	3,519	7,607	3,903	3,704
10 - 14	7,164	3,676	3,488	7,227	3,708	3,519
15 - 19	7,553	3,875	3,678	7,159	3,673	3,486
20 - 24	8,040	4,120	3,920	7,529	3,859	3,671
25 - 29	8,093	4,144	3,949	8,013	4,103	3,910
30 - 34	7,595	3,888	3,707	8,069	4,130	3,938
35 - 39	7,069	3,617	3,453	7,571	3,873	3,698
40 - 44	7,089	3,622	3,467	7,036	3,595	3,441
45 - 49	7,722	3,937	3,785	7,032	3,586	3,447
50 - 54	8,372	4,248	4,123	7,615	3,865	3,751
55 - 59	8,132	4,093	4,039	8,198	4,126	4,071
60 - 64	7,104	3,534	3,570	7,884	3,922	3,962
65 - 69	6,199	3,027	3,171	6,765	3,305	3,460
70 - 74	5,955	2,816	3,140	5,721	2,713	3,008
75 - 79	5,945	2,676	3,269	5,194	2,336	2,858
80abave	10,817	4,183	6,636	10,433	4,000	6,433
Total	127,704	63,078	64,625	126,947	62,748	64,199

Table-5(9) The population composition according to the sex age in the future

(unit:1,000 person)

ages	2065			2070		
	Total	Male	Female	Total	Male	Female
0 - 4	7,784	3,994	3,790	7,455	3,826	3,630
5 - 9	7,874	4,040	3,834	7,766	3,985	3,781
10 - 14	7,607	3,903	3,704	7,874	4,040	3,834
15 - 19	7,223	3,706	3,517	7,602	3,900	3,702
20 - 24	7,137	3,658	3,479	7,201	3,690	3,510
25 - 29	7,504	3,843	3,661	7,113	3,642	3,470
30 - 34	7,989	4,089	3,899	7,481	3,830	3,652
35 - 39	8,043	4,115	3,928	7,963	4,074	3,889
40 - 44	7,536	3,851	3,685	8,006	4,091	3,915
45 - 49	6,980	3,559	3,421	7,476	3,812	3,664
50 - 54	6,936	3,520	3,416	6,885	3,494	3,390
55 - 59	7,457	3,753	3,704	6,792	3,419	3,373
60 - 64	7,946	3,953	3,994	7,228	3,595	3,633
65 - 69	7,507	3,667	3,840	7,565	3,695	3,870
70 - 74	6,245	2,962	3,283	6,929	3,287	3,643
75 - 79	4,992	2,253	2,739	5,452	2,462	2,991
80abave	9,453	3,603	5,853	8,731	3,336	5,394
Total	126,215	62,468	63,747	125,518	62,176	63,342

Table-5(10) The population composition according to the sex age in the future

(unit:1,000 person)

ages	2075		
	Total	Male	Female
0 - 4	7,263	3,727	3,536
5 - 9	7,438	3,816	3,621
10 - 14	7,765	3,984	3,781
15 - 19	7,869	4,037	3,832
20 - 24	7,579	3,884	3,695
25 - 29	7,176	3,675	3,501
30 - 34	7,091	3,630	3,461
35 - 39	7,457	3,815	3,642
40 - 44	7,926	4,050	3,876
45 - 49	7,942	4,049	3,892
50 - 54	7,374	3,743	3,631
55 - 59	6,742	3,394	3,348
60 - 64	6,584	3,275	3,309
65 - 69	6,880	3,360	3,520
70 - 74	6,980	3,309	3,670
75 - 79	6,048	2,730	3,318
80abave	8,777	3,383	5,394
Total	124,890	61,862	63,028

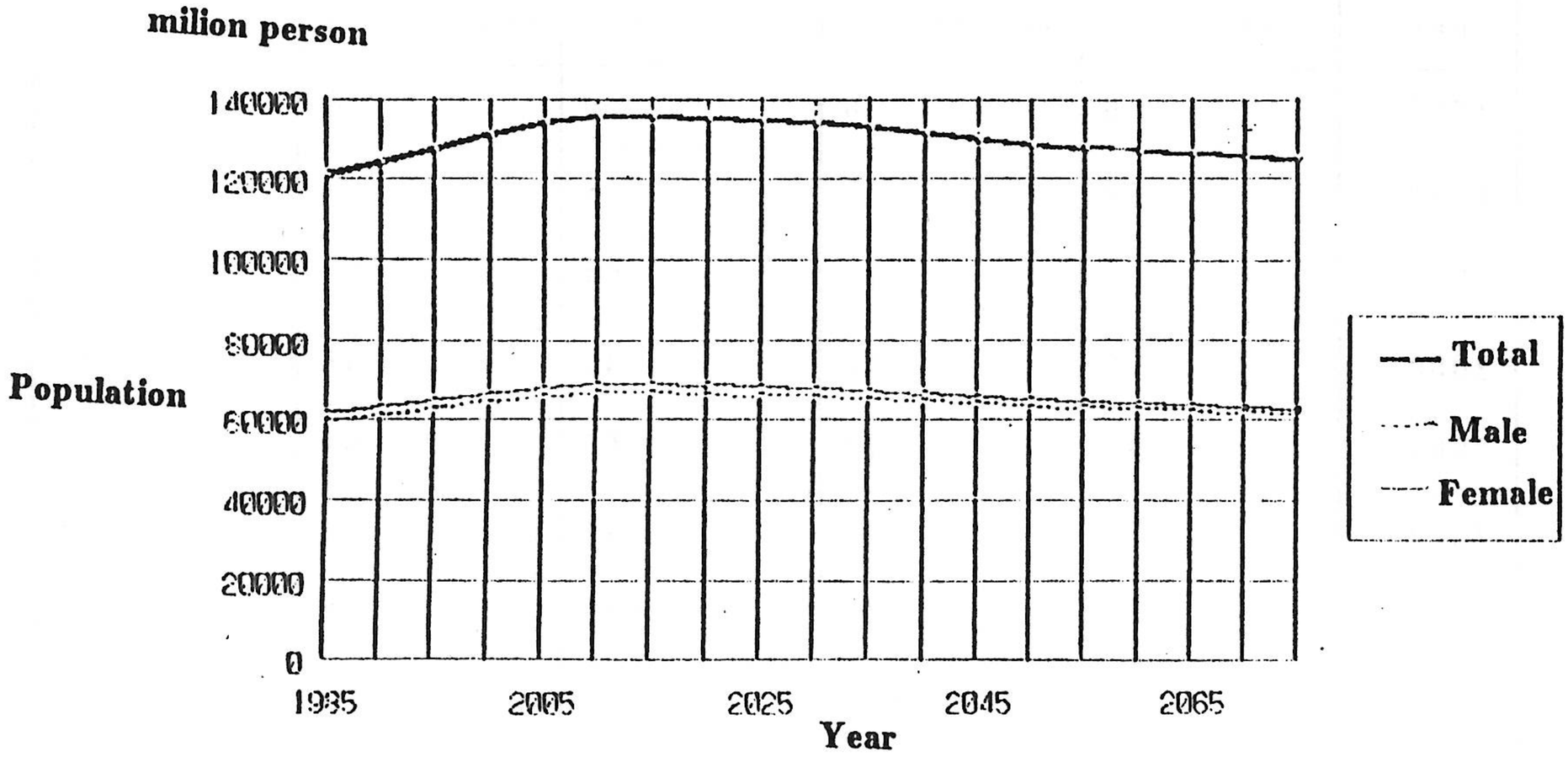

Figure-5 Transition of population in the future.

6.4 Estimate of number of the dead due to skin cancer

We had estimated number of the death by skin cancer,based on number of death of skin cancer at present. Table-6 show result by scenario. Moreover, Figure-6 and Figure-7 show the transition according to the ages of the number of the skin cancer dead according to the regulatory scenario.

Table-6 Estimate number of death by skin cancer.

year	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5
1985	0	0	0	0	0
1990	17	8	8	8	8
1995	34	24	24	24	24
2000	56	45	45	45	45
2005	85	72	65	59	59
2010	151	97	82	74	74
2015	287	140	123	98	90
2020	440	176	149	113	104
2025	653	214	185	147	110
2030	925	270	210	161	113
2035	1066	293	234	176	120
2040	1179	321	263	189	133
2045	1393	378	301	207	151
2050	1830	435	355	248	172
2055	2336	487	386	278	192
2060	2922	517	418	285	193
2065	4969	543	438	309	202
2070	6372	572	449	321	216
2075	8363	609	484	344	228
total	144484	24481	19893	14577	10608

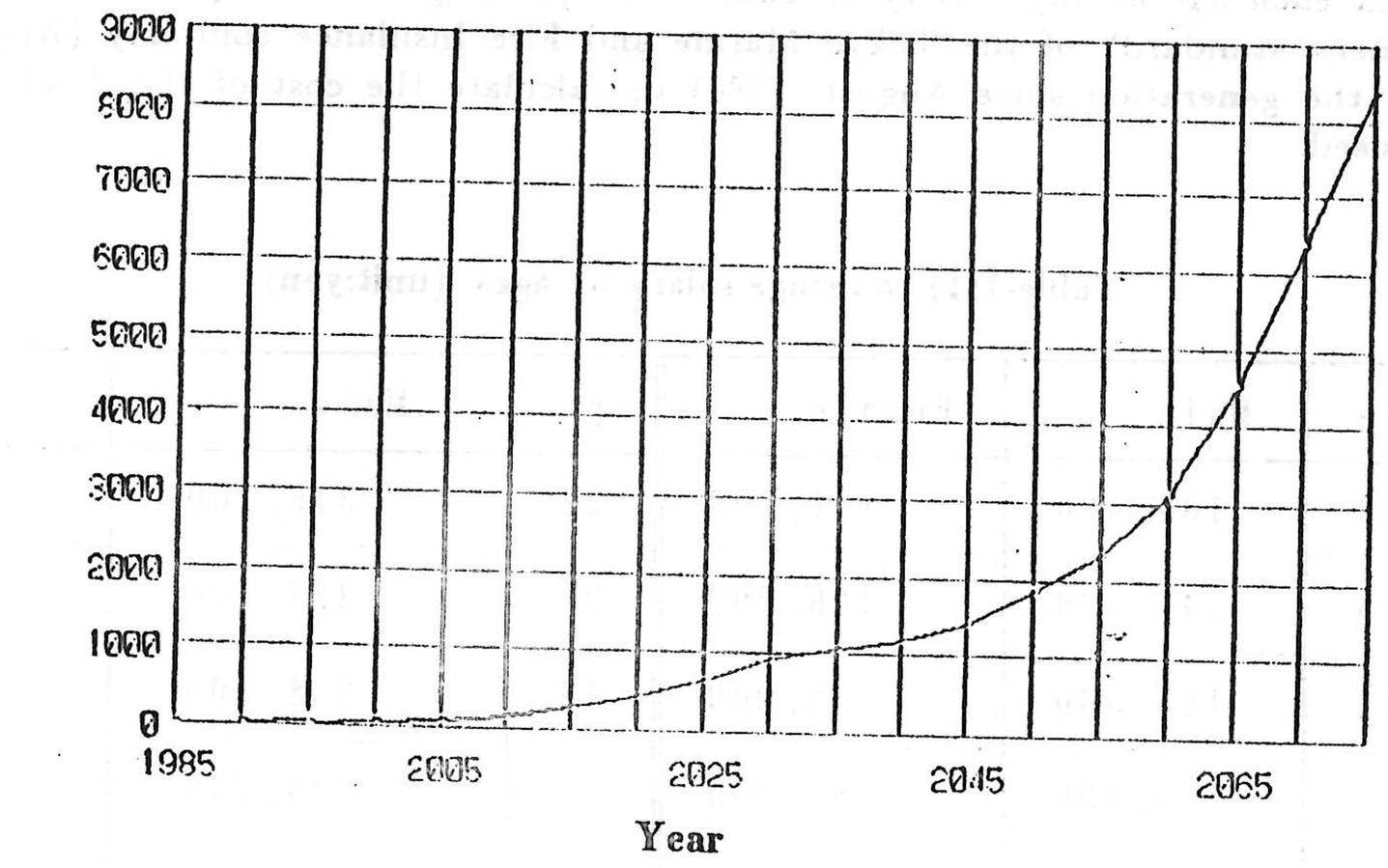

Figure-6 Transition of the number of the death **by skin cancer of scenarios 1.**

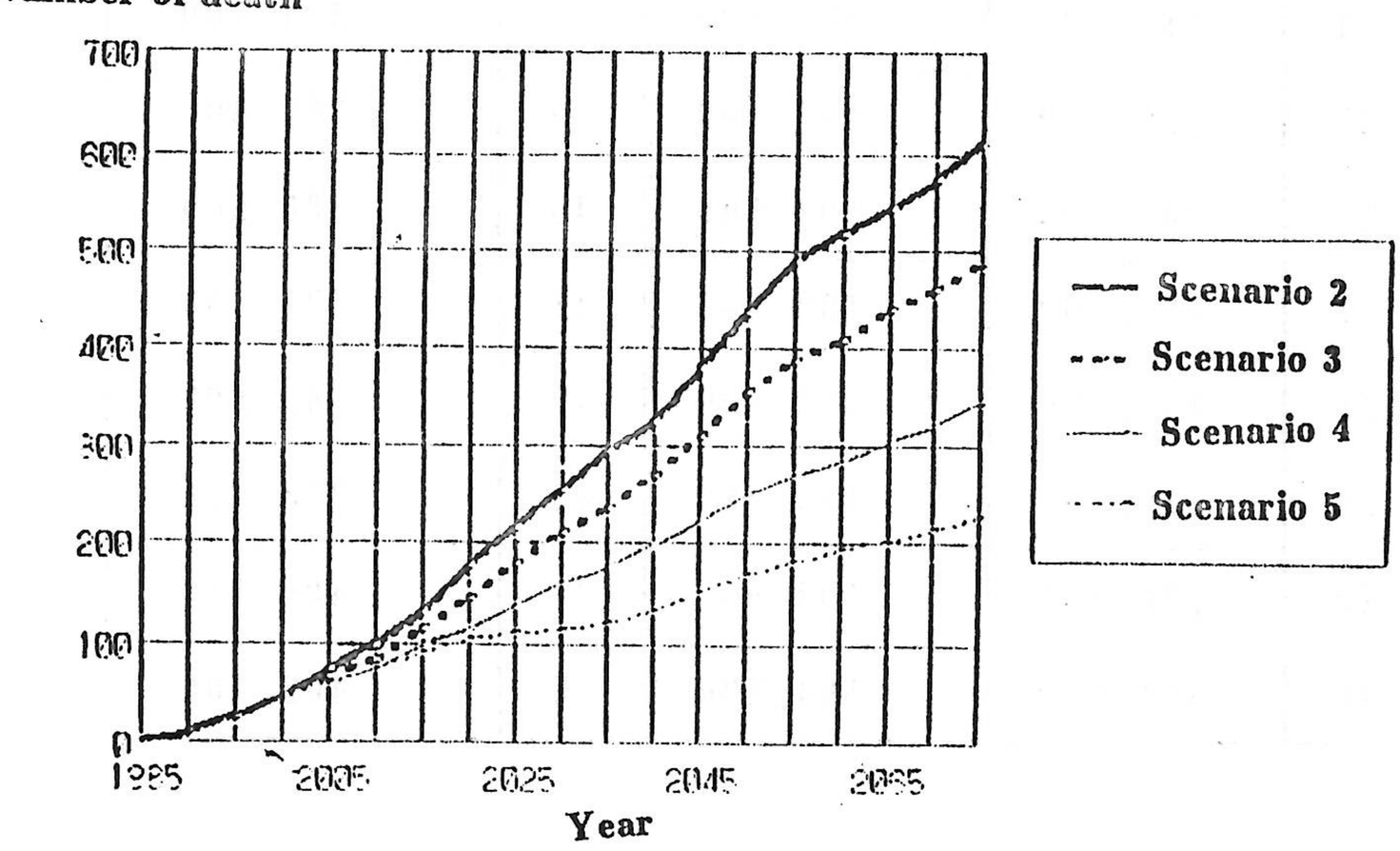

Figure-7 Transition of the number of the deth by skin cancer of each scenario.

6.5 Setting of average salary according to ages

The sex each age average salary of Table-7 of printing to "car personal compensation health payment standard" of the Tokyo Marine and Fire Insulance company (Applied to the accident of the generation since August, 1986) to calculate the cost of the dead due to skin cancer was used.

Table-7(1) Average salary by ages (unit:yen)

age	Male	Female	age	Male	Female
18	136,800	121,100	32	316,700	194,600
19	147,600	126,900	33	327,500	192,800
20	163,500	139,000	34	338,400	191,000
21	179,300	151,200	35	349,200	189,300
22	195,200	164,000	36	360,100	187,500
23	206,400	173,400	37	370,900	186,100
24	217,700	182,800	38	376,100	185,100
25	229,400	192,100	39	381,300	184,500
26	242,500	192,500	40	386,500	183,800
27	255,600	192,800	41	391,700	183,200
28	267,900	193,200	42	396,800	182,600
29	280,100	193,500	43	398,800	182,500
30	292,300	193,900	44	400,700	182,500
31	304,500	194,200	45	402,700	182,500

Table-7(2) Average salary by ages (unit:yen)

age	Male	Female	age	Male	Female
46	404,600	182,500	58	316,900	186,600
47	406,500	182,500	59	301,500	183,200
48	405,000	185,100	60	289,800	179,900
49	403,600	187,600	61	278,100	176,600
50	402,100	190,200	62	266,500	173,200
51	400,600	192,800	63	262,500	171,200
52	399,100	195,400	64	258,600	169,200
53	397,600	194,300	65	254,600	167,300
54	396,100	193,200	66	250,700	165,300
55	375,100	192,100	67	246,700	163,300
56	354,100	191,000	68～	242,800	161,300
57	333,100	189,900	-	-	-

6.6 Present state of family numbers and home scale

Table-8 shows family numbers and home scale from 1970 to 1985 by 5 year.

Table-8 Family number and home scale

(unit:thautand families)

year	family number	home scale								
		1	2	3	4	5	6	7	8	9～
1970	30297	6137	4184	5322	6885	3907	2285	983	387	207
1975	33569	6561	5257	6259	8301	3904	2037	882	283	111
1980	35824	7105	6001	6475	9070	3982	2033	843	236	78
1985	37980	7895	6985	6813	8988	4201	1985	836	211	65

6.7 Estimate of number of family number and home scale

The average home scale in 1985 is 3.187 persons a family and this average home scale is assumed no change in the future. It was assumed that the composition ratio of the home scale did not change after 1985. Table-9 shows the transition of the number of the families and the home scale in the future. Figure-8 is showing of the transition of the number of a total home in the future.

Table-9 Transition of family number and home scale in the future.(1000 families)

year	family number	home scale		
		1	2	3 above
1985	37980	7895	6985	23099
1990	38976	8102	7168	23705
1995	40024	8320	7361	24342
2000	41162	8556	7570	25034
2005	42120	8756	7746	25617
2010	42615	8858	7837	25917
2015	42652	8866	7844	25940
2020	42453	8825	7808	25819
2025	42245	8782	7769	25693
2030	42064	8744	7736	25583
2035	41771	8683	7682	25404
2040	41305	8586	7597	25121
2045	40794	8480	7503	24810
2050	40375	8393	7425	24556
2055	40068	8329	7369	24369
2060	39831	8280	7325	24225
2065	39601	8232	7283	24085
2070	39382	8186	7243	23952
2075	39185	8145	7207	23832

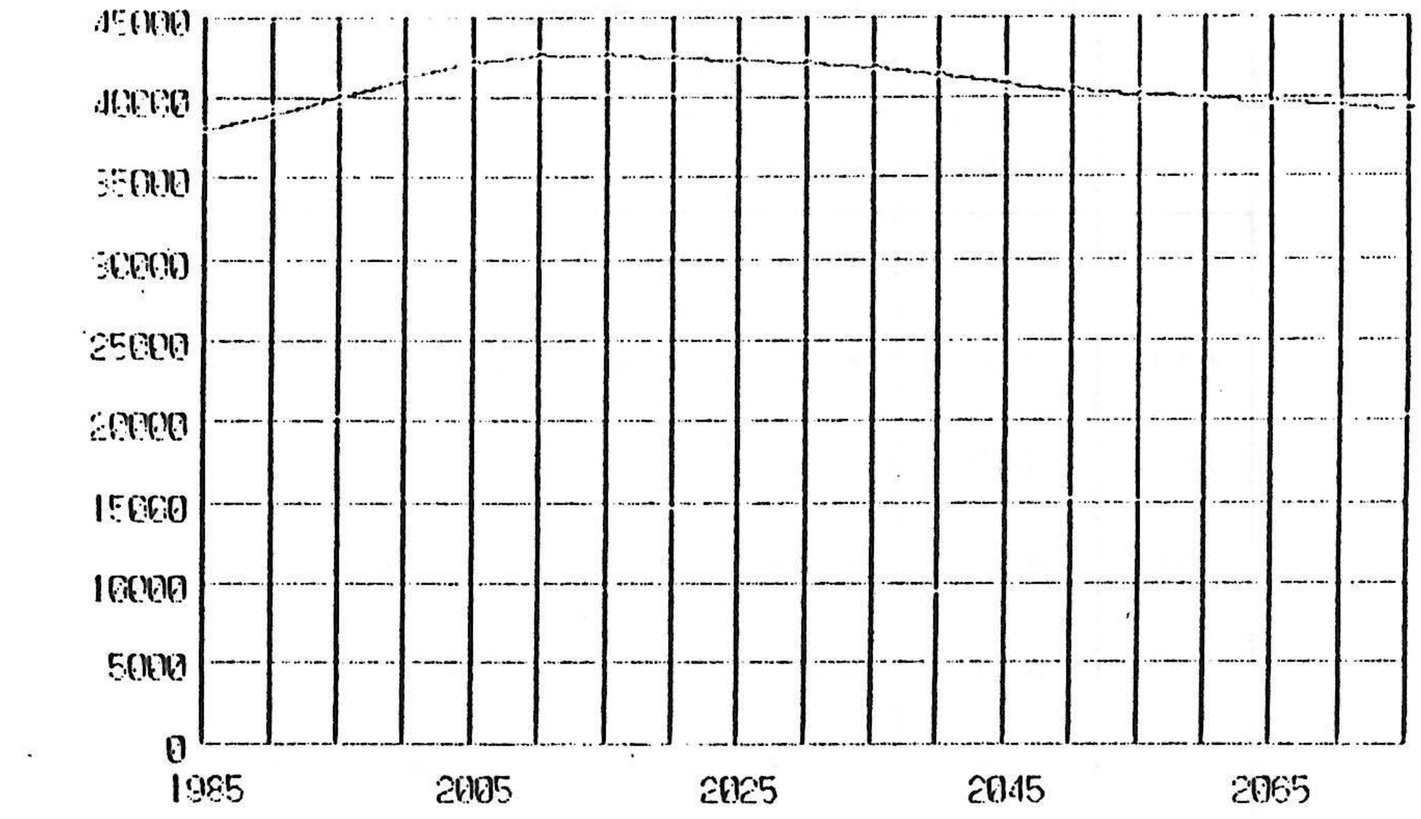

Figure-8 Transition of family number and home scale in the future.(1000 families)

6.8 Cost calculation of the death person due to skin cancer.

The cost is calculated from the death person due to skin cancer according to the regulatory scenario and the age in the future presumed by the following methods (car personal compensation insurance payment standard).

(1) For less than 18 years old (include infant)

We calculated the cost of death person due to skin cancer of less than 18 years old by the following expressions.

$$Ct1 = (Sa1 - Li1) \times Hof \times Dt1$$

Ct1 : The cost for less than 18 by skin cancer.
Sa1 : Average Salary for less than 18.
Li1 : Amount needed for living on.
Hof : New hoffman coefficent.
Dt1 : Death number for less than 18 by skin cancer.

(2) For 18 years old or more

We calculated for the death person due to skin cancer of 18 years old or more by the following expressions.

$$Ct2 = (Sa2 - Li2) \times Hof \times Dt2$$

Ct1 : The cost for 18 or more by skin cancer at each ages on several years.
Sa1 : Average Salary for 18 or more.
Li1 : Amount needed for living on.
Hof : New hoffman coefficent.
Dt1 : Death number for 18 or more by skin cancer.

(3) Setting of the cost of living

The cost of living is as follows according to the number of the person of the supporting person.

a) No supporting person : 50% of average salary
b) Supporting person one : 40% of average salary
c) Supporting person two : 35% of average salary
c) Supporting person three or more : 30% of average salary

(4) New hoffman coefficient which corresponds at years when one can work

The new hoffman coefficient which corresponds to years when one can work according by the age is Table-10.

Table-10(1) Years when one can work by age correspond to new hoffman coefficients

age	work years	New Hoffmn	age	work years	New Hoffmn	ages	work years	New Hoffmn
0	49	16.419	19	48	24.126	38	29	17.629
1	49	16.716	20	47	23.832	39	28	17.221
2	49	17.024	21	46	23.534	40	27	16.804
3	49	17.344	22	45	23.231	41	26	16.379
4	49	17.678	23	44	22.923	42	25	15.944
5	49	18.025	24	43	22.611	43	24	15.500
6	49	18.387	25	42	22.293	44	23	15.045
7	49	18.765	26	41	21.970	45	22	14.580
8	49	19.160	27	40	21.643	46	21	14.104
9	49	19.574	28	39	21.309	47	20	13.616
10	49	20.006	29	38	20.970	48	19	13.116
11	49	20.461	30	37	20.625	49	18	12.603
12	49	20.938	31	36	20.275	50	17	12.077
13	49	21.442	32	35	19.917	51	16	11.536
14	49	21.971	33	34	19.554	52	15	10.981
15	49	22.530	34	33	19.183	53	14	10.409
16	49	23.123	35	32	18.806	54	13	9.821
17	49	23.750	36	31	18.421	55	12	9.215
18	49	24.416	37	30	18.029	56	11	8.590

Table-10(2) Years when one can work by age correspond to new hoffman coefficients

age	work years	New Hoffmn	age	work years	New Hoffmn	ages	work years	New Hoffmn
57	10	7.945	76	4	3.564	95	1	0.952
58	9	7.278	77	3	2.731	96	1	0.952
59	8	6.589	78	3	2.731	97	1	0.952
60	8	6.589	79	3	2.731			
61	8	6.589	80	3	2.731			
62	7	5.874	81	3	2.731			
63	7	5.874	82	3	2.731			
64	7	5.874	83	2	1.861			
65	6	5.134	84	2	1.861			
66	6	5.134	85	2	1.861			
67	6	5.134	86	2	1.861			
68	5	4.364	87	2	1.861			
69	5	4.364	88	2	1.861			
70	5	4.364	89	2	1.861			
71	5	4.364	90	2	1.861			
72	4	3.564	91	2	1.861			
73	4	3.564	92	2	1.861			
74	4	3.564	93	2	1.861			
75	4	3.564	94	1	0.952			

(5) Death cost calculations due to skin cancer

The result of calculating the cost of the dead due to skin cancer according to the regulatory scenario is shown in Table-11 by using the calculation type of (1). Moreover, Figure-9 and Figure-10 are the transition chart of the accumulation cost according to the restriction scenario.

Table-11 Death cost by skin cancer (Hundred million yen)

year	scenario 1	scenario 2	scenario 3	scenario 4	scenario 5
1985	0	0	0	0	0
1990	26	13	13	13	13
1995	48	34	34	34	34
2000	70	56	56	56	56
2005	92	77	70	63	63
2010	142	91	77	70	70
2015	251	122	108	86	78
2020	364	146	123	94	86
2025	508	166	144	114	89
2030	687	200	156	120	92
2035	793	218	174	131	96
2040	900	245	201	144	102
2045	1071	291	231	159	116
2050	1385	329	269	188	131
2055	1747	363	288	208	143
2060	2231	394	319	218	147
2065	3898	425	343	242	159
2070	5068	454	356	255	172
2075	6594	479	381	271	179
total	112893	19327	15766	11643	8588

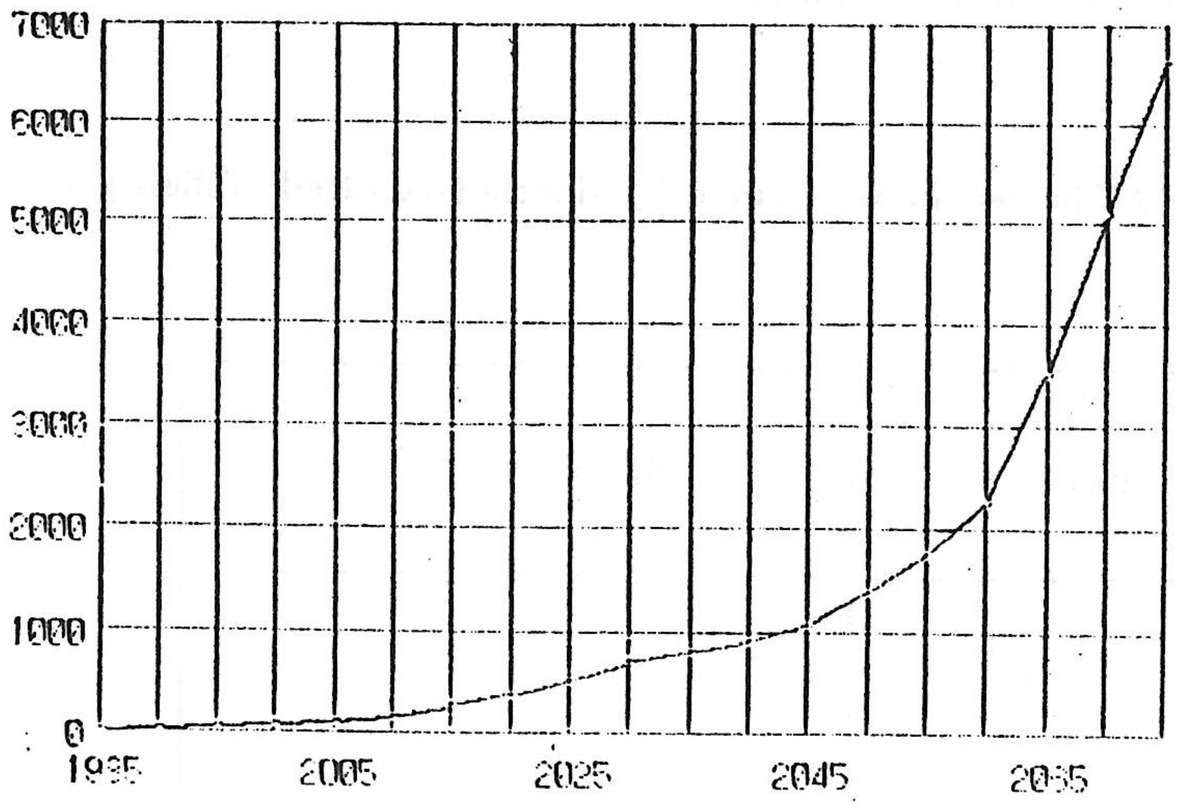

Figure-9 Cost of the dead in skin cancer of scenarios 1.

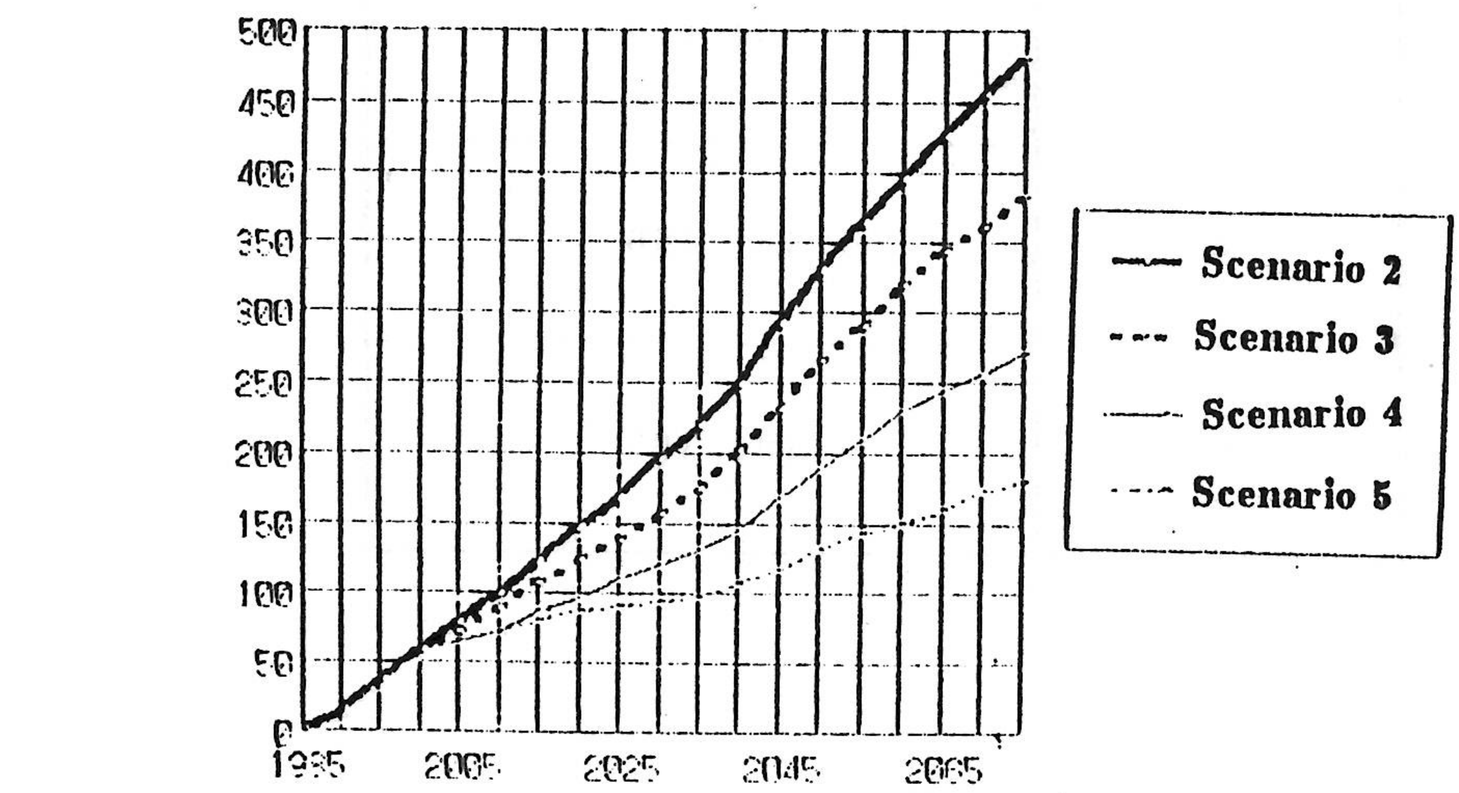

Figure-11 Cost of the dead in skin cancer of each senario.

(6) Calculation of regulatory scenario profit

The regulatory benefit from scenario 2 to scenario 5 shows in Table-12 for the non-regulatory scenario 1.

Table-12 The regulatory benefit by sinario.(Hundred million yen)

Scenario	Benefit
1	—
2	93,566
3	97,127
4	101,250
5	104,305

7. Calculation of effect cost for economic society.

7.1 Calculation procedure effect cost for economy society

(1) Cost due to decrease of cooling efficiency of refrigerator.

Do the consider influential of HFC-134a as the substitute in the future though flon-12 is being used in a home refrigerator. Moreover, HCFC-123 is thought about as a sub- stitute of flon-11 used as a ridged foam of the heat insulator. The decrease of the cooling efficiency of the refrigerator will be brought in such situations when HCFC-123 is used as HFC-134a and a redged foam and the increase of the amount of the electric power use of each home will be invited. It is thought to be going to become a big cost in the entire Japan even if the increase of the amount of the electric power use by an individual home is a little.

Then, the calculation of the electric power consumption increase cost with the flon substitute assumed the case that flon of all refrigerators was substituted and calculated the cost by the following methods.

Figure-12 is a calculation procedure of the cost due to the decrease of the cooling efficiency of the refrigerator.

a) The amount of the average electric power per year use is calculated for refrigerator.

b) The cooling performance decrease coefficient of substitute is estimeted.

c) The number of the family in the future is presumed.

d) Average possession number for refrigerator by family is presumed.

e) Power cost is set.

f) The amount electric power use increase cost is requested by using a) - f)

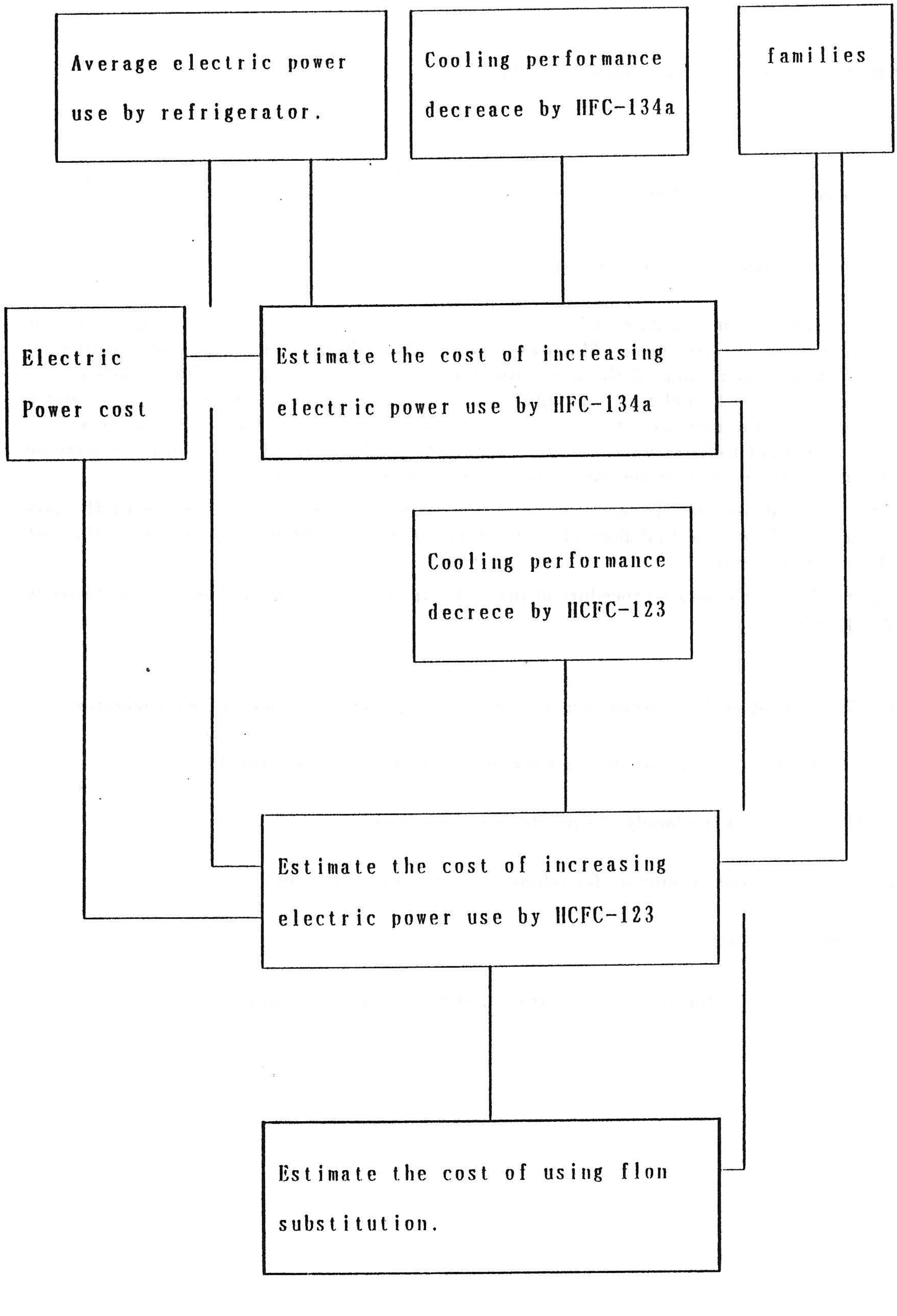

Figure-11 calculation procedure of the cost by flon substitution for refrigerator.

(2) Cost because of efficiency drop of car air conditioner.

The most powerful chemical product is HFC-134a as this substitute though flon-12 has been used for the air conditioner of the car now. The energy efficiency will decrease when all putting on this substitute and changing and the amount of the gasoline consumption increases. The air conditioner installation rate of the car reaches the passenger car 81% and the truck 39% at the level in our country in 1988 and 69% is occupied as a whole. Therefore, the efficiency drop of the car air conditioner is increased the amount of the gasoline consumption and can be called an economical effect is large.

Then, the calculation of the gasoline consumption increase cost with the flon substitute assumed the case that flon of all car air conditioners was substituted and calculated the cost by the following methods. Figure-12 is a calculation procedure of the cost due to the decrease of the cooling efficiency of the car air conditioner.

a) Estimation new car demand and air conditioner installation rate

b) Traveling stand Km at period of air conditioner use

c) Fuel cost

d) gasoline price composition

e) Efficiency decrease coefficient of flon substitute

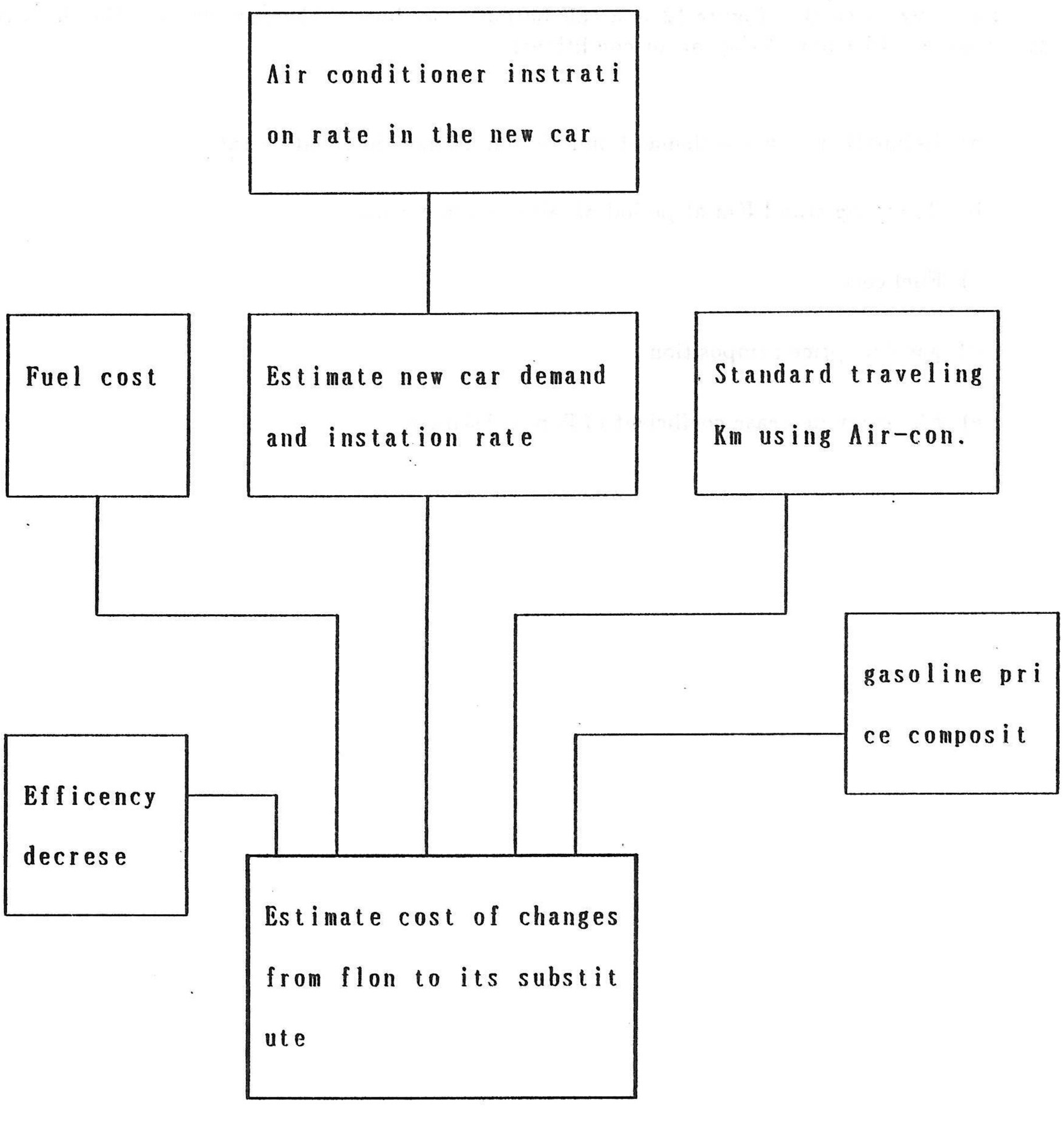

Figure-12 Calculation procedure of the cost by substitution of car airconditioner.

(3) Cost by substitution of chlorine system solvent

It is thought that the effect of the restriction reinforce- ment of this flon-113 on my domestic production industry is large by the amount's of the use of flon for the our country cleaning flon-113 occupying 75% of all over the world. Therefore, the effect cost is calculated by the conversion to the substitute especially staring at the chlorine system solvent restriction reinforcement idea.

Figure-13 shows calculation procedure of substitute flon-113 and 1,1,1-torichloroethane.

a) Estimate trend of demand for flon-113 and 1,1,1-torichloroethane.

b) Trend of substitution technology

c) Cost presumption of substitution material

d) Effect cost calculation by substitution

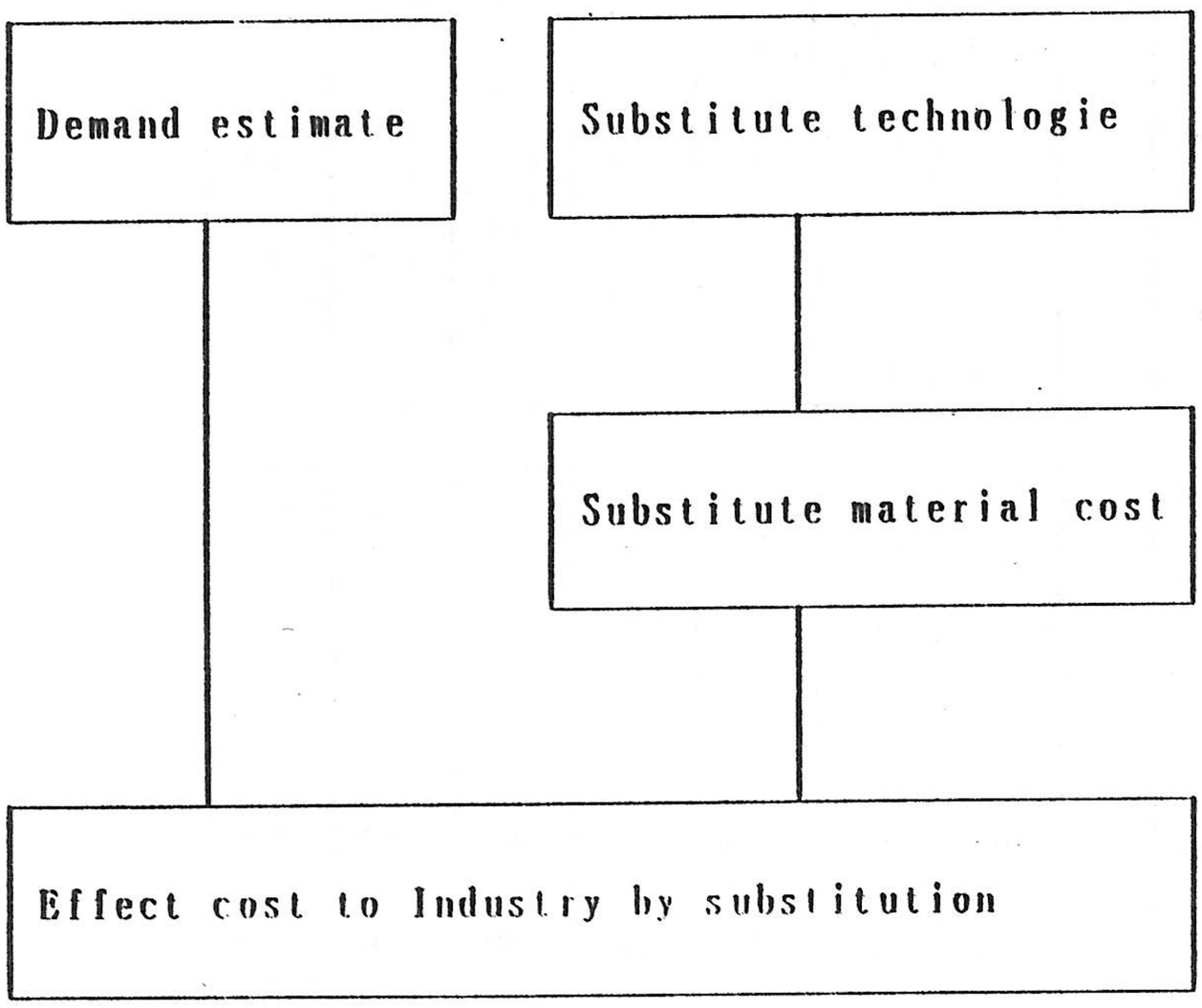

Figure-13 Cost calculation procedure by substitution of chlorine solvent system

7.2 Calculation of cost due to decrease of cooling efficiency of refrigerators

(1) It is an amount of the average electric power use during year of the refrigerator.

In our country , at 1987 , refrigerator of 300l above is occupied 35%. In the future(at 1993) will be occupied 50%. Figure-15 is a transition chart of refrigerator capacity by shea of the industry association of Nippon Electric Co. Ltd. until 1987. When the amount of the average electric power is presumed by using the composition ratio in 1987 during year of the refrigerator, electric power use will become as follows. Moreover, the number of the refrigerator possession by one family is 1.2. And this figure was assumed to be the one which did not change in the future.

The average electric power use per year	514.8kwh
The refrigerator possession number of one family	1.2

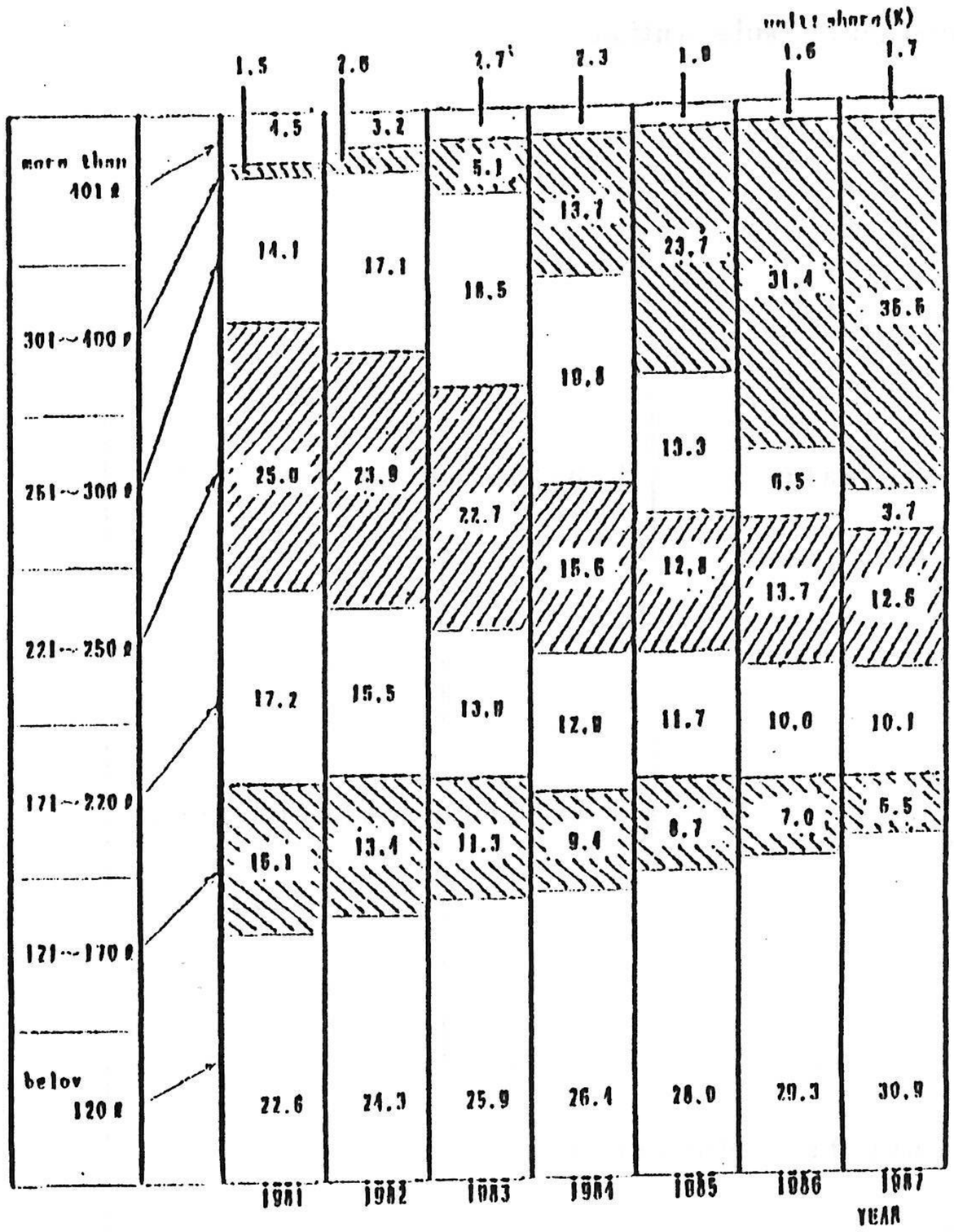

Figure-14 Transition of shea according to capacity of refrigerators

(2) Presumption of cooling performance decrease coefficient

The cooling performance decrease coefficient when HFC-134a was used as a substitute of flon-12 was assumed to use the following numerical values by private communications with Mr. Fujimoto in the Hitachi Ltd..

Cooling performance decrease coefficient of HFC-134a	0.08 - 0.20
Insulated performance decrease coefficient of HCFC-123	0.07 - 0.10

(3) Number of family

The number of the family in the future was used in 6.2 section.

(4) Setting of power cost

The price of The Tokyo Electric Power Company, Inc. is shown in Table-13. The electric power charge which had been set at this time assumed the charge which hung on the electric power which exceeded 120kwh for 250kwh from amount 121 of the electric power of use of following amount light 25 to be a unit price of power cost.

Power cost	23.85 yen/kwh

Table-13 Electric power charge table of capital electric power

<table>
<tr><td rowspan="2">A</td><td colspan="2">Electric power use
≦8kwh</td><td>①233 (basic) ×Electric power use</td></tr>
<tr><td colspan="2">Electric power use
≧ 9kwh</td><td>②233+17.8×(El power use−8kwh)
+ (①+②) ×0.03</td></tr>
<tr><td rowspan="6">B</td><td colspan="2">③basic fare</td><td>Basic charge by 10A～60A</td></tr>
<tr><td rowspan="4">④
f
a
r
e</td><td>power use
≦120kwh</td><td>⑤ 17.80×power use</td></tr>
<tr><td>power use
120～250kwh</td><td>⑥ ⑤+23.85×(power use−120kwh)</td></tr>
<tr><td>power use
≧251kwh</td><td>⑦ ⑤+23.85×130kwh+
26.32× (power use−250kwh)</td></tr>
<tr><td colspan="2">Total</td><td>③basic charge+④fare+
(③+④) ×0.03</td></tr>
</table>

(5) Calculation of cost because of electric power use increase with substitute .

The cost because of the electric power use increase by changing from flon-12 to HFC-134a was calculated by the following methods.

- Caluculation cost by Scenario 2

The amount of the flon use which corresponds to the number of the family in 1985 the calculation of the cost of scenario 2 assumes that it is possible to maintain , calculates the cost which corresponds to the amount of the increase electric power use of each age, and calculates the cost accumulation from 1985 to 2075. The cost of the amount of each year's increase electric power use was calculated by the type in the under.

$$EPWC = EPW \times CRT \times (FMY - FM85) \times POS \times EPC$$

EWPC : Increace electric power cost per year.
EPW : Electric Power use
CRT : Cooling decrease rate
FMY : Number of family
FM85 : Number of family at 1985
POS : The refrigerator possession number of one family
EPC : Power cost

-Calculation cost by scenario 3 - 5.

The cost at calculated 100% reduction was calculated , and was calcutated by reduction scenario

$$EPWC = EPW \times CRT \times FMY \times POS \times EPC \times RED$$

EWPC : Increace electric power cost per year.
EPW : Electric Power use
CRT : Cooling decrease rate
FMY : Number of family
FM85 : Number of family at 1985
POS : The refrigerator possession number of one family
EPC : Power cost
RED : Reduction rate by each sinario

Table-14 The Cost by each scenario.(hundred million yen)

scenario	Substitute HFC-134a	Substitute HCFC-123	Total cost
1	—	—	—
2	3,084	2,699	5,783
3	8,668	7,584	16,252
4	21,693	18,961	40,654
5	34,709	30,337	65,046

7.3 Cost because of efficiency drop of three car air conditioner

(1) New car demand forecast and air conditioner installation rate

The new car demand and the air conditioner installation rate were used from "demand of the car air conditioner" of the industry association of Japanese frozen airconditioning. Table-15 shows the demand estimation and the air conditioner installation rate.

Table-15 The demand estimation and the air conditioner installation rate.
(the upper: 1000 vhieclel, the lower: Percent)

Item	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
demand	5205	5344	5412	5490	5677	5854	6535	6730	6800	6870
Instrat-ion rate	56	56	63	68	70	74	78	80	81	82

The demand forecast since 1992 was not done and it was assumed that the number of a new chassis in 1985 continued until 2075 at this time. Moreover, the number of the car possession of our country is 46,000,000 in 1985 almost. Table-15 as follows from the above-mentioned number of air conditioner equipment chassis

Air conditioner equipment chassis number	31,400,000

(2) Setting of traveling stand Km at period of air conditioner use

Traveling stand km was set during year of the hit by one as follows.

It is average traveling stand km during year	20,000km/year

If Tokyo is thought, traveling stand km between these will become the following one for for five months from May to September for the period of use of the air conditioner.

Period air conditioner use mileage	8300 km/vhicle

(3) Fuel cost

Fuel cost was set as follows.

Fuel cost	10 km/l

(4) Gasoline price composition

The nationwide average price from 1976 to 1988 was calculated from the consumer prices indices annual reports and the retail prices statistics investigation annual reports. The result is shown below.

Nationwide average gasoline price	89.9 - 146.4 yen/l

By the way, the tax is included in the above-mentioned price and the composition is as follows.

a) crude oil tariff 0.35 yen/l

b) oil tax 2.04 yen/l

c) gasoline tax 53.80 yen/l

d) total 56.19 yen/l

The gasoline prices except the tax are as follows.

Gasoline price	36 - 90 yen/l

(5) Efficiency decrease coefficient of substitute

Efficiency decrease coefficient of substitute	0.33%

(6) It is an amount of the gasoline consumption during year of the hit by one. We calculated by the next expression.

$$GSL = \frac{KM}{FEL} \times DEC = 2.74$$

GSL : gasoline consumption (l/year/vhiecle)
KM : Traveling standard Km
FEL : fuel consumption per Km
DEC : decrease coefficent substitute

(7) Total cost during year

We calculated by the next expression.

$$TOT = GSL \times INS \times GCT = 31-77(hundred-million-yen)$$

TOT : Total cost during year
GSL : gasoline consumption
INS : air conditioner instration rate
GCT : gasoline cost

(8) Calculate cost of reguratory sinario.

The cost at calculated 100% of the cost of five reduction was calculated from scenario 3 by an undermentioned expression and we calculated additionally at the reduction rate of each scenario. Table-16 is a result of adopting one with a low cost of the cost according to the scenario calculated by the above-mentioned technique.

Table-16 Cost of regulatory scenarios (hundred million yen)

scenario	cost
1	—
2	—
3	558
4	1,395
5	2,232

7.4 Cost by substitution of chlorine solvent

(1) Calculation method of demand curve

It is assumed that demand y is shown as the demand model by the next expression when time changes with t.

$$y(x) = \frac{\xi}{1+\beta \times e^{-\alpha t}}$$

The shape of this curve is called the growth curve or logistic curve. By the way,

$$y(0) = \frac{\xi}{1+\beta}$$

$$y(\infty) = \xi$$

Therefor,the following differential equations are obtained because of being a as for this demand curve.

$$\frac{dy}{dt} = \frac{\alpha}{\beta} y(\xi - y)$$

t was applied to time series y(t) because of being nonlinear and the α , β , and ξ were decided from an actual amount of production from 1981 to 1988 by the minimum mean square method.

Next, the demand (production level) since 1989 was calculated by using the decided α , β , and ξ.

(2) Demand forecast result

Because the amount of the production of flon-11 and flon-113 in 1988 and amounts of consumption were guessed it was already in the production adjustment in expectation of the restriction, we estimate since 1988 in the demand. Moreover, 1,1,1-trichloroethane did not expect the restriction at the time of in 1988 and made since 1989 a forecast object. 1,1,1-trichloroethane can be said that it is in the growth process in 2000 though flon-11 and flon-113 are in the diminishing successively tendency when this demand curve is seen. The amount, flon-11 is comparatively small compared with 1,1,1-trichloroethane and flon-113.

Demand estimate result of flon-11 shows Table-17

Demand estimate result of flon-113 shows Table-18

Demand estimate result of 1,1,1-trichloroethane shows Table-19

Demand curve of flon-11 shows Figure-15

Demand curve of flon-113 shows Figure-16

Demand curve of 1,1,1-trichroloethan shows Figure-17

Table-17 Demand estimate result of flon-11

year	Demand (product)	
1981	20, 733	
82	21, 373	
83	22, 832	
84	24, 861	
85	25, 308	
86	29, 401	
87	34, 231	
88	37, 105	
89	38, 818	↓
90	41, 570	estimate
91	43, 021	
92	44, 817	
93	47, 381	
94	48, 425	
95	49, 457	
96	50, 494	
97	51, 624	
98	52, 562	
99	53, 117	
2000	53, 668	

Table-18 Demand estimate result of flon-113

year	Demand (product)	
85	38, 000	—
86	63, 510	—
87	78, 132	—
88	85, 061	↓
89	90, 920	estimate
90	95, 837	
91	98, 501	
92	101, 123	
93	105, 062	
94	106, 803	
95	108, 332	
96	110, 253	
97	111, 641	
98	114, 508	
99	116, 566	
2000	237, 436	

Table-19 Demand estimate result of 1,1,1-trichloroethane

year	Demand (product)	
1981	87,891	
82	89,195	
83	95,702	
84	110,977	
85	120,032	
86	127,634	
87	130,701	
88	138,501	
89	145,662	↓
90	153,943	estimate
91	162,346	
92	170,834	
93	179,373	
94	187,923	
95	196,447	
96	204,909	
97	213,272	
98	221,502	
99	229,566	
2000	237,436	

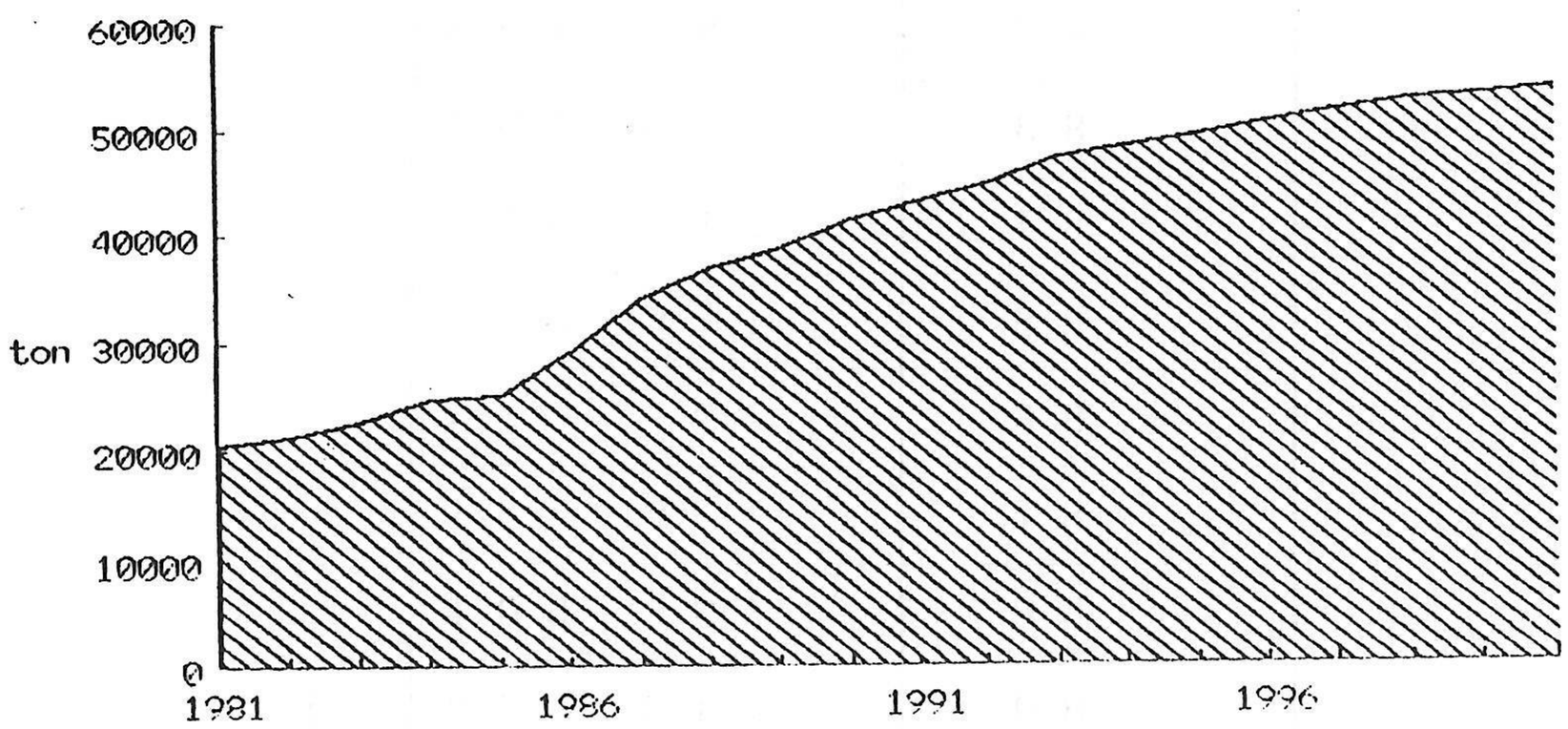

Figure-15 Demand curve of flon-11

Figure-16 Demand curve of flon-113

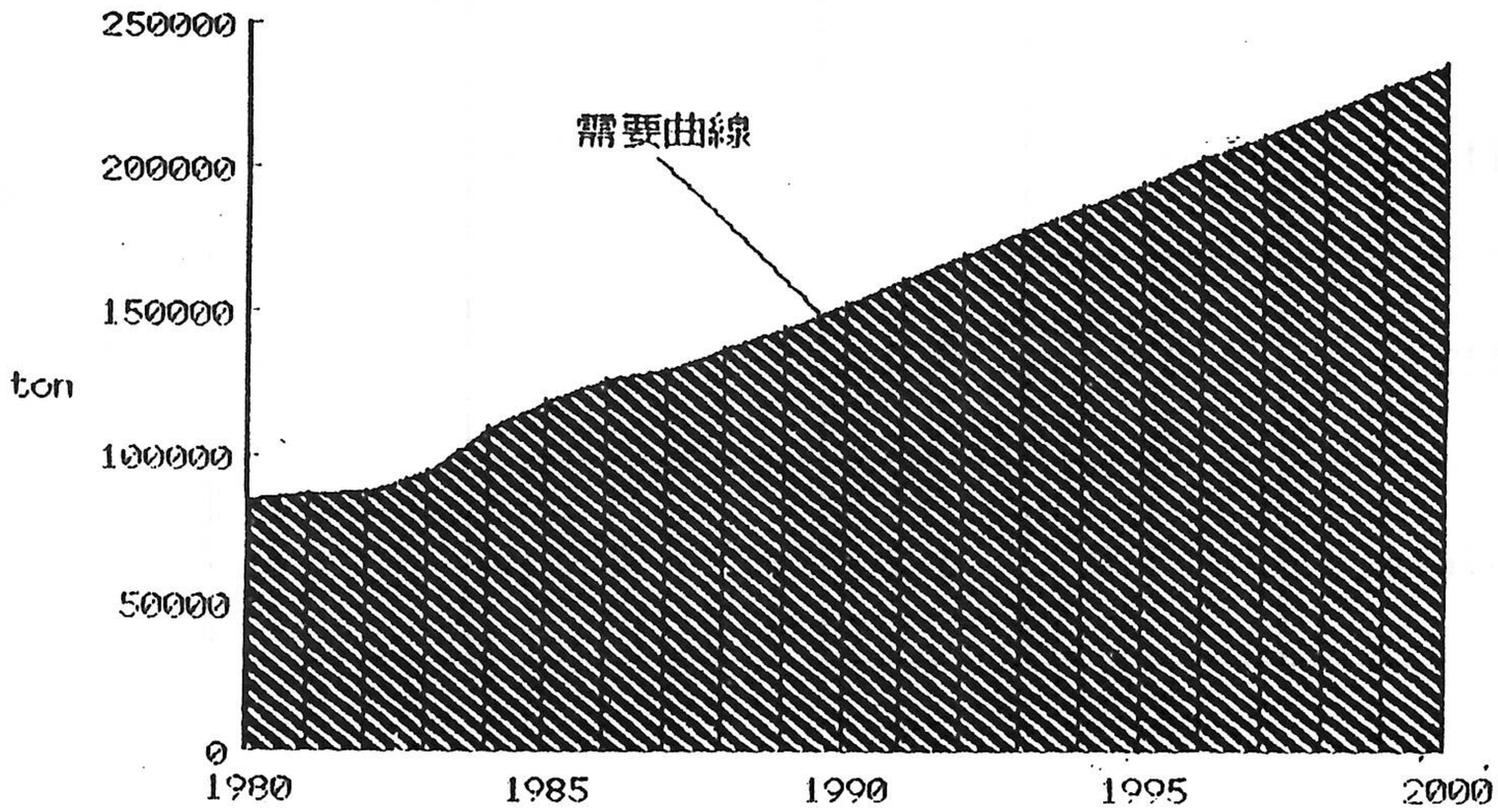

Figure-17 Demand curve of 1,1,1-trichloroethan

(2) Assumption of alternative technology

The ratio of an alternative technology in 2000 was set with the washing medicine as follows. The composition ratio from 1989 to 2000 was assumed no change.

Table-20 Composition of solvent substitute (at the time of in 2000)

solvent	HCFC	Water	Resycle	alchol	others
CFC-11	100%	0%	0%	0%	0%
CFC-113	20	50	2	18	10
trichloro	18	42	20	0	20

(3) Object quality and cost of alternative material

The average cost of the object quality such as flon in 1989 is assumed 2.06 US dollars in report "Regulatory Impact Analysis : Protection of Stratosperic Ozone" of EPA (United States Environment Agency). Moreover, the rise rate of the cost according to the age of flon is Table-21 as. However, a present price of CFCs-113 is "search for alternative " . At Present,the price of CFC-113 is 2.06 US dollars/kg, and 1,1,1-trichloromethane is 0.89 US dollars/kg. Figure-19 is maked by Dupon't ,this figure shows about 300-400 yen are assumed about 1200 yen for up to 1989 at the time of in 1995.

In this work,we assumed 2.06 US dollars/kg for CFC-113 and 0.89 US dollars/kg for 1,1,1-trichloroethane at present. And from Figure-19 the cost rise rate in the future was assumed 1.07 US dollars.

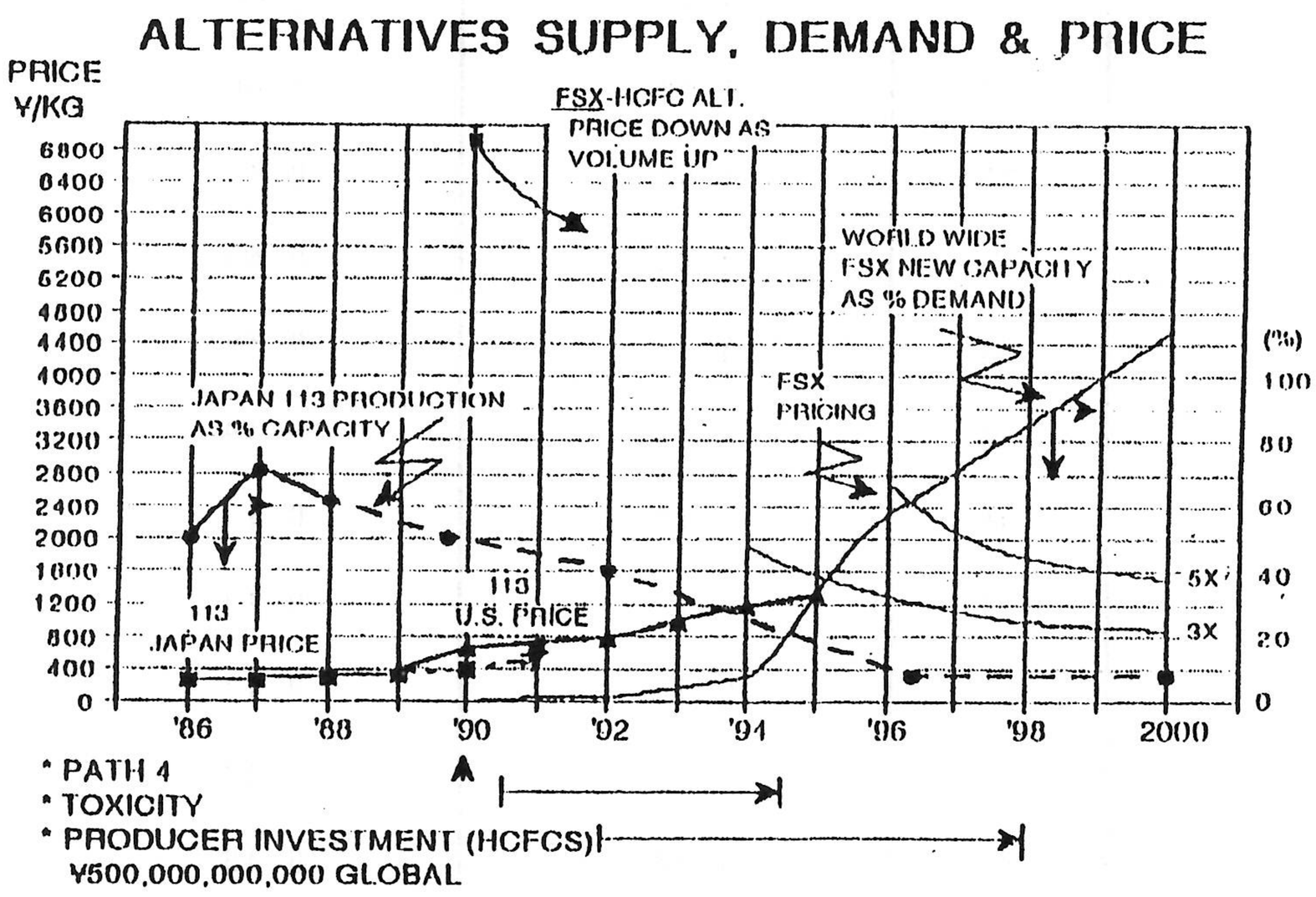

Figure-19 Cost rise of CFC-113

Table-21 CFCs cost rise rate

	cost up by sinario (1985 U.S. dollas)	
	CFCs	Halons
1989年	6.69	0.00
90	5.32	0.00
91	1.84	0.00
92	1.60	0.49
93	3.93	0.49
94	3.77	0.49
95	3.77	0.49
96	3.77	0.49
97	3.77	0.49
98	5.48	0.49
99	5.48	0.49
2000	5.48	0.49
10	5.48	2.75
25	5.48	2.75
50	5.48	2.75

The cost of the substitute is a situation by which a clear cost is' not' presented because there are a lot of one of the development step possible. However, one is said to about 10 times in various documents. Therefore, the cost of an alternative material of this investigation was set Table-22 as following.

Table-22 The cost of substitution by solvent

item	HCFC	water	Recycle etc.	alchol	others
１９８９年	１０	2	1.2	1.5	1
２０００年	2	0.5	1.1	1.5	1

(4) Calculation of cost rise by cost The calculation type is as follows.

$$CUP = \sum_{i=1}^{N} \frac{(FLN \times SUB \times UNT \times TIM - UNT \times UPR)}{YEAR}$$

CUP : Cost rise by usage devision.
FLN : CFCs amount use by usage devision.
SUB : Substitute rate
UNT : Unit price
TIM : Substitute ratio
UPR : Cost rise rate
YEAR : 1989 - 2000

The calculation result is Table-23 and is Table-24 as.

Table-23 Cost rise by CFC-113

usage devision	70%reduct	100%reduct
print substrat	1.2	1.7
machine part	38.4	51.5
presice part	2.4	3.3
solvents	0.3	0.4
others	1.1	1.5
total	43.4	58.4

However, 100%reduction is not enclude essential use.

Table-24 Cost rise by 1,1,1-trichloroethane.

usage devision	30%reduct	50%reduct	70%reduct	100%reduct
print substrat	0.7	1.2	1.7	2.3
machine part	1.2	1.9	2.7	3.8
presice part	0.3	0.5	0.7	0.9
solvents	0.1	0.2	0.2	0.3
others	0.4	0.7	0.9	1.3
total	2.7	4.5	6.2	8.6

However, 100%reduction is not enclude essential use.

Moreover, the entire cost rise is presumed from an actual conversion example.

Table-25 is an example of converting each company. This example is assumed to be an example of the representative of all flon-113 though there are only one example example of converting flon-113. Moreover, 1,1,1-trichloroethane can see the cost rise ratio on average though is the width from 0.14 to 0.67 and the example of B company E and the company be regarded by 0.4 at the rise rate as the example of the representative.

The name of the company of the example of converting Table- 25 each company object quality conversion example running cost before converting increase expense of the running cost water washing This cost does not contain the cost rise of the substitute.

Table-25 Example of converting each company.

Company	use cfc	exchange method	before runni g cost①	after runn ing cost②	②／①
A	CFC-113	Water	1,000千円	900千円	0.9
B	Triethan	Water	1,500	700	0.47
C	Triethan	Water	700	100	0.14
D	Triethan	Water	300	200	0.67
E	Triethan	Water	400	160	0.4
Average			2,900	1,160	0.4

Next, if the example of A company and E company is expanded into CFC-113 and 1,1,1-trichloroethane,we are get as follows

CFC-113:

$$C113 = MDM \times 0.9 \times CST = 290(handred-million-yen)$$

C113 : Converting cost for cfc-113.
MDM : Avarage Demand from 1988 to 2000
CST : CFC-113 cost

CFC-113:

$$C111 = CDM \times 0.4 \times TST = 100(handred-million-yen)$$

C111 : Converting cost for 1,1,1-trichloroethane
CDM : Avarage Demand of 1,1,1-trichloroethane from 1988 to 2000
TST : 1,1,1-trichloroethane cost

This considers CFC-113, and 1,1,1 trichloroethane rise because of the substitution of running cost and distribution to each industry is thought about. Table-26 is a cost rise by the substitution of CFC-113.

Moreover, Table-27 is a cost rise by 1,1,1-trichloroethane,

Table-26 Cost rise by the substitution of CFC-113.

usage devision	70%reduct	100%reduct
print substrat	6.7	10.3
machine part	203.1	306.7
presice part	23.9	19.4
solvents	1.5	2.7
others	6.0	9.3
total	241.2	348.4

Table-27 Cost rise by 1,1,1-trichloroethane,

usage devision	30%reduct	50%reduct	70%reduct	100%reduct
print substrat	8.8	15.2	21.5	29.0
machine part	15.2	24.0	34.1	48.0
presice part	3.8	6.3	8.8	11.4
solvents	1.3	2.5	2.5	3.8
others	5.1	8.8	11.4	16.4
total	34.2	56.8	78.3	108.6

(5) Effect cost by substitution of chlorine solvent

The cost calculation result according to the scenario is Table-29 as.

Table-28 Cost of regulatory sinario (hundred million yen)

sinario	CFC-113	1,1,1-tri-chloro-ethane	Chlorine substitute total cost
1	—	—	—
2	2,857	891	3,748
3	3,680	1,147	4,827
4	4,605	1,435	6,040
5	5,221	1,627	6,848

7.5 Total cost by regulatory sinario.

Energy cost shows figure-29 when CFCs substitute is used for refrigerator,Car air conditioner,and solvent.

Table-29 Cost by regulatory Scenario (hundred million yen)

scenario	from refrigeralter	from car air conditioner	from solvent	Total cost
1	—	—	—	—
2	5,783	—	3,748	9,531
3	16,252	558	4,827	21,637
4	40,654	1,395	6,040	48,087
5	65,046	2,232	6,848	74,126

8. Cost and Benefit of each regulatory Scenario.

From 6.section ,we get benefit and from 7 section ,we get cost by reguralory scenario. The cost of the regulatory scenario by which was calculated was synthesized and the cost benefit was tried. Table-30 is the result.

Table-30 Cost-benefit to 2075 by regulatory scenario.

sinario	health benefit	Energy Cost	Total benefit
1	—	—	
2	93,566	5,783	87,783
3	97,127	16,810	80,317
4	101,250	40,654	60,596
5	104,305	67,278	37,027

It is the most appropriate to select the following scenarios in case of based on information which has been obtained by now.

Present state (1985) freezing of scenario 2

9. Summury.

This work able to be done by this investigation and research after the United States. As for this, the United States depends on a weak characteristic's to the ultraviolet rays there in the white society. Moreover, the calculation of the energy cost examined by this investigation and research is not considered in the investigation of the United States. On the other hand, We did not include the effect on the fishery examined fine in the United States, the effect on farm products, effects of making mildly the earth, etc. in this investigation and research.

This depends on being not able insufficient the data of the problem of these of our country and calculating the cost. The effect is different though the difference between such United States and our country is to cause the country and the problem of CFC-ozone is a global problem in each country. Therefore, the result which contains these research methods should open to the public to the foreign country widely as information, execute an original investigation and the research in each country, and execute a global cost profit in the entire earth as the piling.

If this investigation and research become a help of an international investigation like the above, it is happy.